

CLEAN ENERGY TRENDS 2006

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MARCH 2006



THE CLEAN-TECH MARKET AUTHORITY

CLEAN ENERGY TRENDS 2006

At long last, the tipping point is nigh: For the first time in modern history, clean-energy technologies are becoming cost-competitive with their “dirtier” counterparts. While oil and natural gas prices remain stubbornly high and frustratingly volatile across the globe, and as nuclear and coal-based energy remain dogged by environmental and safety concerns, clean-energy prices continue their near-relentless downward march.

Consider wind power. In certain regions, it is now one of the least expensive and most easily deployed sources of new generating capacity. Or ethanol, which has gained favor for vehicle use in both in the U.S. and abroad. Or biodiesel, made from a wide range of animal and vegetable oils, whose price is within striking distance of petroleum-based diesel. Even solar, still relatively expensive without subsidies, competes favorably in some places and is often the cheapest choice for power in remote regions.

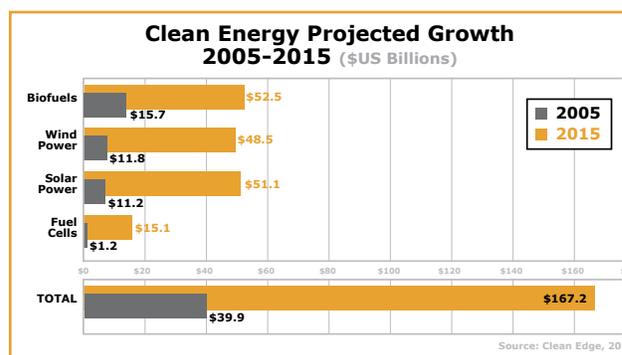
Suddenly, so-called “alternative” energy technologies are looking pretty mainstream.

The growth of clean-energy markets reflects its growing acceptance. Global wind and solar markets reached \$11.8 billion and \$11.2 billion in 2005 – up 47% and 55%, respectively, from a year earlier. The market for biofuels hit \$15.7 billion globally in 2005, up more than 15% from the previous year.

Multinationals like Archer Daniels Midland, BP, GE, Sharp, and Toyota are partly responsible for stoking these technologies’ aggressive growth, leading the way with billion-dollar divisions dedicated to solar, wind power, ethanol, and hybrid electric vehicles, among other technologies. State and city governments throughout the U.S. are playing a key role, too, competing feverishly to become clean-energy hubs that attract economic development and jobs. The Silicon Valley venture firms that financed the Internet and wireless telecom revolutions – among them Draper Fisher Jurvetson; Kleiner Perkins Caulfield & Byers; Mohr, Davidow Ventures; and VantagePoint Venture Partners – have begun placing increasingly bigger bets on clean-energy.

Even America’s Oilman, George W. Bush, seems to be warming to clean energy. In his 2006 State of the Union address, he declared what pretty much every other American already knew: the U.S. is “addicted to oil.” Not an inconsequential statement for a Texan whose vice president once dismissed energy conservation as merely a “personal virtue.” Bush proposed an initiative that calls for a 22% increase in clean-energy research and a goal of replacing at least 75% of U.S. Middle East oil imports by 2025 (though he offered no substantive funding to do these things).

For the first time in modern history, clean-energy technologies are becoming cost-competitive with their “dirtier” counterparts.



Disclosure: Clean Edge or its principals have provided consulting services or hold equity in the following companies mentioned in this report: General Electric, General Motors, Miasolé, Sharp, and Solaicx.

\$156 Billion Market in 10 Years

Even without federal intervention, global clean-energy markets will flourish. According to Clean Edge research, biofuels (global manufacturing and wholesale pricing of ethanol and biodiesel) will grow from \$15.7 billion in 2005 to \$52.5 billion by 2015. Wind power (new installation capital costs) will expand from \$11.8 billion in 2005 to \$48.5 billion in 2015. Solar photovoltaics (including modules, system components, and installation) will grow from an \$11.2 billion industry in 2005 to \$51.1 billion by 2015. And the fuel cell and distributed hydrogen market will grow from \$1.2 billion (primarily for research contracts and demonstration and test units) last year to \$15.1 billion by 2015.

In total, we project these four clean-energy technologies, which equaled \$40 billion in 2005, to grow fourfold to \$167 billion within the coming decade.

It's not all smooth sailing, however: There remains turbulence in the clean-energy sector. The solar industry is experiencing growing problems, unable to gain access to

enough silicon feedstock to keep pace with demand. It will continue to put pressure on upward pricing over the short term. Biofuels, while showing great promise, face obstacles, not the least of which is how to quickly ramp up widespread distribution channels. Growth of wind turbines, while currently expanding rapidly, could flag as well as short-term price increases due to high steel costs and shifting currency valuations. And mass adoption of fuel cells and hydrogen remain decades away.

We believe many such obstacles are surmountable through a combination of incremental and breakthrough technology developments, the continued scale-up of manufacturing, and smart investments by corpora-

tions, investors, and governments. As we've seen over the last five years since issuing our first report on clean technologies (*Clean-Tech: Profits and Potential*, April 2001), the market has considerable momentum and represents one of the fastest-growing technology sectors on the planet.

