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FEATURED COMPANY

## FuelCell Energy

BY NAMRITA KAPUR

A brownout can ruin your whole day.

A power dip that barely causes a light bulb to flicker can send your computer network into a tailspin, disrupt manufacturing processes, and upset financial service operations. Not to mention what it does to your air-conditioning on a sweltering summer day.

Far from being a rarity, brownouts and blackouts are happening with increasing frequency as demand for electricity swells and capacity remains stagnant. Indeed, the Electric Power Research Institute reports that power outages doubled in the US between 1996 and 1998 at a cost of more than \$50 billion annually. No wonder companies like Oracle Corporation are spending millions of dollars to build their own backup generating plants.

The situation has created an opportunity for alternative energy that is cost-effective, efficient, and reliable. Among the most promising of these technologies is the fuel cell. And one of the companies poised to leap into the burgeoning market is FuelCell Energy (FCEL) of Danbury, CT.

### From Military to Commercial Applications

Founded in 1969 as Energy Research Corporation (ERC), the company began developing fuel cells for the United States military. In the mid-seventies, it inaugurated its carbonate fuel cell program with over \$350 million in research grants from government and industry. Since 1983, the company has shifted its emphasis away from military applications

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## Alternative Energy: Beneficiary of the New Oil Crisis?

BY ELLEN PFEIFER

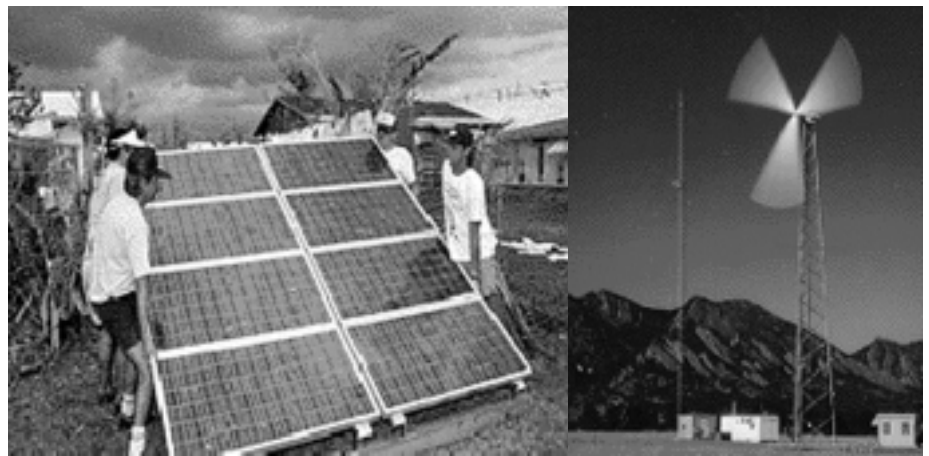
"OIL PRICES AGAIN HIT A 10-YEAR HIGH." "STATE TRYING TO BOOST OIL STOCKPILES." "CONSUMER HEATING COSTS IN NEW ENGLAND EXPECTED TO CLIMB BY 25% OR MORE." THE RECENT NEWS ABOUT ENERGY HAS BEEN RELENTLESSLY GLOOMY. AFTER YEARS OF ABUNDANT, CHEAP FOSSIL FUEL, DEMAND FOR POWER IS HIGHER THAN EVER. U.S. ELECTRICITY CONSUMPTION IS PROJECTED TO REACH 4.35 TRILLION KWH BY 2020, AN INCREASE OF 33% OVER 1997 LEVELS.

But now we have oil and gas shortages, stagnant electric generating capacity, a flare-up in Middle East conflicts, and higher OPEC prices for crude oil. That adds up to an economic squeeze play. Indeed, the energy

would also lower pollution and ease the depletion of natural resources.

### The Time is Right for Renewables

As "Business Week" described in a recent analysis of the U.S. energy situation, "...high



Alternative energy sources: Solar and Wind Turbines

question has become an urgent issue in the otherwise lackluster presidential campaign.

