

# CLEAN ENERGY TRENDS 2009

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CLEAN EDGE

THE CLEAN-TECH MARKET AUTHORITY



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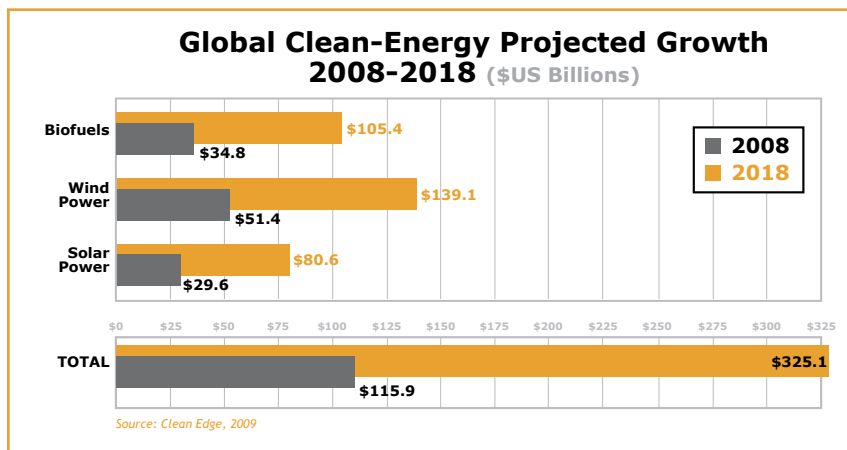
## CLEAN ENERGY TRENDS 2009

In last year's *Clean Energy Trends* report, we noted that 2008 would prove to be another banner year for clean energy even in the face of a brooding economic storm. That prognosis proved correct, with revenue growth among our three key clean-energy sectors expanding by 53 percent globally between 2007 and 2008.

***For the first time, one sector alone, wind, had revenues exceeding \$50 billion.***

Last year's significant revenue increase was based on a number of factors, including the continued double-digit expansion of our tracked markets as well as growing wind farm development costs due primarily to high-demand, low-supply market dynamics that loomed throughout most of 2008. We don't see a repeat performance of such growth happening in 2009.

Clean Edge, which has been tracking the growth of clean-tech markets for nearly a decade, reports that global revenues for solar photovoltaics, wind power, and biofuels expanded from \$75.8 billion in 2007 to \$115.9 billion in 2008. For the first time, one sector alone, wind, had revenues exceeding \$50 billion. New global investments in energy technologies – including venture capital, project finance, public markets, and research and development – expanded by 4.7 percent from \$148.4 billion in 2007 to \$155.4 billion in 2008, according to research firm New Energy Finance.



But despite this striking increase in global revenue and continued growth in global investments, the clean-energy sector faces considerable challenges moving forward. A sinking stock market continues to plague the initial public offering (IPO) markets, with only a small handful of energy-related IPO listings on U.S. exchanges in 2008. This means that venture capitalists (VCs) are faced with a dearth of

exit opportunities for their current portfolio companies, making it harder for new companies to garner VC investments. According to research firm Renaissance Capital, there were just 43 U.S. IPOs of all types in 2008 that raised at least \$50 million, down from 272 in 2007, marking the slowest year for IPOs in nearly three decades (1979). Clean Edge's two clean-energy-related stock indexes, which were both up more than 60 percent in 2007, were down a similar amount in 2008, reflecting the volatility of the clean-energy sector and broader markets overall.

Severely tightened credit markets also began to take their toll. In late 2008 and early 2009, the extent of constrained credit became apparent, with a range of clean-energy companies delaying plans, laying off staff, or scuttling projects entirely. While we

expect to see continued growth for the sector in the mid- to long-term, we believe 2009 will be a year of refocus, consolidation, or retrenchment for many firms. At the same time, new government spending, regulation, and policies should help the industry weather the current economic crisis better than most other sectors. On balance, we believe clean energy and energy intelligence will be seen as a means to help economies around the world pull out of the current economic malaise.

