CLEAN ENERGY TRENDS 2008

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CLEAN EDGE
THE CLEAN-TECH MARKET AUTHORITY

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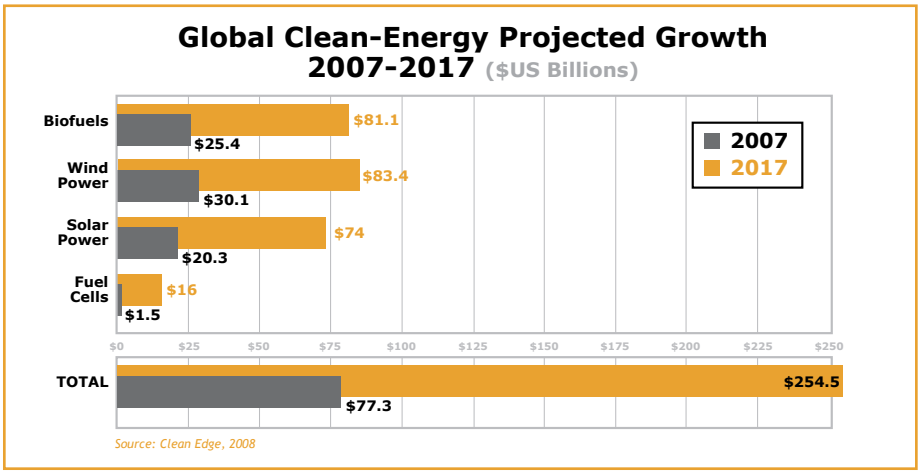
CLEAN ENERGY TRENDS 2008

Amid a challenging economic outlook—plummeting housing prices, rising foreclosure rates, record-high oil prices, sinking consumer confidence, looming recession—2007 was another banner year for clean energy, with no signs of a slowdown in 2008. Solar, wind, biofuels, geothermal, energy intelligence, hybrid- and all-electric vehicles, advanced batteries, green buildings, and other clean-energy-related technologies and markets provided bright spots in an otherwise sluggish economy.

2007 was another banner year for clean energy, with no signs of a slowdown in 2008.

Clean Edge, which has been tracking the growth of clean-energy markets since 2000, reports a 40 percent increase in revenue growth for solar photovoltaics, wind, biofuels, and fuel cells in 2007, up from $55 billion in 2006 to $77.3 billion in 2007. For the first time, three of these are generating revenue in excess of $20 billion apiece, with wind now exceeding $30 billion. New global investments in energy technologies—including venture capital, project finance, public markets, and research and development—have expanded by 60 percent from $92.6 billion in 2006 to $148.4 billion in 2007, according to research firm New Energy Finance.



Further proof of clean tech's move from marginalized to mainstream is abundant. A growing number of governments announced plans to generate electricity from renewables. Corporations continued to jump on, if not lead, the race to transition to a cleaner, greener economy. Venture capitalists in the U.S. invested $2.7 billion in the clean-energy sector, representing more than 9 percent of total VC activity. Clean-energy indices outpaced the broader markets in 2007. For example, the NASDAQ® Clean Edge® U.S. Liquid Series index (co-developed by Clean Edge and NASDAQ) was up 66.67 percent last year, compared with 3.53 percent for the S&P 500 index and 9.81 percent for the NASDAQ Composite index.

According to Clean Edge research:

- Biofuels (global production and wholesale pricing of ethanol and biodiesel) reached $25.4 billion in 2007 and are projected to grow to $81.1 billion by 2017. In 2007 the global biofuels market consisted of more than 13 billion gallons of ethanol and 2 billion gallons of biodiesel production worldwide.
- Wind power (new installation capital costs) is projected to expand from

$30.1 billion in 2007 to $83.4 billion in 2017. Last year's global wind power installations reached a record 20,000 MW, equivalent to 20 large-size 1 GW conventional power plants.

- Solar photovoltaics (including modules, system components, and installation) will grow from a $20.3 billion industry in 2007 to $74 billion by 2017. Annual installations were just shy of 3 GW worldwide, up nearly 500 percent from just four years earlier.

- The fuel cell and distributed hydrogen market will grow from a $1.5 billion industry (primarily for research contracts and demonstration and test units) to $16 billion over the next decade.

Together, we project these four benchmark technologies, which equaled $55.4 billion in 2006 and expanded 40 percent to $77.3 billion in 2007, to grow to $254.5 billion within a decade.

Scaling Up

Clean energy, while still a fraction of global energy supplies, is scaling up. In 2007, global cumulative installed wind power capacity exceeded 94,000 megawatts (MW) and the solar industry surpassed the 10,000 MW mark with new additions of 20,000 MW and 2,821 MW respectively. Total global biofuels production reached more than 15 billion gallons last year, with the U.S. accounting for nearly half of all global output.

Global Installation/Production Growth: Solar, Wind, Biofuels

	2003	2007	2017 (est.)
Solar PV Installations	620 MW	2,821 MW	22,760 MW
Wind Power Installed	8000 MW	20,060 MW	75,781 MW
Biofuels Produced	7 Billion Gallons	15.6 Billion Gallons	45.9 Billion Gallons

Source: Clean Edge, Inc., 2008

The current scale-up is an encouraging sign, offering the promise for manufacturers, installers, and developers to bring down costs and leverage economies of scale. The opportunity hasn't escaped the attention of legendary oil and gas investor and prospector T. Boone Pickens. He recently announced plans to build the world's largest wind farm at 4,000 MW, with an estimated development price tag of around $10 billion. "I have the same feelings about wind," Pickens told the *New York Times*, "as I had about the best oil field I ever found."