Select Clean-Energy Stocks

(As of End of Session 3/3/2006)

Ticker	Name	Last (\$US)	52-Week Range (\$US)	Market Cap (\$US Millions)
ACPW	ACTIVE POWER INC	4.38	2.39 - 4.97	213.5
AVA	AVISTA CORP	19.20	16.31 - 20.20	932.4
BLDP	BALLARD POWER SYS	6.56	3.40 - 6.85	739.5
CPST	CAPSTONE TURBINE	3.35	0.89 - 5.89	344.2
DESC	DIST. ENERGY SYSTEMS	9.48	2.58 - 11.00	348.9
ENER	ENERGY CONV DEVIC	46.91	16.27 - 57.84	1,449
ESLR	EVERGREEN SOLAR	16.20	4.68 - 16.27	993.4
FCEL	FUELCELL ENERGY	11.24	7.05 - 12.25	545.7
HYGS	HYDROGENICS CORP	4.17	2.50 - 5.38	382.3
IDA	IDACORP INC HLDG	31.69	26.22 - 33.28	1,341
ITRI	ITRON INC	60.55	26.14 - 62.75	1,510
MDTL	MEDIS TECH LTD	18.77	11.67 - 21.60	519.9
PLUG	PLUG POWER INC	5.07	4.84 - 8.20	434.8
SPIR	SPIRE CORP	9.75	3.60 - 13.37	70.3
UQM	UQM TECHNOLOGIES	4.05	2.60 - 4.85	100.0

Source: Clean Edge, Inc.: www.cleandedge.com/stocks

It could be said that 2005 was the Year of the Sun. On both the private and public markets, solar outshined other energy technologies. VCs put more than \$150 million into U.S.-based companies such as Advent Solar, Energy Innovations, Heliovolta, Miasolé, Nanosolar, and PowerLight in 2005 – double the investments in 2004.

Solar Shines for Investors

Solar’s glow was even more evident in the public markets. The three largest technology IPOs of 2005 were for solar companies: Q-Cells, SunPower, and Suntech Power. Combined, they raised more than \$800 million (on the Frankfurt, NASDAQ, and NYSE exchanges, respectively), and by the end of their first trading day, each had market capitalizations exceeding \$1.5 billion.

Clean-tech stocks in general are doing well. A number of clean-energy stalwarts are trading at or near their 52-week highs.

At the time of publication, Energy Conversion Devices (ENER), Evergreen Solar (ESLR), Itron (ITRI), and Spire Corp. (SPIR) were all trading at roughly double their year-ago levels. But stock prices for other clean technologies, including fuel cells and microturbines, showed less energy.

U.S.-based venture capital investments in energy technologies increased from \$716 million in 2004 to \$917 million in 2005. As a percent of total VC investments, energy tech increased from 3.3 percent in 2004 to 4.2 percent in 2005. Over the last six years, venture investments have more than quadrupled as a percent of total VC investments, increasing from under 1 percent of total venture investments in 1999 to last year’s 4.2 percent. (See next page for more information from Nth Power on venture capital investment trends.)

In the United States, clean energy has become a politically unifying issue with wide support from those of every political stripe, from traditional liberals to current and former military brass. This bipartisanship has been particularly evident at the state level, where nearly twenty states now have renewable portfolio standards (RPS) that mandate a percentage (often up to 20-25 percent) of electricity coming from clean energy. States like California, Hawaii, New York, and Pennsylvania are embarking on aggressive – and impressive – clean-energy programs.

It’s a trend we expect to continue as states view clean energy as an opportunity to address air pollution, public health problems, greenhouse gases, and grid congestion – and a way for states to become known as centers for clean-technology development, with all the new jobs and businesses that can result.

Clean Energy Venture Capital Investments in U.S.-Based Companies as Percent of Total

Year	Total Venture Investments (US\$ Billions)	Energy Technology Investments (US\$ Millions)	Energy Technology Percentage of Venture Total
1999	\$59	\$468	0.8%
2000	\$103	\$1,329	1.3%
2001	\$41	\$932	2.3%
2002	\$21	\$566	2.7%
2003	\$18	\$547	3.0%
2004	\$20	\$716	3.3%
2005	\$22	\$917	4.2%

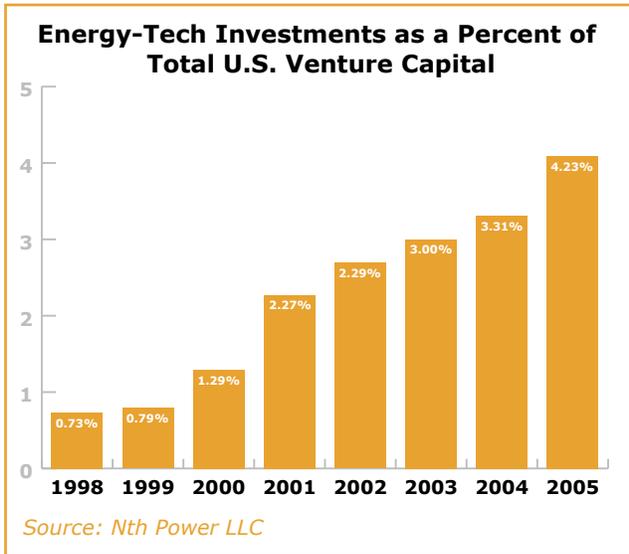
Source: Nth Power LLC and Clean Edge, Inc.

