THE HUBER MILLS digital power report
Powering the Telecosm
February 2001/Vol. 2 Issue 2
Published by Gilder Publishing, LLC

From California to Calpine

When they were selling, Calpine was buying. When they fought construction of new power plants, Calpine built them anyway.

What Powercosm lessons emerge from California's chaos? What deep technology insights can we glean from rolling blackouts and finger-pointing politicians? None at all, one is tempted to answer, and that's pretty close to right. Politics is a low-9s enterprise. Beginning in the 1970s, California authorities were persuaded by a cabal of efficiency mavens and end-of-growth pundits that demand for electrons was leveling off, and would soon decline, while supply was plentiful, and would soon become a glut. They regulated accordingly. But they were wrong on both counts. Many other high-tech, high-growth states didn't make the same mistakes. End of story.

With that said, California's miseries represent a huge opportunity for companies that understand the digital economy's appetite for power. Calpine (CPN) 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.

Though it didn't go public until September 1996, Calpine has spent 16 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.

"Dig More Coal, The PCs are Coming"

That was the title of an article we published in *Forbes* nearly two years ago. The utility managers serving Silicon Valley would have done well to read it. The area's demand for power has been growing 5 percent annually. On peak days, the Valley now consumes nearly 3,000 MW of electricity. The San Francisco Bay Area will need to add 1,500 MW of electricity before 2005; 300 MW of that for Silicon Valley alone.

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. He did read our *Forbes* piece, and then our *Powerchip Paradigm*, published four months later. He phoned us. Not long after, we met over breakfast with Cartwright and his able second in command, Ron Walter, at the top of one of the few high-rises in San Jose. The homes of the Valley's countless fabs, server farms, and software sweatshops stretched out below us, to the north, like so many diminutive chips on a faded olive circuit board.

At that early stage, well before most Californians realized they had a problem, Cartwright was already scrambling to meet the silicon-power crunch. Cartwright wanted to hear our views on where digital loads were headed, and on the quality of power they'd need. We followed up a few months later with a presentation to Calpine's executive team and Board, and to the Wall Street types who follow the heavy-iron power sector. Soon after, Calpine formed a new subsidiary, Calpine c*Power, to supply high-9s power to major corporate users. President Bob Hepple described c*Power's plans at our first Powercosm conference in San Diego last June–just as the first power brownouts were beginning to roll across California.

California Dreamin'

Half (at least) of the Calpine story centers on America's rising appetite for electric power. If you don't buy this part of the story, skip the rest.

We buy it. Bits consist of defined units of energy that have to be sifted, herded, and propelled through the airwaves, across planes of silicon, and through tunnels of copper, coax, and glass. This requires reliable electricity–and lots of it. In 1999 we estimated that the manufacture and use of computers and networking hardware, along with their power backup and cooling systems, consumed a stunning 8 percent of our electric power; that number rose to about 13 percent when we added in the rest of the IT infrastructure deployed at the foothills of the Internet.

But our numbers were much too high, a handful of critics howled. The most vocal, we gently note, had published a memorably wrongheaded conclusion just a few years earlier. "The US commercial sector market is becoming saturated (especially for PC CPUs and monitors)," they declared in 1995. Saturated? There were fewer than 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 (CSCO) shipped more than 340,000 routers; over 1.5 million were shipped last year.

Amusing though bad forecasts appear in retrospect, they can have serious consequences when made. For a long stretch, and nowhere more so than in California, the saturated-market pundits persuaded regulators, and through them utilities, that the century-long rise in demand for electricity was coming to an end. Light bulbs and motors had accounted for the first great wave of demand for electric power; air conditioning had accounted for the second. By the late 1970s, it was supposed to be all over–efficiency and conservation were going to take over from there on out.

That meant that California had already built the last big power plant it was ever likely to need. Especially because neighboring states had more capacity than they could use. Oregon, Utah, Arizona, or Montana could breathe the dirty air, and California would import whatever modest, additional power it might require. Nobody listened when one of us argued the opposing case before the California Energy Commission in the early 1990s.

In 1996–still locked in the saturated-market mindset–California authorities decided to finish the job. They directed utilities to sell all their power plants to non-utility generating companies; thus, utilities would be wire companies only. The authorities strictly forbade utilities to sneak back into generation through the back door, by signing long-term supply contracts with independent power producers. Utilities were to buy power only in the spot market, and collectively, through a newly created "Independent System Operator." Consumer rates were to be cut by 10 percent immediately, and price-capped thereafter. The package as a whole was called "deregulation."