What few of the pundits and politicians have considered are other strategies to combat the new energy crisis. Instead of just scrambling for more oil and natural gas, the country could move toward the adoption of alternative or renewable power. Not only would such a move reduce our dependence on foreign oil, it

fossil fuel prices and growing environmental concerns have given renewable power its first big boost since the oil shocks of the 70s."

Still in its infancy during the oil crisis of the 70s, alternative energy has matured in the intervening decades. Now the technology is more sophisticated and the costs are beginning to drop. Indeed, last month in energy-strapped

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# Green Energy: The Perfect Hedge

BY JACKSON W. ROBINSON

Oil and gas prices are hitting new highs. Therefore, oil and gas stocks are great investments. Right?

Wrong! Even though gasoline and other fossil fuel prices began escalating early in 2000, oil and gas stocks have not produced attractive absolute or relative returns this year.

In the October 1999 issue of the Winslow Environmental News, we made the case for "green" energy stocks noting that oil and gas producers are poor investment candidates because of their mounting environmental liability. In comparing conventional fossil fuel

and green energy stocks, we did not factor in the huge jump oil prices would take in 2000. So we thought it would be enlightening to revisit our analysis and examine how the two energy groups have fared over the last twelve months.

To that end, our ace researcher, Denise Garcia, created two indexes: the first comprises the seven largest oil and gas companies in the S&P 500; the second contains eleven publicly-traded emerging energy companies from the wind, solar, fuel cell, battery, and flywheel industries (see table). For benchmarking purposes, Denise compared the energy indexes to the NASDAQ and the S&P 500.

The results are compelling and a statistically significant (see chart). For the twelve months

ended October 4, 2000, the green index jumped +113%, well ahead of the NASDAQ which climbed +31% and the S&P500 which rose +11%. Surprisingly, the seven oil and gas stocks rose only a paltry +8% despite the big jump in prices.

If ever there were an example of the perfect hedge, this was (and may still be) it. An investor who had bought a basket of emerging energy stocks and sold short the oil and gas index would have realized a one-year return of +105% with very little market risk.

The lesson here is important. No one can predict future prices or markets; however, we can take a lesson from the market and identify new and important trends. Notwithstanding the highest fossil fuel prices in decades, oil and gas stock returns are disappointing, especially when compared to the performance of emerging energy stocks.

Why?

The fossil fuel industry sells commodity products with low margins, low growth rates, and large environmental liabilities. The industry has little control over its destiny, as it is highly regulated and has little influence over the prices that it can charge.

On the other hand, the alternative/renewable energy segment has arrived at an

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as a service to our clients and  
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**Editor-in-Chief**  
Jackson W. Robinson

**Managing Editor**  
Channing Page

**Print Manager &  
Publications Coordinator**  
Leigh Ann Steele, [lsteel@ahh.com](mailto:lsteel@ahh.com)

**Contributors**  
Eric Anderson, Barbara Emery,  
Denise Garcia, Ellen Pfeifer,  
E.G. Woods, Steve Viederman

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### Emerging Energy Index

<b>Vestas Wind Systems</b> . . . . .	Wind turbines
<b>NEG Micon</b> . . . . .	Wind turbines
<b>IMPSCO Technologies, Inc.</b> . . . .	Systems to deliver clean fuels
<b>Evercel, Inc.</b> . . . . .	Rechargeable nickel-zinc battery
<b>AstroPower, Inc.</b> . . . . .	Solar cells, modules, panels, and systems
<b>American Superconductor</b> . . . .	Superconducting magnetic energy storage
<b>Ballard Power Systems, Inc.</b> . .	Proton exchange membrane fuel cells
<b>FuelCell Energy, Inc.</b> . . . . .	Carbonate fuel cells
<b>SatCon Technology Corp.</b> . . . .	Products to improve energy efficiency
<b>Active Power, Inc.</b> . . . . .	Flywheel energy storage system
<b>York Research Corporation</b> . . .	Energy from natural gas and renewables

