THE HUBER MILLS digital power report

Powering the 21st Century

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Transmission & Distribution

Electric networks will ultimately depend on data acquisition and intelligent control

Who would buy technology stocks in times like these? Read no further if you believe that America's economic future resides in Treasuries, CDs, bonds, or gold under the mattress. We don't. Technology will remain the engine of economic growth, and the right technology companies will prosper again in the coming decade, just as they did in the '80s and in the '90s.

We track real technology, not virtual. Our space is power—watts, kilowatts, megawatts, and on up—power under precise control, power suffused with order and logic. This kind of power—digital power—is the essential fuel of the digital economy. It is also the power of tomorrow's factory and hybrid-electric automobile, the power of solid-state lighting, infra-red vision, and millimeter-wave radar, the power of multi-spectral sight and imaging, the power of civilian security at home, and of armed conflict anywhere. We don't write about business plans sketched out on napkins. We write about the technologies that propel muscular quantities of electrons and photons through wires and the airwaves, surrounded by and interacting with the intelligence of digital logic. We aren't interested in companies whose business strategy is to game regulators. We follow technologies that do real work, with all the speed and mathematical precision that the word "digital" implies.

And demand for that kind of power will be rising rapidly in the next few years—we are more convinced of that now than ever before. Digital power stands today where digital logic and digital wireless stood at the beginning of the '90s. We can't time Wall Street, nor even Detroit, with day-to-day or month-to-month precision. But over the coming years, sales of cutting-edge digital-power technologies will rise sharply. The vast infrastructure of power—of energy in motion—is going to change as profoundly in the early decades of this new century as it did in the early decades of electrification a century ago.

Paper and Power

Prudent investors look at the economic fundamentals of the companies in which they invest. But smart investing ultimately pivots on next year's books, not last year's, and to look forward in technology-driven markets, you have to start with technology, not with financials. That's what we do. We have technical backgrounds in engineering and physics. We don't believe in the magic of high technology; we believe in the logic of well-engineered materials and structures. If it still looks

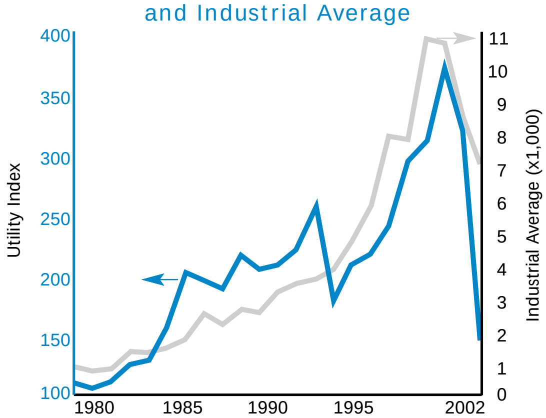
THIS ISSUE OF DPR INAUGURATES some changes in format, but not in vision, or overall approach. DPR is a technology newsletter written for investors. Starting with this issue we will generally include more graphics, charts, and tables to summarize overarching trends and provide a more wide-ranging description of technologies and companies in a particular sector. The Power Panel will continue to identify one featured company with key strengths in the technologies we consider important, but will typically name several others as well which compete in the specific area addressed in that issue. As we have said all along, we don't analyze financial statements, inventories, sales forecasts, trailing averages, quarterly statements, or any of the other standard Wall Street metrics. We leave that (important) task to others. We describe the overarching technological trends and what's driving them; we identify pivotal sectors of energy and power technology; and we identify one or more companies that are leading the way in the development and commercialization of that technology.

like magic to us after we've peered under the hood, we leave it alone.

In the bubble years, people asked us again and again why we never wrote about the magnificent Enron. Because it wasn't a technology company, we replied. As we explained in the *Wall Street Journal* a year ago (December 6, 2001), Enron's genius, while it lasted, was to get out of the still-regulated market for energy and into the largely deregulated market for contracts. Its revenues, while they lasted, came from trading of cubic feet of gas it didn't extract or burn, of kilowatt-hours it didn't generate, and of fiber-optic lines it didn't light. Enron Online's trading floor was a sophisticated dot-com, basically, engaged in commodity barter and arbitrage. Real companies can make honest money in those lines of work, but they aren't our lines. And as Enron painfully demonstrated, it can be difficult to distinguish real from fake in those virtual lines of work, particularly when new markets in new forms of paper are taking shape.