Clean-Energy State of Mind

ENERGY-TECH INVESTMENTS

Rodrigo Prudencio, Principal, Nth Power

Energy dominated the news in 2005, and with those headlines came a sharp rise in the venture capital dollars invested in energy-tech companies. Investors poured \$917 million – an increase of more than 25 percent from 2004 – into more than 80 private companies. In 2005, more than 4 percent of the \$21.7 billion venture capital market was represented by energy-tech investments, compared with 3.3 percent in 2004.

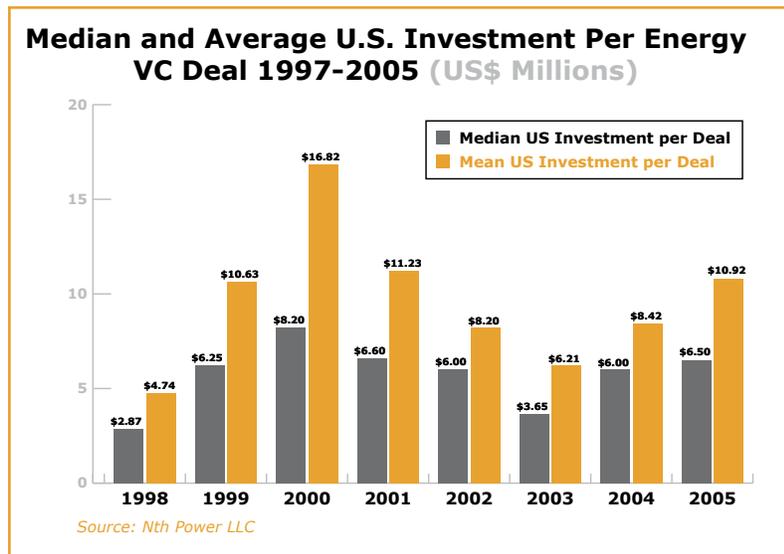


Among the reasons: the rise of oil and gas prices, the growing debates over “peak oil,” and the massive destruction caused by the 2005 U.S. hurricanes showed how unexpectedly vulnerable the U.S. energy supply was to disruption.

But the energy challenges go well beyond the oil platform and gas pump. Accordingly, the diversity of deals attracting private-equity money and the growth of energy’s share of total VC investments suggests investors have their eyes on broad energy opportunities.

A Bigger Slice of the Pie Each of the five principal energy-tech categories increased last year, and investments were spread across a range of technologies:

- **Distributed Energy.** Onsite power and distributed hydrogen and other fuels totaled \$329 million, up from \$266 in 2004, led by investments in solar (\$156 million) and fuel cells (\$86 million).
- **Energy Intelligence.** The application of software, sensors, and data management to energy drew \$274 million, up from \$231 million. The biggest draws were firms offering power line communications technology.



■ **Power Reliability.** Batteries, flywheels, and other reliability solutions received \$119 million, up from \$112 million.

■ **Advanced Materials and Nanotechnology.** In 2005, investors committed \$100 million to companies developing materials for energy application, up from \$38 million the year before.

- **Related Services.** Companies with specialized service solutions for the energy industry grew by roughly half, pulling in \$94 million, up from \$67 million in 2004.

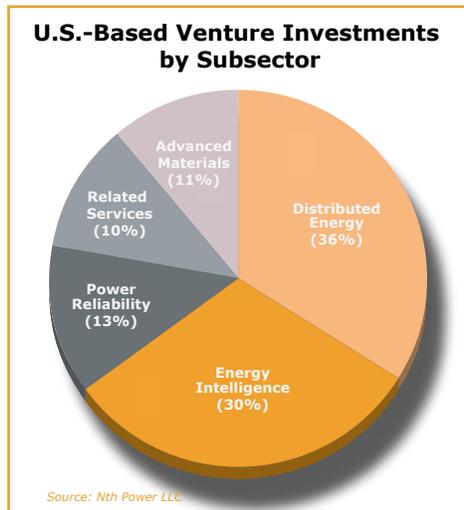
The 81 companies that received venture capital investments last year represent a slight drop from the 84 that attracted capital in 2004. The growth in average investment size, however, grew. In 2005, the average energy-tech investment swelled to \$10.9 million, from \$8.4 million in 2004, the highest level since 2001. Last year's average investment was even higher than the \$10.6 million average in 1999, although the median investment was largely in line with past activity.

Three other notable developments in energy-tech investing:

- **Solar Shines Bright:** As noted earlier, IPOs, joint ventures, start-up activity, and expanding government support combined to make solar the darling of the equity markets in 2005. Silicon shortages did little to slow the momentum. But for the first time, venture investments began moving away from traditional silicon-based solar solutions to some of the more cutting-edge alternative technologies.
- **Portable Power Race:** Continuing a trend we detected last year, battery technologies and portable fuel cells are racing to solve the needs of the cordless power market. Users of PDAs, phones, power tools, and laptops are all eager to cut the cord – and entrepreneurs smell an opportunity.
- **Diminishing Dinosaur Fuel:** The high price of oil has led investors to seek opportunities in biofuels. VCs are beginning to fund the high-risk, high-reward start-ups that other private-equity investors and banks won't touch.