Hawaii is also serious about scale. The state's Republican governor, Linda Lingle, has announced plans to get 70 percent of the state's energy from renewables by 2030 and is partnering with the U.S. Department of Energy to reach that goal. This is more than double the most ambitious targets set by any other U.S. state.

Singapore, vying to be a new center for clean-tech industry, is playing the scale card as aggressively as anybody. Last November, Norway-based REC announced plans for a 1.5

gigawatt solar solar manufacturing facility—the largest in the world—to be built 30 minutes from downtown Singapore. Neste Oil of Finland is building the world's largest biodiesel facility there, at a planned output of 250 million gallons a year.

Such ambitions around clean-energy development would have seemed pie-in-the-sky just a few years ago, but are now becoming business as usual for a range of traditional stakeholders within government, industry, and finance.

Are Coal and Nuclear on the Decline?

If Europe's experience in this decade is any indication, we could be moving into an era where coal and nuclear begin to contract instead of expand. Unlikely as that may seem, especially with approximately one new coal plant being brought online each week in China and India, it's hard to overlook the European experience.

Parts of Europe, such as France, generate more than half of their power from nuclear, but since the beginning of the decade the EU has added 47,000 MW of new wind energy compared with just 9,600 MW of coal and only 1,200 MW of nuclear, according to Platts PowerVision and the European Wind Energy Association. Perhaps even more telling, 2007 saw net capacity additions of 8,504 MW for wind, whereas both coal and nuclear saw net capacity reductions, of 750 MW and 1,203 MW, respectively.

It's not just Europe. In the U.S., which gets half of its electricity from coal-fired plants, more than 50 new coal plants have been put on hold because of legislative and investor concern about greenhouse gas emissions. Wall Street has loudly sounded the alarm on coal in anticipation of federal carbon emissions caps in the next presidential administration and Congress. Citigroup, JPMorganChase, and Morgan Stanley have issued strict new guidelines for coal investments, noting that "investing in CO_2-emitting fossil fuel generation entails uncertain financial, regulatory, and environmental liability risks." Kohlberg Kravis Roberts, Texas Pacific Group, and other investors made their $45 billion buyout of TXU contingent upon the Texas utility scrapping plans for 8 of its 11 planned coal plants.

Capital Cost for New Plants

Conventional wisdom has it that renewables cost significantly more than conventional, fossil fuel-based power generation. But things are beginning to shift. The table below shows the average estimated capital costs, per 1,000 MW, to build a range of power plants. Whereas coal, nuclear, and geothermal plants are able to provide baseload power, solar and wind are intermittent resources. In order to compete head-to-head with conventional sources, solar and wind will require the implementation of energy storage/smart-grid capabilities. It's also important to note that solar, wind, and geothermal do not have "fuel" costs, they get their power from the sun, wind, and the earth's heat – free of charge.

Typical Construction Costs per 1,000 MW ($US billions)

Coal Plant	Geothermal	Wind	Nuclear	Solar
$.75 - 1.4	$1.6	$1.4 - 1.8	$2 - 6	$5 - 10

Source: Clean Edge, Inc., 2008

Even in China, which currently gets around 80 percent of its electricity from coal, the move toward renewables is palpable. The government has plans on the drawing board for 120 GW of new renewables by 2020—more than ten percent of total projected energy demand—three times its plans for new nuclear power.

Putting aside carbon con-

straints, pollution, and other environmental issues, looking at pure costs alone paints a very compelling picture for emerging renewables. The average upfront capital costs for a 1 GW nuclear plant currently range between $2 and $6 billion. Compare this to 1 GW of geothermal and wind power at less than $2 billion and 1 GW of solar at between $5 and $10 billion, and the move towards renewables makes economic sense.

Select Corporate Clean-Energy Developments of 2007

- **General Electric** posted its largest annual wind power revenues since getting into the business in 2002. The company generated a whopping $4.5 billion from its booming wind business in 2007.
- **Google** launched a number of clean-energy initiatives backed up by tens of millions of dollars. The company's aim: making renewables cost competitive with coal within years, not decades.
- **MEMC**, the semiconductor giant, announced solar-grade-silicon wafer supply agreements worth a projected $12 billion to the company over a ten-year period.
- **PG&E** doubled its planned solar thermal commitments to 2,000 MW and **FPL Group** announced plans to spend $1.5 billion in new solar thermal power development.
- **Royal Dutch Shell** will work with HR Biopetroleum to construct a pilot facility in Hawaii to grow marine algae for conversion into biofuel.

Potential Pitfalls and Potholes

To be sure, not all the news has been positive for clean energy. The growth sector faces a number of challenges that could significantly impact the future for clean-energy markets, including:

- the rising impact of biofuel production on food supplies and commodity agriculture prices;
- the need to conduct accurate environmental and life-cycle analysis for a range of renewables and conventional sources in order to understand the true impact of investment and development decisions;
- constrained credit markets and access to finance which could derail clean-tech projects that require project financing/debt equity;
- uncertain U.S. policies around production tax credits for renewables and carbon regulations, which could hinder or eliminate growth;
- a global economic recession which could curtail spending across a range of industries, including clean tech.