Paper doesn't move and shape power. That happens in conductors and semiconductors, switches and wires, transformers, motors, light-emitting diodes, and lasers, and in a constellation of other technologies that control and convey electrons, photons, and the antecedent fuels, piston engines, and turbines. And power is more important than ever. Energy consumption continues to rise. Energy security is a high legislative priority. A major energy bill is stalled in the waning days of this Congress; if it doesn't pass, another bill much like it will get taken up in the next Congress. The current bill contains a major section addressing the upgrading of the electric power infrastructure, the issue in fact which has served as the main sticking point in getting the legislation passed.

Fig.1. Dow Jones Utility Index and Industrial Average



Source: Dow Jones Indexes Historical Reports, www.djindexes.com.

And finally, electric power is one of nine key sectors singled out for attention in post-9/11 planning to protect and harden key components of the national infrastructure. Electricity is in fact a critical input to the eight other "critical" sectors placed on the same list—power fuels all the communications and banking services, most government, law enforcement, and health services, most of the "critical" aspects of the transportation sector (because it is so dependent on communications, like air traffic control), and much of the water, oil, and gas sectors, because they are so dependent on electrical control and communications systems.

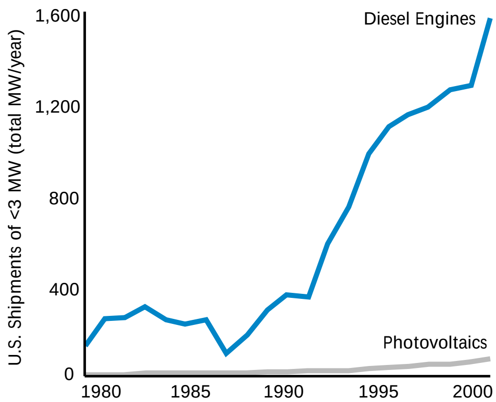
Yet to judge from recent trends on the post-Enron Wall Street, electric power has no future at all, or at least not a profitable one. For decades, the Dow Jones Industrial Average and the Dow Jones Utility Index moved in close synchrony—then, in the last year, the utility index dropped far below the DJIA. Call it the Enron/California chasm. (See Figure 1.) The chasm doesn't make much sense to us, nor, apparently, to Warren Buffett—in 1999 Buffett bought a real utility, MidAmerican (now private with publicly traded fixed-income securities), and has made it clear that, through MidAmerican, he intends to be the proud owner of many more.

Buffet can afford to buy a whole utility and use it as a nucleation point for further purchases. Some investors may choose to follow him, building portfolios of utilities— companies like Duke Energy (DUK) and American Electric Power (AEP) that mainly stuck to their electrical knitting during the Enron-bubble. To prosper in utilities themselves, you have to understand a lot more than the basic direction of demand (which is technology-driven). Federal and state regulators have an enormous impact on the fortunes of the 240 investor-owned utilities, the 2,000 public power agencies, and the nearly 1,000 rural electric co-operatives. A great deal of restructuring is impelled by the need to placate regulators and to separate regulated from unregulated assets—for example, Reliant's recent action to split itself into two

Authors	Peter W. Huber
	Mark P. Mills
Managing Editor	Marie Lavinio
Art Director	Charles Bork
Chairman	George Gilder

The Digital Power Report is published monthly by Gilder Publishing, LLC. Editorial and Business address: 291A Main Street, Great Barrington, MA 01230. Editorial inquiries can be sent to: peterhuber@gilder.com or markmills@gilder.com.

Fig. 2. Distributed Generation



Source: "Diesel & Gas Turbine Worldwide"; National Renewable Energy Laboratory.

companies: a local distribution company (gas and electric) on the one hand, and a power plant, energy trading, and retail sales company on the other. A repeal of the nearly 70-year-old Public Utility Holding Company Act (PUHCA) is probably on the near-term horizon. Buffett, among others, is calling for PUHCA's repeal, and if that happens, it will have a major impact on corporate structure, and thus also on technology investment, in the power sector. Expect, in any event, further disaggregation of the three basic tiers of the industry: generation, long-distance transmission, and local distribution.

Almost all of the new generation capacity is now coming from IPPs, the independent power producers, and they have been rushing to roll out new capacity in the past five years. In the very short term, there is now an overcapacity of both plans to build and construction actually under way; expect some continuing and serious melt in announced merchant generating capacity (and collaterally, orders for behemoth turbines from the likes of GE (GE) and ALSTOM (ALS). New capacity that is deployed will be heavily weighted in the 10 - 60 MW range of small natural-gas-burning stations—far smaller than the 500 - 1,000 MW plants that still churn out most of the wholesale electrons. Much smaller generators will continue to be deployed to add reliability—high-9s—to local nodes, but not raw baseload capacity. The dream of a highly decentralized mesh of relatively tiny (under 3 MW) generators remains just that—a very distant dream. In the distributed generation sector, the generation bet with the largest base and the surest growth is the oldest and the most traditional—the diesel generator, which means Caterpillar (CAT) the dominant player, or perhaps Cummins (CUM), the "Avis" to CAT's Hertz. (See Figure 2.)