According to Clean Edge research:

- Biofuels (global production and wholesale pricing of ethanol and biodiesel) reached \$34.8 billion in 2008 and are projected to grow to \$105.4 billion by 2018. In 2008 the global biofuels market consisted of more than 17 billion gallons of ethanol and 2.5 billion gallons of biodiesel production worldwide. For the first time, ethanol leader Brazil got more than 50 percent of its total national automobile transportation fuels from bio-ethanol, eclipsing petroleum use for the first time in any major market.
- Wind power (new installation capital costs) is projected to expand from \$51.4 billion in 2008 to \$139.1 billion in 2018. Last year's global wind power installations reached a record 27,000 MW. In the U.S., which accounted for more than 8,000 MW, wind installations represented more than 40 percent of total new electricity generating capacity brought online in 2008 – and moved the U.S. ahead of Germany as the world's leading generator of wind energy.
- Solar photovoltaics (including modules, system components, and installation) will grow from a \$29.6 billion industry in 2008 to \$80.6 billion by 2018. Annual installations reached more than 4 GW worldwide in 2008, a fourfold increase from four years earlier, when the solar PV market reached the gigawatt milestone for the first time.

### Clean-Energy Scale-Up

In some regions, clean energy is not just providing a mere 1-2 percent of electricity and energy use, but moving into mass adoption. No longer rounding errors, clean energy can now represent 10-50 percent of the electricity or fuel mix. Some regions on the leading edge of this transition include:

Location	Energy Source	Segment	Market Share
Brazil	Ethanol	Transportation Fuel	Approximately 50% of nation's automotive fuel supply (not including diesel)
Denmark	Wind	Electricity Generation	15+% of nation's electricity mix
Iowa	Wind	Electricity Generation	5.5% of state's electricity mix in 2007. The state, however, more than doubled its cumulative wind installations in 2008
U.S.	Ethanol	Transportation Fuel	Approximately 8% of nation's automotive fuel supply (not including diesel)
China	Solar Thermal	Hot Water Heating	Although still a small fraction of total hot water production, solar thermal now represents about 20% of the nation's new hot water heater sales

Source: Clean Edge, Inc., 2009

Together, we project these three benchmark technologies, which equaled \$75.8 billion in 2007 and expanded 53 percent to \$115.9 billion in 2008, to grow to \$325.1 billion within a decade.

[Editors' Note: For the first time, Clean Edge is not tracking current and projected revenues for the fuel cell and distributed hydrogen market. While we stand behind the fuel cell numbers issued in past reports, it has become increasingly difficult to track and analyze current market size and to determine future growth in a sector that remains primarily in demonstration mode.]

**Government Stimulus Takes Center Stage**

As noted earlier, one of the most positive developments against a dire economic backdrop has been the increased attention and investment the sector is getting from governments. Contrary to concerns that a depressed economy would negatively impact government investments in clean energy, many political leaders are making clean energy a central tenet of their economic recovery efforts. A recent Deutsche Bank Group DB Advisors report entitled *Global Climate Change Regulation Policy Developments* counted more than 250 climate-change-related policy developments between July 2008 and February 2009 by governments around the globe. In that same period, governments committed approximately \$200 billion in stimulus spending for clean-energy and climate-related

activities such as green buildings, grid upgrades and improvements, renewables, and public transportation, according to the report.

Most notably, the American Recovery and Reinvestment Act of 2009, signed into law by President Obama in February, includes more than \$70 billion in direct spending and tax credits for clean-energy and transportation programs, including:

**U.S. Top 10 Disclosed Energy-Tech Venture Deals (2008)**

Company	Primary Sector	Total Invested (U.S. \$ Millions)
Miasolé	Solar	\$227.0
BrightSource Energy	Solar	\$115.0
Sapphire Energy	Biofuels	\$100.0
Amyris Technologies	Biofuels	\$91.0
Mascoma	Biofuels	\$81.0
Luminus Devices	Efficiency: Green Buildings	\$72.0
Fisker Automotive	Efficiency: Transportation	\$65.0
GridPoint	Efficiency: Digital Energy	\$63.5
Ausra	Solar	\$60.6
Infinia	Solar	\$57.0

Source: *New Energy Finance, 2009*

- \$11 billion towards “smart grid”
- \$6 billion to subsidize loans for renewable energy projects
- \$6.3 billion in state energy efficiency and clean-energy grants
- \$5 billion to weatherize modest-income homes
- \$4.5 billion to make federal buildings more energy efficient
- \$2 billion in grants for advanced batteries for electric vehicles

- \$8.4 billion for mass transit
- \$9.3 billion for construction of high-speed railways
- \$20 billion in tax incentives and credits for renewable energy, plug-in hybrids, and energy efficiency

To back up these investments, a number of recently passed policies are poised to support the growth of clean-energy sectors in the U.S. These include:

- an 8-year extension for the investment tax credit (ITC) for solar
- a 3-year extension for the production tax credit for wind
- new rules that allow utilities, for the first time, to participate in ITCs
- a new provision that allows renewable energy developers to receive up to a 30 percent government grant instead of a tax credit

***This policy-stimulus combination represents the largest federal commitment in U.S. history.***

This policy-stimulus combination represents the largest federal commitment in U.S. history for renewables, advanced transportation, and conservation initiatives. Based on these new rules, we expect to see many more utilities ramping up their clean-energy programs. And in a world where few companies or energy developers have profits against which to apply tax credits, a straight-up grant should help speed up development. Equally important, the U.S. is poised for additional support, including the likely passage of a national renewable portfolio standard requiring approximately 25 percent of the U.S. electricity mix to come from renewable sources by 2025, and a potential cap-and-trade system for greenhouse gas emissions.

While government investments and initiatives will not act as a silver bullet, they can play a critical role in moving markets in new directions. But they cannot act alone. For example, it's great if a developer can receive up to 30 percent of the cost of a project in government grants or tax incentives, but it won't help if they can't

line up the other 70 percent in debt equity financing. Also, the U.S. government doesn't have the best track record when it comes to financing clean-energy technologies. Back in 2005, the Department of Energy was given authority to issue millions of dollars in clean-energy loan guarantees to companies and project developers, but it never issued a single guarantee. If the Obama Administration is to succeed, it must figure out ways to streamline the process and get money flowing again.

**Global Clean-Energy Jobs (Direct and Indirect):  
Solar and Wind**

	2008 (Current)	2018 (Projected)
Solar Photovoltaics	190,819	1,341,968
Wind Power	413,522	1,315,324
<b>TOTAL</b>	<b>604,341</b>	<b>2,657,292</b>

Source: Clean Edge, Inc., 2009

**Clean Energy  
= Jobs**

In addition to its other benefits, clean energy offers the promise of creating new jobs and rebuilding downtrodden economies. Some people refer to this as the “green jobs” dividend.

Our analysis shows that solar photovoltaics and wind power industries currently account for more than 190,000 and 413,000 direct and indirect jobs worldwide, respectively, a total of more than 600,000 jobs. By 2018, we project the number of jobs at more than 1,341,000 for solar and 1,315,000 for wind, for a total of nearly 2.7 million jobs. These numbers are based on our projections for global industry growth through 2018.

**U.S. Energy VC  
Reaches Nearly 12  
Percent of Total**

U.S.-based venture capital investments in energy technologies increased 22 percent, from \$2.7 billion in 2007 to \$3.3 billion in 2008, according to New Energy Finance. As a percent of total VC investments, energy tech grew nearly 30 percent, from 9.1 percent of all investments in 2007 to 11.8 percent in 2008. In 2000, energy tech represented just a half a percent of all VC investments.

**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	\$22.0	\$483	2.2%
2003	\$19.7	\$446	2.3%
2004	\$22.5	\$663	2.9%
2005	\$23.0	\$1,038	4.5%
2006	\$26.5	\$1,555	5.9%
2007	\$29.4	\$2,665	9.1%
2008	\$28.3	\$3,351	11.84%

*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.*

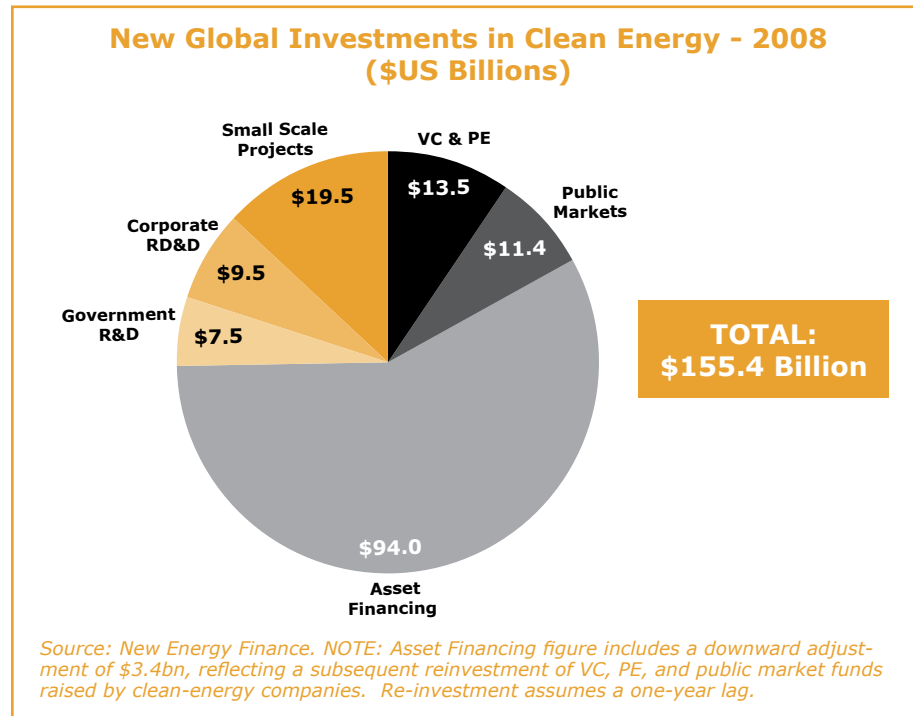
**Total Investments  
Reach \$155 Billion**