This is the fourth year since downturn in energy-tech investments that followed the fall of Enron and the slowdown of power deregulation in the U.S. The companies that survived should now be stable, setting their sights on exit opportunities. If last year was any indication, the public markets are ready to absorb a good energy-technology story, and solar almost exclusively took the spotlight. This trend should persist in 2006 but across a wider spectrum of technologies. Look for companies in the energy intelligence category to play to investor interest in energy-related info-tech opportunities. Similarly, battery technologies should find favor in the public markets as the first commercial-scale innovations find their way into cordless and wireless products.

Of course, the fact that Emerson, General Electric, Itron, Schneider, Siemens, and other energy-tech giants have yet to turn to acquisition strategies in a significant way could mean that a wave of merger and acquisition deals is forthcoming in this sector. And with energy tech commanding growing attention from the major banks, the deals will only get easier to consummate.



What to Watch for in 2006

FIVE TRENDS TO WATCH

How will clean-energy markets develop? Here is how we view the landscape.

1. CLEAN ENERGY BECOMES A U.S. SECURITY ISSUE

A growing chorus of notable – and often politically conservative – voices have taken up the cause and George W. Bush himself has joined in, of a fashion.

Clean energy as a national security imperative, extolled by clean-energy advocates since the 1970s, has reached center stage. A growing chorus of notable – and often politically conservative – voices have taken up the cause and George W. Bush himself has joined in, of a fashion.

Although many are skeptical of the commitment and funding levels in Bush's proposed Advanced Energy Initiative – only moderate budget increases, including chunks for “clean coal” and nuclear power – there's no doubt it placed clean energy squarely in the national security spotlight. “The energy question,” wrote influential New York Times columnist Thomas L. Friedman in February 2006, “has overtaken Iraq as the most important issue in U.S. foreign policy.” Advocacy groups like the Energy Future Coalition and the Set America Free Coalition, with national security luminaries like former CIA director R. James Woolsey and former Reagan security adviser Robert McFarlane, are pushing for clean-energy technologies like plug-in hybrid cars and biofuels.

Consuming 25 percent of the world's oil with just 2 percent of its proven reserves, the U.S. economy is increasingly vulnerable to supply disruptions and price spikes resulting from trouble in any of several global hotspots – not just the Middle East but in places like Angola, Kazakhstan, Nigeria, Russia, and Venezuela. Another security issue is the concept of “peak oil” – the point at which global oil production tops out, making the remaining oil increasingly harder and more expensive to extract.

Profile:

SkyBuilt Power

Location

Arlington, Virginia
www.skybuilt.com

Founded

2002

Employees

6

Technology

The Mobile Power Station, a standard shipping container delivered to an off-grid site or disaster zone. Solar PV panels, wind turbines, or other components are shipped inside the container, then mounted on or near it to create a fully powered mobile office, command center, medical facility, or storage unit – or a backup power system for other needs.

The Buzz

SkyBuilt has taken a systems-integrator approach, letting customers choose the technologies – micro-hydro on the Nile, a wind turbine in the Arctic, or any combination. It's a promising game plan that emulates the successes of high-tech players.

Brain Trust

CEO and co-founder David Muchow has decades of experience as an energy industry attorney; he was general counsel of the American Gas Association. VP and co-founder Scott Sklar is a well-known solar guru and former head of the Solar Energy Industries Association.

Bankrollers

In-Q-Tel, the CIA's venture capital arm, gave SkyBuilt a huge boost last fall with an undisclosed strategic investment and an R&D agreement. SkyBuilt also has several undisclosed angel investors.

Our Take

SkyBuilt stands amid growing interest in remote clean energy by the military and homeland security agencies. Its products could become integral to efforts to improve government disaster response.

Since roughly two-thirds of the oil used in the U.S. is for transportation, energy security advocates are focusing on hybrid and plug-in hybrid vehicles to save gasoline, and on biofuels – ethanol and biodiesel – as key means to replace it. U.S. biodiesel production tripled in 2005 to 75 million gallons, domestic ethanol output continued its steady growth to nearly 4 billion gallons, while U.S. hybrid car sales grew 144 percent to more than 205,000, more than half of them Toyota's Prius. Plug-in hybrids, still in the demo stage but gaining speed, can get 80 miles per gallon or more by running in all-electric mode for the first 30 miles, about the length of a typical commute.

War and terrorism aren't the only security concerns. There's also recovery from natural disasters that disrupt a region's energy infrastructure. The U.S. hurricane season of 2005 not only sent oil and natural gas prices rocketing to new highs, it spotlighted the need for emergency on-site power from solar, fuel cells, and other distributed and clean-energy technologies. And a growing number of companies addressing these needs are attracting attention and investors.

The goal, after all, is to ensure that such essential commodities are available and reliable not just during troubled times, but 24/7/365.