Finding answers and solutions to these and other vexing issues will require vision, leadership, technical and market insight, and sound policy action.

U.S. Venture Capital Continues to Grow and Grow

U.S.-based venture capital investments in energy technologies more than quadrupled from $599 million in 2000 to $2.7 billion in 2007, according to New Energy Finance (with supporting data from Clean Edge and Nth Power). As a percent of total VC investments, energy tech increased from 0.6 percent in 2000 to 9.1 percent in 2007. Between 2006 and 2007, venture investments in the U.S. clean-energy sector increased by more than 70 percent.

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
2000	$105.1	$599	0.6%
2001	$40.6	$584	1.4%
2002	$22	$483	2.2%
2003	$19.7	$446	2.3%
2004	$22.5	$663	2.9%
2005	$23	$1,038	4.5%
2006	$26.5	$1,555	5.9%
2007	$29.4	$2,665	9.1%

Source: New Energy Finance with supporting data from Nth Power and Clean Edge. NOTE: New Energy Finance's energy-tech VC numbers include investment in renewable energy, biofuels, low-carbon technologies, and the carbon markets. VC figures are for development and initial commercialization of technologies, products and services, and do not include private investments in public equity (PIPE) or expansion capital deals.

Total Investments Reach $148 Billion

According to New Energy Finance, new global investment in all clean-energy sectors soared to $148.4 billion in 2007, up 60 percent from $92.6 billion tracked in 2006. This figure includes investments made by VC and private equity investors; public-market activity (IPOs, etc.); project financing; asset financing; government research & development; and corporate research, development, & deployment.

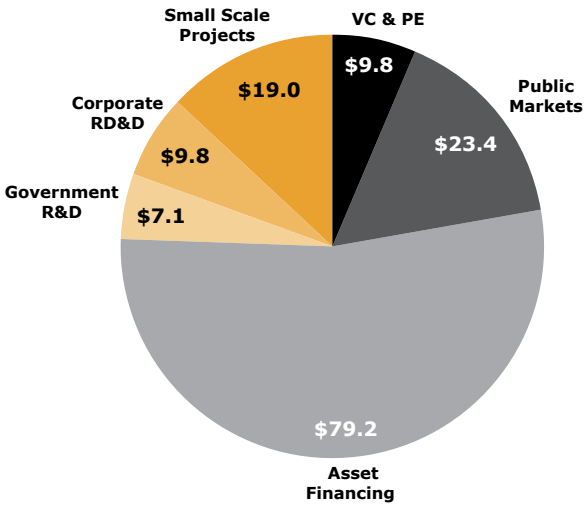
While this investment figure is significant, we could see continued growth in coming years. The International Energy Agency, an intergovernmental body focused on energy policy, has estimated that $16 trillion needs to be invested by 2030 (or about $600 billion/year) to meet the growth in projected demand for new electricity and fuel sources worldwide. In a carbon constrained world, we expect that an increasing percentage of that expenditure will be focused on renewables and efficiency technologies.

U.S. Top 10 Disclosed Energy-Tech Venture Deals (2007)

Company	Primary sector	Total invested (U.S. $ Millions)
HelioVolt Corporation	Solar	$100.5
GreatPoint Energy	Efficiency: Supply Side	$100.0
Arcadian Networks	Efficiency: Supply Side	$90.0
Solyndra Inc	Solar	$79.2
SolFocus Inc	Solar	$63.6
Calera Corporation	CCS	$58.5
Miasolé Inc	Solar	$50.0
Solaria Corp	Solar	$50.0

Source: New Energy Finance, 2008

New Global Investments in Clean Energy - 2007 ($US Billions)



TOTAL: $148.4 Billion

Source: New Energy Finance. NOTE: Asset financing figure includes a downward adjustment of $5.3bn, reflecting a subsequent reinvestment in projects of VC, PE and public market funds raised by clean-energy companies. Re-investment assumes a one-year lag.

What to Watch for in 2008

As American baseball icon Yogi Berra put it, "The future ain't what it used to be." That certainly seems to be the case when forecasting the energy industry. Instead of the once-conventional vision of cheap coal, inexhaustible supplies of oil, and unlimited nuclear power, we now have cities choking on power plant emissions, $100 barrel crude, and nuclear proliferation and radioactive waste nightmares. The future doesn't belong to the incumbents, but to a range of emerging technologies that are reshaping the global economic landscape.

We live in interesting times: the transition from a reliance on high-carbon energy sources to low- and zero-emission technologies. The trend, we believe, is incontrovertible. On the following pages we look at some of the key clean-energy trends that we believe will have the largest impact in 2008 and beyond.

FIVE TRENDS TO WATCH

1. START-UPS POWER THE ELECTRIC CAR

Move over, Toyota. Step aside, GM. The new generation of green vehicles may not be driven by Detroit or its Euro or Asian counterparts. A growing line of start-ups is rendering moot the question of "Who killed the electric car?" While the global car companies go through years-long retooling to create plug-in hybrids, electric cars, and other alt-fuel vehicles, these start-ups are beating the big guys to market, delivering greener cars to a waiting public.

While the global car companies go through years-long retooling to create alt-fuel vehicles, smaller firms are beating the big guys to market.

