

Power Currents

Monthly Coverage of the Energy Technology Industry

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Energy Insecurity

- Soaring oil prices.
- \$2 a gallon gasoline.
- Threat of war in the Middle East.

Somehow it seems like a re-run of the bad movie we saw in 1973. In late January, with the price of crude near \$40 per barrel on the virtual shutdown of the Venezuelan petroleum industry and concerns about the effects of war on oil supply, the Bush administration unveiled its response—the “FreedomFuel” initiative, a \$120 million 5-year project to develop a hydrogen-based fuel infrastructure to support its “Freedom-Car” hydrogen-powered vehi-

cle program.

Later in this issue we assess the FreedomFuel project, look at the implications of a high oil-price regime on the energy technology industry and examine the issues surrounding the use of hydrogen for fuel. The summary version is this: over the long term (starting 20 years out) hydrogen-powered vehicles could become commercially viable, and over the very long term (50+ years) hydrogen could begin to supplant petroleum as the foundation fuel of our energy supply.

But in the near term, while we wait for the dawning of

the hydrogen age, should wars in the Middle East lead to a third oil crisis, other segments of the energy technology industry could benefit. Technologies and applications that could gain include:

- alternative fuels that can substitute for oil;
- diesel to natural gas conversion kits;
- hybrid electric vehicles; and
- combined heat and power.

See pp. 2 and 26-30 for more.

Publication Information

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Please see p. 31 for important disclosures and notices.

In This Month's Issue

During the first 30-60 days of 2003, two key themes stand out. First, there have been a number of promising initiatives in renewable energy, which we detail at several points in the *Energy Techline* section. And second, signs of economic recovery remain tenuous and public company earnings estimates continue to trend lower.

More on this in *TapeTalk* and *DataWerks*.

Of note at the *(De-)Construction Site* is news on the continued consolidation of the energy software industry. And last, in *Inductance & Reactance* we assess the possible effect of high oil prices on energy tech and discuss using hydrogen as an alternative.

Phone Co. Phun

Apologies to those who called the phone number listed at the back of last month's issue. In a classic bait-and-switch, just after we sent the issue out but just before the scheduled phone line installation, Verizon changed the phone number it had initially assigned us. The final and official phone #: **212.252.1883**

GridWatch

Energy and Power Industry Announcements and Developments

Overview. The last month or so has seen a flurry of activity in alternative and renewable energy. Examples include the Bush administration's FreedomFuel initiative, the formation or extension of subsidy programs in Germany and Austria, Japanese aid for renewable energy projects in developing countries, and the promulgation of an aggressive renewable energy portfolio target in the state of New York. In a different arena but of significant import, federal regulators proposed sizable new incentives for constructing or upgrading transmission network assets.

January 30. As more customers embrace renewable energy, up to 75% of U.S. utilities are set to offer a residential green power program of some description by the end of 2003, Chartwell reports in a new study. Several utilities are achieving a response rate much higher than the usual 1%. Some consumers are asking specifically for 'dark green' power, which comes from non-combustible renewable sources like the sun or wind and excludes power from high-efficiency combined-cycle natural gas turbines. By 2002, the percentage of U.S. utilities offering or in the planning stages of offering a green power program had risen to 46%, up from 30% a year earlier. In addition, in 2002, three out of 50 utilities (compared to zero in 2001) saw green power rapidly become their most popular residential market product.

January 29. In his State of the Union Message, President Bush announced a \$1.4 billion initiative to develop the technology needed for commercially viable hydrogen-powered fuel cells. The initiative will include about \$150 million per year to provide continued assistance to U.S. automakers for the development of fuel cell vehicles, and roughly \$120 million annually to develop the technologies and infrastructure needed to produce, store, and distribute hydrogen fuel for use on fuel cell vehicles and electricity generation.

Comment. The Bush administration's eager embrace of hydrogen raises several important questions. The public benefits of moving from a petroleum-based transportation infrastructure toward one based on hydrogen seem clear – energy independence, reduced military spending and substantial environmental gains – so the case for public-sector support becomes self-evident. The first question then is how much support is sufficient? An expert at the Union of Concerned Scientists was recently quoted in the *New York Times* as saying that the \$270 million per year the Bush plan proposes is possibly an order of magnitude too low. In addition, a read of the fine print reveals that part of the annual \$270 million will be directed to develop next-generation nuclear power plants that could generate both electricity and hydrogen.

But regardless of the level of spending, developing inexpensive fuel cell vehicles and the infrastructure to support them will take time. The second question, therefore, is how long? By the administration's own estimates, it will not be possible to determine the commercial viability of a hydrogen-based transportation system until 2015, and mass production of fuel cell vehicles will not begin until 2020. And of course, it will take many years after that for the existing fleet of gasoline-powered vehicles to be phased out through retirement and replacement.

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The administration has resisted Higher CAFE standards, probably the single best sustainable near-term way to increase energy independence, were opposed by the Bush administration. Moreover, instead of providing substantial public support for hybrid-electric vehicles, which are commercially available today (and do not need to be plugged in at night as some might think), lift fuel by up to 50% and more while reducing emissions by up to 90%, all without sacrifice space, comfort or performance (in fact, they tend to be quicker off the line because of their electric drive trains), the Bush administration is instead putting taxpayer money into technology whose commercial viability is unknown and that will not bear fruit for up to three decades in any case.

January 26. Germany is said to be planning positive changes to its already generous subsidies for renewable power sources. Support for wind farms at favorable coastal sites would be cut back, but the deadline for offshore windmill operators to claim subsidies will be extended to 2010 from 2006. The extension gives the industry time to develop 5MW wind turbines, it was reported. In addition, measures would be taken to compensate for the end of subsidies to homeowners who install solar panels on their roofs, and small biomass plants could get more money.

Comment. While wind power is already economic in many locations, and close to economic in many others, subsidies have accelerated the growth of the installed base. Subsidies have been much more important to the spread of grid-connected solar power. Germany's subsidy programs have been a major source of growth for the wind and solar power industries. For the last several years Germany has been the world's largest buyer of wind and solar power systems, and the country now has one of the largest installed bases of renewable energy anyway. The proposed measures in Germany to alter and extend its subsidy program would be a real win.

January 24. **Cape Wind Associates** recently announced it has selected **GE Wind Energy** to provide wind turbines for its 420-megawatt offshore wind farm project in Horseshoe Shoal off the coast of Cape Cod, MA. By using GE Wind's offshore wind turbines, the company should be able to reduce the number of turbines in the project from 170 to 130 and increase the distance between the south shore of Cape Cod and the wind farm.

Comment. Even if the Horseshoe Shoal program ends up using 130 turbines instead of 170, that is 130 turbines too many for certain local homeowners and environmental organizations. Concerns include damage to the shoals from the installations, hazards to birds, and visual pollution. There may well be other places to site an offshore wind farm. But ultimately the growing appetite for power must be satisfied. The visual pollution of a wind farm seems like a small price to pay compared with the greenhouse gases and other pollutants poured into the air by a natural gas-powered or coal-fired power plant. The alternative is to reduce electricity demand with energy-efficient appliances, "green" building designs and materials or voluntary behavior changes like using less air conditioning.

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January 17. After about two years of sales and marketing activity, **Green Mountain Energy Company**, a large retail provider of cleaner electricity, says it will discontinue serving all of its 1,312 customers in Connecticut as of March 31, 2003. The company pointed to regulations that make it expensive to bring green energy into Connecticut along with as well as the lack of competition in the state's retail power market as reasons for its pullout. Green Mountain will instead focus its eastern US efforts in New Jersey, New York and Pennsylvania.

Comment. While wholesale power market deregulation has with certain caveats been a success, retail market deregulation has proved more problematic. Green Mountain is among the most effective power retail marketers in the business. For Green Mountain to withdraw from Connecticut is indicative of both the issues with the Connecticut retail power market specifically and the challenges of designing competitive retail power markets more generally.

January 17. The **City of Chicago** and 13 companies have set up the **Chicago Climate Exchange (CCX)**, a trading program designed to barter greenhouse emissions in return for pollution output reductions by exchange member. Total emissions by the membership totals an estimated 275 million tons, and the participants pledged to cut 11 million tons. Discussions reportedly are underway with 53 additional corporations interested in becoming CCX members, and new names could be announced within the next 90 days. CCX will operate under the regulatory umbrella of the NASD, and will use Rothschild Inc. for investment banking services. Membership thus far includes **Chicago, AEP, Baxter International, DuPont, Equity Office Properties Trust, Ford Motor Co., International Paper, Manitoba Hydro, MeadWestvaco, Motorola, STMicroelectronics, Stora Enso North America, Temple-Inland** and **Waste Management**.

Comment. The CCX is not blazing any new trails here, which is actually a positive, not a negative—it means that the business model for trading pollution credits is already understood and proven. US companies have been free to trade sulfur dioxide (responsible for acid rain) for some years now, and there are markets for trading greenhouse gases operating in Europe. CCX members admit that the voluntary reductions they achieve, at least early on, will likely not meet Kyoto Accord standards. Nonetheless, they believe that the voluntary approach favored by the Bush administration will give way sooner or later to mandatory pollution cuts, and the fact that they have already achieved some modicum of progress should make it easier to meet the mandated reductions and win them some sort of regulatory concession or recognition for launching and participating in the CCX.

GridWatch

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January 16. The Board of Directors of **ISO New England Inc.**, operator of the region's bulk power system and wholesale power market, voted unanimously to pursue the creation of a Regional Transmission Organization for New England. ISO New England will work with the New England transmission owners to seek the input and advice of all market participants, regulators, and other stakeholders to prepare a joint petition for the Federal Energy Regulatory Commission (FERC) to propose the formation of an RTO for New England.

Comment. This decision represents one more step on the thousand-mile journey to create large regional transmission networks and more liquid wholesale power markets.

January 15. A group of 20 vehicle and automotive parts manufacturers, including **Toyota, DaimlerChrysler, Ford** and **Nissan**, has set out to increase the range of fuel cell vehicles by developing a standardized high-pressure hydrogen fuel tank, with 40% extra capacity. By increasing a fuel cell vehicle's range from 300km (roughly 190 miles) at present to 500km (about 320 miles), in line with conventional vehicles, the automotive industry hopes to create a competitive pollution-free alternative. The consortium intends to have these new tanks ready for commercial sale by 2005.

January 15. In an effort to give US utilities more incentives to build new transmission, the **Federal Energy Regulatory Commission** (FERC) proposed boosting return on equity by up to 3 percentage points for firms that participate in the agency's grid-building efforts. FERC has tried to encourage US utilities to form and join large regional transmission organizations (RTOs) to provide cheaper and more reliable wholesale electricity to customers, provided additional transmission lines and infrastructure are built to meet growing electricity demand. The agency has linked a shortage of transmission to bottlenecks on the grid and resulting higher prices for consumers. The agency said it will give utilities until the end of 2004 to qualify for the incentives. Under the proposal, a US utility that joins a regional transmission grid would get 50 basis points added to its return on equity through 2012. Utilities that have already joined a regional grid and agree to divest transmission assets to the grid would get an extra 150 basis points through 2022. Utilities that agree to build new projects could receive 100 extra basis points to their rate of return.

Comment. Utilities have been reluctant to invest in the transmission network in large part because of regulatory uncertainty about ownership of the assets, and this in turn is degrading the performance of the grid and driving power prices higher. The FERC's incentive package is an effort to resolve both issues. By encouraging RTO formation, the question of transmission asset ownership is put to rest, while the incentives to invest in new projects should promote needed additions to capacity.

GridWatch

Energy and Power Industry Announcements and Developments

January 14. **IntercontinentalExchange** announced that it has received approval from the Commodity Trading Futures Commission (CFTC) permitting registered traders and locals with floor or electronic trading privileges on any regulated US futures exchange to execute over-the-counter transactions on Intercontinental's electronic trading platform. Transactions executed on Intercontinental's platform may be settled on a bilateral basis or cleared through a designated clearing organization that has a clearing relationship with Intercontinental.