### Oil & Gas Index

<b>Amerada Hess Corporation</b>	<b>Royal Dutch Petroleum Company</b>
<b>BP Amoco p.l.c</b>	<b>Chevron Corporation</b>
<b>Exxon Mobil Corporation</b>	<b>Texaco, Inc.</b>
	<b>Phillips Petroleum Company</b>

important and long-awaited inflection point. The technologies are improving, costs are declining, demand is rising, and profits are growing at double-digit rates, a mosaic of compelling trends. We believe that the long-term investment potential for green energy stocks is extremely positive. To judge by the stocks' performance over the past year, it is clear that the market thinks so too. 🐷

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and toward the private sector.

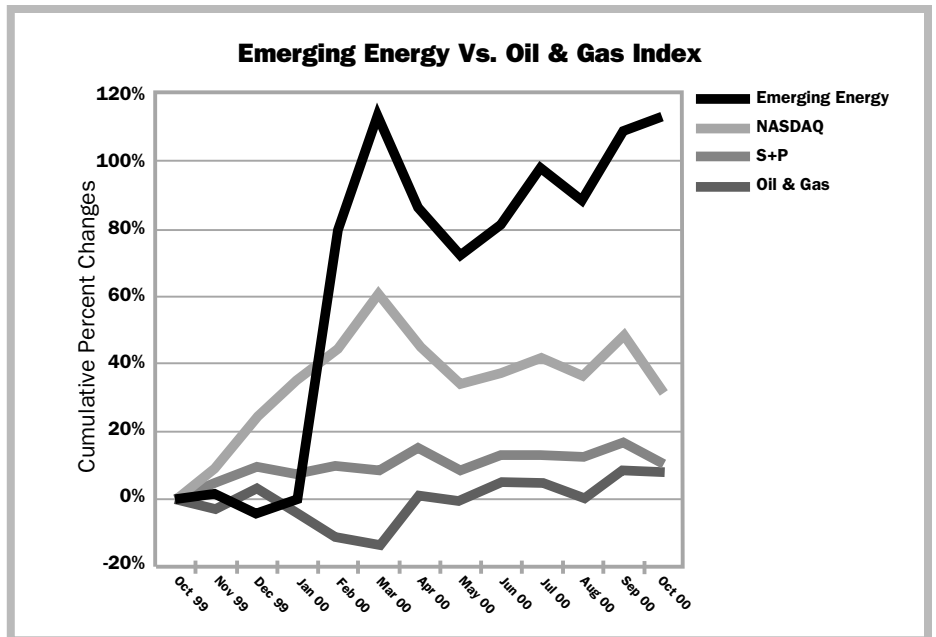
Today, with several successful field trials behind it, the company is gearing up to enter the stationary power market with three configurations — 250 kilowatt (kW), 1 megawatt (MW), and 2 MW units. The 250kW unit, which will be available in late 2001, could power a 100-home subdivision or a light industrial/commercial facility. The MW units, which the company plans to roll out in 2002, would provide enough electricity for hotels, shopping centers, and large office buildings.

**Fuel Cell Advantages**

Fuel cells are devices that chemically convert a supply of hydrogen-based fuel and air into electrical energy. Individual cells are modular and are stacked together to provide the desired amount of power. Because no combustion is involved, the technology is much cleaner than fossil fuel.

There are a variety of fuel cell types. FCEL has focused on the molten carbonate version that accepts fuel directly without requiring a reformer to extract the hydrogen. Highly versatile, it can run on natural gas, coal gas, ethanol, methanol and biogas.

The company's market entry product, the DirectFuelCell (DFC), operates at mid-range temperatures of approximately 1200 F, which eliminates the need for the precious metals and ceramics required by higher and lower temperature versions. The DFC delivers electrical efficiency of 50-55%, a figure that FCEL believes it can boost to nearly 80% by harnessing the high-pressure steam by-product for co-generation.



**Getting the Cost Down**

So far, fuel cells have been slow to generate wide commercial appeal because of their high costs.