It's not just the Tesla, the high-profile manufacturer of the high-performance and high-priced Roadster—though that company remains on course to roll out its battery-powered vehicle capable of zooming from 0 to 60 in about as much time as it takes to say, "Six thousand, eight hundred and thirty-one lithium-ion battery cells." There's also Fisker Automotive, whose sporty Karma plug-in would lag the Tesla to the 60-yard line by a full two seconds, but which nonetheless drew gawking crowds to the Detroit Auto Show this year. The Tesla and the Fisker aren't exactly popularly priced—$98,000 and $80,000, respectively.

Behind them are two others, both based in southern California. One is Aptera Motors, whose futuristic three-wheeler, Typ-1, will be available in both an all-electric model (up to 120 miles per charge) and a gas-electric hybrid (with a range of up to 600 miles). Delivery is expected later this year with an anticipated $30,000 price tag. The other, Phoenix Motorcars, is focusing on the "mass production of full-function, green electric trucks and SUVs for commercial fleet use." Its prototype Phoenix SUT (for Sport Utility Truck) uses an AeroVironment battery pack that will drive the five-seat truck for 100 miles—and recharge in less than 10 minutes.

Profile:

REVA Electric Car Co.

Location

Bangalore, India
www.REVAindia.com

Founded

2001

Employees

360

Technology

Makes electric vehicles that run off 6-volt lead-acid batteries. The current model seats 2 adults and 2 children and can reach 80% charge in 2.5 hours and 100% in 5-6 hours. In 2008, the company will release a new model powered by lithium-ion batteries, increasing the vehicle's range from 50 to 70 miles between charges.

The Buzz

RECC has sold around 1,800 vehicles to date, half outside India, and is expanding manufacturing from 6,000 to 30,000 vehicles per year , perhaps positioning for an acquisition.

Brain Trust

Chetan Kumaar Maini, Deputy Chairman and Managing Director, worked for both GM and Amerigon before starting RECC. Dr. Lon Bell is founder of both AEV, which is a minority holder of RECC, and the thermoelectric device company, Amerigon.

Bankrollers

RECC is a joint venture between the Maini Group India and California's AEV. In 2006, it received $20 million from Global Environment Fund and Draper Fisher Jurvetson.

Our Take

REVA claimed to be the best-selling on-road EV in the world last year, gaining traction in European cities, where new emission and congestion fees are popping up. Making inroads with the horsepower-hungry US market may prove difficult and even at its low price, the car is out of reach for most in India. But India is poised to become the fastest-growing car market, putting RECC in the driver's seat to create the everyman's EV.

And then there's software entrepreneur Shai Agassi, whose audacious vision for an electric-vehicle infrastructure led to Project Better Place—and garnered $200 million in the process. His vision: deploy EVs on a mass scale, combining streetside recharging points with battery-swapping stations throughout his native Israel, site of the initial roll-out. In this case, the start-up is partnering with Renault and Nissan for its vehicles, designing and operating the balance of the system.

There are others, a growing United Nations of Mobility: Eliica (Japan), Miles (U.S.), NICE (U.K.), REVA (India), Spark (China), Think (Norway), Venturi (France), ZAP (U.S.), and ZENN (Canada)—more than a hundred makers of EV vehicles and systems overall. There's also the infrastructure folks, like Boulder, Colo.-based Intrago, which has developed a smart docking/charging station for renting EVs by the hour; Vancouver-based Delaware Power Systems, with its modular battery management system; and Scottsdale, Ariz.-based ECOtality, which offers chargers and battery systems.

Of course, the majors aren't exactly stuck in Park. Chrysler has its GEM cars, GM is touting its forthcoming Volt, and plug-in vehicles from Toyota, Honda, and others are destined to hit U.S. showrooms by 2010. By then, however, some start-ups will have kicked into high gear, potentially leaving the world's legacy car makers in the dust.

2007 Top Headlines

Reimagining the Automobile Industry by Selling the Electricity

Tesla Passes 500 Reservations for 2008 Model Year Roadster

Think Raises $60 Million for Electric Cars

At $30,000 and 80-mph, an Electric Car for the Common Man

So, You Want to Start an Electric Car Company?

30 Electric Cars Companies Ready to Take Over The Road

Silicon Valley's $200 Million Electric Car Startup

ZAP Says Its $30K Electric Sports Car Is Coming in 2009

Select Companies to Watch

Delaware Power Systems
www.delawarepowersystems.com

Intrago
www.intragomobility.com

Phoenix Motorcars
www.phoenixmotorcars.com

REVA Electric Car Co.
www.REVAindia.com

Venturi
www.venturi.fr

2. SUSTAINABLE CITIES SPROUT FROM THE GROUND UP

For the first time in human history, more than half of the world's population now resides in urban areas. So how can the cities of the 21st century achieve sustainability in a world of increasing restraints on traditional energy resources and carbon emissions? A vision of those future cities is beginning to emerge, creating intriguing new opportunities for clean-tech development and investment—some in unlikely places.

A vision of future cities is beginning to emerge, creating intriguing new opportunities for clean-tech development and investment—some in unlikely places.