January 14. Officials in Japan have announced plans to fund projects in developing countries that will be conducted under the Kyoto Protocol beginning next fiscal year. By supporting the projects, officials said the government hopes to obtain more than 1 million tons of greenhouse gas emission reductions credits per year. The government will provide about a third of the costs for the projects, which will include wind farms and landfill gas reclamation plants. Three projects slated to launch next year have received allocations of about 300 million yen (about \$2.5 million).

January 14. Representative J.D. Hayworth, an Arizona Republican, has reintroduced a bill that would offer tax credits equaling 15% of the cost of residential solar electric and hot water systems. The proposal passed both the House and Senate last Congress, and was supported by the White House, but did not become law because the comprehensive energy bill was never passed. The Hayworth bill has been referred to the House Committee on Ways and Means.

Comment. It has been the states, not the federal government, that have provided the overwhelming amount of public support for solar power and other forms of renewable energy. Given growing concerns about mercury emissions from coal-burning power plants as well as energy security, there is clearly a case for some form of federal subsidy for renewables. The passage of the Hayworth bill, which would add an additional layer of support on top of what many states already offer, should further accelerate the adoption of solar power. This would come at an opportune time for the solar power industry, which has recently been adding substantial new capacity.

January 13. **Hawaiian Electric** has given its new subsidiary, **Renewable Hawai'i**, \$10 million, and will commit more as the initial projects start to show results. Gov. Linda Lingle has established a statewide goal of having 20% of all power coming from renewables by 2020, up from about 7% today. Most of that 7% currently comes from solid municipal waste and sugar cane combustion and geothermal wells. Wind and solar power provide only a nominal share of the present total, but Hawaiian Electric has been pursuing partnerships to produce wind power.

GridWatch

Energy and Power Industry Announcements and Developments

January 10. As part of a broad range of support for renewable energy technologies in Austria, solar photovoltaics will receive support through a scheme similar to Germany's Renewable Energy Law. From January 1, 2003, solar electricity will be remunerated at a level up to 60 euro cents/kWh. Solar plants below 20 kilowatts in size will qualify for the 60 cents/kWh rate, while larger systems will receive 47 cents/kWh. These rates will be payable for a period of 13 years from startup of the solar installation. The regulation applies only to new plant installations approved between 1 January 2003 and 31 December 2004. Other renewable energies will receive smaller incentives.

Comment. This solar power subsidy program is among the most generous in the world. The incentive structure is very close to that of Germany's highly successful 100,000 Solar Rooftops program. Although Austria does not have Germany's population, overall it receives more sunlight, particularly compared to Germany's northern reaches. At a time when the solar power industry is absorbing a large capacity expansion, the incremental demand created by this program should be welcome.

January 8. In his State of the State speech, Gov. George Pataki said he will order the state Public Service Commission to implement a renewable portfolio standard of 25 percent on in-state power generation within 10 years. About 17 percent of the electricity generated in New York currently is produced by renewable sources, virtually all of that hydroelectricity. A Greenhouse Gas Task Force appointed by Pataki recommended that a renewable electricity mandate be adopted in New York. Thirteen other states have some form of a mandate, including Massachusetts, New Jersey, Connecticut, Pennsylvania, Texas and California. In June 2001, Pataki issued an executive order giving all state agencies until 2010 to get their sources from "green" sources.

Comment. A 25% renewable portfolio standard is among the largest in the US, if not the largest hands down. Since it is not likely that any new hydroelectric capacity will be added, the additional 8% needed to get there from the current 17% level will probably come from wind, solar and possibly some biomass, unless in the actual implementation of the program fuel cells are considered a renewable source (at present they are not—the hydrogen fuel they use in most cases comes from natural gas).

GridWatch

Energy and Power Industry Announcements and Developments

Week of January 6. The California Air Resources Board (CARB) proposed new changes to its Zero-Emission Vehicle (ZEV) program, delaying the start of the program until 2005. ZEVs are generally either battery- or fuel cell-powered. Battery-powered ZEVs need to be plugged in to “refill” once they have used up their stored electricity, while fuel cell ZEVs run on hydrogen. The ZEV program is intended to improve air quality by mandating that a certain share of vehicles sold in California produce no emissions. Its start date has continued to recede—in 1990 when the program was first launched, the mandates were supposed to roll in beginning in 1998. 1998 then became 2003, and 2003 has now become 2005. Legal challenges thrown up mostly by the auto industry, the technical difficulties of producing commercially viable ZEVs, and the administrative issues involved, have been responsible the delays.

In the new proposal, the ZEV program will begin in 2005, hybrid electric vehicles (HEVs) and vehicles with gaseous storage systems will earn partial credits irrespective of their fuel efficiency, and higher partial credit will be awarded for HEVs that can be recharged by being plugged in. Sale of these “advanced-technology partial ZEVs” (AT PZEVs) will satisfy most (75%) of an automaker’s ZEV quota. Separately, the CARB announced grants of up to \$11,000 per vehicle for fleets that purchase ZEVs.

Comment. These amendments to the ZEV program make its success much more likely. In particular, we believe the incentive it creates to sell hybrid electric vehicles is a major positive. HEVs are here now, they can offer substantial improvements in fuel efficiency and emissions, their cost premium over internal-combustion vehicles is modest, and they have already demonstrated customer acceptance. On the other hand, the immaturity of fuel cell ZEVs and the very limited range of battery-powered ZEVs makes the requirement to satisfy at least 25% of the ZEV quota with one of these technologies (or something similar) possibly unrealistic. The ZEV program continues to face legal challenges from the auto industry (and indirectly from the Bush administration), but on the whole we believe its implementation would be an important win for a number of energy technologies, such as advanced batteries, ultracapacitors, power semi-conductors and power electronics, and of course the environment as well.

Energy Techline

Company News Releases

January 22. **Toyota Motor Corporation** announced last week that it will discontinue production of its RAV4 EV, an all-electric sport utility vehicle, this spring. On its website, the company blamed low sales for its decision, saying that hybrid electric systems and other advanced technologies had greater potential. Twenty-five Toyota dealerships sold just 216 RAV4 EVs from February to mid-November 2002. The announcement came a week after the California Air Resources Board announced plans to delay its Zero-Emissions Vehicle program.

Comment. By this point the automobile industry has pretty much abandoned the electric vehicle (EV). High cost, limited driving range and the frequent need to plug in the vehicle for recharging are among the factors that have made EVs unattractive. There appear to be only two potential alternatives to the internal-combustion engine: hybrid-electric vehicles (HEVs) and fuel cell-powered vehicles. HEVs offer significant improvements in fuel efficiency and emission levels, and are already achieving growing mass-market acceptance. Meanwhile, fuel-cell vehicles remain a long way from commercial viability, and it may take until 2020 before they become competitive. So with EVs out of the picture and fuel cells nearly 20 years away, HEVs seem positioned to be the sole challenger to the internal-combustion engine for a long time to come.

January 15. According to a German newspaper, **Masterflex AG**, a leading German producer of plastic hoses and pipes, plans to enter the portable fuel cell market. The company currently employs around 400 people, 10 of whom are in their newly created fuel cell division. The company aims to produce small PEM fuel cells for use in portable devices. Masterflex, supported by local research facilities and partly funded by the local government with EUR 580,000, will present its first prototype at the IT fair “CeBIT” in March in Hannover.

Comment. Of the three broad fuel cell markets – portable power, stationary power and automotive power – we believe portable holds the greatest near-term promise. Grid-connected stationary power and automotive fuel cells are competing against very inexpensive and highly reliable incumbent technologies. In contrast, portable fuel cells are targeting incumbent solutions that are both expensive per unit of energy stored and unsatisfactory in performance – mobile phone and laptop computer batteries, for example, are notorious for running out of energy at inconvenient times. In portable power markets, many customers will pay up for extended operating life. With the cost hurdle for portable fuel cells set significantly lower than for other fuel cell types, we expect they will be the first to achieve widespread acceptance.

Energy Techline

Company News Releases

January 2. **Ford Global Technologies**, which manages intellectual property for its parent **Ford Motor Company**, has recently been granted a patent by the US Patent Office for an “ultrahigh power density miniaturized solid oxide fuel cell.” According to the patent abstract, a “miniaturized solid-oxide fuel cell and process for making the same are provided. A fuel cell is provided that contains an electrolyte material, electrodes, and interconnects. Manifolds can be placed either within the electrodes or within the interconnects. Techniques common to the microelectronic industry are used to manufacture a miniaturized fuel cell. The miniaturized fuel cell is created by stacking individual fuel cells over one another to maintain a sufficient level of power density and durability.” Although the abstract does not state how the fuel cell might be used, our guesses include portable power for consumer electronic products, remote locations, and other portable applications, and possible stationary power generation.

Comment. Ford is not the only automaker leveraging its fuel cell technology into the stationary and portable power markets. General Motors has announced its intentions to roll out a line of stationary power fuel cells, and Honda may be doing the same. It will be interesting to see whether they are successful—the automakers certainly know volume manufacturing and cost reduction, but do not necessarily know the markets for stationary and portable power. In addition, they may end up competing against companies like Caterpillar and Cummins that also know something about volume manufacturing and cost reduction, but are deeply entrenched in the power industry. In the end maybe joint ventures provide one solution.

TapeTalk

Energy Tech Company Share Price and Earnings Performance

For the month of January, stock action was driven by company-specific issues as much as by industry or market dynamics. The median stock was down about -2%. The big winner was Caminus, a provider of software for energy trading, risk analysis and asset management, up 275% on the announcement of its pending acquisition by Sungard Data Systems (more on the transaction at *The (De-)Construction Site*). Energy tech stocks gave up another -2% or so in the first three weeks of February, generally following the broader market down.