And so it was–if you swallowed the saturated-market line. Prices were bound to fall anyway, so ordering an immediate cut in retail rates wasn't really regulation at all. Spot prices were bound to be lower than long-term contracts, so forbidding the latter wasn't really regulation either. Utilities remained free to short power generation and bet against rising demand or rising price, and in a saturated market no rational utility would wish to do otherwise.

As for the independent power producers like Calpine, well, they could spend their own money as they pleased, so long as they did not run afoul of green regulators along the way. Independents were especially welcome to invest in new facilities outside California's own borders; the state's green authorities hardly objected to that at all. Out-of-state systems from British Columbia to Arizona now account for about one-quarter of the peak capacity on which California depends.

Cartwright and Calpine thought the matter over, and jumped right into the briar patch.

Calpine

Not long after our breakfast with Cartwright, we were back in the Valley again. In a windowless conference room that offered no view of the valley at all, we clustered around a drab formica table with a small group of engineers from Cupertino Electric (a major contract builder of electric infrastructure) and Calpine c*Power. We heard an informal report from an earnest Mike Pretto. Mike is the Division Manager for Silicon Valley Power, the municipal utility for Santa Clara, a town nestled in the heart of the Valley.

It had been a tough summer already, and Pretto saw it getting worse. Companies like Oracle (ORCL) (13 MW) and Sun Microsystems (SUNW) (26 MW) were inhaling as much electricity as small steel mills, and their require-

Editors Peter W. Huber, Mark P. Mills
Publisher Lauryn Franzoni
Managing Editor Debi Kennedy
Associate Editor Keri Geiger
Designer Julie Ward
President Mark T. Ziebarth
Chairman George Gilder

The Digital Power Report is published monthly by Gilder Publishing, LLC. Editorial and Business address: P.O. Box 660, Monument Mills, Housatonic, MA 01236. Editorial inquiries can be sent to: peterhuber@gildertech.com or markmills@gildertech.com. Single-issue price: $50. For subscription information, call 800.261.5309, e-mail us at help@gildertech.com, or visit our website at www.powercosm.com and www.digitalpowerreport.com

ments were growing more than 7 percent per year. Worse still, Silicon Valley Power had before it a stack of applications for new, high-capacity power connections from new digital enterprises. If all the applicants really meant it, Pretto figured he'd have to double capacity in the next 18 months; his utility hadn't seen that much increase in the previous 15 years combined. Nobody could possibly have foreseen such growth. But Calpine had.

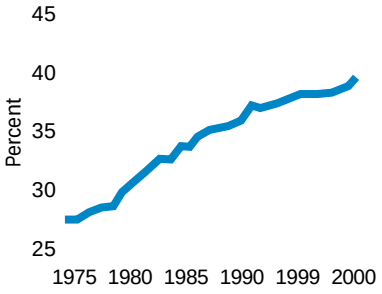
Founded in 1984, Calpine's original mission was to provide engineering, management, finance, and operation and maintenance services to the nascent independent power industry. In 1988, Calpine decided to get into the power generation business itself, and launched a large buy-or-build strategy to acquire capacity. Electrowatt eventually bought out its partner; Calpine then went public in 1996.

At that time, with 466 MW of gas-fired capacity and 436 MW of geothermal capacity and steam fields, Calpine still ranked as a small independent. By the end of last year, Calpine had either built or acquired 4,400 net MW in 47 plants. That makes Calpine about as big an owner of generating capacity as the better-known Enron (ENRN).

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–some 23 projects, totaling 11,100 MW of base-load capacity under construction, another 12,100 MW of construction announced, and a further 11,800 MW in late stages of development. By 2004, Calpine expects to have interests in 95 plants, roughly 40,000 MW of base-load capacity, and an additional 7,500 MW of peaking capacity, in 27 states. These numbers will position Calpine as the biggest domestic independent producer, and among the largest electric power producers of any kind in the country. And we predict Calpine will soon be revising its growth plans upward substantially.