The oil-rich territory of Abu Dhabi in the United Arab Emirates recently broke ground on Masdar City, which aims to be the world's first zero-carbon, zero-waste, car-free city. The government's Masdar Initiative includes $4 billion in direct funding of infrastructure, such as solar PV canopies over pedestrian walkways, and an additional $18 billion in corporate investments. Those include a $250 million Clean Technology Fund whose partners include Credit Suisse and Siemens. "Abu Dhabi," wrote the *New York Times*, "hopes to show that petrodollars can develop innovation in clean energy." Among the fund's U.S. investments are HelioVolt, NanoGram, and Segway.

By 2016, Masdar City aims to have 50,000 residents and 1,500 businesses, all powered by solar energy. Drinking water will come from solar-powered desalination, with treated wastewater irrigating the landscape. Masdar selected global engineering firm CH2M Hill as program manager for the first phase of development.

But Masdar (Arabic for "source") won't be alone in its quest to be the world's greenest city. On Chongming Island near Shanghai, the eco-city of Dongtan aims to complete its first phase (20,000 people) for the 2010 World Expo in Shanghai. Principally designed by British design and engineering firm Arup, Dongtan will use extensive water recycling, have a goal

Profile:
CH2M Hill

Location

Englewood, Colorado

www.ch2m.com

Founded

1946

Employees

23,000

Technology

One of the world's leading construction management and large-scale engineering design firms. The company works on transportation, energy, water, and industrial infrastructure, with an increasing focus on clean energy, LEED-certified green buildings, and other carbon reduction technologies.

The Buzz

Selected to head engineering and construction in the first phase of Abu Dhabi's Masdar Initiative, CH2M Hill has staked out a strong position to build sustainable 21st century cities. It does similar work in the private sector, recently inking a deal to help engine manufacturer Cummins reach its pledged target of 25% corporate-wide greenhouse gas reduction by 2010.

Brain Trust

Chairman and CEO Ralph Peterson joined in 1965, when it was a regional firm in Corvallis, Ore. President and COO Lee McIntire, ex-Bechtel, has led many of the company's clean-tech initiatives, such as overseeing LEED certification of a library/community center in post-Katrina New Orleans.

Bankrollers

CH2M Hill is the United States' sixth largest employee-owned company, with revenue of more than $5 billion.

Our Take

As more and more cities around the world seek to promote clean energy and reduce carbon emissions on a large scale, CH2M Hill is in good position to play a major role in this growing trend. It has strong big-project bona fides and clearly sees the business potential of expertise in the design and management of sustainable energy and water systems. The company has the clout needed to deliver on its ambitious plans.

of 90 percent waste recovery, and be fully powered by renewable energy, chiefly wind and biomass.

Urban sustainability, of course, is not just about new cities. Mayors of nearly 800 U.S. cities have pledged to reduce greenhouse gases to Kyoto Protocol targets, and 16 large cities worldwide have committed to upgrading the energy efficiency (by 20 to 50 percent) of city-owned buildings. That initiative, launched in 2007 with the Clinton Foundation, is funded with $1 billion each from ABN Amro, Citi, Deutsche Bank, JPMorgan Chase, and UBS.

The cities, including Chicago, London, Mumbai, New York, Sao Paolo, Seoul, and Tokyo will work with HVAC/energy-systems giants Honeywell, Johnson Controls, Siemens, and Trane on the "green makeover" of thousands of buildings. Johnson Controls recently announced the first specific project, a retrofit of Mumbai's largest mall.

"Cities have more than 50 percent of the world's population and use 75 percent of its natural resources," says San Francisco Mayor Gavin Newsom, whose own city plans to develop a 6,000-resident, solar-powered community on Treasure Island in San Francisco Bay. "It's at the local level where the world will be advancing—or degenerating."

2007 Top Headlines

Masdar Initiative Breaks Ground

UK and China to Lead on Eco-towns

Sustainable Cities: Projects Move from Virtual toward Reality

ThinkPark: Tokyo's First Step Toward Green Urbanism

Bill Clinton Unveils Green Makeover for 16 Cities

Urban Initiative: The Future is Looking Greener for Toronto

MIT to Help Develop Renewable Energy Institute in Middle East

Communities Take Initiative to Combat Climate Change

Select Companies to Watch

Arup
www.arup.com

CH2M Hill
www.ch2m.com

Foster + Partners
www.fosterandpartners.com

Johnson Controls
www.johnsoncontrols.com

Masdar Clean Tech Fund
www.masdarctf.com

3. OVERSEAS PLAYERS POWER U.S. WIND MARKET BOOM

A walk across the convention floor at Windpower 2007, the American Wind Energy Association's annual trade show, felt like a crash course in Globalization 101. Most of the largest booths housed turbine manufacturers, component suppliers, and wind farm developers from China, Denmark, Germany, India, Japan, Portugal, Spain, Sweden, the U.K., and other countries. Remember, this was the *American* Wind Energy Association convention.

Spurred by renewable portfolio standard mandates, growing investor and public awareness, and the weakness of the dollar, the U.S. is among the fastest-growing markets for wind power.

The U.S., with some notable exceptions—like General Electric, whose turbines power half the nation's new wind capacity—long ago ceded wind power market leadership to overseas competitors, mainly in Europe. But with traditional leading wind power markets like Denmark and Germany maturing, the U.S. wind market has become a leading growth opportunity.