Oil Dependence can be Solved with Hybrid Vehicles

Unlikely Bedfellows Lobby Against US Gas-Guzzlers

U.S. Navy Calls for Broad Use of Biodiesel at Navy and Marine Facilities

Retrofitted Plug-In Hybrid Vehicle Surpasses 100 Miles Per Gallon

Growth in Biomass Could Put U.S. on Road to Energy Independence, Says Study

Building a 'Green' Island for Tsunami Survivors in the Maldives

New York Governor Unveils Plan to Cut New York's Dependence on Imported Energy

National Plug-In Hybrid Coalition Launched

2005 Top Headlines

A123Systems

www.a123systems.com

Energy Future Coalition

www.energyfuturecoalition.org

Plug-in Partners

www.pluginpartners.org

SkyBuilt Power

www.skybuilt.com

Valence Technology

www.valence.com

Select Organizations to Watch

2. INNOVATION STRETCHES SILICON FOR SOLAR

Amazingly, it's projected that solar will outpace semiconductors by 2008 as the largest user of raw silicon. This dramatic development has had unforeseen ramifications.

A shortage of silicon is casting a cloud over the growth of solar energy – but there's a silver lining for some technology innovators. Whether and how they succeed will help determine how brightly solar energy shines in the near-term.

In most solar cells, silicon – the second-most-abundant element in the Earth's crust (think sand) – serves as the medium that converts photons (sunlight) into electrons (electricity). But the supply of processed polysilicon, the cells' main ingredient, has been bottlenecked due to growing demand and limited supply – five manufacturers constitute 88% of global polysilicon production.

Amazingly, it's projected that solar will outpace semiconductors by 2008 as the largest user of raw silicon. This dramatic development has had unforeseen ramifications. Silicon prices, which represent up to half of a solar cell's cost, have more than doubled. This is the opposite of what was supposed to be happening: solar's strong demand should be driving down prices thanks to improved economies of scale.

Although a bit late to the game, silicon feedstock manufacturers are finally ramping up capacity – albeit tentatively, having been burned during the semiconductor industry's last boom-and-bust cycle. Last year, for example, Michigan-based Hemlock Semiconductor began a \$400 million effort to increase its capacity by 50 percent. And Norway's Renewable Energy Corp. bought a majority interest in Advanced Silicon Materials and is ramping up its silicon-grade solar division.

Beyond that is a corps of firms making cells that use a fraction of the silicon needed for conventional cells. The potential winners include industry leaders like BP and Sharp and smaller players like Evergreen Solar and Q-Cells.

Profile:

Hemlock Semiconductor

Location

Hemlock, Michigan
www.hscpoly.com

Founded

1979

Employees

350

Technology

For more than a decade in "Michigan's Silicon Valley," Hemlock has been the world's largest producer of polycrystalline silicon, the leading feedstock for solar cells and semiconductor chips.

The Buzz

Hemlock started on a \$400 million manufacturing expansion spree in late 2005 that will grow its silicon output from 8,000 to 14,500 tons a year. Sounds bold, but it's actually low-risk. The company says customers are lined up to buy nearly all the new inventory when it completes the expansion in early 2008.

Brain Trust

President and CEO Donald E. Pfuehler joined Hemlock parent Dow Corning as an intern in 1966 and moved consistently up the company ladder. He took over the Hemlock helm in 1997.

Bankrollers

Originally a subsidiary of Dow Corning, Hemlock in 1984 became a joint venture with Japanese single-crystal wafer manufacturers Shin-Etsu Handotai and Mitsubishi Materials. Dow Corning still holds a 63.5 percent stake.

Our Take

Hemlock got burned in 1998 by ramping up production just ahead of a severe economic downturn in Japan, but that's not likely to happen this time. Talk about pent-up demand: global solar giants like BP, Kyocera, and Sharp can't wait to crank out more solar products for voracious markets in California, China, and Germany – not to mention the fast-ramping demand in the rest of the world. The faster that Hemlock and other silicon suppliers can meet that demand, the better.

Evergreen boasts a proprietary technology it calls “string ribbon” due to the continuous strands of crystalline silicon that result. The process yields more than twice as many solar cells per pound of silicon as conventional methods. Already, Evergreen has proved the concept at a 15-megawatt U.S. plant; a 30 MW plant will be completed this year in Germany.

And then there are companies like San Jose-based Miasolé, Austin-based Heliovolt, and Mountain View, Calif.-based Nanosolar, all pursuing thin-film solar technologies that replace silicon altogether, using copper, gallium, indium, selenium, and other exotic materials. Even Honda plans to start producing thin-film cells in 2007. It’s far from a sure thing: thin film has yet to match the efficiency, reliability, or durability of silicon-based cells.

Which brings us back to the incumbent technologies: Don’t count them out. The technology is mature, efficient, and durable. And with heavy investments from the likes of Kyocera, Sharp, Siemens, and others, and the ramping up by silicon feedstock manufacturers, silicon cells aren’t likely to vanish back into sand any time soon.

Demand in Solar Drives \$400 Million Hemlock Semiconductor Expansion

Kyocera to Introduce New Low-Cost, Low-Silicon Solar Module

Researchers Develop Technique to Use ‘Dirty’ Silicon for Cheaper Solar

Wacker to Expand Polysilicon Production with Focus on Solar PV Industry

Solar Power Industry Slowed by Pricey Silicon

Honda to Mass Produce Next-Generation Thin Film Solar Cell

Sharp to Expand Solar Cell Production to 500 MW in 2006

Sanyo Electric to Lift Solar Cell Capacity 15-Fold to 1000 MW in 5 Years

2005 Top Headlines

Hemlock Semiconductor Corp.

www.hscpoly.com

REC Silicon

www.rec-pv.no

ScanWafer ASA

www.scanwafer.com

Solaicx

www.solaicx.com

Wacker

www.wacker.com

Select Companies to Watch

3. RENEWABLES CROSS A TIPPING POINT

By early 2006, electric utility customers buying wind power in at least three U.S. states paid less, for the first time, than those purchasing the conventional power mix from the same utilities.