The global growth rate in clean-energy investments, across a wide range of investment categories, was much smaller than that exhibited in the U.S. venture sector. According to New Energy Finance, new global investment in clean energy increased 4.7 percent, from \$148.4 billion in 2007 to \$155.4 billion in 2008. 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. This is a far cry from the previous year's growth rate: Between 2006 and 2007, global clean-energy investments expanded by approximately 60 percent. One reason: Public market investments saw a significant decline,

falling from \$23.4 billion in 2007 to \$11.4 billion in 2008, while other investment arenas either remained steady or increased slightly.

To a large extent, the clean-energy industry has been a good-news story – what other industry has sustained annual growth rates exceeding 30 percent for the past decade? But the clean-energy industry is not immune to the forces impacting the overall economy. For example, clean-energy manufacturers and developers are facing the same daunting credit freeze as other businesses. But against this backdrop, clean energy has proven resilient and stands at the center of many governments’ efforts to rebuild their economies. As President Obama exclaimed in his address to Congress on

**Moving Forward**



*Clean energy has proven resilient and stands at the center of many governments’ efforts to rebuild their economies.*

February 24, 2009, “We know the country that harnesses the power of clean, renewable energy will lead the 21st century.”

Indeed, some have called clean energy the “mother of all markets.” As the market transitions to low-carbon fuel and electricity sources, conservation and efficiency efforts, and the deployment of a smart, 21st century grid, we believe clean energy offers one of the greatest opportunities for both local and global economies to compete and thrive.

On the following pages we look at five of the key trends we believe will shape clean-energy markets in 2009 and beyond.



## FIVE TRENDS TO WATCH

### 1. THE GRID GOES ONLINE

*The marriage of IT and energy tech was consummated long ago, but now the couple is raising a brood of smart offspring.*

If you think about the evolution of IT – how a bunch of dumb terminals surrounding a mainframe computer became smarter, more self-sufficient, able to have a two-way conversation with the mainframe, and eventually communicate with a broad range of other devices, and do so wirelessly – that’s a reasonably good description of where the electrical grid is going.

The local power plant – that’s the “mainframe.” We live and work in one of the “dumb terminals.” Eventually, those terminals will get smarter, more self-sufficient, able to have a two-way conversation with the mainframe, and eventually communicate with a broad range of other devices, in some cases wirelessly.

The marriage of IT and energy tech was consummated long ago, but now the couple is raising a brood of smart offspring. The result: an emerging network of devices connected by switches, routers, and software, interacting in ways that could engender radical new efficiencies in the electricity system. Increasingly, these devices, from commercial refrigeration units to residential washing machines, will have a unique identifier – an Internet Protocol, or IP address, in geek-speak – that will allow the integration of buildings, vehicles, cell phones, and more.

Many of today’s IT leaders are finding their way into the smart-grid space: Cisco, GE, Google, HP, and IBM among them. Most of the big utilities are already deploying smart meters, including a few systemwide. Southern California Edison plans to install 5.3 million smart meters by 2012, enabling it to reduce energy demand by about 5 percent, or roughly 1,000 megawatts.

Behind the big guys are established leaders like Itron and dozens of start-ups, from

#### **Profile:**

#### **Silver Spring Networks**

##### **Location**

Redwood City, California  
www.silverspringnetworks.com

##### **Founded**

2002

##### **Employees**

200

##### **Technology**

The company’s Smart Energy Network consists of networking equipment and energy management software, allowing utilities to create an IP-based smart grid that delivers energy usage data and promptly alerts of power outages.

