Silicon Power Play

How the Net crashed California and how new power companies will reboot it

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Ten years ago in Sacramento, the California Energy Commission wrestled with competing visions of the future of electricity. The vision that prevailed is bearing fruit today. Just five years ago, California had a 30 percent electricity supply surplus. An electron glut was forecast to prevail well into the 21st century. Whatever can be said about how California effected "deregulation" of electric power, the heart of the problem is that someone guessed wrong on the demand side of the equation.

In those long-forgotten Sacramento hearings of 1991, efficiency mavens put forth a consensus forecast. Future growth in demand for electricity would be "flat as the Kansas horizon." There were no significant new uses for electricity. New technologies held great promise to drive efficiency (and cut demand), none more so than the microprocessor. By 1991 we had already reveled in seven years of astounding information technology progress since the PC explosion was kicked off by the seminal 1984 Super Bowl "Big Brother" commercial from Apple. Energy analysts embraced the power of technology to create efficiency even while supporting economic growth. New technologies would pave a yellow brick road of efficiency improvements that would quickly make central power plants "dinosaurs."

The mavens were right about one thing. Efficiency improvements came. But they were wrong about demand. The state traded "dinosaurs" for Stage 3 Alerts which are triggered by a black-out-inducing 1.5 percent margin between demand and supply.

On February 7 this year, California announced the first of what will no doubt be a series of huge power deals for electrons from big-iron central power plants-the antithesis of the vision hatched a decade earlier. (The deal is almost certainly too little, too late for this summer; even if the economy is cooler, the weather won't be.) The deal inked between Gray Davis, California's kilowatt-seeking governor, and Peter Cartwright, Calpine's kilowatt-flush visionary CEO, crystallizes the role of electrons in the 21st century economy, as well as the kinds of technologies and companies poised to benefit. Little-known Calpine, a merchant power producer, stands out because it owns and has under development more future central power capacity than any other company in the nation. And Calpine has the only two new central power plants scheduled to come on-line this summer in the great state of California.
Calpine's rejection of the no-growth vision makes it a winner-along with its customers-of one of the biggest technology bets in recent decades, and one of the most visible in a rich new field of heretofore (and still largely) ignored technology companies serving the silicon-energized power needs of the U.S. economy.

How did the no-growth group get demand so wrong? To paraphrase a famous political slogan: "It's the Internet stupid." Despite NASDAQ's sag, exuberance is the rational reaction to the deep and spreading revolution of the microprocessor, especially as amplified by networks of copper, optical fiber, and wireless transmitters. There is a powerful transformation underway, driven by the ever strengthening, ever-lower cost, and ever-deeper penetration of silicon intelligence into every kind of device, everywhere in factories, offices, schools, and homes. The California no-growth faction saw the microprocessor as an engine of economic growth, and an engine of energy efficiency. They were right. It was both, and continues to be so. The Calpine faction saw the rest of the story: the tech industry as the newest driving force in the century-long trend of continuing growth in electric demand.

Silicon Productivity

California has more houses, bigger ones, more air conditioners, more Christmas lights and more brightly illuminated storefront signs. Gov. Davis issued an Executive Order January 17 for businesses to turn off "unnecessary" outdoor lighting, or face fines. That's the story? California's kilowatt woes arose because somebody forgot to turn out the lights? Hardly.

Electric demand is up more than expected in large measure because California's and the nation's economy grew more than expected. And what was the single largest factor driving this past decade's economic boom? Silicon devices. The intellectual capital emerging from Silicon Valley, and every other regional silicon alley, plain, and zone, is embedded in machine tools, medical devices, warehouse inventory and even the trucks that ship it. Microprocessor and information technologies have permanently and positively altered businesses and ignited small revolutions in every corner of the economy-driving productivity.

It was about ten years ago that Nobel Laureate Robert Solow, professor emeritus of economics at MIT, said, "We see the computer age everywhere but in the productivity statistics." The question is no longer if information technology (IT) drives productivity, but how much. In March last year, a report from the Federal Reserve concluded that the manufacture and use of IT equipment accounted for roughly two-thirds of U.S. productivity growth-i.e., about $250 billion of additional GDP-over the course of the last five years alone. Productivity growth in the U.S. has picked up noticeably in recent years. From 1996 to 1999, average labor productivity in the private, non-farm U.S. economy grew at a 2.8 percent annual rate, more than twice the rate that prevailed between 1980 and 1995.