Then there's the long-distance transmission network—680,000 miles of long-haul high-voltage wires, with some 7,000 bulk-power substations. FERC (the Federal Energy Regulatory Commission) does most of the regulating; NERC—the "voluntary" North American Electric Reliability Council—is in charge of reliability and coordination of power flows among the regional long-wire networks. Even before 9/11, transmission congestion problems were attracting a lot of attention, because of the sharp decline in new facilities construction in recent years (see Figure 3), and rising demand for use of those lines. Now, protection of the grid figures prominently on the homeland security agenda as well. One way or another, there is going to be a lot of new spending in this sector—most of it centered on upgrading existing lines and corridors with new steel hardware and new silicon-based switching and control.

And then, finally, there's distribution—and this, in our view, is where most of the near-term opportunity lies. (See Table 1.) Some 2.5 million miles of local distribution loop and 100,000 substations account for 80 percent of all reliability problems. While they are largely under separate regulatory domains, and are therefore often treated as separate by the industry, transmission and distribution (T&D) form a continuum of wires and technologies. Distribution systems usually operate at lower voltages, but even that distinction sometimes disappears in big cities, where the power demand is high and capacity constraints are the most severe. And as smaller generating systems are deployed in larger numbers, closer to the end user, the lines between primary transmission and secondary distribution can blur completely.

Table 1. Grid Spending

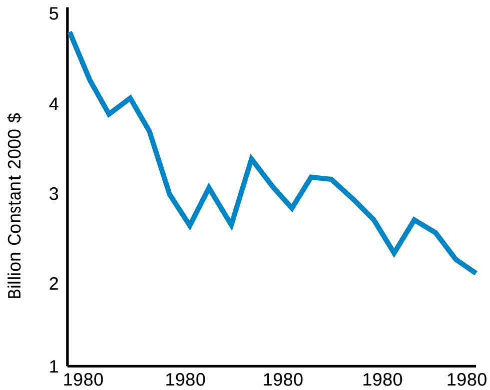
Category	$ Billion/Year	Comments
Transmission	2.0	Long-distance transmission
Distribution & Specialty Transformer	5.0	Largely the "local loop"
Switchgear & Related	9.0	"Local loop," buildings
Relay & Industrial Control	12.0	Primarily in-building network
Total	***28.0***	

Sources: U.S. Census Bureau," Annual Survey of Manufactures"; Dept. of Energy, "National Transmission Grid Study."

Transmission and Distribution

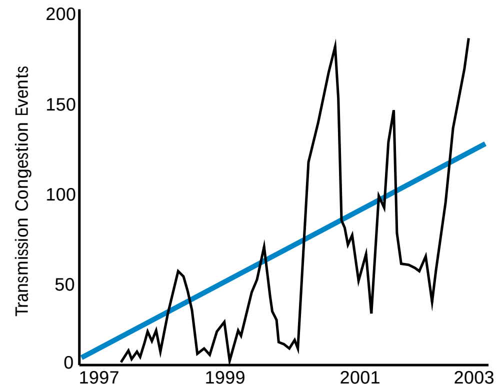
Wires may seem old-hat and low-tech, but this is in fact where a wide range of new technologies now ready for commercial deployment address the inter-

Fig. 3. U.S. Transmission Investment



Source: Hirst, E. and B. Kirby,"Transmission Planning for a Restructured U.S. Electricity Industry," Edison Electric Institute (2001).

Fig. 4. Electric Grid Congestion



Source: North American Reliability Council (NERC) Transmission Loading Relief Logs.

twined challenges of raising capacity, increasing reliability, and the broader concerns relating to homeland security. In recent years, a variety of comprehensive studies and analyses have sounded a consistent, complementary theme. An ABB-authored (DOE-sponsored), in-depth analysis outlines practical strategies for increasing distribution reliability in dense urban areas, focusing on Chicago. A recent RAND study surveys transmission technologies with a special focus on superconductors. NERC regularly explores emerging reliability trends and has issued a special analysis on homeland security implications. And last May, the Department of Energy released a tome on transmission reliability, its second in a few years. We aren't talking policy wonk papers any more; a broad consensus is now forming in favor of substantial new investment in transmission and distribution.