##### **The Buzz**

A growing list of projects includes recent deals with PG&E, Oklahoma Gas & Electric, and Pepco Holdings. Silver Spring’s open source network and Technology Alliance Program have caused some to bill the company as the Cisco of Smart Grid.

##### **Brain Trust**

President and CEO Scott Lang joined in 2004, prior to which he spent 16 years at Perot Systems, most recently leading the Strategic Markets Group. CFO Warren Jensen was named one of the Best CFOs in America by Institutional Investor magazine and previously served as CFO for Electronic Arts, Amazon.com, and NBC.

##### **Bankrollers**

In late 2008, Kleiner Perkins Caufield & Byers led a \$75 million funding round with capital from its Green Growth Fund.

##### **Our Take**

Use of an open source network should allow Silver Spring to flourish even as competitors unveil new smart devices and applications. It will be challenging to cement a frontrunner position in the rapidly evolving smart-grid sector, especially with increased interest in the area from corporate powerhouses Cisco, GE, IBM, and Intel. On the other hand, the company’s recent interoperability partnership with automation giant ABB suggests that its big competitors can be customers, too.

Aclara (advanced metering infrastructure technologies) to Ziphany (demand response software). Among the most promising: Echelon (smart meters and related systems), Ecologic Analytics (meter data management systems), eMeter (advanced metering applications), SmartSynch (real-time energy use data over wireless networks), Tendril (connecting in-home devices to the utility back office), and Tollgrade (advanced sensor technology). Some start-ups, like Connected Energy, Serveron, and V2Green, already have been gobbled up by bigger players.

The federal government's stimulus package, which includes \$11 billion in grid improvements, should provide a surge to this new generation of smarter energy technology. But the future already can be seen in Boulder, Colo., where Minneapolis-based Xcel Energy has installed about 14,000 smart meters and strung more than 100 miles of cable over power lines for broadband transmission. And in Austin, Texas, where the Pecan Street Project – which includes such partners as Cisco, Dell, GE, IBM, Intel, Microsoft, and Oracle – aims to create a showcase, next-gen grid.

There's symbolism in GE's 2009 Wizard of Oz "If I Only had a Brain"-themed Super Bowl ad focusing on smart grid technology. The tagline: "Innovation you don't have to wait for." That seems a worthy assessment of a long-awaited trend.

*GridWise Alliance Report Says 280,000 Jobs to be Created Through Smart Grid*

*GridPoint Announces Acquisition of V2Green, Electric Vehicle Grid Integrator*

*IBM to Prime Pump for Smart-Grid Start-ups*

*BPL Global Acquires Connected Energy and Serveron*

*eMeter Corporation Raises \$12.5 Million for Smart Grid Technology*

*Xcel Energy Announces Smart Grid Plan for City of Boulder*

*Kleiner Perkins Leads \$75 Million Investment in Silver Spring Networks*

*Trilliant Receives \$40 Million Investment For Smart Grid Activities*

## 2008 Top Headlines

**BPL Global**  
[www.bplglobal.net](http://www.bplglobal.net)

**GridPoint**  
[www.gridpoint.com](http://www.gridpoint.com)

**Optimal Technologies**  
[www.otii.com](http://www.otii.com)

**Silver Spring Networks**  
[www.silverspringnetworks.com](http://www.silverspringnetworks.com)

**Tollgrade Communications**  
[www.tollgrade.com](http://www.tollgrade.com)

## Select Companies to Watch

## 2. TECHNOLOGIES SAVE CLEAN ENERGY FOR A RAINY (OR CALM) DAY

*Several storage technologies are vying for utility business, though there is not likely to be one clear winner.*

The intermittent nature of both wind and solar power poses a major challenge for utilities, since the peak power output of the wind and the sun doesn't always sync up with peak power demand. The technology solution is utility-scale energy storage, now emerging as a major arena of attention, innovation, and investment. Along with electrical transmission and distribution infrastructure improvements (see p. 14), large-scale storage for renewables is the number-one barrier to significantly scaling renewables in the energy mix of a utility, state, or nation.