The long-awaited crossover point between the costs of clean energy and fossil fuels has arrived. Clean-energy sources, particularly wind power and biofuels, are now often price-competitive with their conventional rivals – and in some cases, they’re cheaper. That’s the result of prices for oil and natural gas increasing from global supply and demand dynamics, and clean-energy costs falling due to market growth, economies of scale, and technology advances.

By early 2006, electric utility customers buying wind power in at least three U.S. states paid less, for the first time, than those purchasing the conventional power mix (mostly natural gas and nuclear) from the same utilities. At times over the past year, the price of biodiesel dipped below that of petroleum diesel in some states. And ethanol, with significant increases in both production and competition in the U.S., is less expensive than the MTBE additive it’s replacing and competes on price with gasoline as well. In Brazil, it’s cheaper than gas.

To be sure, some of this may be temporary. Wind turbine prices are on the rise due to steel cost hikes (thanks to China’s gluttonous appetite for steel) and a strong euro affecting the price of turbines from manufacturers in Denmark, Germany, and Spain. A worldwide silicon shortage is pushing up solar cell costs (see page 8). The prices of biofuel feedstocks like corn and soybeans are subject, somewhat ironically, to the volatility of fossil-fuel prices.

But there’s no denying the trend lines: clean-energy costs are dropping while fossil-fuel costs rise. Even solar PV, still the most expensive clean-energy source, competes favorably with peak-usage utility power in places with strong solar subsidies and high electric rates such as

Profile:

Xcel Energy

Location

Minneapolis, Minnesota
www.xcelenergy.com

Founded

2000 (by merger of New Century Energies and Northern States Power)

Employees

10,650

Technology

The U.S. fourth-largest combined electric and natural gas utility, Xcel is a leader in wind energy development. It generates or purchases 1,100 MW of wind power, making it the nation’s second-largest wind retailer behind Southern California Edison (SCE). Xcel’s Windsource green-power program, the nation’s largest, has more than 40,000 residential and business customers in Colorado, Minnesota, and New Mexico.

The Buzz

Xcel made history last November when rates for Windsource dropped below the cost of conventional power, a first for an investor-owned utility. As of March 2006, the program was sold out, with a waiting list of more than 1,000.

Brain Trust

Chairman and CEO Wayne Brunetti, a 42-year utility industry veteran, says Xcel will surpass SCE as the U.S. largest seller of wind power by acquiring 775 additional MW of capacity by the end of this year. Brunetti is a past chairman of Edison Electric Institute, the utility industry’s trade association.

Customers

More than 3.3 million in 10 states, using more than 15,000 MW.

Our Take

Xcel is a classic case of market signals driving clean-energy growth. When Windsource became the cheapest customer option, it quickly became oversubscribed. So Xcel is aggressively seeking more wind supply (though not quickly enough, say some local wind advocates). Windsource may not always be cheaper, but the clean-energy commitment of Xcel and its customers ensures long-term growth and price competitiveness for clean power.

California, New Jersey, and Japan. That's shrinking the investment-payback time for both commercial and residential PV systems.

In the wake of last fall's hurricanes, a spike in natural gas prices caused a rise in utility fuel charges, kicking conventional electricity from several U.S. utilities to a higher price than wind power, which is immune from fuel price rises.

For example, last November, buyers of Xcel Energy's Windsource power in Colorado, generated by two company-owned wind farms cranking out 60 megawatts in the state, began paying at least 6 cents less per kilowatt-hour (kWh) than their neighbors. Similarly, the cost of Austin Energy's GreenChoice wind power option dipped below the rate for regular power by about a penny per kWh after a fuel-charge bump in January 2006, and Austin's wind buyers have the added benefit of a locked-in rate.

Not surprisingly, both the Windsource and GreenChoice programs are fully subscribed with waiting lists; "No Wind for You," said a headline on one Denver TV station's Web site. In Oklahoma, wind-buying customers of OG&E Electric Services and Edmond Electric are also saving money – and likely earning the envy of their neighbors.

*Novozymes and NREL Reduce Enzyme Cost 30-fold for Biomass
Cost Competitive Electricity from Photovoltaic Concentrators Called 'Imminent'*

New Process to Make Biodiesel Production Cheaper

Rising Oil Prices Fuel Investment Returns in Renewable Energy

California PUC Approves Landmark Solar Program - 3,000 MW in 11 Years

Xcel Energy Plans Major Wind Acquisition in Colorado

Nuclear Power Station Cleanup Cost Soars in Britain

US Wind Industry Up in 2005, Sustained Growth Projected for At Least Two Years

2005 Top Headlines

Austin Energy
www.austinenergy.com

Novozymes
www.novozymes.com

OG&E Electric Services
www.oge.com/es

Seattle BioFuels
www.seattlebiofuels.com

Xcel Energy
www.xcelenergy.com

Select Companies to Watch

4. FLEX FUELS GAIN POWER AND SPEED

While most in the eco-transportation crowd were busy ogling the Prius and other hybrids as the feature attraction, flex-fuel vehicles quietly sneaked onto the stage and began stealing some of the limelight.