T&D projects involve very large-scale—though often little-noticed—construction and investment. The nation's first true merchant power line, for example, was approved (with notably little fanfare) by FERC in July 2001. The Neptune RTS project from Atlantic Energy Partners (backed by a consortium that includes Texas-based TXU) is quietly building two 600-MW underwater high-voltage DC cables to convey power from Sayerville, New Jersey, to grid-constrained Manhattan and Long Island, just the first step in an ambitious plan. Such projects are leading indicators, we believe, of a significant change of course in T&D markets.

Spending on long-distance electric transmission has been in sharp decline for over 30 years now—like the interstate highway system for cars, the main investments in the electron highways were decades ago. By all indications, however, investment is now poised to rise rapidly once again. We won't be building many altogether new T&D routes and lines, but there will be substantial investment to refurbish and upgrade the old ones. The number of times that congestion has forced the grid operators to restrict flow ("transmission relief") is measured as a "transmission relief log"—on the clear rise. (See Figure 4.) Unlike highways, the carrying capacity of electron pathways can be dramatically upgraded with modern hardware. (See Table 2.)

Additional demand for "distribution" hardware is being spurred by the private deployment of stand-by generating capacity. Homeland security begins close to home; power is critical to telephone companies, banks, chip fabs, hospitals, and countless other enti-

Table 2. Technologies to Improve Transmission

Technology	Description	Status
Flexible AC Transmission System	Silicon-based FACTS improves control and increases power	Available
Power Sensors	High-power dynamic sensors increase control and capacity	Available
High-Voltage DC	HVDC alternative to AC; can link asynchronous systems	Available
Underground Cable	5 to 10 times more costly than overhead; more reliable	Available
Compact Transmission Line	Computer-optimized tower designs increase power flow	Available
Distributed Generation	Diesel generators, turbines; relieve grid congestion	Available
Energy Storage	Improve system control; SMES, capacitors, flywheels, batteries	Available
Ultra-High Voltage	Higher voltage carries more power; 765 kV highest in N.A.	Available
Variable Frequency Transformer	Transformer improves phase matching and thus power handling	Available
Composite Conductor	Composite cores replace steel; lighter and greater power	Demonstration
Six or Twelve Phases	Replace standard 3-phase AC; more power	Demonstration
Superconducting Cable	Increases power carrying and stability of grid	Demonstration
Modular Equipment	Increases flexibility and speed to deployment critical components	Development
Superconducting Transformer	Superconducting wires decrease size, increase performance	Development
Wireless Power Transmission	Microwave or laser based; possible space power	Exploratory

ties that depend on computers, communications systems, pumps, motors, cooling systems, or electrically operated valves. The private sector grasped, long before the government did, that the hardening of our electric power infrastructure requires action to protect not just the nuclear plants and high-voltage transmission lines, but also hundreds of thousands of smaller nodes and private grids, ranging from tens of kilowatts to tens of megawatts in size. And every stand-by or back-up generator requires a cluster of hardware to interconnect it with local power distribution plants, and to interface it with—or isolate it from—the grid. A new engineering discipline of power reliability has emerged, building on the techniques pioneered in aviation and nuclear power. There is the important though little noticed 7x24 Society, along with firms like the private EYP Mission Critical Facilities, which defines the engineering gold-standard for mission-critical power (full disclosure: one of us serves on EYP's Board).

Table 3. T&D Hardware Companies

Company	Revenues	Comments
ABB (ABB) www.baileynm.com	$24b	ABB Network Management: Grid technologies from substation to long-haul
American Superconductor (AMSC) www.amsuper.com	$12m	Leader in emerging commercial superconductor T&D systems
Cooper Industries (CBE) www.cooperpower.com	$4b	Cooper Power, subsidiary of Cooper Industries
Eaton (ETN) www.cutler-hammer.com	$7b	Cutler-Hammer division: market leader in low-voltage
Emerson Electric (EMR) www.ascoswitch.com	$16b	ASCO subsidiary is global supplier of power transfer switchgear
Eve Transmission (Private) www.evetransmission.com	NA	UK and int'l. transmission line construction
GE (GE) www.zenithcontrols.com	$126b	In all power levels; $200m Zenith subsidiary big in low and medium voltage
Mitsubishi Electric Corp. (MIELY) www.meppi.com	$27b	Technologies from power lines to powerchips
S&C Electric (Private) www.sandc.com	$434m	Major private global player; founded in 1911
Schneider Electric SA (SCHN.PA) www.squared.com	$10b	$3b SquareD the main N.A. division and leading brand
Siemens (SI) www.siemenstd.com	$85b	$100m T&D division in all markets
SPX (SPW) www.waukeshaelectric.com	$4b	$135m Waukesha subsidiary, a major transformer supplier
TransÉnergieUS www.transenergieus.com	NA	Hydro-Quebec subsidiary; transmission construction