However, FCEL maintains that it can lower costs dramatically once its new manufacturing facility in Torrington, CT is fully operational. (See accompanying chart). From the current 11 cents per kW hour, the company expects to reduce costs to 5 cents by 2004 when it will ramp capacity to 400 MW.

monopolies, residential consumers can and want to go green. A recent poll by RKS Research and Consulting showed over 75% willing to pay 5-20% more for renewables.

Year	Planned \$ Price/kWh	Customer Cost
2001	4000	\$0.09-\$0.10
2002	2500	\$0.07-\$0.085
2003	2200	\$0.06-\$0.075
2004	1800	\$0.05-\$0.065

**Favorable Climate for Development**

The timing of FCEL's entry into the market could hardly be better. Consider the following:

- Increasing energy demand and unresponsive capacity: U.S. consumption of electricity in 2020 is projected to be 33% higher than in 1997. Yet the uneven rate of American electricity deregulation has resulted in stalled expansion projects of roughly 162,000 MW.
- Electricity reliability concerns: Surges in electricity demand often result in voltage collapses because there is no market incentive to maintain a reserve supply.
- The spread of deregulation and rise of environmentalism: With the end of the old

- Favorable legislation: To combat global warming, federal and state governments are offering incentives to use green energy including direct purchase subsidies, net metering laws, fuel cell assistance projects, and tax benefits.
- Volatile oil prices: Heavy dependence on oil and gas means American energy needs are unusually vulnerable to fluctuating supplies, international tensions, and corporate mandates.

**Competitors and Competing Technology**

FCEL is not the only company eager to enter the market for commercial high efficiency energy. It faces strong competition

*Please see FUELCELL page 5*

## Emerging Energy Industry

Energy Generation	Cost/kWh	Maximum Power Output	Efficiency	Dimensions/ Infrastructure	Life Span	Environmental Impact	Markets/ Applications
Fuel Cell	\$0.11/kWh	Auto: 25 kW On-site: 200kW Plant: 2.85 MW	Converts 50-55% of energy to electricity; 80% if heat is used.	Virtually any size - individual cells or stacked; size ranges from cell phone batteries to car engines to power plant.	5-20 years (depends on technology). No moving parts, reliable.	Depends on source of fuel: Pure hydrogen derived from natural gas and electrolysis is cleanest; fuel cell using gasoline does little to reduce emissions.	Automobiles, stationary (residential and commercial), power plants.
Photovoltaics (Solar Energy)	\$0.20/kWh	Module of 36 cells can produce 110 -120 Watts.	Convert 7-17% of light energy into electric energy.	Cells: 5-6 inches. Range: Highway sign 20 sq. inches; power plant, over 40,000 modules.	10-20 years.	Renewable, zero emissions.	Remote power, residential, utilities.
Wind Turbine	\$0.03- \$0.05/kWh	600-1650 kW.	Produce 20% of its rated power at average wind speed of 15 mph.	Rotor diameter of 141-216 feet. Towers are spaced 5-7 rotor diameters apart.	120,000 operating hours.	Renewable, zero emissions.	Sited in remote locations, requires energy storage and transmission to home/ commercial applications.
Coal Powered Electric Plant	\$0.02/kWh	A plant consuming 1.6 billion lbs. of coal produces 356 MW; 11 billion lbs. produces 1,950 MW.	Converts 33% of fuel into electricity.	Requires generation units, transmission and distribution lines.	30 years (depends on maintenance and technological upgrades).	CO <sub>2</sub> , sulfur and nitrogen emissions. Produces 2.095 lbs. of CO <sub>2</sub> per kWh.	Utilities.

**Kilowatt: 1,000 watts      kWh: 1,000 watts of electricity**  
**Megawatt: 1 million watts      used for one hour.**

Sources: FuelCell Energy, ECO-USA, Renewable Energy Policy Project, Energy Information Administration, American Wind Energy Association, Environmental and Energy Study Institute, AstroPower, Fuel Cells 2000, Schatz Energy Research Center, Renewable Energy Policy Project, Oklahoma Gas & Electric, Britannica.com.