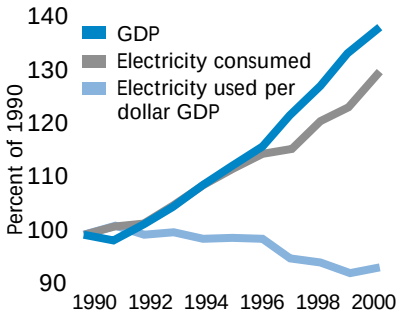
Calpine's move into generation began in California, and over a quarter of its current capacity is still located there. In 1989 Calpine bought into two geothermal plants in Northern California; the company's first gas-fired plant (purchased in 1995) was also in California. Today, Calpine owns 1,326 MW of capacity in the Golden state, and has a $4-billion construction program under way, the largest in the state. Since January 1999, California regulators have received 23 applications to build large, (600-MW average) new, base-load plants; nine have been approved; three are Calpine's. The company's Los Medanos (500-MW) and Sutter (545-MW) 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 MW of base-load capacity (and 1,100 MW of peakers) either in California itself, or in bordering states near enough to ship power to where Californians need it. About 550 MW of that capacity will fire up by May, another 1,100 MW by July.

Share of U.S. Energy Consumption for Electricity



Source: Energy Information Administration

GDP and Electricity



Source: Energy Information Administration

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 GE's and Siemens' output for the next five years (199 turbines for delivery by 2004–some 50,000 MW worth of capacity). 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.) As the largest buyer of gas-fired turbines, Calpine will also get favored treatment on service and parts, an important advantage. Calpine has also entered into a long-term contract with St. Louis-based Nooter/Erikson to purchase 85 Heat Recovery Steam Generator systems, which boost thermal efficiencies.

Calpine manages all aspects of the capacity that it builds–engineering and design, construction, fuel supply, operations, and power marketing. Though it started out in geothermal, Calpine is now strongly focused on combined-cycle, natural gas-fired plants–by far the fastest growing segment of the U.S. power industry, and the technology best suited for shorter-wire, higher-9s deployment under tight air-quality, noise, and other environmental constraints. Calpine's plants are, on average, about five years old–compared to twenty years for the average utility-owned plant. Last December, Calpine bought Power Systems Manufacturing to further solidify its engineering expertise in gas-fed turbines.

Though still big by the heavy-iron-lite standards (October 2000 DPR), most of Calpine's planned generating units are smaller (100 to 300 MW) than the 500- to 1000-MW behemoths long favored by old-guard utilities. And the new gas technology that Calpine favors runs so clean it can be more easily deployed in smaller plants. Calpine's facilities can thus be situated closer to the loads–which makes for more reliable power to end users, with less dependence on the already overloaded transmission grid. For c*Power, Calpine has already ordered 15 of GE's 60-MW gas turbines (derived from the big engines GE builds for jumbo jets); it also plans

to buy GE's 10-MW units to deliver short-wire, high-9s power to major digital customers. c*Power recently secured a contract to build a 250-MW plant to power U.S. Dataport's three million sq. ft. monster center in Northern Virginia.

Turbines need fuel; Calpine is equally far ahead in locking up its supplies of natural gas. 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. Over the last several years Calpine has bought more than 300 billion cubic feet of reserves. When the spot price of gas quadrupled in the last year, Calpine was largely unaffected.

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. The two other criteria that shape its expansion plans are deregulation and the opportunity to displace older, less-efficient facilities operated by aging utilities. Calpine's plants have thus landed on the West Coast (12 plants operating or under construction in California, Washington, Oregon and Arizona) the Northeast/ Mid-Atlantic (14 plants in Virginia, New Jersey, Pennsylvania, Massachusetts, Rhode Island and Maine), and Texas (10 plants). This gives Calpine a strong alignment with the places where the data-center industry concentrates–in the vicinity of the Internet backbone's nine main access points: LA, San Jose, Seattle, Chicago, Boston, New York, Washington, D.C., Atlanta, and Dallas. More recently, Calpine has targeted selected growth areas in the Southeast (four plants in Alabama, Florida, and Louisiana) and the Midwest (three in Illinois and Missouri).

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

Making your peace with green regulators is an essential complementary skill in this business. Calpine began in "renewable" geothermal; it operates 694 MW of geothermal capacity in California and remains by far the largest operator of geothermal plants anywhere–a strong green point in its favor from the get go. All its new capacity is fueled with gas, the one fossil fuel that greens (grudgingly) favor. In the west, where water scarcity is a major issue, Calpine uses recycled ("gray") water for cooling. Calpine gets additional green credits for the very high thermal efficiency of the combined-cycle systems it's deploying.