In 2007, the nationwide electric utility of Portugal, Energias de Portugal, acquired Horizon Wind Energy from Goldman Sachs for $2.15 billion, the largest price ever for a pure-play wind power developer. Spanish energy giant Iberdrola, after acquiring three U.S. wind development companies in 2006, followed with its blockbuster $22.5 billion buyout of Scottish Power. That portfolio includes Portland, Oregon-based PPM Energy, which aims to operate 3,500 MW of wind capacity in the U.S. by 2010. Iberdrola also picked up CPV Wind Ventures in Silver Spring, Md., bringing its U.S. wind portfolio to 8,500 MW. Another Spanish powerhouse, Acciona, acquired development rights for some 1,300 MW of wind projects in the Midwest from EcoEnergy LLC.

The motivation for these deals is no secret. Spurred by renewable portfolio standard mandates in half the states, growing investor and public awareness of wind energy's benefits, and

Profile:
Iberdrola Renewables

Location

Madrid, Spain

www.iberdrolarenovables.com

Founded

2007 (IPO spinoff from Iberdrola)

Employees

1,000

Technology

Spun off from parent Iberdrola in 2007, it is now the world's largest wind power producer. Its capacity outside Spain grew sevenfold last year. The U.S. is its largest foreign market at 2,145 megawatts.

The Buzz

Iberdrola entered the U.S. wind market in 2005 and is now among the largest and most active overseas players here. With North American headquarters in Radnor, Penn., Iberdrola Renewables has nearly 22,000 MW of U.S. wind power on the drawing board – more than half its planned wind capacity worldwide.

Brain Trust

USA head is Terry Hudgens, a U.S. energy and utility veteran. After 25 years as president of Texaco's North American natural gas business, he joined utility Pacificorp and later became CEO of PPM Energy after its acquisition by Scottish Power. Iberdrola then acquired Scottish Power in 2007.

Bankrollers

Parent company Iberdrola spun off Iberdrola Renewables in a €4.07 billion public offering, the largest-ever clean energy IPO and the second largest overall in Europe last year. The new entity pulled in more than $1 billion in revenue (€953 million) in 2007, turning a €117.5 million profit.

Our Take

One of the world's most aggressive energy companies, Iberdrola has consistently called the U.S. its most important overseas market for wind power. We see Iberdrola, along with fellow Spaniards Acciona, Endesa, and Gamesa, as key players in growing the U.S. wind market for years to come. At press time, Spanish construction firm ACS and a French utility were mulling a takeover bid of parent Iberdrola, but we don't see the firm's commitment to wind power flagging.

the weakness of the dollar, the U.S. (along with China) is the world's fastest-growing major market for wind power. Expanding its wind capacity by 5,244 megawatts and more than $9 billion in new investment in 2007, a 45 percent growth rate, the U.S. is on pace to surpass Germany as the world's largest wind market by the end of 2009.

Foreign-based turbine manufacturers are flocking to set up production facilities in the U.S., often bringing hundreds of jobs to economically distressed rural areas. Among facilities planned or operating in the U.S. include an Acciona plant in West Branch, Iowa, a Gamesa facility in Ebensburg, Penn., a Vestas Wind Systems factory in Windsor, Colo., and a Pipestone, Minn., turbine plant for India-based Suzlon Energy.

But the current American wind boom comes with a major caveat. As this report went to press, the industry was holding its breath on congressional extension of the critical production tax credit for wind, due to expire at year's end. Without an extension, wind becomes a much less attractive opportunity for all investors, domestic or foreign.

2007 Top Headlines

US Wind Power Capacity Grew 45% in 2007

Horizon and Suzlon Sign 400 MW Wind Turbine Deal

American Superconductor Receives $70 Million Order from Chinese Wind Company

Acciona Acquires 1300MW of Wind Development Assets in Midwest

Vestas Build its First US Factory in Colorado

Iberdrola to Acquire CPV Wind Ventures

EDP Acquires Horizon Wind

BP Plans Construction of Five US Wind Projects in 2007

Select Companies to Watch

Acciona
www.acciona.com

Energias de Portugal
www.edp.pt

Iberdrola
www.iberdrola.com

Suzlon Energy
www.suzlon.com

Vestas Wind Systems
www.vestas.com

4. GEOTHERMAL RESURFACES AS A GROWTH SECTOR

Geothermal power dates to 1904, when Italian engineers lit five light bulbs with power generated from steam vents in Tuscany. More than a century later, geothermal is experiencing a global renaissance as a key clean energy source with improved technology, new construction, and renewed investor interest.

The U.S. is the global leader in geothermal, with about 3,000 of the world's 9,700 MW of current generation.

In the United States, utility-scale geothermal is only available (so far) in the western states, Alaska, and Hawaii. Most of those states also have mandated targets, which are helping drive new geothermal development. Geothermal is the only clean-energy resource besides hydroelectric that provides baseload power 24 hours a day, and with average plant uptime of 98 percent, it does so even more reliably than nuclear or coal-fired power plants, both of which require more downtime for maintenance. With average geothermal electricity rates between 4-7 cents per kilowatt-hour, it's no surprise that California's three large investor-owned utilities—PG&E, Southern California Edison, and San Diego Gas & Electric—have announced new geothermal contracts in the past 12 months.

A 2008 survey by the Geothermal Energy Association predicted that 86 new projects underway in 12 states will more than double U.S. geothermal capacity to more than 6,300 megawatts (MW), enough to power some 6 million homes. The U.S. is already the global leader in geothermal, with about 3,000 of the world's 9,700 MW of current generation. Overseas, Chevron dominates the landscape, with more than 1,200 MW of geothermal generation, mostly in Indonesia and the Philippines, accounting for more than 12 percent of the world's geothermal electricity capacity.