The silicon "wealth effect" is only part of the story though. IT wealth can drive dollars to SUVs and aircraft, increasing oil use, not just electric use. But the IT sector itself has become a major energy-consuming industry, one that is inherently electron dependent: you can't light up a Pentium with a woodstove; power a router, or even build one with propane. Commerce Department data pegs the IT sector at over 10 percent of the national GDP. If anything, the IT part of the GDP should consume more than its pro rata share of U.S. kilowatt-hours. Ten percent may sound modest, but on the margin this much electron demand becomes that straw on the camel's back. The paper and chemical industries combined do not consume 10 percent of the nation's electron output.

And we're just beginning. The silicon and bandwidth structural changes in the economy are permanent and growing. The consumption of kWh has tracked a rising GDP virtually without interruption for a century. A major (if little-noticed) study published by the National Academy of Sciences in 1986 concluded that, "electricity use and gross national product have been, and probably will continue to be, strongly correlated." Since that study, GDP grew 60 percent, electricity consumption 55 percent. There is no evidence that economic growth can de-link from electric growth. The growth in U.S. electric consumption this past decade required as much additional electron supply as exists in all of Central and South America.

Silicon Valley's demand for power has been growing at an annual clip roughly triple the forecast a decade back; on peak days, the Valley itself now consumes nearly 3,000 megawatts of electricity. The San Francisco Bay Area will need to add 1,500 megawatts of electricity before 2005; at least 300 megawatts of that for Silicon Valley alone.

Silicon efficiency

Demand for electricity was supposed to have leveled off, even reversed, according to the array of green and no-growth forecasters peddling this vision to compliant utilities, regulators and legislators in every state of the union. If they had been right, the roles of companies like Calpine and PG&E would have been reversed: the former would be facing bankruptcy instead of the latter.

Vast federal and state programs, billions in subsidies and legislation were enacted-nowhere more aggressively than in California-to stem the growth in electric demand. This was "Demand Side Management." The logic was seemingly inescapable. Eliminate the need for more power plants by managing demand through efficiency. Efficiency did improve. The average office space saw electric demand from lighting and air conditioning drop 20 percent. The average annual electricity used by a refrigerator is 60 percent less today compared to 20 years ago; for air conditioning systems it's down 33 percent; and for a freezer, down 70 percent. Consumption of electricity kept rising anyway.

Who should we blame? Try Economics 101. Improving energy efficiency has one direct effect; it effectively lowers the cost of energy. Lower prices encourage demand. Thus one is faced with the seeming paradox: efficiency and demand rise together.

Consider: If digital technologies boost power consumption by 5 percent, and boost the GDP by 10 percent, then power consumed per unit of GDP does indeed drop-but the Calpines of the world still see 5 percent growth. The net effect is a rise in both the absolute use and the relative importance of kilowatt-hours. Electricity accounted for 25 percent of our energy consumption 25 years ago, it accounts for 40 percent today, and it will account for over half within a decade or two.

The ultimate rebuttal to the silicon economy's electron appetite is the ever-popular "clicks versus bricks." Order a book on-line, click-and-ship saves energy compared to driving to the store. The same argument is offered for telecommuting and Internet teleconferencing. Use a Dell instead of a Buick or Boeing. To be sure, a PC appears to be more abstemious with fuel. But the reality is more complex. In the last digital decade, teleconferencing has really taken off; so have total air miles flown, rising from 4.3 to 5.8 billion a year. The number of telecommuters has grown five-fold in the decade, to over 20 million. People are driving more than ever too, and in bigger vehicles. Transportation fuel use is up 12 percent against an already enormous baseline.

You could argue that growth in travel would have been even greater "but for" the savings from IT. Probably so. Doesn't change the fact that travel energy use is up overall. It is arguable (and probable) that the silicon productivity effect (bigger economy, more money) more than offsets the silicon efficiency effect. Even Vinton Cerf, the co-inventor of the Internet, has concluded: "The Internet has the funny effect of increasing the amount of travel."
But what of the Amazon.com efficiencies in inventory and distribution of consumer goods via the Internet? Surely clicks beat bricks here. Perhaps. The economic benefits are powerful (hence the continuing rush to business-to-business e-commerce in particular), but the jury is out on the energy effect.