However big or small the power plant, and wherever it's located, it has to be connected to the motor, air conditioner, light bulb, or microprocessor by way of steel, ceramic, copper, silicon, and epoxy hardware. A vendor like Cooper Industries (CBE), a leading (nearly pure-play) supplier of electrical hardware used in industrial and commercial markets (though it does also sell about $700 million annually into the utility market) manufactures hundreds of devices, sold in thousands of different configurations. On a round-the-clock average, the power flowing through the electric wires exceeds, by about one-third, the power transmitted through the drive train of all the cars and trucks on all the streets of America. The control and regulation of the electric power depends on switches, transformers, connectors, relays, fuses, surge arrestors, lightning protectors, large capacitors and filters, and a wide array of sensors, data acquisition, and communication systems. All of these systems require specialized cabinets, racks, connectors, trays, and specialized handling tools—you don't reach for a live 34,000-volt circuit breaker with a standard pair of pliers.

There are a very large number of small (private) companies and divisions within conglomerates making all manner of components for the stunningly wide variety of niche markets that comprise "electric power hardware." But the supply and integration of all this equipment at the power distribution level is dominated by a surprisingly small set of leading global manufacturers. (See Table 3.) The list is short because the equipment is more difficult to manufacture than one might suppose, and—at least as important—because it takes years to earn the trust of customers (utilities and architect engineers) who tend to be extremely (and necessarily) conservative about who they'll deal with. The hardware has to last a very long time; it is often difficult and expensive to install; and failure is expensive, at best, and lethal at worst. For several summers, residents of Washington, D.C., witnessed steel manhole covers popping into the air like tiddly-winks when old underground equipment failed catastrophically. Hardware designed to handle hundreds of amperes and thousands of volts does not look like, nor can it be built like, familiar everyday wall plugs. High voltages arc out; magnetic fields reach out and induce currents; inductance and capacitance inherent in the wires behave like a load, or a source of power. Lightning, switches, and loads create surges and dips in power. As we have written before, the technological frontier in this area is defined by high-power semiconductor switches that add logic to the flow of power in much the same way as microprocessors do, but at far higher power levels. But even the most advanced power switches must remain surrounded by huge arrays of analog equipment—steel boxes, metal joiners, emergency fuses, capacitors, transformers, insulators, and so forth.

And behind all the equipment: sophisticated software for design, fault analysis, maintenance, and operations.

Itron

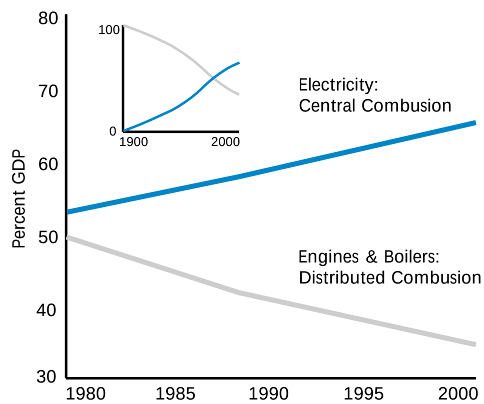
For an investor looking for a piece of the action in this space, the challenge is to find a T&D company that isn't merely part of a much larger conglomerate (like Britain's National Grid, which owns the T&D assets of the former utilities, Eastern Utilities Associates and Niagara Mohawk), or private (like TransElect, a merchant long-wire company planning to roll-up transmission assets, which just agreed to acquire the transmission lines of Illinois Power, a "troubled" Dynegy subsidiary), or a spin-off (CenterPoint Energy (CNP), the T&D business of Reliant), or that isn't just manufacturing commodity-like equipment with no price margins or technology advantage. For us, the company of most interest is Itron Inc. (ITRI). Not long ago we might have called it a "meter company." It still is one—Itron is a global supplier of wireless data acquisition products for electric, gas, and water utilities, and its handheld systems (about 30 percent of sales) are installed at over 2,000 utilities in more than 45 countries. But at this point it's fair to begin thinking of Itron as a software company.