Calpine doesn't get a free pass, of course. Cisco (of all people) has opposed–on the usual not-in-my-backyard grounds–the 600-MW plant that Calpine is trying to build near San Jose, next to Pacific Gas and Electric's (PG&E) Metcalf Power Substation, a major entry point for electric power distribution to Silicon Valley. But like others in the industry, Calpine has learned to hide such plants well. From the outside, the Metcalf project will resemble two office buildings. The proposed generators are efficient and clean enough to have won the support of a wide array of green and energy-conservation-minded groups. The mayor of San Jose is obstructing, but the California Energy Commission is reviewing the case, and has authority to overrule him. With most of his high-tech base now begging for power, that may well be what even the Mayor himself is quietly hoping will happen.

Other Independents

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. Many large utilities have been selling off generating capacity, as directed by regulators in their home regions; most have been buying up capacity, alongside the independents, in new geographic markets where they don't own the wires. And an entirely new business has emerged at the interface, occupied by the marketers who buy and sell kilowatt-hour futures. Before it ever lights a sliver of silicon, over half of all power is now traded as a commodity among wholesalers.

Locked as they remain in the coils of regulation, the T&D companies are interesting to us only because they're major buyers of reliability-boosting technologies, like those supplied by American Superconductor (AMSC) and ABB. At the other pole, the power traders (such as Duke Energy Trading, PG&E Trading, and Enron) aren't regulated at all, and they've been on as wild a ride as any to be found in the commodities-futures amusement park. If you know how to beat the pork-bellies market (we don't), you can perhaps beat this one too.

Then there are the generators themselves. Set aside industrial cogeneration plants, which are numerous but small, and the large and rapidly growing infrastructure of relatively tiny back-up generators, at least some of which will eventually also serve as "peak shavers," wherever green regulators will let them do so. Set aside about 3,000 (mostly tiny) municipal power companies, and rural cooperatives, and the nine (mostly huge) federal electric companies (like TVA). The main action in the heavy-iron power market is now centered on independent merchant power companies–both the pure independents, and the more numerous old-guard utilities

that have set up new, wholly separate subsidiaries to buy or build plants outside their home regions.

The merchants now own nearly 140,000 MW of capacity nationwide–just under half bought from monopoly utilities, the rest built by the merchants themselves in the last five years or so. Non-utilities collectively now own 20 percent of the total national capacity, their share is rising fast, and they account for almost 100 percent of new construction. Other than Calpine and AES, all the other top-ten generators are affiliates of old-guard utilities. Many are likely to cut loose, and sooner rather than later. Orion Power (ORN) 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.

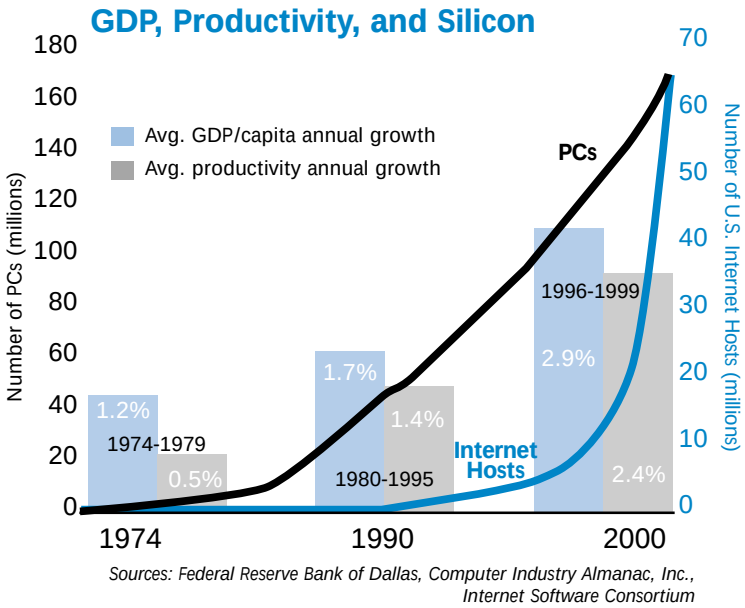
Calpine already ranks among the top 10 merchants, and its present construction schedule should soon place it unequivocally at the top of the list among domestic producers. Alone among the top 10, Calpine views overseas markets as a distraction. AES, currently the largest merchant, has only 20 percent of its capacity in the United States. Other large merchants include Edison International (SCE's beleaguered affiliate), National Power (itself a subsidiary of a British merchant), Reliant, NRG, Southern Company, Duke, and Dominion. The best leading indicator of where these companies are headed is actual orders placed for big gas turbines. Calpine has ordered the most new turbine capacity–twice as much as the next two in line, Duke Energy, and Entergy/FPL.