With recent improvements in drilling technology, geothermal plants can now be built and operated

Profile:

Ormat Technologies

Location

Reno, Nevada

www.ormat.com

Founded

1965

Employees

775

Technology

Its Energy Converter is a time-tested workhorse, the most common system used by geothermal power plants around the world. Ormat also operates its own plants in the U.S., Guatemala, Nicaragua, and Kenya.

The Buzz

A geothermal player for years, Ormat appears to have good market momentum. Late last year, Southern California Edison signed a 20-year deal to purchase power from a new Ormat plant in California's Imperial Valley—30 MW initially, with the potential to expand to 100 MW.

Brain Trust

A unit of Israel-based Ormat Industries, a true family business. Chairman Lucien Bronicki and his wife and CEO Yehudit Bronicki founded the company, and their son Yoram took over as president of Ormat Technologies last September. Mom's still CEO.

Bankrollers

The largest pure-play public geothermal company in terms of market cap, Ormat has ridden the wave of renewed Wall Street interest in geothermal. Before the market woes of early 2008, Ormat's stock rose 66% in six months, and the company is listed on several clean-tech indices. Parent Ormat Industries recently staved off a takeover attempt from Israeli investor group Gazit. Current market cap is about $1.8 billion.

Our Take

With its stock ownership battle hopefully behind it, Ormat is poised for growth as both a technology supplier and a power generator. Ormat also looks to play in the potentially high-growth field of enhanced geothermal, partnering with the U.S. Department of Energy in the first commercial test of that deep-drilling technology, at Ormat's Desert Peak plant in Nevada.

at costs comparable to coal-fired plants – but with zero fuel cost. "All the improvements in oil and gas drilling are transferable to geothermal," says John McIlveen, research director at Jacob & Co. in Toronto, one of Canada's clean-energy leaders among investment banks. Even some projects that had been shelved or closed in recent years, like the 55 MW Bottle Rock plant in northern California, are back on line. Bottle Rock has attracted an investment stake from Carlyle/Riverstone's Renewable Energy Infrastructure Fund, a strong sign of Wall Street's renewed interest in geothermal.

A further boost could come from an unlikely source: Google. In its effort to make utility-scale renewable energy cheaper than coal, the Internet search giant has targeted "enhanced geothermal" as a key technology, along with solar thermal and high-altitude wind. Enhanced geothermal entails drilling far deeper than conventional systems to reach so-called "hot dry rocks" present throughout the planet, not just in volcanic zones. "If we could crack the code on this, it's a big breakthrough and the scale-up could be rapid," says Dan Reicher, Google's director of climate and energy. An MIT study put the potential for this at 100 GW worldwide by 2050. That could make a hundred-year-old energy concept a hot new energy technology.

2007 Top Headlines

SDG&E to Add 40 MW of Geothermal

Idaho's First Geothermal Plant Goes Online

Geothermal Energy Supply to Double in U.S.

Geothermal Research Gets Congressional Boost

Google Sets Goal of Making Renewables Cheaper Than Coal

Raser Begins Geothermal Drilling in Utah

Ormat Signs 20-Year Geothermal Power Agreement With Southern California Edison

Calpine to Increase Geothermal Production by up to 80 MW in Northern California

Select Companies to Watch

Chevron
www.chevron.com/deliveringenergy/geothermal

Google.org
www.google.org

Ormat Technologies
www.ormat.com

Raser Technologies
www.rasertech.com

US Geothermal
www.usgeothermal.com

5. OCEANGOING SHIPPING TAKES A CLEANER TACK

The trillion-dollar shipping industry accounts for 4.5 percent of global CO_2 emissions, double the latest estimates for aviation.

Cargo ships represent a largely hidden environmental problem, the vessels unseen by most people. But the trillion-dollar shipping industry—the means by which more than 90 percent of the world's traded goods are transported—spews 14% of all nitrogen emissions from fossil fuels and 16% of sulfur emissions from petroleum, according to Carnegie Mellon University. In 2008, scientists commissioned by the UN's International Maritime Organization found that ships account for 4.5 percent of global carbon dioxide emissions, double the latest estimates for aviation.

One reason is that cargo ships run on "bunker fuel," the dirtiest, cheapest product that remains after gasoline and other high-grade fuels are refined from crude oil. Bunker fuel contains up to 5,000 times more sulfur than diesel. As a result, according to the activist group Bluewater Network, a single container ship emits more pollution than 2,000 diesel trucks.

Ships also pollute when docked but idling. More than 400,000 residents within 45 square miles of the ports of Long Beach and Los Angeles in California have a cancer risk 200 times higher than the federal government deems acceptable. Emissions from ocean-going ships cause about 60,000 deaths a year from heart and lung-related cancers, according to another study.

But new technologies promise a sea change. Ports, shippers, entrepreneurs, and others are finding ways to reduce the impacts. Some of this is in response to mandates. Late last year, ports in Los Angeles and Long Beach said they will require ships to turn off all on-board power systems while docked, using plug-in electrical systems instead, and will prohibit pre-1989 big-rigs at the ports. Shipping giant APL began using shoreside electric power when its 863-foot containership

Profile:

SkySails

Location

Hamburg, Germany
www.skysails.info

Founded

2001

Employees

40+

Technology

Developed the world's first practicable towing kite propulsion system for commercial shipping and luxury yachts. The system consists of a fully automated towing kite propulsion and a wind-optimized routing system. The company says the system can be retrofitted on most cargo ships and "superyachts."