Itron's primary focus is manufacturing and marketing automated meter-reading systems—it provides radio- and telephone-based automatic meter-reading units for 2,000 utilities. But the hardware, of course, pivots on software embedded in chips. And Itron also sells software directly—its products are used by most U.S. utilities to collect usage and event data from commercial and industrial metering points, for example. Most importantly, Itron now has a clear strategy to build up a significant new line of business in data collection and network management. Aside from software for automatic meter reading and customer billing, Itron is now emerging as a leading developer of software for the planning, design, and monitoring of T&D networks and substations, load profiling, power quality monitoring, and outage detection.

Itron has made a series of small acquisitions in the last year that all point in the same direction—a systematic plan to move data collection and management up the wires, from the retail base it already serves into the T&D network. Itron recently acquired LineSoft Corp., a privately held, Spokane-based company that designs software and provides consulting services that help monitor power systems for utilities. Other recent acquisitions: Regional Economic Research, Inc., a San Diego, California-based company specializing in energy consulting, analysis, and forecasting services and software; and eMobile Data Corporation, a provider of wireless, Web-based workforce management solutions for the utility industry. And Itron has partnered with ABB (ABB) to develop a common platform for automatic meter reading.

Itron recently reached an agreement with Tampa Electric—a solid utility with excellent judgment in such matters—to provide software to optimize the design of the utility's distribution system. As Itron points out, just five large electric utilities alone will be spending almost $2 billion on distribution infra-

Fig. 5. Fuels for the Economy*



* Excludes residential energy: counts only fuels used by GDP-producing sectors; transportation, industry (incl. mining, agriculture), and services.

Source: EIA Annual Energy Review 2000; Bureau of Economic Analysis.

structure improvement over the next five years. Itron can benefit in two ways from such plans—first, by providing smart meters that can help manage loads network-wide, and thus postpone or even substitute for much more costly new investment in T&D. And second, by providing the software needed to plan and design the T&D upgrades when they do get implemented. Itron's outage detection technology can be deployed at key customer locations and can help diagnose and ultimately anticipate problems as they occur. Utilities are being increasingly tied to performance-based rates, and the systematic analysis of outages can reveal points of vulnerability where new investment will do the most good. And as the Pentagon well knows, the most critical factor in protecting vulnerable assets on the ground from deliberate attack is to develop effective means to generate, convey, and integrate information. In their T&D networks, utilities operate vulnerable assets, and the vulnerability is attracting a great deal of critical attention in the post-9/11 world.

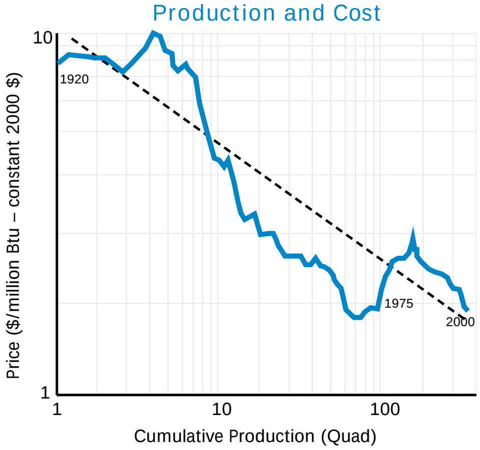
Electrification

We analyze technologies, not financial statements, still less, financial markets. But for what it's worth, here's our read on what the markets are doing with technology stocks today—and why it makes perfect sense to keep plodding along in our corner of this now wildly unpopular sector. Many investors leapt into technology on the strength of buzz, not fundamentals. They arrived late to the game, lost heavily on virtual technologies and virtual bookkeeping, and are now sour on technology—and indeed on Wall Street—across the board.

But over time, technology and market fundamentals do reassert themselves. Electricity is the ascendant fuel of our modern economy. More than 90 percent of the growth in U.S. energy demand since 1980 has been met by electricity. About 60 percent of our GDP now comes from industries and services that run on electricity—in 1950, the figure was only 20 percent. (See Figure 5.) Some 60 percent of all new capital spending is on information-technology equipment, all of it powered by electricity. All the fastest growth sectors of the economy—information technology and telecom most notably—depend entirely on electricity.

The shift to electricity has been impelled by the fact that electricity is by far the fastest and densest form of power that has been tamed for ubiquitous use. Electricity moves at the speed of light; all other forms move at the speed of sound, or even more slowly. It is possible to pack an enormous amount of electrical power in a very small amount of space. The electrification of our energy economy is accelerating today because new power-conversion technologies have emerged in the last decade that are unlike any ever seen before. Power semiconductors now let us control electrons as quickly and efficiently and cheaply as logic semiconductors let us control bits. (*Powerchip Paradigm II: Broadband Power, Digital Power Report Special Report*) The same materials that switch microwatts of logic are now switching kilowatts and even megawatts of real power. And over the long term, the real price of electricity has fallen steadily, and will continue to fall. (See Figure 6.) Even aside from the economy's clear, inherent appetite for electricity—every first-year economics student knows what happens as a product's price keeps falling.