### *ENERGY Continued from page 1*

California, the 5-cents-per-kWh price of wind-powered electricity was cheaper than fossil fuel electricity (over 10 cents per kWh). This turn of events has actually provoked concern that wind power companies might exploit the situation and gouge consumers. As Richard Rosen of Boston's Tellus Institute framed it, "the question is, will wind providers be willing to sell below the high prices of the fossil energies, although still making a profit, in order to increase their market share over the long term?"

#### **Wind Power: the Hottest Product on the Shelf**

Without question, wind power is the leader of the alternative energy pack. "It is the fastest-

growing energy technology in the world," says Namrita Kapur, an emerging energy analyst with Adams, Harkness & Hill. "From 1995 to 1998, over 4,800 MW of additional capacity was installed, a worldwide average growth rate of 27.75%." That translates into a \$4 billion market that Kapur estimates will grow to \$150 to \$400 billion by 2020 when wind is expected to supply 10% of world power needs.

In the United States, the growth of wind power is driven by electricity deregulation, carrot-and-stick legislation, the manufacture of ever larger wind turbines, and prices that have dropped from 40 cents per kWh in 1980 to today's 5 cents. Two Danish companies that manufacture the big turbines, Vestas Wind

Systems and NEG Micon, dominate the wind power industry with a combined market share of approximately 50%.

#### **Fuel Cells for Stationary Power Generation**

Electricity created from hydrogen is a promising development on the horizon. (See accompanying story on FuelCell Energy.) Almost twice as efficient as internal combustion engines, fuel cells are reliable, long-lived, and can be used for both stationary applications and transportation. They can also be adapted to a wide variety of hydrogen-producing fuels.

Many potential fuel cell products have not yet reached the market and the prototypes are

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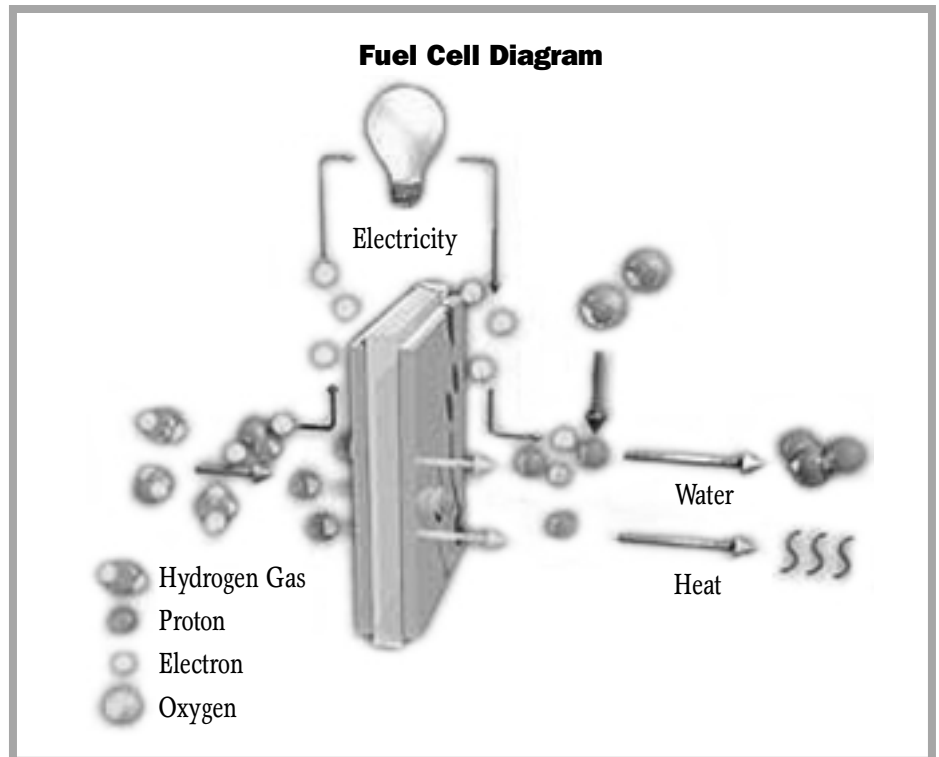
FUELCELL Cont. from page 3

from the following companies:

- Ballard Power Systems and Plug Power with Polymer Exchange Membrane cells.
- Capstone Turbine, Elliot Energy Systems and Honeywell with microturbines.
- ONSI with its Phosphoric acid fuel cells.
- SiemensWestinghouse, Mitsubishi, and Global Thermoelectric with solid oxide fuel cells.

This competition notwithstanding, FCEL may prevail if it can be first out of the starting gate, if it can keep to its ambitious timetable of expansion, and if it can develop additional strategic partnerships. 🐢

Namrita Kapur is an analyst specializing in Emerging Energy at Adams, Harkness & Hill in Boston, MA



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still relatively expensive. Nonetheless companies like First National Bank of Omaha have installed fuel cell systems to backstop their conventional power sources, reasoning that the initial expense of \$3.4 million for an 800 kW generator is justified in protecting its credit card operation from the devastating consequences of a power outage.

Among the players poised to jump into the fuel cell market are Ballard Power Systems, FuelCell Energy, and Plug Power.

### Solar Power and Photovoltaics Experiencing Big Growth

Although its relatively high cost still makes solar energy a more attractive option in off-grid rural areas, the industry is experiencing healthy growth. According to analyst Kapur, "On-grid shipments of solar power systems constituted 24% of sales in 1998." Indeed, since 1994, this segment has outstripped the off-grid market and is expected to grow 39% annually through 2005.

Solar technology appears particularly applicable to the distributed (or back-up) energy market and to the powering of cellular tele-

phone base stations. Costs have been dropping as companies learn how to make photovoltaic panels more efficiently.

Among the companies that could reap the benefits of an expanded market are AstroPower, Spire, BP Solar and Siemens Solar USA.

### BioMass: Waste into Power

This category includes fuels derived from agricultural residue (corn cobs, sugar beet pulp), waste wood (industrial pallets), and municipal solid waste. Such fuels - particularly agricultural residue - are often problematic in availability and require special handling.

Municipal solid waste, however, has become a reliable source of power in Europe where 27 million metric tons are used annually to generate heat and electricity. The U.S. is catching on too. In Texas, for example, Waste Management Inc. will soon be supplying Houston with 4 MW of methane-derived power from a dozen landfills.

### Geothermal Pumps Tap the Earth's Heat

The heat from shallow ground water, deeper hot water, and eventually even rock pockets and magma can be tapped for heating and cool-

ing purposes. Geothermal heat pumps (GHP) exploit the temperature differential between a building and the nearly constant 50-60 degrees of the upper layer of Earth's surface. In other applications, deeper reservoirs of natural hot water can be pumped to power a generator.

According to Kapur, the Geothermal Heat Pump Consortium, in partnership with the Department of Energy, "seeks to increase annual installations of GHP systems to about 400,000 by 2005 and reach a total of 2 million installed that same year." Right now, obstacles to development include cost, lack of infrastructure, and consumers' unfamiliarity with the technology.

### The Price May Be Right

Different alternative energy technologies will lend themselves to different regions, depending on everything from climate to geomorphology to population. But it could be that the current energy anxiety will encourage us to look beyond the one-size-fits-all solutions of oil and natural gas. Many of the technologies are there, ready- or nearly ready- for adoption. This may be the moment to seize upon them. 🐢

# PORTFOLIO UPDATE

## **Corning, Incorporated** (NYSE: GLW)

CORNING, NY - Corning's DuraTrap™ RC diesel particulate filter is the latest in the company's armory of diesel emission controls. It will enable medium and heavy-duty diesel trucks to meet stricter U.S. and world emissions standards. The DuraTrap reduces soot with a consistent filtration efficiency of 90 percent or greater. Corning's previous generation of particulate filters offered the same efficiency rate, but the DuraTrap has greater thermal durability.