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 3 to 4 percent 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 MW–the capacity of eight, large billion-dollar-plus plants–for that year. If the gap persists, the same again the following year, and so on.

California's Political U-Turn

In the 1970s, California's power regulators got all excited about renewables. The state is now littered with high-cost, low-efficiency wind and solar facilities, that produce limited amounts of unreliable power, for which California ratepayers have overpaid by at least $25 billion in the intervening years. In 1996, the regulators bet even more wildly on the saturated-market theory. That mistake has already cost ratepayers comparable amounts, with a mountain of further debits still ahead.

California politicians are now scrambling to pull a Calpine–to buy turbines, secure gas supplies, acquire new



Sources: Federal Reserve Bank of Dallas, Computer Industry Almanac, Inc., Internet Software Consortium

plants, expand supply, and push down price. A law passed last September ostensibly streamlines the plant-approval process, and authorizes utilities to sign long-term contracts (PG&E immediately signed up to buy power from Calpine). Governor Davis now proposes to ban all further utility sales of power plants, and talks wildly of seizing other plants by eminent domain. The state that so eagerly deregulated wholesale prices now discerns price-fixing conspiracies, threatens windfall-profits taxes, and demands price caps from Washington. Having very deliberately chosen to push the generating capacity it needs into neighboring states, California now declares, in sonorous, Jimmy Carteresque terms, that "never again can we allow out-of-state profiteers to hold Californians hostage."

Will the political reaction hurt Calpine? We doubt it. In economic life, sometimes the bulls win, and sometimes the bears do, and a bearish state just doesn't get to trade places with winning bulls after the markets have closed. Should its lawmakers forget that, the courts will be there to remind them of the basic rules of economic fair play. California now desperately needs private capital, like Calpine's, to dig out of the depths of the saturated-market pit. When not posturing for the public, all the cooler political heads know it.

The Unsaturated Market

But as we said, forget about Calpine, forget about all the independents, if you believe that America's digital appetite for reliable power will continue to grow fast, if you believe instead, that the power market "saturated" around 1995, and hasn't changed much since, and won't, all the silicon in creation notwithstanding.

Some diehards still insist just that. PCs consume about 1 percent of the nation's electric power, all office

The 10 Dimensions of Digital Demand

1. Burn electrons to burn silicon. The manufacturing of digital equipment is very electric intensive – as a rough rule of thumb, the manufacturing of a digital box consumes as much power as a year of 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.

2. Chips multiply. Silicon chips are multiplying across the continent like locusts. Rising energy densities in the individual microprocessor are mirrored across the motherboard and adjacent desktop peripherals, through backup power supplies, network cards, modems, telephone switches, routers, wireless links, lasers, caching systems, and servers.

3. The race is to the swift. Faster chips beat slower, and faster chips consume more power.

4. Most chips don't sleep. Most of the new, all-electric industrial infrastructure is always on. That has a huge impact on aggregate demand.

5. Networks amplify. Stand-alone boxes like refrigerators and air conditioners can consume lots of power, but networks have a unique character: the loads drive each other. The more you use your Palm, the more you also use the host PC, wireless modem and transmitters, and Internet servers with which the Palm interacts. In networks, files, music tracks, and video clips are copied and cloned many times over. A single malignant virus can set microprocessors humming and hard drives spinning around the planet. The network's power requirements, like its utility, grow as the square of the number of nodes on the network.

6. Stored bytes accumulate. Almost nothing digitally stored on the Web today was stored on it ten years ago. But much of what's stored on it today will still be stored on it twenty years hence, along with much of everything else created digitally between now and then. The power it takes to store a byte will continue to drop, but the number of bytes stored will rise much faster.

7. More 9s, more power. It takes about 1.1-1.2 Watts in from the mains for every one "uninterruptible" Watt out to the PC through an uninterruptible power supply (UPS). It takes a lot of power just to layer and switch between multiple sources of power; every extra layer of reliability infrastructure adds to the overall electrical load.