Researchers at Carnegie Mellon examined the total environmental impact of the frenzy to purchase the latest Harry Potter book last fall, they concluded that it was entirely possible that (compared to bulk shipments via truck to retail outlets) more materials, energy, and environmental impact arose from Amazon's sales of 250,000 books shipped and wrapped individually. The Harry Potter orders for Amazon required a fleet of 100 airplanes and 9,000 trucks to deliver the pent-up demand following the lifting of a midnight embargo on shipping the book. (Convenience, it would appear, does have a price; click away.)

Today's claim for IT's virtues as an energy saver is a modern version of the promise of the paperless office at the dawn of word processing. According to the American Forest and Paper Association, annual paper consumption is today some 20 million tons higher than in 1990.

Silicon brings economic efficiency, which in turn brings economic growth, and more electric demand. It has been so since Thomas Edison's lightbulbs and motors. Electric motors profoundly improved factory efficiency and productivity. And they consumed kilowatt-hours; lots of them. Gordon Moore's silicon microprocessors similarly drive productivity. And they too consume kilowatt-hours. This last fact seems to have escaped many analysts (not Calpine's). Perhaps because silicon central processing units (CPUs) seem so tiny compared to motors and lightbulbs, it's easy to ignore their voracious collective appetite for electrons.

Silicon demand
The 20th century's ascendant electric load, the lightbulb, comes in all sizes. Most are turned off, most of the time. And they've been getting more efficient; same lumens with fewer watts. Average watts per average bulb keeps dropping. Total number of bulbs sold per year, constant at 4 billion for the decade. Net effect: electron consumption from lighting has been dropping.

The 21st century's ascendant load, the integrated circuit, comes in all sizes too. Many are on, most of the time. They too have been getting more efficient; more MIPS (logic operations) for fewer watts. But unlike lightbulbs the demand for logic operations is propelled by price elasticities that increase demand by a substantial multiple of every drop in costs. The average power used per CPU has been rising as the total number of transistors per CPU keeps soaring (one million per CPU a decade ago; 150 million now). Compound this by the total number of integrated circuit chips sold per year, rising dramatically from 6 billion a year a decade ago to 16 billion last year. Net effect: electron consumption from silicon has been rising.

A power plant can't tell what's on the grid, whether it's a lightbulb or CPU, a water pump or laptop, a refrigerator or router. From the perspective of primary power fueling the grid, electrons heating toast or warming silicon are the same. They're all just "loads." But the demand for warming toast, water, rooms and lightbulbs is truly saturated. Demand for silicon is still growing, geometrically.

A crucial difference between the 20th century's "dumb" loads and today's information loads is the network effect. There is nothing in the action of your turning on a lightbulb that compels another dozen lightbulbs to turn on somewhere else, hundreds of miles away. But turn on your Internet browser, and the hot microprocessor on your desktop compels other microprocessors to turn on as well. The Internet desktop, or palmtop, is nothing without the network. And the network contains not hundreds but billions of other microprocessors standing by hot 24/7, ready to light up to transmit, sift, amplify, route, store and translate the vast quantities of bits coursing through wired, and increasingly wireless, networks. Metcalfe's Law, known for the observation that networks have an inherent multiplier in their spread and value, also applies to the network's appetite for electrons. (The bits in the networks are, after all, just bundles of electrons.)

Combined, all these effects confound the no-growth forecasters. "The U.S. commercial sector market is becoming saturated (especially for PC CPUs and monitors)," they had declared in 1995. Saturated? There were under 25,000 servers in operation in the United States in 1995; there are 6 to 10 million operating today, and a good many individual buildings now house more than 25,000 servers. Saturated? There were 87 million PCs on home and business desktops in the United States in 1995; last year that total blew past 160 million. Saturated? In 1995, companies like Cisco shipped about 340,000 routers; over 1.5 million were shipped last year.

When my colleague and I first suggested that it might take serious gigawatts to power it all, one saturated-market theorist responded (I'm not making this up) that bits simply glide over the phone companies' existing infrastructure, and thus require no additional power whatsoever. Consider what has actually happened to the infrastructure. Over $800 billion has been added in the form of new telecom/datacom infrastructure over just the past five years. Over the past seven years, IT equipment purchases have accounted for one-third of capital spending by businesses, the largest single entry on their new capital ledger. Last year, for the first time, spending on IT equipment matched spending on all other business equipment, both hitting an annual rate of $500 million. (Just three years ago, IT spending was $300 million and non-tech $400 million.) That's a lot of equipment. And all of it gets plugged in.