Company	Price 21-Feb-03	Mkt Cap (\$MM)	Share Price % Change			Price/Earnings		Price/ Book	Price/ Cash	Price/ LTM Sales
			2003 YTD	Last Mo.	Last Yr.	FY 02	FY 03			
Distributed Generation										
AstroPower	6.29	137	-21.3%	-15.5%	-70.4%	31.5	18.0	0.9	4.1	1.6
Ballard Power	10.48	1,099	-5.3%	-4.8%	-62.6%	n/a	n/a	1.5	2.7	12.1
Capstone Turbine	0.81	66	-10.0%	-2.2%	-83.4%	n/a	n/a	0.3	0.5	2.5
Energy Conversion Devices	9.46	207	-3.5%	4.8%	-48.3%	n/a	n/a	1.6	1.5	2.7
Evergreen Solar	1.48	17	14.7%	-7.0%	-62.1%	n/a	n/a	0.5	1.3	3.1
FuelCell Energy	5.43	214	-17.1%	-11.6%	-63.9%	n/a	n/a	0.8	1.0	5.2
H Power	4.14	45	8.1%	0.5%	22.8%	n/a	n/a	0.8	1.0	14.9
Millennium Cell	1.81	53	-24.3%	-11.3%	-54.2%	n/a	n/a	7.2	4.8	75.0
Plug Power	5.40	275	20.3%	14.3%	-48.6%	n/a	n/a	2.6	3.6	25.2
Proton Energy Systems	2.73	91	-9.0%	4.7%	-63.6%	n/a	n/a	0.5	0.6	16.3
Average			-4.7%	-2.8%	-53.4%			1.7	2.1	15.9
Clean Fuel & Combustion Technology										
Catalytica Energy Systems	2.60	46	-5.8%	-0.4%	-39.6%	n/a	n/a	0.6	0.6	9.5
Fuel-Tech N.V.	4.04	79	-3.6%	-1.0%	-30.7%	17.6	11.5	5.1	9.7	3.0
Headwaters	14.84	407	-4.3%	-7.8%	35.3%	11.3	9.2	3.7	29.1	2.1
Methanex Corporation	8.74	1,098	4.3%	9.2%	51.3%	n/a	n/a	1.2	2.6	1.1
Quantum Fuel Systems Tech	2.99	63	27.2%	27.7%	-59.5%	n/a	n/a	1.3	6.1	3.0
Syntroleum Corporation	2.45	80	41.6%	75.7%	-75.6%	n/a	n/a	(20.4)	5.4	6.9
Average			9.9%	17.2%	-19.8%			(1.4)	8.9	4.3
Energy Information Technology										
Caminus Corporation	8.53	146	264.5%	275.2%	-89.8%	n/a	n/a	1.2	3.7	1.6
Intergraph	18.64	860	5.0%	-2.7%	29.3%	41.4	23.3	1.4	1.6	1.7
Itron	17.18	347	-10.4%	-16.8%	-36.7%	14.3	11.9	2.1	10.6	1.2
Average			86.4%	85.2%	-32.4%			1.6	5.3	1.5
Energy Storage										
Active Power	1.43	60	-19.7%	-12.9%	-73.8%	n/a	n/a	0.6	0.7	4.4
Beacon Power	0.18	8	-14.3%	4.8%	-83.8%	n/a	n/a	0.4	0.4	n/a
C&D Technologies	16.67	428	-5.7%	-1.8%	-22.7%	22.8	17.5	1.7	51.0	1.2
Electric Fuel Corporation	0.53	18	-17.2%	-15.6%	-61.4%	n/a	n/a	1.5	5.1	3.4
Medis Technologies	3.37	71	-32.6%	-3.2%	-32.0%	n/a	n/a	1.0	9.0	461.7
Ultralife Batteries	3.88	49	4.9%	-11.9%	-17.6%	n/a	n/a	2.6	54.6	1.5
Valence Technology	2.00	122	53.8%	46.9%	-61.4%	n/a	n/a	(7.4)	21.1	67.9
Average			-4.4%	0.9%	-50.4%			0.1	20.3	90.0
ENERGY TECHNOLOGY INDUSTRY										
Mean			4.3%	7.5%	-46.2%			1.0	7.3	15.9
Median			-4.1%	-2.0%	-53.8%			1.2	3.4	1.9

Note: Data presented in TapeTalk are sourced from I/B/E/S, Market Guide and Vortex Energy LLC estimates

TapeTalk

Energy Tech Company Share Price and Earnings Performance

Despite the downdraft in the first part of February in energy tech as well the broader market, power semiconductor stocks managed to swim upriver to gain roughly +7%. This segment has perhaps the most diversified customer base in energy tech, with power semiconductors winding up in computing and communications hardware, cars, trucks, trains, medical devices, aerospace and defense systems, industrial controls, motor drives, etc. etc. Generally speaking, the publicly traded power electronics companies are more exposed to tech hardware. Even though merchant power electronics companies are important users of power semiconductors, their technology market focus could help explain the weak performance of their stocks relative to the power semiconductor companies.

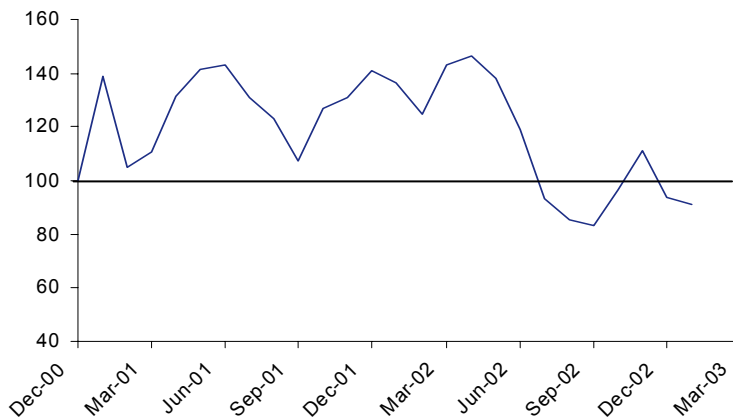
Company	Price 21-Feb-03	Mkt Cap (\$MM)	Share Price % Change			Price/Earnings		Price/ Book	Price/ Cash	Price/ LTM Sales
			2003 YTD	Last Mo.	Last Yr.	FY 02	FY 03			
Power Semiconductors										
Advanced Power Technology	4.20	44	29.6%	13.3%	-72.1%	n/a	n/a	0.6	2.4	1.2
AVX Corporation	9.43	1,640	-3.8%	-10.2%	-58.5%	n/a	117.9	1.1	2.3	1.4
Fairchild Semiconductor	12.05	1,409	12.5%	2.1%	-62.0%	26.8	14.5	1.2	2.2	1.0
International Rectifier	21.87	1,402	18.5%	7.5%	-47.1%	29.6	17.6	1.5	2.1	1.7
IXYS	6.37	203	-9.8%	-17.4%	-12.7%	n/a	24.5	1.4	5.5	1.7
Kemet	8.39	723	-4.0%	-29.0%	-50.8%	n/a	279.7	0.9	2.6	1.6
Maxwell Technologies	6.32	87	4.5%	4.1%	-38.3%	n/a	31.6	1.7	10.4	1.5
Microsemi	8.14	236	33.7%	30.5%	-79.5%	58.1	18.9	1.3	8.7	1.2
O2Micro International	9.04	344	-7.2%	-6.9%	-59.5%	30.1	17.4	2.6	3.1	5.1
ON Semiconductor	1.40	247	2.2%	-6.6%	-33.8%	n/a	10.0	(0.4)	0.9	0.2
Power Integrations	21.84	622	28.5%	27.1%	-25.6%	37.7	28.0	4.4	5.7	5.8
Semtech	13.37	977	22.2%	21.8%	-69.3%	28.4	25.7	2.9	2.0	5.0
Siliconix	22.40	669	-4.3%	-3.4%	-14.7%	11.4	8.9	1.7	4.9	1.8
Average			9.4%	2.5%	-48.0%			1.6	4.1	2.2
Power Electronics										
Artesyn Technologies	3.60	138	-6.2%	-9.4%	-58.8%	n/a	32.7	1.1	2.1	0.4
Magnetek	3.35	79	-24.5%	7.0%	-50.7%	n/a	67.0	0.7	26.3	0.4
PECO II	0.40	8	-37.5%	1.6%	-89.3%	n/a	n/a	0.1	0.3	0.1
Power-One	4.92	393	-13.2%	-13.2%	-45.5%	n/a	54.7	1.4	3.7	1.7
Powerwave Technologies	3.78	248	-30.0%	-23.7%	-68.8%	n/a	25.2	0.8	1.5	0.6
SatCon Technology	0.90	15	-35.7%	-28.6%	-73.1%	n/a	n/a	0.6	9.0	0.4
UQM Technologies	3.00	57	18.6%	32.4%	-53.4%	n/a	n/a	6.3	25.7	3.3
Vicor	6.06	257	-26.5%	-17.2%	-49.1%	n/a	35.6	1.0	2.5	1.7
Average			-19.4%	-6.4%	-61.1%			1.5	8.9	1.1
Power Quality										
American Power Conversion	16.10	3,157	6.3%	2.7%	4.8%	20.6	17.5	2.4	4.5	2.4
American Superconductor	3.51	74	16.6%	65.8%	-75.4%	n/a	n/a	0.5	3.1	5.6
Intermagetics General	16.74	276	-14.8%	-14.1%	-24.2%	17.8	15.1	1.9	3.7	1.9
Average			2.7%	18.1%	-31.6%			1.6	3.8	3.3
ENERGY TECHNOLOGY INDUSTRY										
Mean			4.3%	7.5%	-46.2%			1.0	7.3	15.9
Median			-4.1%	-2.0%	-53.8%			1.2	3.4	1.9

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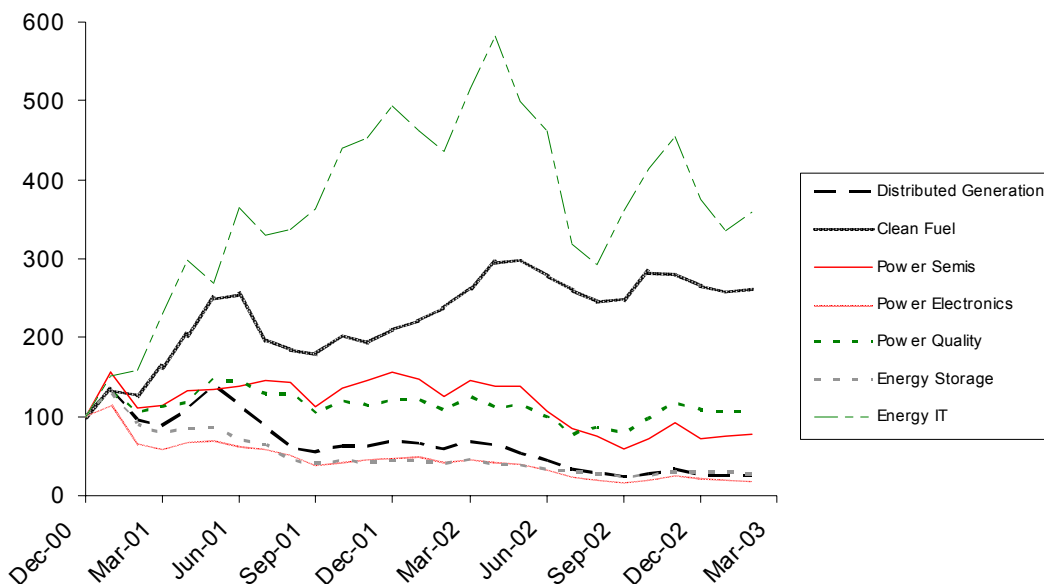
Energy Tech Company Share Price and Earnings Performance

The first graph below, plotting the stock price performance of the overall energy tech industry, shows that energy tech shares have held up reasonably well over the course of two difficult years (2001-02). The second graph below share price performance by industry segment, and underscores the importance of stock selection. Energy IT (topmost green dashed line) and clean fuel & combustion technology shares outperformed the others by a wide margin, with a principal driver being the solid revenue and earnings growth posted by such names as Headwaters, Itron and Methanex, and Caminus as well for at least some of that period.

VORTEX ENERGY TECH INDUSTRY INDEX



VORTEX ENERGY TECH SEGMENT INDEXES



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Energy Tech Company Share Price and Earnings Performance

Overall, technical stock indicators are slightly positive compared to last month. First, insider buying has remained well ahead of selling but is still concentrated at a few companies. Second, short interest in January was flat against December; the only change of note was the uptick in short interest at O2Micro to 13% of the float from 10%. And third, 4-week relative strength versus the S&P 500 improved slightly, to 1.3 from 1.0.