Several storage technologies are vying for utility business, though there is not likely to be one clear winner. Technologies include sodium sulfur, redox flow, vanadium, zinc, and large-scale lithium-ion batteries; compressed air energy storage; flywheels; and molten salts for solar thermal storage. In each case, entrepreneurs and manufacturers are battling learning curves and, especially, high costs. That's what matters most to utilities. "Our main concerns are what's the cost to implement it, what's the cost to run it, and how does the concept of storage add value to our company?" says John Bryan, program manager of utility innovations at Xcel Energy.

There's no denying the business opportunity. Emerging technologies research firm Lux Research sizes the current global market for grid energy storage at \$2.4 billion, but estimates a \$50 billion market for batteries alone if just 10 percent of the world's current wind farms used them for storage. The past year has seen significant venture capital investment in storage, including a \$33 million round for cooling storage provider Ice Energy, \$22 million for flywheel supplier Pentadyne, \$15 million for redox flow battery maker Deeya Energy, and a hefty

### **Profile:** **SolarReserve**

#### **Location**

Santa Monica, California  
[www.solar-reserve.com](http://www.solar-reserve.com)

#### **Founded**

2008

#### **Employees**

100

#### **Technology**

Concentrating solar power thermal power plants that use a proprietary molten salt mixture to store energy. The heat can be dispatched to power steam turbines even when the sun isn't shining.

#### **The Buzz**

SolarReserve boasts a big-league corporate and technology pedigree; it was formed in 2008 to commercialize solar thermal generation and storage. United Technologies picked up the technology when it acquired aerospace pioneer Rocketdyne from Boeing in 2005. Rocketdyne became part of UTC's Hamilton Sundstrand power systems division, which formed SolarReserve in partnership with private equity firm US Renewables Group. SolarReserve holds the exclusive worldwide license for Rocketdyne's technology.

#### **Brain Trust**

CEO Kevin Smith has 20 years of experience in large-scale power systems with Invenergy, Insight Energy, Rolls-Royce, and Indeck Energy. President Terry Murphy brings Rocketdyne continuity to the team, with 27 years there. Chairman Lee Bailey is managing director of US Renewables.

#### **Bankrollers**

Leading with US Renewables in SolarReserve's \$140 million Series B round were Citi's Sustainable Development Investments and Good Energies, plus PCG Clean Energy & Technology Fund, Nimes Capital, and Credit Suisse's Customized Fund Investment Group.

#### **Our Take**

Energy storage is key to the growth of utility-scale renewables, and SolarReserve is well-capitalized to help make CSP a viable source of utility power. What it needs now is a major utility power-purchase contract to confer commercial legitimacy.

\$140 million for SolarReserve, which is building solar thermal plants with molten salt technology. A123 Systems, better known for electric-car batteries but also supplying 1 MW lithium-ion batteries to an AES Corp. wind project, raised \$149 million in venture capital last year.

One of the most closely-watched renewables storage test projects is the partnership among Xcel, Japanese battery supplier NGK Insulators, the National Renewable Energy Laboratory, and others. Xcel is testing NGK's 1 MW sodium-sulfur battery (which is actually 20 modules storing 50 kW each) at a wind farm in western Minnesota. When fully charged, the battery could power 500 homes for more than seven hours, providing wind energy when the wind isn't blowing. NGK is also working with American Electric Power, the largest U.S. utility, on storage for fossil fuel-generated energy.

Concentrating solar power (CSP) thermal plants present a different storage opportunity. Seeking to cash in on the physics advantage that it's easier to store heat than electrons, companies such as SkyFuel, SolarReserve, Abengoa Solar, and Andasol are building plants that store solar-generated heat in tanks of molten salt. The heat can be used to heat liquid for steam turbines. Abengoa plans to use molten salt storage at one of the world's largest planned solar generation facilities, a 280 MW CSP plant in Arizona.

*Hamilton Sundstrand to Commercialize Concentrated Solar Power Technology*  
*Xcel Energy to Test Storage of Wind Power Using 1 MW Battery System*  
*Energy Storage and Power Champions Compressed Air Energy Storage*  
*GridPoint Teams Up With NGK and Xcel Energy for Wind-to-Battery Project*  
*Oregon BEST and BPA to Fund Wind Energy Storage Research*  
*Saft and ABB Develop New Battery System to Enhance Stability of Power Grids*  
*SolarReserve Gets \$140M Series B Funding*  
*Beacon Power and National Grid to Study Flywheel Energy Storage*