Sometimes an incredible amount gets plugged in, in a single building. Unlike lightbulbs, where a handful per room in a 100-room building saturates the potential for demand, single buildings now contain millions of microprocessors. These server farms or data warehouses are full of electron-consuming, microprocessor-laden hardware: servers, routers, drives, amplifiers, transmitters. Such a single, innocuous grocery store-sized building's electron demand rivals a half dozen high-rise office towers. A decade ago, such buildings simply didn't exist. Today there are well over 10 million square feet of such buildings, and another 15 million under construction or planned within just the next two years. (The NASDAQ sag has only modestly abated this pace; in New York City, apparently, the pace has not abated at all.) The total electric demand from these giant "bit processors" rivals the electric demand of the nation's entire food processing industry.

Power suppliers in cities across the country, and around the world, from Seattle to Stockholm, Los Angeles to London, are struggling to meet this demand. (There is an entirely new class of technologies and industries emerging just to deal with the unique reliability demands of such enormous and demanding digital power loads-the exclusive subject, by way of full disclosure, of the investment newsletter I write with my colleague Peter Huber, The Digital Power Report.)

There is actually much more to the digital power story. One obvious example: Over the past five years semiconductor manufacturing has ascended to become the nation's largest manufacturing industry-bigger than autos. Silicon plants are the factories of the 21st century. Their fuel of choice: kilowatt-hours. The manufacturing of digital equipment is very electric intensive. A rough rule of thumb: the manufacture of a digital box (from silicon to desktop) consumes as much power as a year of its operation. In dollar terms, IT equipment now accounts for 20 percent of the nation's manufacturing. And the manufacturing sector as a whole consumes almost 30 percent of U.S. power.
Consider a tiny Palm Pilot or Compaq PDA with wireless Internet access. Stuff of science fiction a decade ago. Today the electricity consumed, not by the Palm itself, but in the invisible networks linking that Palm to and through the vast labyrinth of networked IT hardware, totals 1,000 to 2,000 kilowatt-hours per year (pro-rated for each user's share of the data hotels and beyond). That's what a household refrigerator consumes. Each wireless Palm Pilot is a refrigerator's worth of electric demand. Add up the Palms, or consider instead just your wireless cell phone. The power consumed per wireless phone in the networks (all those cellular base stations use electricity) is comparable to the hot water heater in your basement.

Truth be told, it is not easy to accurately document the quantity of electricity IT and the Internet consumes today by counting microprocessors, or the boxes they reside in. No organization tracks or monitors this data. It is truly only possible to make a reasonable estimate from aggregate equipment sales and bellwether facilities (such as data hotels). Otherwise, analysts quickly get bogged down in the paucity of data, and an engineer's equivalent of the old theological debate of "how many angels can dance on the head of a pin." Some alternative analyses (primarily from the no-growth faction) put forward lower numbers; fair enough. Using their data, an Internet-connected Palm Pilot consumes as much as the hot water heater. Still amazing.

Add it all up-from silicon manufacturing, to telephone networks, wireless networks, Internet server farms, cooling systems, reliability systems, and the ubiquitous desktop PCs. The total: an estimated 8 to 13 percent of the nation's electricity is being consumed by the Internet and IT sector. At least 3 percent of the nation's electricity is powering just the PCs, printers and peripherals themselves, according to the best data from the Energy Information Administration (even the best can hardly be very good given the dynamism of this sector).

All of the forward-looking trends point not to saturation but more growth. A Cisco-sponsored study by economists at the University of Texas ("Measuring the Internet Economy," January 2001) concludes that U.S.-based "Internet Infrastructure" companies-companies that manufacture the computers and network equipment used for Internet access, and that provide Internet access services-are currently selling some $300 billion of equipment and services a year. That figure has been rising fast and without interruption since the dawn of the Internet, and its impact on power consumption compounds year by year. Note also that the Texas study deliberately excludes substantial amounts of digital investment (e.g., 40 percent of all office computers) that isn't used for Internet access.

Heavy iron power companies, like Calpine, Duke Energy, Dynegy, and a growing host of others, don't have to concern themselves too much with such nationally aggregated consumption figures, because power generated in Peoria can't be used to light silicon in Palo Alto. Population and wealth come with silicon technology, and merchant power companies build where the new demand is. That demand might be stagnant or even falling half a continent away doesn't affect the need to build new capacity.