8. Digital heaven is thermal hell. All the energy that enters a building as electricity must leave it again through an air conditioner – and that typically boosts total power loads another 40 percent. Hot summers boost air conditioning loads. So do several hundred billion hot silicon chips.

9. Efficiency rises … but loses. Within the chip itself, the electrical energy required to process a single instruction is cut in half about every 18 months, as the average size of the individual gate shrinks. But the total number of chips, the number of gates per chip, the chips' clock speeds, its duty cycles, and thus the total number of bits processed, rise much faster, more than offsetting the efficiency gains. A Nintendo has thousands of times more computing power than the original ENIAC computer, and is far more efficient — but one Nintendo per teenager adds up to much more electric load than one ENIAC per planet.

10. Wealth is Power. Digital technologies make us richer, rising efficiency makes us richer still – and the richer we get the more power we consume. A major 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 then, GNP has grown by 60 percent, electricity consumption by 55 percent.

equipment no more than about 3 percent, and these numbers just aren't changing fast, so there's nothing more to discuss. What about the $800 billion that has been invested in the new telecom/datacom infrastructure hardware over the past five years? When we first suggested that it might take serious watts to power it all, one saturated-market expert responded (we're not making this up) that bits simply glide over the phone companies' existing infrastructure, and thus require no additional power whatsoever. What about the 10- to 50-MW datacom warehouses now springing up all over the landscape? They're easily dealt with–utilities should simply jack up their prices and "sock it to those folks," another saturated-market sage counsels. And what about the blackouts? Oh, they're a consequence of economic growth, not digital demand.

It's not the rise of information technology, in other words, it's the rise of GDP. Sure it is. But the information technology (IT) sector now accounts for over 10 percent of GDP, and a rapidly rising fraction of GDP growth in all other sectors too, as computers and Internet services transform everything from car manufacturing to the hauling of trash. 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 ledgers. A March 2000 report from the Federal Reserve estimated that the manufacture and use of IT accounted for roughly two-thirds of the productivity growth–i.e., about $250 billion of additional GDP–over the course of the last five years alone. All that IT equipment is fueled by electrons. Nothing but electrons.

Yes, but GDP is rising faster than demand for electricity, the saturated-market crew respond. It is, but so what? If digital technologies boost power consumption by 5 percent, and 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. GDP has been rising faster than energy consumption since the dawn of humanity. In subsistence societies, the whole GDP is energy (i.e., food); energy becomes a smaller percentage of GDP when your community can

afford a philharmonic orchestra, and a still smaller percentage when your teen-agers are all buying digital music synthesizers. But total energy consumption rises all along, and consumption of electricity, the highest-grade form of energy, rises the fastest. 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.

Pinning down reliable aggregate figures, however, is getting a lot harder, as much of both supply and demand moves off the regulated utilities' books. According to the most recent estimates of official electron-counters at the Energy Information Administration (EIA), electricity generation increased an average annual rate of 1.8 percent from 1990 through 1994, and 2.8 percent from 1995 through 2000. That's a substantial change for a market in which Thomas Edison had a century's head start over Andy Grove, but don't try to infer too much from such figures. The EIA frequently revises its estimates, sometimes for a year or two after they're published, and all the revisions lately have been up. The projection for last year's increase was 1.4 percent at mid-year, but 3.1 percent in October. And the figures simply omit all "smaller" (under 20 MW) generating facilities –the category that is growing faster than any other.

All of the forward-looking trends point not to saturation, but more growth. (See Box "The Ten Dimensions of Digital Demand) 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 service 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, because capital equipment sold this year will use power for the next three to five years of its useful life. Note also that the Texas study deliberately excludes substantial amounts of digital investment (e.g., 40 percent of all office computers) that is not used for Internet access.

Finally, even the most saturated academics don't dispute that digital devices require high-9s power, or that providers of wired services will pay high premiums to get it, or that delivering it requires a raft of new technology and hardware. However little the overall demand for power may be rising, the demand for 9s is rising fast. And even a company like Calpine doesn't have to concern itself too much with nationally aggregated consumption figures, because power generated in Peoria can't be used to light silicon in Palo Alto. Population and wealth come with the silicon technology, and Calpine builds where the new demand is. That demand might be stagnant or even falling half a continent away doesn't affect Calpine's prospects at all.