Company	Insider Trading		Short Interest - Jan		Short Interest - Dec		Average Volume		Beta	Relative Strength	
	Buys	Sells	Shares	% of Float	Shares	% of Float	Daily	Monthly		4-week	13-week
Distributed Generation											
AstroPower	2	-	5,196	27.8%	5,236	28.0%	97	3,747	2.2	-6	-12
Ballard Power	-	-	10,477	10.2%	11,456	11.2%	537	18,263	2.0	9	-17
Capstone Turbine	13	-	1,084	2.2%	1,329	2.7%	378	8,031	4.0	-12	-14
Energy Conversion Devices	-	-	528	2.9%	555	3.0%	57	964	1.1	-1	-4
Evergreen Solar	-	-	116	1.4%	116	1.4%	16	621	2.7	19	93
FuelCell Energy	-	-	3,197	9.5%	3,102	9.3%	309	8,612	1.7	2	-28
H Power	-	174	125	1.6%	155	1.9%	25	933	2.3	20	13
Millennium Cell	-	356	713	3.2%	977	4.4%	96	2,628	1.4	-15	-5
Plug Power	-	526	2,971	17.2%	3,000	17.3%	244	7,077	2.0	28	-1
Proton Energy Systems	1	-	326	2.9%	378	3.3%	50	1,130	3.4	2	7
Clean Fuel & Combustion Technology											
Catalytica Energy Systems	107	-	77	0.5%	81	0.5%	18	409	-0.7	-4	9
Fuel-Tech N.V.	-	49	215	1.4%	180	1.2%	8	372	-0.1	-8	27
Headwaters	1	-	791	3.0%	396	1.5%	196	6,860	0.6	0	-4
Methanex Corporation	-	-	169	0.1%	158	0.1%	53	2,776	0.2	-1	8
Quantum Fuel Systems Tech	-	-	1,099	6.2%	1,141	6.5%	80	2,613	0.0	21	55
Syntroleum Corporation	482	-	40	0.2%	43	0.2%	42	2,145	0.2	4	54
Power Semiconductors											
Advanced Power Technology	18	-	92	1.6%	91	1.5%	22	861	2.8	6	12
AVX Corporation	-	-	826	1.5%	748	1.4%	171	6,015	1.7	4	-13
Fairchild Semiconductor	-	130	2,482	3.1%	2,552	3.2%	670	23,993	2.2	14	-17
International Rectifier	-	-	4,235	6.9%	3,488	5.7%	600	15,936	2.7	12	-3
IXYS	2	-	409	2.2%	396	2.2%	34	749	2.3	-6	-3
Kemet	-	28	3,126	3.7%	3,239	3.8%	273	8,967	1.5	8	-11
Maxwell Technologies	-	315	847	6.7%	908	7.2%	15	302	1.2	-3	-1
Microsemi	-	-	1,796	6.5%	1,512	5.5%	168	7,353	1.8	15	48
O2Micro International	-	-	3,057	13.4%	2,290	10.0%	218	6,628	3.5	-21	-22
ON Semiconductor	15	20	73	0.1%	90	0.1%	109	2,967	3.2	6	-36
Power Integrations	-	120	2,536	9.1%	2,048	7.3%	615	11,564	1.8	5	14
Semtech	3	-	4,343	6.2%	5,207	7.5%	1,458	34,515	1.5	4	-11
Siliconix	-	-	21	0.4%	38	0.7%	18	314	1.5	-4	-12
Power Electronics											
Artesyn Technologies	21	-	52	0.2%	70	0.2%	72	2,926	2.5	11	-2
Magnetek	128	-	114	0.5%	213	0.9%	70	1,214	1.1	-20	-39
PECO II	-	-	24	0.2%	23	0.2%	275	1,928	0.9	-42	-37
Power-One	1,423	11	1,881	3.0%	2,736	4.4%	490	14,933	3.3	-8	-5
Powerwave Technologies	-	-	1,300	2.0%	888	1.4%	619	19,202	2.6	-17	-32
SatCon Technology	-	-	101	0.9%	169	1.4%	88	1,666	1.3	-7	-46
UQM Technologies	-	20	4	0.0%	4	0.0%	25	475	0.9	-15	22
Vicor	-	10	157	0.8%	180	0.9%	32	914	1.8	-17	-20
Power Quality											
American Power Conversion	-	63	3,202	1.9%	2,038	1.2%	1,128	38,916	1.8	3	9
American Superconductor	-	-	1,410	6.8%	1,342	6.5%	43	1,796	2.0	-8	10
Intermagetics General	-	23	469	2.9%	523	3.3%	29	1,547	1.0	1	-9
Energy Storage											
Active Power	169	-	1,850	5.3%	1,887	5.4%	157	2,649	3.4	-14	-13
Beacon Power	4,411	4,411	16	0.1%	7	0.0%	25	1,706	2.1	-21	-24
C&D Technologies	4	-	542	2.2%	543	2.2%	67	2,137	1.7	-3	-8
Electric Fuel Corporation	-	125	535	2.1%	633	2.5%	97	4,412	1.3	17	-30
Medis Technologies	-	-	731	8.3%	663	7.5%	15	359	1.8	-30	-27
Ultralife Batteries	62	33	219	2.2%	217	2.2%	15	410	0.5	20	55
Valence Technology	15,465	1	2,955	7.7%	3,459	9.0%	174	5,030	2.3	19	66
Energy Information Technology											
Caminus Corporation	61	-	318	2.6%	341	2.8%	210	6,305	1.6	-1	322
Intergraph	1	45	546	1.3%	381	0.9%	279	6,461	0.7	10	15
Itron	-	123	826	4.2%	927	4.7%	170	4,893	0.4	3	-23
Total	22,389	6,460	67,393	4.1%	67,227	4.1%	223	6,449	1.8	-1.0	-2.2

All share data in thousands

Insider trading data covers the last 6 months of activity

Daily trading volume based on 10-day average; monthly volume based on 3-month average

Relative strength indicates how well a stock has performed versus the S&P 500 over a specified time

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Energy Tech Company Share Price and Earnings Performance

EPS remain largely negative. Revenues at many companies are trending higher both sequentially and year over year. However, median revenues in power semiconductors and power electronics, by far the largest sectors by revenue, were flat /down -5% sequentially; and while sales were up about +10% in power semis, they were down close to -15% among power electronics companies against what should have been an easy comp.

Company	Revenues				Last Q Revs - % Chg		Diluted Continuing EPS			
	Last Q	2001	2000	LTM	Q/Q	Y/Y	Last Q	2001	2000	LTM
Distributed Generation										
AstroPower	23.0	69.5	49.8	84.8	12.7%	25.0%	0.04	0.16	0.18	0.23
Ballard Power	29.3	90.9	36.2	90.9	4.6%	120.3%	(0.35)	(1.29)	90.90	(1.24)
Capstone Turbine	3.9	36.0	23.2	26.0	-47.3%	18.2%	(0.14)	(0.61)	(12.82)	(0.89)
Energy Conversion Devices	18.5	91.7	71.4	76.9	16.4%	-30.7%	(0.26)	(0.96)	(0.27)	(1.15)
Evergreen Solar	2.1	2.5	2.2	5.4	61.5%	250.0%	(0.24)	(1.10)	(2.96)	(1.18)
FuelCell Energy	13.7	41.2	26.2	41.3	14.2%	104.5%	(0.53)	(1.25)	0.45	(1.25)
H Power	0.7	2.6	3.6	3.0	-22.2%	-12.5%	(0.87)	(2.59)	(2.20)	(2.82)
Millennium Cell	0.2	0.7	-	0.7	100.0%	n/a	(0.12)	(0.58)	(0.72)	(0.58)
Plug Power	3.0	5.7	8.4	10.9	20.0%	233.3%	(0.21)	(1.56)	(1.99)	(1.02)
Proton Energy Systems	1.6	3.0	0.7	5.6	23.1%	300.0%	(0.13)	(0.15)	(5.92)	(0.35)
Clean Fuel & Combustion Technology										
Catalytica Energy Systems	1.5	5.5	5.5	4.8	36.4%	25.0%	(0.22)	(1.33)	(1.25)	(1.02)
Fuel-Tech N.V.	8.0	17.7	21.9	26.8	0.0%	90.5%	0.02	(0.09)	0.02	0.06
Headwaters	88.7	119.3	45.5	189.7	103.0%	382.1%	0.29	0.94	0.87	1.04
Methanex Corporation	307.0	1,008.8	1,149.0	1,008.8	3.5%	57.2%	(0.24)	0.21	0.46	0.21
Quantum Fuel Systems Tech	5.6	23.4	23.4	20.8	21.7%	-3.4%	(0.30)	(2.46)	(1.71)	(1.64)
Syntroleum Corporation	2.4	11.6	6.7	11.6	-38.5%	50.0%	(0.29)	(1.98)	(0.91)	(1.98)
Power Semiconductors										
Advanced Power Technology	13.1	36.9	44.2	37.3	22.4%	92.6%	0.01	0.19	0.50	(0.38)
AVX Corporation	282.6	1,250.0	2,608.1	1,148.0	-4.3%	-7.1%	-	(0.04)	3.22	0.01
Fairchild Semiconductor	353.9	1,411.9	1,407.7	1,411.9	-1.9%	9.0%	0.03	(0.02)	(0.42)	(0.02)
International Rectifier	209.5	720.2	978.6	801.3	-1.3%	21.7%	(1.90)	0.75	1.35	(1.29)
IXYS	35.5	82.8	111.4	118.6	0.6%	120.5%	(0.03)	0.07	0.49	(0.18)
Kemet	103.7	508.6	1,406.1	458.7	-8.3%	-11.6%	(0.37)	(0.32)	4.00	(0.63)
Maxwell Technologies	16.6	77.9	102.3	58.0	25.8%	10.7%	(1.53)	(0.82)	(1.66)	(4.70)
Microsemi	45.9	212.6	243.4	201.6	-6.7%	-19.5%	(0.06)	(0.16)	0.59	(0.37)
O2Micro International	18.0	45.8	40.4	67.2	1.7%	51.3%	0.07	0.16	0.21	0.30
ON Semiconductor	265.7	1,084.5	1,214.6	1,084.5	-2.3%	-0.4%	(0.24)	(0.82)	(4.21)	(0.83)
Power Integrations	29.2	108.2	94.1	108.2	3.5%	23.7%	0.12	0.33	0.23	0.32
Semtech	47.2	191.2	256.7	194.9	-9.4%	8.0%	0.17	0.31	0.79	0.55
Siliconix	98.3	372.9	305.6	372.9	2.3%	28.2%	0.45	1.55	0.51	1.56
Power Electronics										
Artesyn Technologies	83.4	350.8	494.0	350.8	-3.0%	-22.3%	(0.16)	(0.61)	(0.52)	(0.61)
Magnetek	51.3	188.2	298.3	182.7	19.9%	8.9%	0.06	0.06	0.39	(1.05)
PECO II	10.7	62.1	106.7	62.1	-40.2%	-53.5%	(0.47)	(1.85)	(0.31)	(1.87)
Power-One	66.0	230.7	363.7	230.6	10.0%	37.8%	(2.46)	(2.64)	(2.36)	(2.63)
Powerwave Technologies	76.1	384.9	300.3	384.9	-16.6%	-9.8%	(0.06)	0.06	(0.33)	0.07
SatCon Technology	6.9	41.6	41.7	40.2	-38.4%	-16.9%	(0.31)	(1.25)	(1.51)	(1.23)
UQM Technologies	3.7	21.4	25.3	17.1	-9.8%	-28.8%	(0.07)	(0.36)	(0.12)	(0.41)
Vicor	41.6	152.6	195.9	152.5	5.3%	6.7%	(0.08)	(0.38)	(0.01)	(0.37)
Power Quality										
American Power Conversion	358.0	1,300.0	1,404.8	1,300.0	6.2%	5.7%	0.14	0.59	0.58	0.58
American Superconductor	2.8	11.7	16.8	13.4	-37.8%	-20.0%	(0.60)	(2.79)	(1.08)	(3.00)
Intermagetics General	36.7	153.3	138.2	146.1	4.3%	-5.9%	0.16	1.19	0.67	0.75
Energy Storage										
Active Power	3.1	13.5	22.6	13.5	-3.1%	-31.1%	(0.19)	(0.67)	(0.70)	(0.67)
Beacon Power	-	-	0.1	-	n/a	n/a	(0.21)	(0.62)	(10.77)	(0.58)
C&D Technologies	87.6	471.6	615.7	344.3	3.9%	-14.5%	0.20	1.35	2.05	0.70
Electric Fuel Corporation	3.3	4.0	4.1	5.4	300.5%	450.0%	(0.03)	(0.71)	(0.62)	(0.28)
Medis Technologies	-	-	-	0.2	n/a	n/a	(0.22)	(2.02)	(1.79)	(1.18)
Ultralife Batteries	6.8	32.5	24.2	31.8	-20.9%	-10.5%	(0.14)	(2.03)	(1.55)	(1.84)
Valence Technology	0.3	4.9	8.7	1.8	-40.0%	-40.0%	(0.19)	(1.53)	(1.14)	(0.69)
Energy Information Technology										
Caminus Corporation	19.7	74.7	51.7	89.2	4.8%	29.6%	(0.29)	(0.39)	(1.04)	(0.66)
Intergraph	122.0	501.2	532.1	501.2	-8.6%	-8.3%	1.85	7.48	0.39	7.37
Itron	77.3	284.8	225.6	284.9	5.7%	20.4%	(0.03)	0.41	0.75	0.35

All revenue data in millions

For companies with non-calendar fiscal years, revenue and EPS data is for FY2002 and FY2001

Diluted continuing EPS as reported in SEC filings; excludes extraordinary items but includes "above the line" gains and charges

TapeTalk

Energy Tech Company Share Price and Earnings

While the latest EPS results are running above consensus, downward revisions for 1H03 accelerated from last month. We suspect 2H03 estimates may also need to come down—full-year estimates are likely too back-end loaded.