So in this context-a context of electron demand driven by silicon productivity and silicon hardware-it should be no surprise to learn that companies in Silicon Valley like Oracle, at 13 megawatts, and Sun Microsystems, at 26 megawatts, inhale as much electricity as small steel mills, and their requirements have been growing over 7 percent per year. Nobody could possibly have foreseen such growth, right? But Calpine did.

Silicon Power

California's miseries represent a huge opportunity for companies that understand the digital economy's appetite for power, Calpine among them. Headquartered in San Jose, this independent power producer plots its course just a few miles downwind of Silicon Valley, which may help explain why Calpine got it right. While the major players in the electric power business have been preoccupied in recent years with mergers and acquisitions, fighting deregulation (until recently), chasing telecom opportunities, or retail ventures, or foreign investments, Calpine studied and then quietly pursued the domestic market for just providing more electricity.

Calpine's story starts in 1988, though it didn't go public until September 1996. Calpine has spent sixteen years going long on everything that California's senescent utilities and inept regulators were shorting. When they were selling, Calpine was buying. When they fought construction of new power plants, Calpine built them anyway. When they bet that energy conservation would flatten future demand, Calpine's Chairman and CEO Pete Cartwright looked out his sixth-floor San Jose window toward the digital horizon, and bet heavily on new generation.
Seventy-five years old, with a deep history in electric power that stretches back to an early career at constructor Gibbs & Hill, and then at General Electric (GE), Pete Cartwright remains one of the most vigorous, lucid visionaries of the power industry.

At that early stage, well before most Californians realized they had a problem, Cartwright was already scrambling to meet the silicon-power crunch.

At its inception, Calpine began with 466 megawatts of gas-fired capacity and 436 megawatts of geothermal capacity and steam fields, making it a small independent. Today Calpine has either built or acquired 4,400 megawatts in 47 plants. Now a major owner of generating capacity, it will soon be a lot bigger. Calpine now has more new capacity under construction or in "advanced development" than any other electric company (monopoly, independent, or otherwise) in North America. By 2005, Calpine expects to have interests in over 100 plants, roughly 70,000 megawatts of electron capacity. These numbers will position Calpine as the biggest domestic power company, independent or monopoly.

Calpine's move into generation began in California, and over a quarter of its current capacity is still located there. Since January 1999, California regulators have received 23 applications to build large (600 megawatts average), new, base-load plants; nine have been approved; three are Calpine's. The company's Los Medanos (500 megawatts) and Sutter (545 megawatts) plants represent all the new large-scale generating capacity scheduled to come on-line in California this year. Over the next four years, Calpine will add an additional 6,700 megawatts of baseload capacity (and 1,100 megawatts of peakers) either in California itself, or in bordering states near enough to ship power to where Californians need it. About 550 megawatts of that capacity will fire up by May, and another 1,100 megawatts by July.

Calpine recognized well ahead of the herd that delivery backlogs for suitable turbines were a major obstacle to the fast build-out of new gas power plants. So it contracted to buy a substantial share of the GE and Siemens big turbine output for the next five years (over 200 turbines). As a result, Calpine currently owns about 25 percent of the total U.S. orders for new grid-scale generating turbines over the next half decade. ("In the turbine market, you're either Calpine, or you're late and overpaying," Forbes reports.)

Calpine is equally far ahead in locking up fuel supplies for those turbines. The company acquired its first natural gas production company (Montis Niger) in 1997; today, some 85 percent of the gas it burns is either self-supplied or secured under long-term (up to twenty-year) contracts. When the spot price of gas quadrupled in the last year, Calpine was largely unaffected. Going forward, Calpine plans to own at least one-fourth of the gas supplies its power plants will require. Unlike other independents, Calpine is completely focused on the North American market. It has directed most of its business to states with strong demographic growth and high-tech economies.

For the next five years at least, new, gas-fired capacity-like Calpine's-is going to bridge the gap between saturated-market myth and growing-market reality. Calpine has bet big on that gap widening-and it is indeed widening, with demand in key markets now growing at 3 to 4 percent annual rates, when most incumbents have established construction schedules based on 1.5 percent forecasts. On a nationwide basis, a one-percentage point growth gap translates into 8,000 megawatts-the capacity of eight, large billion-dollar-plus plants-for that year. And if the gap persists, the same again the following year, and so on.