That supply might be abundant half a continent away won't keep the silicon lit, either. Californians are now learning this the hard way. Which does have at least one advantage: they really will learn it. If they didn't know it before, California businesses know it now: in this electric-digital age, the cost of doing without reliable power far exceeds the cost of ensuring you get it.

Calpine will prosper in helping California get over its saturated-market follies; so too will many other Powercosm companies. Surging investment in new generating plants, backup systems, silicon power plants, and powerchips will push California hard and fast toward more distributed, more redundant, shorter-wire power. The state will emerge from the tunnel with a power infrastructure that is much more fragmented, decentralized, layered, interconnected–and therefore reliable–than it had going into it.

Peter Huber and Mark Mills
January 26, 2001

Power Panel Update

UltraRF to CREE; Intersil's Powerchips to Fairchild

Last November, the challenging physics of high-power RF chips led us to a hidden gem, UltraRF, a subsidiary of Spectrian (SPCT). Cree Inc. (CREE) liked the company too. On the last business day of December it closed its purchase of UltraRF from Spectrian–for $30 million in cash, 1,815,402 Cree shares, and a two-year agreement to supply Spectrian with RF powerchips. As we noted almost a year ago (April 2000), Cree is the world leader in silicon carbide technology, which could well emerge as the substrate of choice for next-generation powerchips. But, for now, too little of Cree's business is directly anchored in the Powercosm to earn it a place on our Power Panel. Both Cree and Spectrian are fine technology companies; stay tuned.

In last month's discussion of Intersil (ISIL), we looked forward to the inevitable "roll-up of powerchip companies, … with a handful of Intel- and AMD-like giants emerging at the end …" As this issue went to press, Fairchild Semiconductor (FCS) announced a cash purchase of the powerchip operations that account for 30 percent of Intersil's business. Last year, Fairchild acquired a six-inch powerchip wafer fab line in South Korea; the year before it pulled off a brilliant (and long sought) acquisition of Samsung's powerchip operations.

While Fairchild is also involved in optoelectronics, signal, and memory chips, half of its business is in powerchips today, and two-thirds will be after the Intersil deal is completed. Fairchild is already strong in the expanding low-end power MOSFET market, and has mastered the challenging fabrication and cost-paring aspects of that largely commoditized, but rapidly growing market. The company's power-MOSFET revenues grew 70 percent last year alone. Among close to pure-play powerchip companies, FCS's powerchip-related revenues will rank second to International Rectifier's. And a substantial share of those revenues will be derived from what was Intersil's great IGBT technology. Fairchild thus inherits Intersil's spot on our Power Panel.