The Holy Grail of clean energy for transportation is a clean-burning, high-octane fuel that can supplant petroleum, reduce greenhouse gases, create domestic jobs, and free the U.S. and others from foreign oil. It's only recently that political and industrial players have come to recognize that this dream fuel is a reality.

As a result, biofuels – ethanol and diesel from renewable resources – have become the new darlings of the green-vehicle crowd. And while most in this crowd were busy ogling the Prius and other hybrids as the feature attraction, flex-fuel vehicles (FFVs) quietly sneaked onto the stage and began stealing some of the limelight.

FFVs, as their name implies, run on both conventional and alternative fuels. For example, cars that can run on E85 – a mixture of 85 percent ethanol and 15 percent gasoline – also can run on conventional gas, or any combination thereof; their engines continually adjust based on the current fuel mix. Similar with cars, buses, and trucks that run on biodiesel, made from anything from tree trimmings to turkey parts.

The catch? It's the classic chicken-and-egg dilemma: which comes first, flex fuels or flex-fuel vehicles? By all counts, it's the latter that is leading – roughly four million FFVs on U.S. roads, compared to only about 600 fueling stations.

That's changing, albeit slowly. U.S. auto makers, behind the curve in eco-friendly innovations, view FFVs as a means of preening their green credentials. During the 2006 Super Bowl, for example, General Motors unveiled a tagline to promote its line of FFVs: "Live Green, Go Yellow." The color refers, in this case, to corn, the principal feedstock of ethanol, and to the yellow gas caps GM is putting on the 400,000 FFVs it

Profile:

VeraSun Energy

Location

Brookings, South Dakota
www.verasun.com
www.ve85.com

Founded

2001

Employees

120

Technology

Makes technology to convert corn into fuel-grade ethanol for use in vehicles, primarily as E85 fuel.

The Buzz

Over the past year, VeraSun has become a key player in growing the E85 distribution infrastructure through partnerships with both Ford and General Motors. Together, they have created small but significant roll-outs of E85 pumps in existing fueling stations in California and the Midwest. Both Ford and GM have been promoting the stations through a variety of means – a potent marketing team, if ever there was one.

Brain Trust

CEO Don Endres, like most of his other co-founders and senior management team, doesn't boast vast experience in either ag or energy, though Endres et al. have a string of successful start-ups, including one Endres venture that made Inc. magazine's list of fastest-growing companies. Endres became acquainted with ethanol through investments in other energy companies.

Bankrollers

Mostly management-financed, with a round from local South Dakota venture firm Bluestem Capital.

Our Take

It's hard to ignore a company that's quickly become the nation's second-largest producer of one of the hottest and fastest-growing fuels – and that has both Ford and GM doing their bidding. VeraSun has demonstrated that corn-based ethanol can be the grist of entrepreneurs' dreams. The question, of course, is whether and for how long corn remains the feedstock of choice for ethanol, and whether VeraSun can keep up with the markets as cellulosic ethanol begins to capture market, and investor, attention.

will produce in 2006. Ford, for its part, plans to make a quarter-million FFVs this year, and has showcased an SUV prototype boasting both flex-fuel and hybrid technology.

Meanwhile, back at the pump, oil companies like Shell and Chevron are partnering with – or buying stakes in – manufacturers and distributors of ethanol and biodiesel to make such biofuels more widely available. President Bush’s State of the Union address touting ethanol didn’t hurt in building interest.

The venture crowd also is kicking in. A bevy of startups are doing the rounds seeking capital for technologies that create ethanol out of everything from enzymes to “energy crops.” Even Bill Gates is getting in on the action. The billionaire’s firm, Cascade Investment, acquired a major stake in California-based Pacific Ethanol. There’s even buzz of ethanol and biodiesel companies fueling the next wave of clean-energy IPOs.

And where there’s money, there’s politics. In California, Hollywood mogul Steven Bing and Silicon Valley VC Vinod Khosla are bankrolling a ballot initiative that, if approved, could raise up to \$380 million a year to develop ethanol and biodiesel technologies – a pot of biofuel-gold for the Golden State.

Bill Gates Announces Plan to Invest \$84 Million in Pacific Ethanol
Biomass-to-Ethanol Technology Could Help Replace Half of U.S. Auto Fuel
U.S. Ethanol Industry Sets Annual Production Record of 3.4 Billion Gallons in 2004
New Biorefinery Process Turns Wood into Energy
Engineers Invent Ethanol Reactor Capable of Producing Hydrogen
Cargill Announces Plans To Invest In a Biodiesel Facility in Mainz
ADM Announces Plans to Build Biodiesel Production Facility
Shell and Iogen to Study Feasibility of Producing Cellulose Ethanol in Germany

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Select Companies to Watch

Agrivida
www.agrivida.com

Consolidated Biofuels
www.consolidatedbiofuels.com

Iogen
www.iogen.ca

Pacific Ethanol
www.pacificethanol.net

VeraSun Energy
www.ve85.com

5. CHINA AND INDIA LOOM LARGE

China and India, with 40 percent of the planet's population between them, may well accelerate clean-energy's growth.