Calpine is of course far from alone in pursuing the rich market for electrons. Since the 1992 passage of the federal Energy Policy Act, the power industry has been splitting itself up into regulated transmission-and-distribution (T&D) companies on the one hand, and increasingly deregulated generators-"independents" or "merchant power producers"-on the other. Merchant companies specialize in producing electricity-at a profit-by selling it wholesale. In most cases, intermediaries, brokers and resellers move this new commodity (the nation's largest by far) through the markets. The networks distribute; others retail. Many large utilities have been selling off generating capacity, as directed by regulators in their home regions; most have been buying up capacity (through their wholly separate subsidiaries), alongside the independents, in new geographic markets where they don't own the wires.

The merchants now own nearly 20 percent of capacity nationwide-just under half bought from monopoly utilities, with the rest new, built in the last five years or so. Their share is rising fast, and they account for almost 100 percent of new construction. Other than Calpine and AES, the other top ten merchant generators are affiliates of old-guard utilities. Many are likely to cut loose, and sooner rather than later. Orion Power went public last year, soon after acquiring generating assets from a fistful of old utilities. Reliant Energy (Houston Light & Power's affiliate) has filed plans to spin off from its parent. Others will follow.

For inveterate utility haters, the rush to heavy iron-central power plants-seems like a dream dashed, the dream of distributed and small generation. The dream is alive and well, it's just not exclusionary; both will grow. Electron demand is so robust that everything will be needed, at least everything that makes minimal economic sense, from the green-favored and subsidized windmills and photovoltaics, to microturbines, to the (someday) fuel cell, and even the venerable diesel engines of the likes of Caterpillar. Yes, Caterpillar of big yellow truck and 'dozer fame.

Visit an Exodus or AOL data center, and outside you'll see row upon row of big CAT diesels, to keep the silicon lit when the grid goes down. A total of at least 70,000 megawatts of such comparatively small (compared to central stations) diesel generation is already installed, off the grid, uncounted by traditional data sources, much of it from Caterpillar. CAT is in fact the globe's second biggest manufacturer of electric power plants, second only to GE's heavy iron, but all small units; amazing. The backlog to get a CAT diesel in California has jumped from weeks to six-plus months. The reason of course is to provide back-up power when the grid is off, as with those "rolling blackouts" Californians have come to know, and will see again. (California is not alone; a joint report on New York City's power situation from the Real Estate Board of New York, finished in late February, is portentously titled "Electricity Outlook: A Matter of Urgency." Seems NYC's past five-year kilowatt-hour appetite has been running at a growth rate 40 percent faster than previously, or forecast.) That is, as it happens, the primary role for small-scale generation-adding reliability.

For an increasingly large fraction of the economy, reliability has quietly emerged as the single most important metric associated with electron supply-more important than price (although price always matters). Taken together, the broad class of technologies that enhance electron reliability (uninterruptible power supplies, flywheels, batteries, power electronics, and so on) constitutes a digital power sector that entails annual spending which already matches that of big power plants.

Even where the grid is doing better than California (which is most everywhere outside of the third world), it's still not close to reliable enough for "critical" loads for Exodus, Level 3, AOL, e-Bay, or Schwab. Nor increasingly for offices and factories of all kinds. Filling the supply gap for back-up are new companies like Capstone, with their marvelously quiet and clean 30 and 60 kilowatts microturbines. Such technologies can alleviate grid congestion, keeping extra electron traffic off the already over-taxed wires. But their primary use has been, and will continue to be, primarily in backing up critical facilities when the grid is over-taxed by neighbors or natural events. Few companies really want to become their own 24/7 power generators (and in many states, few regulators want that). So the Capstones and Calpines prosper together (and an emergent industry of others similar), bringing more electrons and more reliability to the electric needs of Main Street and motherboards.

Silicon Future

From Game Boys to gene sequencers, computers to car factories, silicon fabs to steel mills, factory floor to financial house, silicon devices and electron demand are powerfully linked. These days talk of a "New Economy" is muted as it appears out of step with the NASDAQ malaise. But technology's clock has not been turned back. Moore's Law (the doubling of computing power every 18 months) continues and accordingly silicon's power is still growing and penetrating all sectors. The economic power inherent in Metcalfe's Law has not been repealed: the enormous amplifying value and synergy of networks as they apply to all manner of commerce. Gilder's Telecosm is only just emerging with the promise of end-to-end broadband optical networks that will unleash our economy's appetite for bits. The next decade promises at least as much technology change as the past. The build-out has just begun. Digital power is a central part of that build-out and promise. There is a lesson to be derived from recent history, and from the California debacle: it is that we should permit, indeed encourage, the entrepreneurs and the technologies needed to fuel this great electric economy.