Latest Quarter Earnings Surprises		Total Estimate Revisions ↑ / ↓		
		Current Q	Next Q	Current Year
Upside	22	2 ↑	3 ↑	9 ↑
Downside	14	9 ↓	7 ↓	9 ↓

Company	Earnings Surprises - Latest Q			EPS Estimate			EPS Est. % Chg		
	Actual	Estimated	Variance	Current Q	Next Q	Current Year	Current Q	Next Q	Current Year
Distributed Generation									
AstroPower	0.04	0.06	(0.02)	0.06	0.08	0.20	0.0%	0.0%	0.0%
Ballard Power	(0.33)	(0.34)	0.01	(0.28)	(0.26)	(0.98)	0.0%	0.0%	0.0%
Capstone Turbine	(0.14)	(0.17)	0.03	(0.14)	(0.14)	(0.61)	0.0%	0.0%	0.0%
Energy Conversion Devices	(0.26)	-	-	-	-	(0.62)	0.0%	0.0%	0.0%
Evergreen Solar	(0.24)	(0.32)	0.08	(0.30)	n/a	(1.14)	0.0%	0.0%	0.0%
FuelCell Energy	(0.53)	(0.40)	(0.13)	(0.43)	(0.39)	(1.37)	0.0%	0.0%	0.0%
H Power	(0.65)	(0.60)	(0.05)	(0.63)	(0.55)	(2.31)	0.0%	0.0%	0.0%
Millennium Cell	(0.09)	(0.10)	0.01	-	-	(0.32)	0.0%	0.0%	0.0%
Plug Power	(0.21)	(0.27)	0.06	(0.26)	(0.25)	(1.01)	0.0%	0.0%	1.9%
Proton Energy Systems	(0.13)	(0.13)	-	(0.10)	(0.10)	(0.39)	0.0%	0.0%	0.0%
Clean Fuel & Combustion Technology									
Catalytica Energy Systems	(0.22)	n/a	n/a	n/a	n/a	n/a	0.0%	0.0%	0.0%
Fuel-Tech N.V.	0.02	0.02	-	0.16	-	0.23	0.0%	0.0%	0.0%
Headwaters	0.29	0.27	0.02	0.22	0.36	1.31	-12.0%	0.0%	0.8%
Methanex Corporation	-	-	-	-	-	1.22	0.0%	0.0%	0.0%
Quantum Fuel Systems Tech	(0.30)	(0.31)	0.01	(0.29)	(0.27)	(1.14)	0.0%	0.0%	0.9%
Syntroleum Corporation	-	-	-	-	-	-	0.0%	0.0%	0.0%
Power Semiconductors									
Advanced Power Technology	0.05	0.02	0.03	(0.05)	(0.04)	(0.04)	0.0%	0.0%	0.0%
AVX Corporation	-	-	-	(0.04)	-	(0.03)	0.0%	0.0%	0.0%
Fairchild Semiconductor	0.10	0.07	0.03	0.04	0.09	0.45	0.0%	0.0%	-2.2%
International Rectifier	0.16	0.13	0.03	0.18	0.23	0.74	5.9%	4.5%	7.2%
IXYS	(0.03)	(0.04)	0.01	-	0.03	(0.16)	0.0%	-25.0%	0.0%
Kemet	(0.04)	(0.03)	(0.01)	(0.03)	(0.01)	(0.03)	0.0%	0.0%	0.0%
Maxwell Technologies	(0.37)	(0.22)	(0.15)	-	-	(1.54)	0.0%	0.0%	0.0%
Microsemi	0.01	0.01	-	0.02	0.04	0.14	0.0%	0.0%	16.7%
O2Micro International	0.06	0.07	(0.01)	0.03	0.06	0.30	-62.5%	-33.3%	-26.8%
ON Semiconductor	(0.14)	(0.17)	0.03	(0.18)	(0.13)	(0.40)	-5.9%	0.0%	7.0%
Power Integrations	0.12	0.08	0.04	0.11	0.13	0.58	22.2%	18.2%	18.4%
Semtech	0.11	0.14	(0.03)	0.10	0.10	0.47	0.0%	0.0%	0.0%
Siliconix	0.45	-	-	0.44	0.47	1.96	0.0%	0.0%	0.0%
Power Electronics									
Artesyn Technologies	(0.15)	(0.17)	0.02	(0.15)	(0.09)	(0.31)	0.0%	25.0%	16.2%
Magnetek	(0.05)	(0.05)	-	(0.05)	(0.03)	(0.20)	-25.0%	-200.0%	-33.3%
PECO II	(0.33)	(0.21)	(0.12)	(0.20)	(0.18)	(0.70)	0.0%	0.0%	0.0%
Power-One	0.06	(0.04)	0.10	(0.03)	(0.02)	(0.05)	-50.0%	-100.0%	-150.0%
Powerwave Technologies	(0.06)	(0.05)	(0.01)	(0.05)	(0.01)	(0.01)	-66.7%	0.0%	-200.0%
SatCon Technology	(0.32)	-	-	(0.12)	(0.12)	(0.40)	0.0%	0.0%	0.0%
UQM Technologies	-	-	-	-	-	-	0.0%	0.0%	0.0%
Vicor	(0.08)	(0.07)	(0.01)	(0.06)	(0.05)	(0.15)	-50.0%	-150.0%	-200.0%
Power Quality									
American Power Conversion	0.23	0.21	0.02	0.15	0.17	0.78	0.0%	0.0%	2.6%
American Superconductor	(0.60)	(0.49)	(0.11)	(0.52)	-	(2.15)	-4.0%	0.0%	-8.0%
Intermagetics General	0.22	0.22	-	0.25	0.26	0.94	0.0%	-3.7%	0.0%
Energy Storage									
Active Power	(0.15)	(0.16)	0.01	(0.16)	(0.15)	(0.60)	0.0%	0.0%	-7.1%
Beacon Power	(0.21)	(0.07)	(0.14)	(0.06)	n/a	(0.69)	0.0%	0.0%	0.0%
C&D Technologies	0.20	0.20	-	0.20	0.21	0.73	0.0%	0.0%	0.0%
Electric Fuel Corporation	(0.03)	n/a	n/a	n/a	n/a	n/a	0.0%	0.0%	0.0%
Medis Technologies	(0.22)	(0.14)	(0.08)	(0.12)	(0.12)	(0.59)	0.0%	0.0%	0.0%
Ultralife Batteries	(0.14)	(0.10)	(0.04)	(0.06)	0.02	(0.09)	0.0%	0.0%	0.0%
Valence Technology	(0.14)	(0.16)	0.02	(0.15)	-	(0.68)	0.0%	0.0%	0.0%
Energy Information Technology									
Caminus Corporation	(0.11)	(0.14)	0.03	(0.07)	-	(0.26)	0.0%	0.0%	0.0%
Intergraph	0.06	0.06	-	0.08	-	0.45	0.0%	0.0%	0.0%
Itron	0.30	0.29	0.01	0.24	0.28	1.20	-4.0%	-9.7%	-2.4%

Capital Markets Monitor

Overview. The \$3.5 million raised by **Electric Fuel Corp.** to help fund portable military battery technology development, the 2.5 million euro **BASF** investment in **ZOXY**, a producer of zinc-air batteries, and the \$1.2 million raised in December by vanadium battery developer **Vanteck**, suggests that energy storage is seen as an attractive investment and market opportunity. Incumbent storage technologies in certain applications, such as lithium-ion batteries for cell phones and laptops, or lead-acid batteries for backup power for mission-critical computing and communications systems, are badly flawed and at some point probably bound for extinction. In the case of small consumer electronics, we believe micro fuel cells plus improved internal power management systems will provide hours, days or weeks of uptime, while we expect clean, compact, highly reliable and long-lived flywheels will replace the vast arrays of toxic and short-lived lead-acid batteries backing up crucial IT hardware systems.

January 30. **BASF Venture Capital GmbH** (Ludwigshafen, Germany) is providing 2.5 million euros to become the lead investor in **ZOXY Energy Systems AG** (Germany), a manufacturer of rechargeable zinc-air batteries. ZOXY plans to use its energy storage devices to drive motor scooters, wheelchairs or mobile cleaning units, and possibly portable power and uninterruptible power supply systems.

January 22. **Azure Dynamics Corp.** announced final regulatory approval for private placements for gross proceeds of \$750,000, as previously announced on November 21, 2002.

January 21. **Quantum Fuel Systems Technologies Worldwide, Inc.** announced that it had priced its public offering of 3,500,000 shares of its common stock at \$2.25 per share. On January 31, the company's underwriters exercised their over-allotment option on a further 525,000 shares. Quantum designs, manufactures and supplies integrated fuel systems to OEMs of fuel cell applications and alternative fueled vehicles.

January 18. The US-based battery maker **ZBB Energy** is planning an IPO of \$10 million on the Australian Stock Exchange within the next six months. Although the company produces its zinc-bromine in Wisconsin, it has a research and development unit in Perth. ZBB Energy CEO Rob Parry states that the batteries are suitable for storing excess energy in large power utilities and could be used for large-scale wind and solar power projects. Funds from the listing are earmarked for expanding ZBB Energy's manufacturing base over the next four years. About 25 per cent of the company would be up for sale. A successful Australian float would probably be a prelude to listing on the Nasdaq market. ZBB Energy was floated on Perth's second board in 1988 and went into provisional liquidation in 1999 after the collapse of a merchant bank in which it had deposited money.

Capital Markets Monitor

January 8. **Pacific Fuel Cell Corp.** announced the investment of \$100,000 at a price of \$0.05 per common share by two offshore entities, for a total purchase of 2,000,000 common shares. Pacific Fuel has signed a contract with the University of California to do research and build a fuel cell prototype based upon Pacific Fuel's proprietary carbon nano-technology. Matching funds will be provided by the State of California. Pacific Fuel owns the worldwide rights (excluding Japan) to proprietary Proton Exchange Membrane (PEM) fuel cell technology. The Company plans to create joint ventures to rapidly commercialize its innovative technology.

January 7. **Solon AG**, the German solar module manufacturer and system integrator, announced that it has successfully raised additional capital. The shareholders of Solon AG signed 1,807,530 shares at a price per share of 1.70 Euro, which provides Solon AG additional paid-in capital of more than 3 Million Euro.

Comment. The strength of German investor demand for equity in renewable energy companies continues to impress. While the U.S. IPO market for renewable and other energy technology companies has been closed since December 2000, and follow-on offerings have been few and far between since mid-2001, German renewable energy companies still have access to capital. A key reason for investor interest is the strong local market for solar power systems, driven by a rich package of public subsidies. Germany has been the engine of growth for the solar power industry worldwide for the last several years.