It's become axiomatic in energy circles that "China and India change everything." Their seemingly boundless demands for energy, goes the conventional wisdom, will affect both the price and availability of fuels worldwide, and contribute mightily to climate change and other environmental problems.

But it's not all doom and gloom. These two behemoths, with 40 percent of the planet's population between them, may well accelerate clean-energy's growth.

Both countries' unquenchable thirst for energy is linked to their economies' breathtaking annual growth rates – an average of 9.5 percent for each of the past two decades for China, and smaller but still vibrant rates for India. Some forecasts have India overtaking China as the world's fastest-growing major economy over the next 15 years, says the nonprofit Worldwatch Institute.

Such growth is straining energy resources – not just China's and India's, but everyone's. China is currently the world's second-largest energy consumer; India is sixth. Both are seeking oil resources from as far away as Sudan and Venezuela – and both have just started to build what are slated to be two of the world's largest auto industries. By 2025, China will burn through 14.2 million barrels of oil a day, double last year's level, while India's oil imports are expected to triple to 5 million barrels a day by 2020.

The good news is that China is tapping into its immense energy flows – solar, wind, and bio-fuels. Example: China's terrestrial and near-off-shore wind potential is roughly 2,000 gigawatts, among the largest in the world. China already is the leader in solar thermal energy for hot water, with 60% of the world's installed systems. And

Profile:

Suntech Power Holdings Ltd.

Location

Wuxi, Jiangsu Province, People's Republic of China
www.suntech-power.com

Founded

2001

Employees

1,300

Technology

Designs, develops, manufactures, and sells a variety of photovoltaic cells, modules, and systems for the residential, commercial, industrial and public utility markets. Employs both mono- and polycrystalline cell technology.

The Buzz

Suntech has quickly risen to the top of the China solar market, the world's fastest-growing economy and soon to be the world's biggest energy market. Suntech's IPO last December, which raised \$396 million for the company, is at the vanguard of a wave of Chinese companies to launch on U.S. exchanges.

Brain Trust

CEO and majority shareholder Shi Zhengrong earned a Ph.D. in electrical engineering at the University of South Wales, staying on in Australia to work in thin-film research before heading back to China to launch Suntech.

Bankrollers

Suntech's IPO included underwriters Credit Suisse First Boston, Morgan Stanley, CSLA Asia-Pacific Markets, and SG Cowen.

Our Take

Things are looking bright for Suntech, which keeps hitting its sales and efficiency targets, and continues to increase its profitability in spite of rising silicon prices, due in part to locking in 10-year contracts with suppliers. As a result the company was able to significantly grow its production capacity in 2005 to 150 megawatts and by the end of 2006 will grow another 60 percent to hit 240 MW. That's an impressive ramp-up in this burgeoning industry, and places Suntech in the pole position to capture a large share of China's solar market.

last year the National People's Congress endorsed a Renewable Energy Promotion Law committed to producing 15 percent of the country's power from clean energy by 2020. India, for its part, aims to establish enough clean energy to electrify all of India's villages by 2010. Under the program, 4,000 MW of renewables would be added by 2007, with the goal of elevating renewables' share to 10 percent by 2012.

Reaching such ambitious clean-energy goals will require mind-boggling investments – up to 1.5 trillion yuan (US\$184 billion) for China, according to estimates. And it will likely spur innovation and new business opportunities for Chinese and Indian companies, along with their American, European, and Asian partners.

As the world already has seen, both countries have vast potential to tap cheap labor and a booming pool of engineers and other talent to leapfrog the Western world's stodgy infrastructure – witness the fact that China already is the world's biggest cell phone market, with 377 million subscribers. (India's share, though smaller, is growing even faster and will surpass China in new mobile subscriptions in 2006.) Could solar panels, wind turbines, or hybrid cars be next?

As we said, China and India change everything.

China's First Auto Works Introduces Enova Hybrid-Powered Bus

China to Spend \$180 Billion to Boost Renewable Energy Use

China Could Become the World Leader in Wind Power, Says Report

World Bank to Help China Scale Up Use of Renewables

China's New Energy Law Could be Turning Point for Sustainable Development

India's First Biomass Power Project to Be Launched

China and India Will Eetermine Energy Future

India Attains Fourth Position in World in Wind Energy

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Enova Systems

www.enovsystems.com

Select Companies to Watch

SELCO

www.selco-india.com

Suntech Power Holdings

www.suntech-power.com

Tata BP Solar

www.tatabpsolar.com

Vestas

www.vestas.com

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Clint Wilder, contributing editor for Clean Edge, is a veteran award-winning technology and business journalist. He currently is writing a book (with co-author Ron Pernick) on the clean-tech revolution, to be published by HarperCollins in 2007. Wilder has written the monthly CE Views column for the CLEANWATCH newsletter and is a frequent speaker at industry events, including United Nations World Environment Day and the Wharton Private Equity Conference. Before joining Clean Edge, he was editor-at-large and columnist for *Optimize* magazine, a monthly journal for high-level business technology executives. Previously, he won the 2002 American Society of Business Publication Editors award for best feature series for *Information Week*.

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