Fig. 6. Cumulative U.S. Electricity Production and Cost



Source: EIA Annual Energy Review 2000; U.S. Census Bureau Historical Statistics of the United States; Fisher, J., Energy Crises In Perspective (John Wiley & Sons, 1974).

Power isn't an end in itself: it's a means toward ends, all human ends, every last one of them. It performs laser surgery, fuels the chess-playing computer and the machines that defend us from domestic terror and fight distant wars in which we suffer almost no casualties. It feeds, moves, informs, and entertains us. Power, in short, is as critical as critical gets, in the national infrastructure, on the corporate premises, and almost everywhere else. There is going to be a mounting wave of new building and new investment in this sector in the coming decade, both to accommodate growth in raw demand for electrons, and to harden the network and improve its reliability. There are a variety of industries and technologies that will feed and ride this wave. But here, as in so many other sectors, everything ultimately depends on a network of data acquisition and intelligent control. Itron is the right company in the right place, and it's doing the right things.

Peter Huber, Mark Mills
October 10, 2002

Table 4. Additional Resources
"The Electricity Sector Response to the Critical Infrastructure Protection Challenge," North American Reliability Council (May 2002).
"National Transmission Grid Study," U.S. Department of Energy (May 2002).
Silberglitt, R., E. Ettedgui, and A. Hove "Strengthening the Grid: Effect of High-Temperature Superconducting Power Technologies on Reliability, Power Transfer Capacity, and Energy Use," RAND (2002).
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"Infrastructure Security Initiative Underway," *EPRI Journal Online*, Electric Power Research Institute (2002).
"Guidelines for Critical Infrastructure Assurance Guidelines for Municipal Governments: Planning for Electrical Power Interruptions," Chicago Metropolitan AreaCritical Infrastructure Protection Program, Department of Energy/Office of Energy Assurance (Feb. 2001).
Rotger, J. and Frank Felder, "Promoting Efficient Transmission Investment: The Role of the Market in Expanding Transmission Infrastructure," TransÉnergieUS (Nov. 2001).
Hingorani and Gyugyi, "Understanding FACTS: Concepts and Technology of Flexible AC Transmission Systems," IEEE Press (2000).
"Reliability Assessment 2001-2010: The Reliability of Bulk Electric Systems in North America," North American Reliability Council (2001).

The Power Panel

For an explanation of the ascendant digital power technology for each of these companies, see the indicated issue of the DPR.