The Power Panel

Ascendant Technology	Company (Symbol)	Reference Date	Reference Price	1/25/01 Price ††	52wk Range	Market Cap	Customers
Power: Heavy-Iron	Calpine (CPN)	1/25/01	40 7/16	40 7/16	17 3/4 - 52 15/16	11.4b	PG&E, Long Island Power, ComEd, Phillips Petroleum, ConEd (NY), New York Power, JFK Airport, Amoco, Sacramento Municipal
Powerchips: Insulated gate bipolar transistors (IGBTs)	Fairchild Semiconductor (FSC) †	1/22/01	17 11/16	16 13/16	11 3/16 - 49 1/2	1.7b	GE, Emerson Electric, Rockwell, Siemens, Bosch, PowerOne, Artesyn, Invensys, IBM, Delta, Marconi
IGBTs	IXYS (SYXI)	3/31/00	6 25/32	23 1/16	3 3/8 - 45 3/8	611m	Rockwell, ABB, Emerson, Still GmbH Eurotherm Ltd. (UK), Alpha Technology
	International Rectifier (IRF)	3/31/00	38 1/8	50 3/4	27 3/8 - 67 7/16	3.1b	Nokia, Lucent, Ericcson, APC, Emerson, Intel, AMD, Ford, Siemens
	Advanced Power (APTI)	8/7/00	15	19 3/4	11 1/4 - 49 5/8	166m	Alcatel, Ericsson, ITI, Power-One, Advanced Energy Industries, Emerson
Power MOSFETs	Infineon (IFX)	11/27/00	43 3/4	42 1/8	32 3/4 - 88 1/4	25.9b	Siemens, Visteon, Bosch, Mansmann-Sachs, Hella, Delphi
	International Rectifier (IRF)	*(see above)*					DaimlerChrysler, Bosch, Bose, Delphi, Ford, TRW
Network Transmission and UPS: High-temperature superconductor	ABB**	9/29/00	96 61/64	98 19/32	N/A	N/A	National Grid (UK), Microsoft, Commonwealth Edison, American Electric Power
	American Superconductor (AMSC)	9/30/99	15 3/8	19 9/16	19 5/8 - 75 1/8	395m	ABB, Edison (Italy), ST Microelectronics, Pirelli Cables, Detroit Edison, Electricite de France
Power: Heavy-Iron-Lite	General Electric (GE)	9/29/00	57 13/16	45 15/16	41 5/8 - 60 1/2	455b	Reliant Energy, Enron, Calpine, Trans Alta, Abener Energia, S.A.
	Catalytica Energy Systems (CESI)	9/29/00	12 3/8	14 1/8	9 1/8 - 19 1/2	297m	GE, Kawasaki Turbines, Enron, Rolls Royce, Solar Turbines
Electron Storage & Ride-Through Flywheels	Active Power (ACPW)	8/8/00	17*	20	12 3/4 - 79 3/4	776m	Enron, Broadwing, Micron Technologies, PSI Net, Corncast Cable, ABC
	Beacon Power (BCON)	11/16/00	6**	9 1/4	6 1/8 - 10 3/4	357m	Century Communications, Verizon, SDG&E, TLER Associates, Cox Cable
Hydrogen Generation	Proton Energy Systems (PRTN)	9/29/00	17*	13 1/16	5 1/4 - 36	432m	Matheson Gas, NASA
Distributed Power Generation Microturbines	Capstone Turbine Corp. (CPST)	6/29/00	16*	33 1/2	17 3/4 - 98 1/2	2.5b	Chevron, Williams ECU, Tokyo Gas, Reliant Energy
Fuel Cells	FuelCell Energy (FCEL)	8/25/00	49 7/8	62 5/8	15 3/4 - 108 3/4	965m	Santa Clara, RWE and Ruhrgas (Germany), General Dynamics, LADWP
Micropower Nano-fuel cells	Manhattan Scientifics (MHTX)	8/25/00	2 3/4	1 13/16	1 7/32 - 5 1/16	N/A	Incubator (no customers)
Silicon Power Plants In-the-room DC and AC Power Plants	Emerson (EMR)	5/31/00	59	74 1/2	40 1/2 - 79 3/4	32.0b	Citicorp, Verizon, Nokia, Motorola, Cisco, Exodus, Qwest, Level 3, Lucent
	Power-One	*(see below)*					
Motherboard Power Bricks, High-end DC/DC converters	Power-One (PWER)	4/28/00	22 3/4	45 3/4	10 7/8 - 89 13/16	3.6b	Cisco, Nortel, Teradyne, Lucent, Ericsson

Note: This table lists technologies in the Powercosm Paradigm, and representative companies that possess the ascendant technologies. But by no means are the technologies exclusive to these companies. In keeping with our objective of providing a technology strategy report, companies appear on this list only for the core competencies, without any judgment of market price or timing. Reference Price is a company's closing stock price on the Reference Date, the date on which the Power Panel was generated for the Digital Power Report in which the company was added to the Table. All "current" stock prices and new Reference Prices/Dates are based on the closing price for the last trading day of the month prior to Digital Power Report publication. IPO reference dates, however, are the day of the IPO. Though the Reference Price/Date is of necessity prior to final editorial, printing and distribution of the Digital Power Report, no notice of company changes is given prior to publication. Huber and Mills may hold positions in companies discussed in this newsletter or listed on the panel, and may provide technology assessment services for firms that have interests in the companies.

** Offering price at the time of IPO.*

*** ABB's plans to list its stock on the NYSE have been "delayed due to the volatility of the U.S. equity markets." ABB plans to provide further information on this issue in February.*

† Fairchild Semiconductor (FCS) announced on January 22, 2001, its plan to acquire all of Intersil's (ISIL) discrete power business. We have used the date of that announcement as the reference date for FCS and thus FCS replaces ISIL on the panel.

†† Because this month's Digital Power Report was printed prior to the end of the month, the reference date for the February Report is the last trading day prior to the press date rather than the last day of the month as is the usual practice.