January 6. **Electric Fuel Corporation** announced the successful placement of \$3.5 million of secured convertible debenture with three institutional investors. The investors also received 3.5 million warrants to purchase shares of Electric Fuel's common stock, that could bring a maximum additional \$3.1 million. The convertible debentures bear interest at a rate of 9% per annum, with a maturity date of June 30, 2005, and are convertible into shares of Electric Fuel's common stock at a conversion price of \$0.75 per share. The investors also received 3.5 million warrants to purchase shares of Electric Fuel's common stock, at prices ranging from \$0.84 to \$0.93. In addition, the restructuring of certain agreements reduced the company's liabilities by about \$1.1 million. Net proceeds from the private placement will be used primarily to help reposition Electric Fuel as a supplier of portable power for the military. The company received its first military battery contract—\$2.5 million from the US Army—last month.

The (De-)Construction Site

Strategic Deals, M&A, Restructurings, Bankruptcies and the Birth & Death of

Overall Comment. Consolidation was the key theme in January, with two energy software deals and one fuel cell-related acquisition announced. The acquirers appear to have made use of difficult industry conditions and tight capital markets to add capabilities, extend into related businesses or consolidate fragmented industries. We would not be surprised to see more acquisition activity in energy IT, and fully expect further consolidation in the fuel cell community.

M&A ACTIVITY

January 23. **ICP Solar Technologies Inc.**, a leading producer of solar chargers, recently acquired the assets of **Intersolar Ltd**, a PV maker and amorphous-silicon cell manufacturer based in Wales. The acquisition includes a 3MW thin-film amorphous solar cell manufacturing plant, solar roof tile technology and all other patents previously held by Intersolar. ICP Solar seeks to further its position and penetration into Europe's garden and ventilation markets. ICP Solar Technologies is the privately-held Montreal-based parent company of a group of companies including **ICP Global Technologies**, which develops, manufactures and markets advanced solar powered products for non-distributed residential, portable and mobile consumer markets.

January 21. **SunGard Data Systems** and **Caminus Corp.** announced that they reached a definitive agreement for the acquisition by SunGard of all the shares of Caminus through a cash tender offer of \$9.00 per share, a premium of nearly four times the closing price of Caminus at the end of the previous week. Based on Caminus's 17.7 million fully diluted common shares outstanding, the transaction has an aggregate value of approximately \$159 million. SunGard expects the deal to close during the first quarter of 2003. Caminus will be an operating unit within SunGard Trading and Risk Systems, a SunGard operating group, and will be led by John Andrus, currently chief operating officer of Caminus. Caminus is a leading provider of integrated trading, risk analytic and asset management software for the energy industry.

Comment. Sungard's core businesses historically have been software for back-office operations in financial services and disaster recovery. The company has offered an energy trading and risk management software package for roughly 4-5 years now, but its market presence has been fairly limited. Sungard appears to be taking advantage of the software industry's depressed valuations, along with the sharp decline in the financial strength of energy and power companies, to increase its exposure to the energy and power industry by acquiring Caminus at what turns out to be a modest price – about 2x trailing 12-month sales, or about 1.6x LTM sales less the cash on Caminus' balance sheet.

The (De-)Construction Site

Strategic Deals, M&A, Restructurings, Bankruptcies and the Birth & Death of

Sungard appears to understand that while energy and power companies may have scaled way back on their financially-driven commodity trading, they still must step into volatile wholesale energy and power markets to trade around their physical assets. In addition, Sungard appears to believe, as do we, that energy and power companies will resume investing in trading, risk and physical asset management software as their balance sheets gradually recover.

The purchase of Caminus is not an isolated event - it is one of at least three acquisitions of energy software companies to take place within the last three months. In October of last year **Siemens Power Generation** acquired privately-held **NewEnergy Associates**, an Atlanta-based provider of energy market and asset management software and consulting services, and the same day of the Caminus transaction **Itron** announced that it was acquiring **Silicon Energy**, an enterprise energy management software developer (see below).

January 21. **Itron**, a leading provider of automated meter reading and other information technologies to the global energy and water industries, announced that it has signed a definitive merger agreement to acquire **Silicon Energy** for a total consideration of \$71.2 million. The transaction is expected to close by the end of February 2003. Silicon Energy, privately-held and based in Alameda, California, provides enterprise energy management solutions that enable utilities, energy service providers, and commercial and industrial energy users to collect and apply energy consumption data; optimize the delivery, procurement and use of energy; and mitigate risk and control energy costs.

Comment. This is the latest of several software acquisitions made by Itron, which appears to be looking to software as a way to pull more revenues from its existing (and substantial) customer base, create recurring revenues in the form of software maintenance fees, and lift overall margins. With Itron's strength in data collection hardware and Silicon Energy's sophisticated information management and analytic software, the potential for synergies between the two companies could be significant. The opportunity and the challenge is that Itron's customer base is overwhelmingly energy-providing utilities providing energy, while Silicon Energy has been selling primarily to the energy-consuming commercial sector. The ideal outcome is to sell an integrated software and hardware system to both the utility and its customers to create new service offerings and optimize energy management from both sides of the trade.

January 21. The Norwegian composites manufacturing group **Hexagon Composites ASA** announced that it had entered into an agreement to acquire **Raufoss Alternative Fuel Systems** from **Raufoss United AS**, a company in the industrial group **Raufoss ASA**. The acquisition price is NOK30mm (roughly US\$4mm), of which NOK10mm is goodwill. Raufoss Alternative Fuel Systems develops and manufactures compressed natural gas and hydrogen systems for the automotive industry. Hexagon Composites said that the company would continue as an independent subsidiary in the Hexagon group.

The (De-)Construction Site

Strategic Deals, M&A, Restructurings, Bankruptcies and the Birth & Death of Companies

January 10. **Eaton Corp.** announced that it has purchased the power systems business of **Commonwealth Sprague Capacitor Inc.** The power systems business includes power-factor correction systems and harmonic filters, products used for power quality, and energy management applications. The purchase price was \$6 million, roughly in line with the business division's 2002 sales volume.

January 8. **Hydrogenics**, a designer and manufacturer of fuel cell technology and test equipment, announced that it has acquired **Greenlight Power Technologies**, its principal competitor in the fuel cell test business, in a transaction valued at approximately \$19 million. Under the terms of the transaction, Greenlight shareholders will receive cash consideration of about \$2.25 million and 4.3 million Hydrogenics' common shares, representing approximately 8% of Hydrogenics outstanding common shares.

According to Hydrogenics, the Greenlight acquisition is intended to firm up its leading position in the fuel cell testing business, while creating more resources for its fuel cell power products business. The consolidation of the companies' test businesses will be led by Greenlight's CEO, David Chapman. Hydrogenics is a designer and developer of commercial proton exchange membrane (PEM) fuel cell systems for transportation, stationary and portable power applications. Greenlight is a leading supplier of testing and diagnostic equipment to the fuel cell industry.

Comment. The purchase of Greenlight follows on its acquisition in April 2002 of EnKat GmbH, a German fuel cell test equipment company. With the acquisition of H Power last December by rival fuel cell power systems developer Plug Power, consolidation in the fuel cell industry appears to be moving ahead on several fronts—both complete systems as well as ancillary support. We commented last month that there are at present too many fuel cell developers (in the neighborhood of 300 at last count) and that consolidation was probably inevitable. We suspect there is more to come.

RESTRUCTURINGS

January 10. After failing to find a buyer for its thin-film solar manufacturing facility in Toano, Virginia, **BP Solar** is shuttering this plant as well as another in Fairfield, California. In November 2002 BP Solar announced that it is setting thin-film technologies aside for now to focus exclusively on crystalline-based systems.

The DataWerks

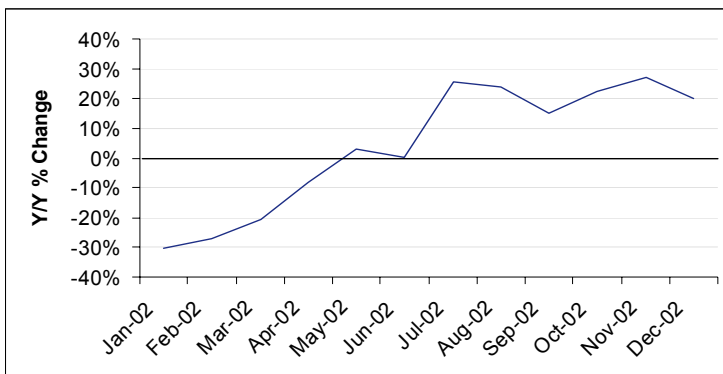
A Statistical Look at Energy Tech Industry Trends

Semiconductor Shipments

(Semiconductor Industry Association unadjusted monthly data)

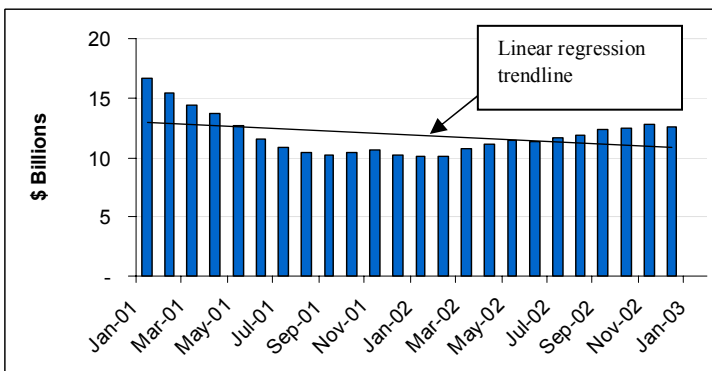
A broad measure of technology industry health. Given that virtually every information processor—logic chip, DRAM, DSP, integrated circuit (IC), etc.—requires a power conversion device—a power semiconductor, embedded power supply, rectifier, and so on, and possibly power quality protection as well—semiconductor shipments also reflect demand for a range of power technologies.

Monthly Shipments—Y/Y % Change, Jan - Dec 2002



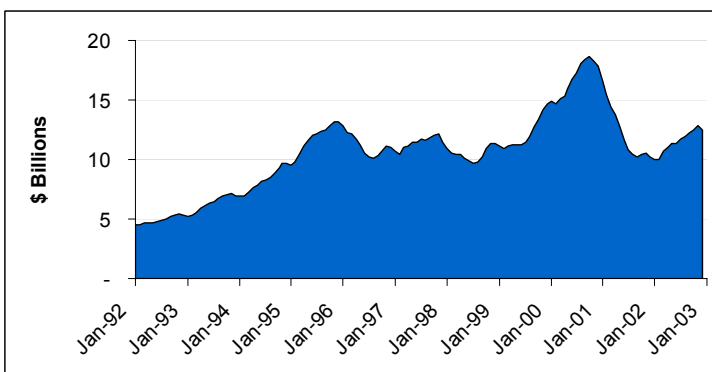
The year-over-year change in the value of semi shipments shows that a recovery may be unfolding, though the early initial move is over. Semiconductor sales could be rebounding ahead of computing and telecom hardware sales because they are not solely dependent on the IT industry; chips are also found in autos, industrial controls, medical devices, aerospace systems, etc.

Shipments—3-month moving average, Jan 2001 - Dec 2002



The semi industry often looks at data on monthly shipment values by using a 3-month moving average to smooth out the characteristic spike in shipments in the third month of the quarter. The data shown here, fitted with a linear regression line to establish a rough trend, also suggests a modest but flattening recovery from the lows of 2H02-1H03.

Monthly Shipments, Jan 1992 - Dec 2002



The 10-year data series shows the surge and subsequent collapse of demand from 1999-2001. Again, this is a graph that reflects an industry regaining a modicum of health. As we will see, the long-term graphs of computer and communications equipment shipments shown on the next two pages do not look as favorable.