FEATURED COMPANY	DPR ISSUE	OTHER PLAYERS IN THE ANALYZED SPACE*
Advanced Power (APTI) www.advancedpower.com	12/00	Hitachi America (subs. HIT); Mitsubishi Semiconductor (subs. MIELY.PK); ON Semiconductor (ONNN); Philips Semiconductors (subs. PHG); Siliconix (SILI); STMicroelectronics (STM); Toshiba (TOSBF.PK)
American Superconductor (AMSC) www.amsuper.com	10/00	ABB (ABB); Intermagnetics General (IMGC); Waukesha Electric/SPX (subs. SPW)
Amkor Technology (AMKR) www.amkor.com	4/02	ChipPAC (CHPC); DPAC Technologies (DPAC)
Analog Devices (ADI) www.analog.com	8/01	Linear Technology (LLTC); Maxim Integrated (MXIM); STMicroelectronics (STM)
Analogic (ALOG) www.analogic.com	12/01	American Science & Engineering (ASE); Heimann Systems/Rheinmetall Group (subs. RNMBF.PK); InVision Technologies (INVN); L3 (LLL); Rapiscan/OSI Systems (subs. OSIS)
C&D Technologies (CHP) www.cdtechno.com	7/02	East Penn (pvt.); Enersys (pvt.); Exide (EXTDQ.OB)
Coherent (COHR) www.coherentinc.com	6/01	OSRAM Opto Semiconductors/subs. Osram (Siemens, SI, sole shareholder); Rofin-Sinar (RSTI)
Cree Inc. (CREE) www.cree.com	5/01	AXT (AXTI); Nichia Corporation (pvt.); Toyoda Gosei Optoelectronics Products/Toyoda Gosei (div. 7282.BE)
Danaher Corp. (DHR) www.danaher.com	2/02	Emerson Electric (EMR); GE-Fanuc (JV GE (GE) and Fanuc Ltd. (FANUF.PK)); Mitsubishi Electric Automation/Mitsubishi Electric (div. MIELY.PK); Siemens (SI)
Emerson (EMR) www.gotoemerson.com	6/00	American Power Conversion (APCC); Marconi (MONI.L); Toshiba (TOSBF.PK)
Fairchild Semiconductor (FCS) www.fairchildsemi.com	1/01	(See Advanced Power entry.)
FLIR Systems (FLIR) www.flir.com	1/02	DRS Technologies (DRS); Raytheon Commercial Infrared/Raytheon (subs. RTN); Wescam (WSC, Canada)
Harris Corp. (HRS) www.broadcast.harris.com	9/02	Al Acrodyne (ACRO); EMCEE Broadcast Products (ECIN); Itelco (pvt.); Thales (THS.L)
Infineon (IFX) www.infineon.com	12/00	(See Advanced Power entry.)
International Rectifier (IRF) www.irf.com	4/00	(See Advanced Power entry.)
Itron (ITRI) www.itron.com	10/02	ABB (ABB); Invensys (ISYS.L); Rockwell Automation (ROK); Schlumberger Sema/Schlumberger Ltd. (SLB); Siemens (SI)
IXYS (SYXI) www.ixys.com	4/00	(See Advanced Power entry.)
Kemet Corp. (KEM) www.kemet.com	5/02	AVX Corporation/Kyocera Group (AVX); EPCOS (EPC); NEC Corporation (NIPNY); TDK Corporation (TDK); Vishay (VSH)
Magnetek Inc. (MAG) www.magnetek.com	8/02	Ascom Energy Systems/Ascom (subs. ASCN, Switzerland); Astec/Emerson Electric (subs. EMR); Delta Electronics (2308, Taiwan); Tyco (TYC)
Maxwell Technologies (MXWL) www.maxwell.com	3/01	Cooper Electronic Technologies/Cooper Industries (div. CBE); NESS Capacitor/NESS Corp. (pvt.)
Microsemi (MSCC) www.microsemi.com	4/01	Semtech Corporation (SMTC); Zarlink Semiconductor (ZL)
Oceaneering Int'l. (OII) www.oceaneering.com	6/02	Alstom Schilling Robotics/ALSTOM (subs. ALS, France); Perry Slingsby Systems/Technip-Coflexip (subs. TKP); Stolt Offshore (SOSA); Subsea 7 (JV Halliburton (HAL) and DSND (DSNRF.PK))
Power-One (PWER) www.power-one.com	5/00	Artesyn Technologies (ATSN); Celestica (CLS); Lambda Electronics/Invensys (subs. ISYS.L); Tyco Electronics Power Systems/Tyco Electronics (div. TYC); Vicor (VICR)
Raytheon Co. (RTN) www.raytheon.com	10/01	BAE Systems (BA.L); Integrated Defense Technologies (IDE); Lockheed Martin (LMT); Northrop Grumman (NOC)
Rockwell Automation (ROK) www.rockwellautomation.com	9/01	Honeywell (HON); Invensys (ISYS.L); Mitsubishi Electric Automation/Mitsubishi Electric (div. MIELY.PK); Parker Hannifin (PH); Siemens (SI)
TRW Inc. (TRW)*** www.trw.com	1/01	Conexant (CNXT); Fujitsu (6702, Taiwan) www.fujitsu.com, Information & Electronic Warfare Systems/BAE Systems (div. BA.L); Northrop Grumman (NOC); RF Micro Devices (RFMD); Vitesse Semiconductor (VTSS)
Veeco Instruments (VECO)** www.veeco.com	7/02	Aixtron (AIX, Germany); Emcore (EMKR); FEI Company (FEIC); Riber (RIBE.LN); Thermo VG Semicon/Thermo Electron (subs. TMO)
Wilson Greatbatch Technologies (GB) www.greatbatch.com	3/02	Eagle-Picher Industries (EGLP.PK); Ultralife Batteries (ULBI)

* Listed alphabetically; not a list of all public companies with similar or competing products; typically does not include private companies, except where they are large in both size and market share.

** Veeco and FEI Company announced a merger agreement on July 12, 2002; FEI will become a wholly owned subsidiary of Veeco, which will be renamed Veeco FEI and continue to trade as VECO.

*** Northrop Grumman and TRW announced a definitive merger agreement on July 1, 2002, in which NOC will acquire TRW.

Note: This table lists technologies in the Digital Power Paradigm and representative companies in the ascendant technologies. By no means are the technologies exclusive to these companies, nor does this represent a recomended portfolio. 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 interest in the companies.