The new device joins an environmental portfolio that includes products such as the 900/2 Ultra-thinwall substrate used in advanced catalytic converters. This substrate was recently awarded the U.S. EPA's "Clean Air Excellence Award."

Corning anti-pollution devices should find a particularly strong market in California which has set a statewide goal of reducing emissions from diesel engines by 90 percent. California is the only state to adopt stricter standards than the federal government.

## **Project Software & Development**

(NASDAQ: PSDI)

BEDFORD, MA - Technology companies took a heavy hit during the fourth quarter and Project Software & Development was one of many to issue earnings warnings.

Chip Drapeau, the company's chief executive, blames weakness in Asian markets and a few large transactions that were postponed until next quarter. Further, PSDI's MRO.com ramp-up is costing PSDI more than expected and will require additional resources if it is to succeed.

Drapeau says the company expects to post a profit for the fourth quarter, but the profit will

likely fall short of Wall Street's expectations.

For the fiscal year, company sales totaled about \$169 million, an increase of 16% from the prior year. Executives expect revenue to be \$44 million, 4% more than the year-earlier period, but less than the Bear Stearns expectation of \$51 million. Analysts polled by First Call/Thomson Financial expected the company to earn 16 cents per share.

Richard Scocoza at Bear Stearns downgraded the company to "attractive" from "buy." "We still believe in PSDI's direction, and for patient investors, the sell-off could be an opportunity to buy."

PSDI creates software to help businesses streamline the supply chain for maintenance, repair, and operations (MRO) materials, all of which is being integrated into Internet applications via MRO.com.

## **Valence Technology, Inc.**

(NASDAQ: VLNC)

HENDERSON, NV - A Scandinavian-based cellular phone manufacturer has selected Valence Technology's advanced lithium-ion polymer cells to power its line of GSM and NMT cellular handsets. The GSM wireless Internet device incorporates a digital camera. In addition, Web pages and text can be downloaded on the handset's large display using a patented touch pad system. Sample and pilot production orders are currently being processed.

Valence's technology is suitable for such applications because it has a high energy density, has a thin form factor, and is lightweight. "The convergence of voice and data in mobile communications requires higher energy to power functions such as digital camera electronics and larger LCD displays. Lithium

polymer technology from Valence provides maximum runtime and utility without compromise to the mobile electronics device," said Lev Dawson, Chairman and Chief Executive Officer.

The announcement comes one week after a US-based supplier of "telematics" (onboard global positioning systems and telecommunications for automobiles) placed an initial order for 100,000 cells. The supplier also declared its intention to buy a minimum of 200,000 additional cells over the next 12 months.

## **Netcentives, Inc.** (NASDAQ: NCNT)

SAN FRANCISCO, CA - When America Online and American Airlines team up to offer consumers frequent flyer bonuses online and offline, it will be Netcentives' technology that streamlines the interactions. Implementation of the first phase of the AOL AAdvantage Rewards program is expected to provide Netcentives with a revenue boost. According to analysts at Thomas Weisel, AOL accounted for 5% of Netcentives' revenues this quarter, a figure expected to increase slightly next quarter.

"America Online and American Airlines both understand the power of reward programs," said West Shell, Chairman and CEO of Netcentives. "By leveraging our industry-leading technology and loyalty infrastructure, AOL AAdvantage Rewards will be able to offer a unique set of earning and redemption opportunities and deliver top-notch value to its members."

Netcentives' Enterprise Incentive Solutions division will also provide Nortel Networks with its Employee Reward System. This is the largest program of its kind delivered to date and is expected to enhance third-quarter financial results.

Jim Marks, Credit Suisse First Boston analyst, maintains a strong buy rating. His 12-month price target for the company is \$60. He expects the company to post a loss per share of \$1.86 in 2000 and a loss per share of \$1.73 in 2001.

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