The DataWerks

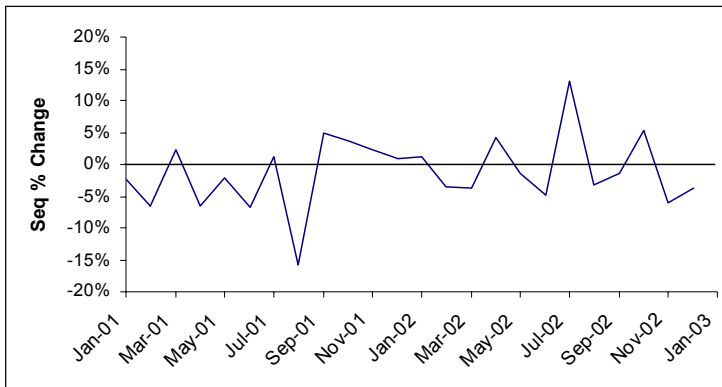
A Statistical Look at Energy Tech Industry Trends

Computers, Storage Devices & Peripherals

(US Census Bureau, seasonally adjusted monthly data)

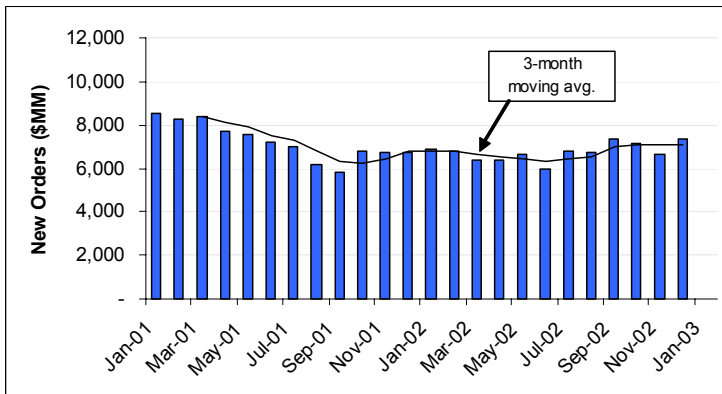
Computer, server, storage device and peripherals sales create pull-through demand for certain types of power conversion systems, such as ac/dc power supplies, voltage regulation modules, point-of-load converters and uninterruptible power supplies.

Monthly Shipments—Sequential % Change, Jan 2001 - Dec 2002



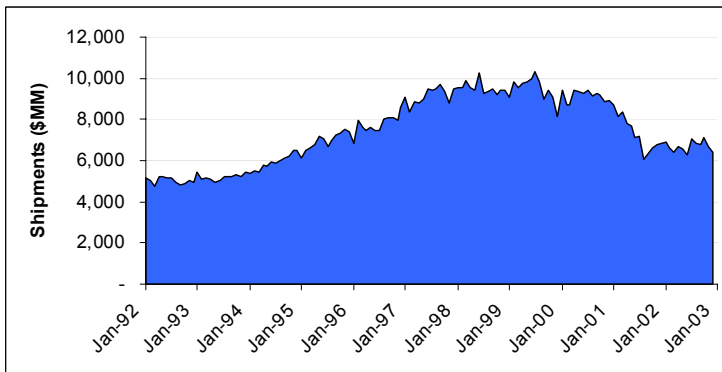
This first graph, showing the sequential change in shipments of computers and related devices, suggests a market that is basically stabilizing but not clearly growing.

Monthly New Orders, Jan 2001 - Dec 2002



As with recent trends in shipments, the data on new order activity, an important leading indicator, points to a stable but flattish market.

Monthly Shipments, Jan 1992 - Dec 2002



The 10-year data series shows that monthly shipments of computers, storage devices and peripherals have settled at 1995 levels, and have not yet decisively turned back up.

The DataWerks

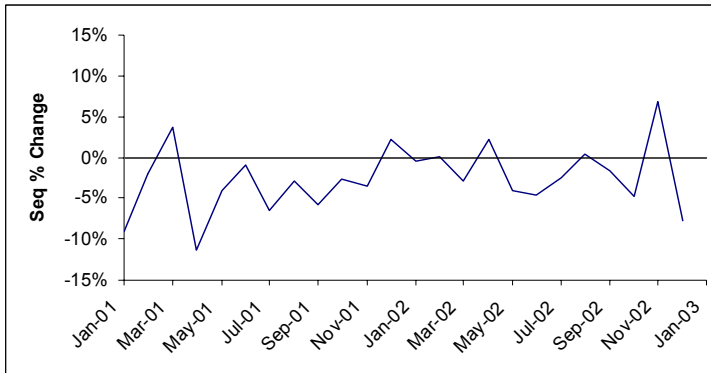
A Statistical Look at Energy Tech Industry Trends

Communications Equipment (non-defense)

(US Census Bureau, seasonally adjusted monthly data)

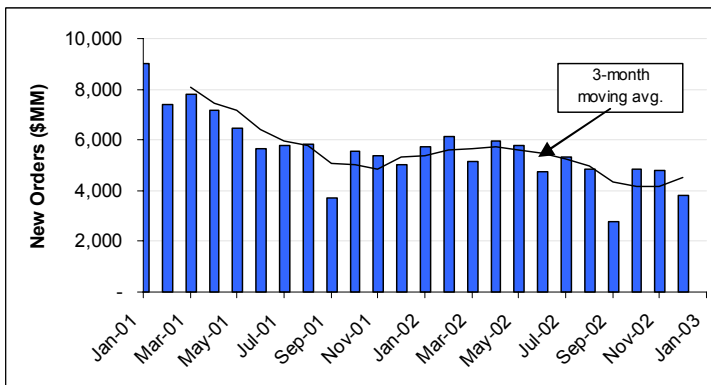
Sales of communications hardware such as switches, routers, wireless base stations and repeaters, generate demand power conversion systems such as power semiconductors, ac/dc front ends, board-mounted ac/dc dc/dc bricks, and dc power plants.

Monthly Shipments—Sequential % Change, Jan 2001 - Dec 2002



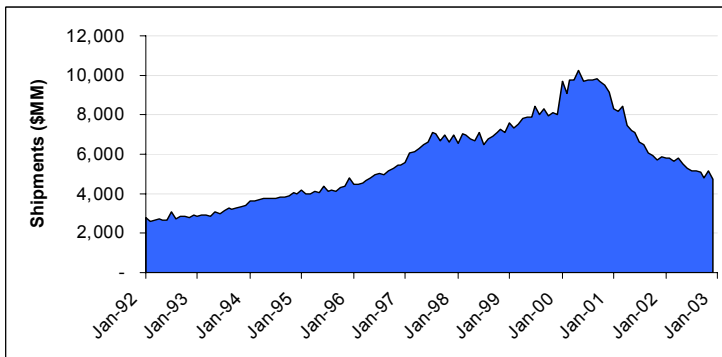
After nearly two years in which sequential changes in communications equipment shipments were overwhelmingly negative, signs of life appeared in November 2002. We commented last month that the November spike looked anomalous, and December data seems to preliminarily confirm that opinion.

Monthly New Orders, Jan 2001 - Dec 2002



New order activity has been volatile but generally flat to down. It is not clear yet that communications equipment demand has truly stabilized.

Monthly Shipments, Jan 1992 - Dec 2002



The 10-year data series highlights both the run-up in shipments in 1999-2000 and the steep drop thereafter. Importantly, the recent direction of monthly shipments has remained downward, but at a decelerating rate.

The DataWerks

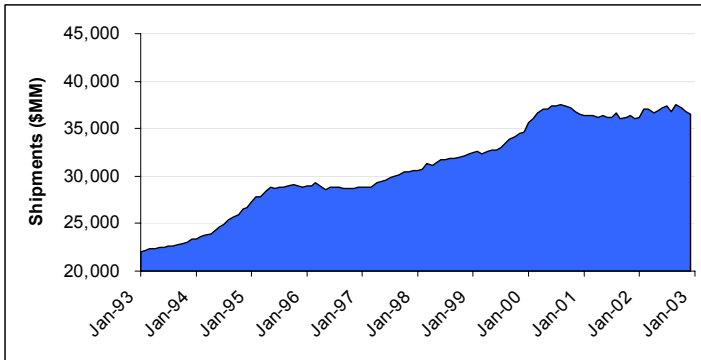
A Statistical Look at Energy Tech Industry Trends

Turbines, Generators & Other Power Transmission Equipment

(US Census Bureau: seasonally adjusted monthly data)

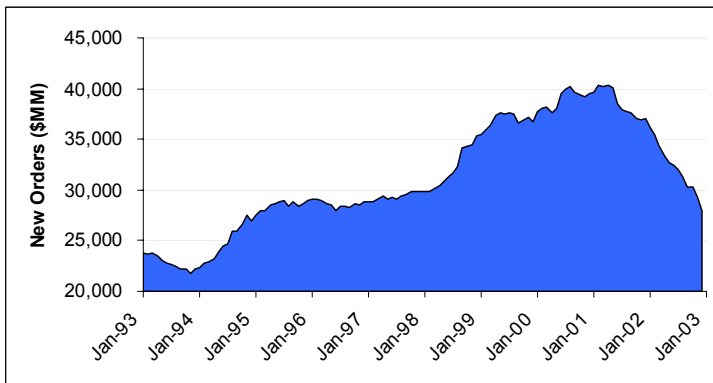
A measure of utility industry investment in large capital equipment. Reflects capacity requirements of global demand for electricity.

Rolling 12-Month Shipments, Jan 1993 - Dec 2002



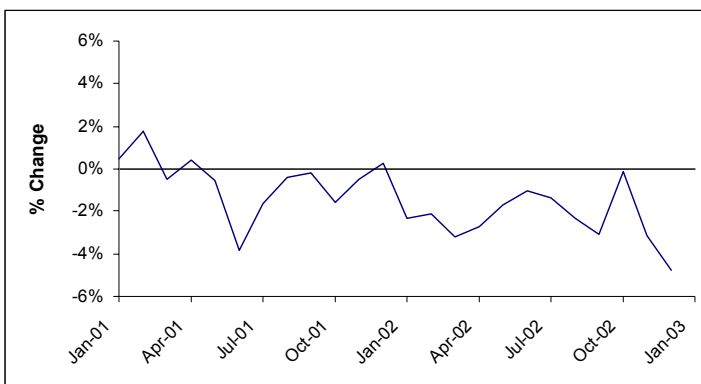
The long-term look at power equipment shipments seems to suggest that we have been witnessing a three-year plateau in the context of a strong secular growth industry.

Rolling 12-Month New Orders, Jan 1993 - Dec 2002



In contrast, the long-term data on new order activity is warning that the plateau ends with a cliff. Since orders for power equipment are placed as long as 2-3 years before shipment is expected, new orders data is a key leading indicator of future shipment value.

Sequential Change, Rolling 12-Month New Orders, Jan 2001 - Dec 2002



Zooming in on new order activity within the last 2 years, we see that the trend has been clearly downward.

Inductance & Reactance

Occasional Comments and Random Observations

The Fog of War and the Fate of Energy Tech

Last month we identified military conflict in the Middle East as a key risk to the consensus scenario of a gradual economic recovery in 2003. We are not qualified to handicap the odds of war or peace. Instead, we will take a brief look at the impact of military conflict on the energy technology industry.

Starting from the macro level, the shadow of war is already affecting the US and global economies in two clear ways. First, the fear of war appears to be depressing corporate and consumer confidence, creating a cycle in which tepid consumer spending keeps capacity utilization low, which in turn restrains corporate capital expenditures. The combination of weak consumer demand and subdued corporate investment means a slow-growth economy. The right fiscal policy could kick-start a recovery, but most observers believe the Bush administration's proposals, centered around a variety of tax cuts, constitute an expensive way of providing little near-term stimulus—exactly when it is needed most. Moreover, with Fed Funds rates already at lows not seen for many years, the Federal Reserve can do little more to spark growth with an accommodating monetary policy. As a result, estimates for S&P 500 earnings and the US economy overall continue to trend lower; by extension, similar processes are pulling down estimates of economic growth for the rest of the world.