The Buzz

SkySails' ingenious technology—which produces propulsion power of about 6,800 horsepower, enabling ships to lower fuel costs by up to 35%—has begun being deployed on cargo ships. The maiden voyage took place early this year on a 133-meter vessel belonging to the Bremen-based Beluga Group, with cargo transported by DHL. Beyond that, the sails are getting high-level interest from the rarified world of private yacht owners.

Brain Trust

Thirtysomething chairman Stephan Wrage studied economical engineering at the Technical University of Kaiserslautern and the Technical University of Dresden, and is backed by a small team.

Bankrollers

Initially funded by Wrage, its principal funder is respected ship financing company Jan Luiken Oltmann Gruppe GmbH. A third (and, says the company, "final") round of private financing took place in 2006.

Our Take

Wrage and company have garnered a fistful of awards, but, more importantly, orders: Wrage says the number of sailing ships could number 35 by 2009. With fuel costs rising and environmental concerns growing, the once-fanciful notion of kite-powered ships seems ready to set sail. And now that the company has a successful voyage to its credit, the sky is the limit.

APL China is docked, cutting as much as 1,000 pounds of exhaust pollutants during a single port call.

Seattle-based Cochran Inc. is one leading provider of shore power systems commonly known as "cold ironing." Its custom-designed transformer substation allows a ship's engines to be powered down in port while shore electricity is used to run onboard services. Cochran has developed this integrated solution for Princess Cruises, Holland America Lines, and Totem Ocean Trailer.

And there are novel ways to power the ships themselves, notably wind power harnessed by a kite. That's the idea behind three companies—Kite for Sail, KiteShip, and Sky Sails—that have found ways to tether a kite to a ship, harnessing high winds that flow above the ocean. In addition to propelling the boat, the kites can help lift the boat, reducing wetted surface that produces drag, and improving hull stability.

The kites aren't pie-in-the-sky. Early this year, the cargo vessel *MS Beluga Skysails* used a kite system to deliver 71 containers from Germany to Venezuela, cutting fuel use 20 percent. Given that shipping emissions, left unchecked, are forecast to grow 30 percent from current levels by 2020, such technologies could be a breath of fresh air.

2007 Top Headlines

BP Cuts Emissions with 'Green' Barge

Acting on Ship Emissions Can Save Lives, Say NGOs

Shipping Emissions Three Times Higher Than Thought

Football Field-Sized Kite Powers Latest Heavy Freight Ship

Tanker Giants Take 'Green And Clean' Initiative

Port of Long Beach Faces Suit Over Air Pollution

Cold Ironing Winning Support in Europe

Ship Uses Kite to Move Tons of Cargo

Select Companies to Watch

Cochran Marine
www.cochranmarine.com

Kite for Sail
www.kiteforsail.com

KiteShip
www.kiteship.com

SkySails
www.skysails.info

Wittmar Engineering & Construction
www.wittmarengineeringconstruction.com

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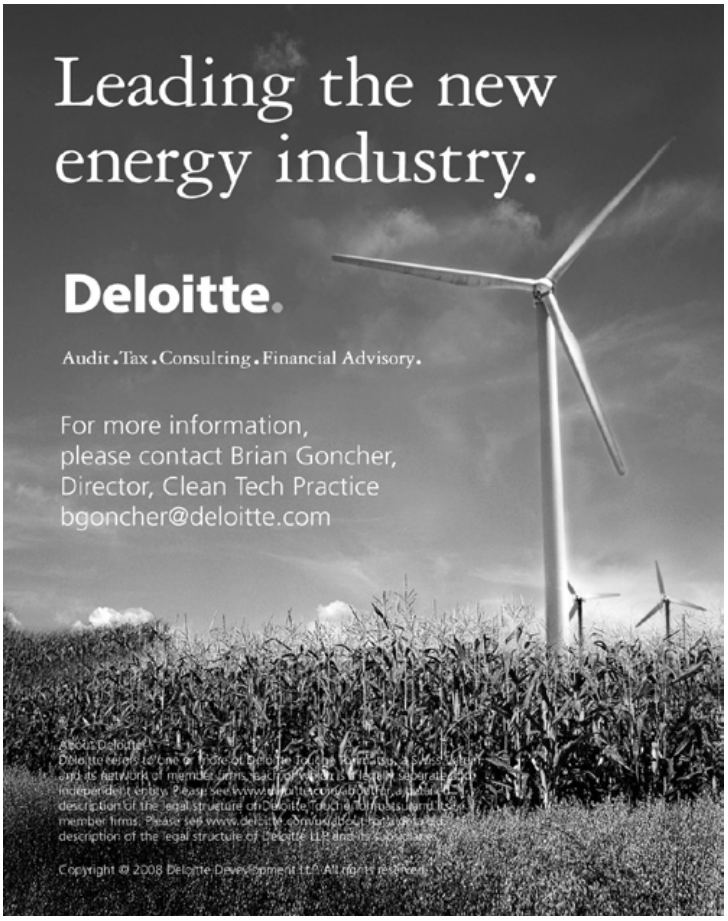

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