Second, Middle East tensions plus disruption of Venezuelan oil exports are keeping crude prices high, which creates an additional drag on the US and global economies. Were hostilities to break out, we believe oil would remain dear even with a quick US victory—the supposed flood of cheap Iraqi oil into world markets will instead remain a trickle because the Iraqi oil industry's infrastructure will require years of repair to return to its pre-1991 productive capacity.

Now on to the implications for energy tech. Let's begin by distinguishing between transportation on the one hand and electric power on the other. A disruption in the flow of oil and the resulting spike in oil prices would have a tremendous impact on anything related to transportation, and of course to anything dependent on petroleum and petrochemicals in general. Therefore, the value of those technologies that either conserve or replace oil would increase dramatically. Examples include synthetic petroleum, diesel to natural gas equipment conversion kits, hybrid electric vehicles and intelligent engine control technologies.

On the other hand, high oil prices would have little direct effect on anything related to stationary power generation. The primary fuels used to generate electric power are coal, natural gas and uranium—very little oil is used in the power generation industry. However, to the extent that oil at \$40+ a barrel drives substitution into natural gas, we would expect to see natural gas and thus electricity prices rise, and the ability to swap out of natural gas and into coal in certain places would likely push coal prices higher as well. High natural gas and electricity prices could have another effect—the increased adoption of onsite combined heat and power packages (CHP), where the waste heat created through natural gas-fired power generation is recaptured and used for space or process heating. Whereas using natural gas to generate heat and power

Inductance & Reactance

Occasional Comments and Random Observations

separately yields fuel efficiencies of roughly 25-35% all in, combined heat and power can achieve efficiencies of 70-80% and higher; clearly an attractive proposition when natural gas and power are pricey. In addition, with every key fossil fuel more expensive, the economics of renewable energy sources such as wind, solar, geothermal and biomass become much more favorable, benefiting the numerous companies involved in those industry segments.

The table on page 30 goes through some of the implications of high oil prices in detail (apologies to those companies that should have been mentioned but were not). The conclusion is that war in Iraq may end up bringing substantial benefits to certain segments of the energy technology industry—though these gains would be paid for in a currency that should not be lightly spent.

Hydrogen—Everywhere and Nowhere

Since hydrogen is getting a lot of attention as an alternative to oil, it is worth taking at least a brief look at the issues surrounding its use. Specifically, there are two common assumptions about hydrogen we will address.

1. Hydrogen will free us from the tyranny of fossil fuels.
2. Hydrogen is a “green” fuel source.

Lest the following discussion suggest that we are hydrogen humbugs, we would first like to clarify our thoughts on hydrogen. Over the very long term (possibly in the second half of this century) hydrogen may well be the dominant fuel for transportation, while oil, gas and coal will be used in certain industrial products and processes and various niche applications. But there will be money to be made long before the age of hydrogen is fully upon us. Over the next few decades we expect there will be abundant opportunities to profitably sell any number of devices that make, move, store and use hydrogen. The hydrogen economy is a “how and when” question, not an “if” question.

That being said, we turn to the question of whether hydrogen can put an end to global dependence on oil, gas and coal. We ourselves believe so. This brings us to “how and when.” What is not well understood is that hydrogen will likely require the crutch of fossil fuels for many years to come before it can walk on its own. The awkward and inescapable truth is that most hydrogen used today comes from the very fossil fuels from which we are to be rescued. Although hydrogen is the most abundant element in the universe, it is also devilishly difficult to contain, transport and store. Hydrogen on earth is almost always bound with something else—with carbon in the case of the hydrocarbon family (i.e., oil, natural gas and coal); with oxygen in the case of water (H₂O); or with sodium and boron in the case of sodium borohydride. More than 80% of the hydrogen produced today comes from reforming (refining) natural gas, and most of the remainder is the by-product of another process, such as petroleum refining and chemical production. In other words, almost all current hydrogen production is based on hydrocarbons.

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Occasional Comments and Random Observations

A very small share of hydrogen production comes from electrolysis—running an electric current through water to separate the hydrogen from the oxygen. This starts to sound good. Now we are discussing a way to produce hydrogen that does not require hydrocarbons. Or does it? As it turns out, the electricity used to peel off the hydrogen was most likely generated by combusting exactly those hydrocarbons whose grip we seek to escape (oil, natural gas and coal). It may have come from nuclear power, in which case we have traded hydrocarbon dependence for reliance on fissionable materials, and must face the attendant problems of safety and disposal. Lastly, the power might have come from a hydroelectric dam. Running existing hydro power plants raises difficult questions about water allocation (remember all the Pacific Northwest salmon that died last summer because of the amount of water redirected from the Columbia River and its dam to local farmers for irrigation?), and building large new hydro plants is so environmentally disruptive that we do not expect new hydroelectric dam construction in the US in our lifetime.

Of course, electric power for electrolysis can also come from renewable sources such as wind, solar and geothermal. Only in this way does hydrogen truly displace hydrocarbons, and the ongoing impact of electrolysis operations is not high. At least for now, hydrogen from electrolysis using renewables is very expensive, both because of the high relative cost of electricity from at least some renewable sources in some locations as well as the fact that electrolysis might ultimately be more suited for onsite use rather than large-scale production.

Briefly on hydrogen from sodium borohydride—this is another production method that does not have to involve hydrocarbons, but issues here include current cost structure, scalability (possibly) and reprocessing or disposal of the by-product, sodium borohydrate.

A last consideration is storage and transportation. Hydrogen produced onsite using electrolysis or sodium borohydride certainly has cost advantages versus hydrogen produced at industrial-scale facilities that must be trucked or piped to the point of use. Nonetheless, within a certain radius (100-200 miles) of the production facility, it is generally more economic to turn out hydrogen in bulk using natural gas. At some point, and possibly sooner rather than later, it may well be the case that renewable-powered electrolyzers or sodium borohydride units will be the more cost-effective method. But for the near term, anyway, it will remain difficult to unseat the role of hydrocarbons somewhere in the hydrogen production chain.

As for the second issue, that hydrogen is a “green” fuel, it is really just a corollary of the first. Much is made of the fact that fuel cell vehicles (FCVs) use nothing but air and hydrogen and produce nothing but electricity and water (in effect, FCVs are reverse electrolyzers). While this sounds good, makes great press and the mass media usually does not fail to bring it up when covering FCVs, the question of where the hydrogen came from goes unaddressed. And as we have seen, hydrogen production today almost always involves fossil fuels. Particularly when H₂

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Occasional Comments and Random Observations

is produced by way of electrolysis using electric power from a coal-fired generator (and more than 50% of the electricity generated in the US comes from coal-burning power plants), the green of hydrogen starts to look a little brown.

Similarly, when coal-based electric power is used for electrolysis to make hydrogen for a fuel cell vehicle, the net resulting pollution may be equal to or greater than the level of pollution created by producing gasoline and burning it in a standard internal-combustion automobile engine. In other words, in certain scenarios a hydrogen-powered vehicle could actually be a worse greenhouse-gas offender than some randomly chosen automobile on the roads today. The comparison improves somewhat by replacing electrolysis based on coal-generated electric power with on-board hydrogen reforming (the conversion of gasoline or natural gas into hydrogen using a small reformer on board the vehicle itself). However, while on-board reforming likely yields fewer pollutants and greenhouse gases than coal-based electrolysis, the resulting level of pollution is not zero.

Over a period probably stretching out for decades, we believe the world will make a gradual shift from a hydrocarbon to a hydrogen economy, many billions of dollars in value will be created along the way and hydrogen will live up to its green promise. But at least for the near term, in the production of hydrogen, there is no such thing as a (pollution-)free lunch.

Technology / Application	Description	Impact of High Oil Prices	Developers & Suppliers
Oil Substitutes	Fuels for transportation and industrial processes produced with non-oil hydrocarbon or synthetic fuel sources	Those fuels commercially viable today at current or modestly higher oil price levels could be major winners. Hydrogen, an oil substitute attracting significant attention, would see little present benefit because the applications (such as fuel cell vehicles) are not yet ready for prime time. However, hydrogen-related development projects could wind up with additional public R&D funding.	Energy Conversion Devices, H2Gen, Hydrogenics, Proton Energy, Millenium Cell, Methanex, Stuart Energy, Syntroleum, Teledyne, Others
Diesel to Natural Gas Conversion	Specialized fuel injectors, manifolds, controls, etc. that enable diesel vehicles and gensets to substitute some or all of their diesel for natural gas	These technologies have already built up significant run-time in field operations, and in at least some instances are commercially available or will be soon. There are abundant supplies of natural gas outside the Middle East in the US, Canada, Russia, and other locations. Of course, natural gas is not cheap now, and more productive capacity would need to be put in place quickly.	Clean Air Partners, Cummins / Westport, Encorp, others
The Silicon Car	The good old-fashioned automobile can add 5% fuel efficiency here, 7% there with changes like intelligent valve control or shutting down 2 of 8 cylinders when they are not needed	The technology to bring more fuel efficiency out of the internal combustion engine through the application of silicon - logic processors, power electronics and so on - already exists. Consumers may become more willing to pay for fuel efficiency if it looked like oil markets would remain tight for some time.	Infineon, International Rectifier, SemTech, Tier One auto suppliers (examples could include Delphi and Johnson Controls), others
Hybrid Electric Vehicles (HEVs)	Vehicles that use both gasoline engines and electric motors to provide motive power	Again, expectations that higher oil prices will persist will likely lead consumers to place a higher value on fuel efficiency, and HEVs should be major beneficiaries - they are available today, they work beautifully, and they improve mileage by up to 50% and more.	Energy Conversion Devices, Honda, Matsushita Group, Maxwell Technologies, StatCon, Solectria, Toyota, UQM, possibly certain flywheel system developers, others
Fuel Cell Vehicles (FCVs)	Vehicles that replace the internal combustion gasoline engine with a fuel cell that runs on hydrogen and generates electricity	On current sales, none - fuel cell vehicles are years away from commercialization. The Bush Administration does not believe the viability of fuel cell vehicles and a hydrogen infrastructure can even be evaluated until 2015. However, public funds for FCV development could increase sharply.	Ballard Power, General Motors, GrafTech, H2Gen Hydrogenics, Millenium Cell, Proton Energy, StatCon, Solectria, Stillwater Mining, Stuart Energy, Teledyne, others
Space Heating	Heating for residential and commercial buildings. Here is the transition into stationary power generation - heat and power can be produced at the same time and at very high fuel efficiencies	Oil, natural gas and electricity (which in turn comes from coal, natural gas and nuclear power generation plants) can all be used for space heating. If high oil prices drives substitution to other sources (probably natural gas) then prices for those other sources will react. In addition, there could be a sizable shift to Combined Heat & Power (CHP) usage because it is such an efficient way to use natural gas.	Ballard, Capstone, CAT, Coast Intelligent, Connected Energy, Cummins / Westport, FuelCell Energy, GE, Ingersoll-Rand, Plug Power, RealEnergy, Siemens, STMPower, Turbec, WhisperTech, others
Stationary Power Generation	Production of electricity either at a large central power plant (centralized generation) or at or near the point of use (distributed generation)	Modest, but it depends - should the high price of oil lead to significant substitution into natural gas, the likely increase in natural gas prices would drive the price of electric power higher, and probably coal as well, and make wind and solar power more attractive.	Natural gas and coal producers and service companies; AstroPower, BP Solar, GE Wind, Kyocera, NEG Micon, Nordex, Powerlight, ScanWater, Sharp, Shell Solar, Sun Power, Vestas, Xantrex, others

Source: Vortex Energy LLC

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