## 2008 Top Headlines

**A123 Systems**  
[www.a123systems.com](http://www.a123systems.com)

**Deeya Energy**  
[www.deeyaenergy.com](http://www.deeyaenergy.com)

**General Compression**  
[www.generalcompression.com](http://www.generalcompression.com)

**NGK Insulators**  
[www.ngk.co.jp](http://www.ngk.co.jp)

**SolarReserve**  
[www.solar-reserve.com](http://www.solar-reserve.com)

## Select Companies to Watch

### 3. NEW CLEAN-ENERGY MARKETS EMERGE AROUND THE GLOBE

*Motivations vary by country, but awareness of the economic development, job creation, and energy diversification benefits is spreading.*

Other than both sending athletes to the Summer Olympics, Aruba and Serbia don't appear to have a lot in common. Except this: They both finalized plans for their first utility-scale wind farm within the past year.

They are part of a larger trend of renewables development sprouting in countries that hadn't previously joined the clean tech revolution. In January, the International Renewable Energy Association (IRENA) launched with 75 member nations, whose ranks don't include the usual players: the U.S., U.K., Japan, China, and Australia. Based in Bonn, IRENA is the first agency dedicated to advance clean energy worldwide.

Motivations vary, but awareness of the economic development, job creation, and energy diversification benefits is spreading. That's powering supportive policies, such as solar feed-in tariffs in France and Greece and a five-year, \$2.9 billion commitment to clean energy in Morocco. Countries with gusts of wind power capacity growth in 2008 included Turkey (up 194 percent), Tunisia (170 percent), and Poland (71 percent), reports the Global Wind Energy Council.

Eastern Europe, shaking off decades of pollution and economic stagnation under Communist rule, is moving quickly. One motivation: reducing dependence on natural gas from Russia, where diplomatic relations can be chilly. Belarus aims to increase renewables (including small and large hydro) to 25 percent of its mix by 2012. Bulgaria's Clever Synergies Investment Fund is financing wind development, with a goal of 220 MW of wind farms near the Black Sea by 2012, up from 16.5 MW today. The region has become a major growth target for Spain's Iberdrola Renewables, which is building or expanding wind projects in Poland, Romania, Hungary, and Estonia.

#### **Profile:**

#### **Solar Cells Hellas**

#### **Location**

Athens, Greece

[www.schellas.gr](http://www.schellas.gr)

#### **Founded**

2005

#### **Employees**

230

#### **Technology**

Manufactures silicon wafers, crystal-line solar PV cells, and PV modules at its 60-megawatt integrated production plant in the Greek city of Patras. Commercial production began in May 2008. The company operates a smaller 10 MW module assembly facility in Bulgaria that it acquired from another Greek PV firm, Energy Solutions.

#### **The Buzz**

SCH aims to be Greece's leading solar manufacturer, with its eye on the burgeoning local industry as well as growth markets throughout Europe. Solar talent is not plentiful in Greece, but SCH is financing doctoral programs at the National Technical University of Athens to help train the solar engineers of the future.

#### **Brain Trust**

Chairman and managing director Dimitrios Panagakos has worked in mechanical and electrical engineering since the 1970s. He has been a leader in the Greek optical disk industry since 1997 and is still the main shareholder of disk maker Oditec. Commercial manager Alexander Zachariou spent five years in PV research at Centre for Renewable Energy Sources, an R&D organization in Athens.

#### **Bankrollers**

Among SCH's investors is the IBG Hellenic Fund, a VC fund of Marfin Financial Group, one of Greece's largest banking and financial service firms.

#### **Our Take**

A shining example of ambitious, early-stage companies in emerging markets. It has built out significant manufacturing capacity, expanded via acquisition, and is eyeing the thin-film solar market. Greece's new feed-in tariff should help propel SCH's fortunes in the local market, but battling larger competitors on the broader European and global stages could cloud its growth projections.

The trend isn't limited to developing economies. France, the poster child for nuclear power, has launched a significant ramp-up in wind and solar. President Sarkozy set a target of 23 percent renewable energy by 2020, including 25,000 MW of wind, up from 3,400 MW in 2008. France surpassed Denmark in wind capacity in 2008, adding 950 MW. For solar, the government passed a very aggressive feed-in tariff last year – roughly 57 cents per kilowatt-hour in U.S. currency – for commercial building rooftops. EDF Energies Nouvelles, the renewables arm of France's national utility, raised \$734 million to fund PV last year.

Greece is another emerging player. Its parliament approved five-year solar feed-in tariffs of 52 to 65 cents/kWh in January, which should boost local PV makers like Solar Cells Hellas, operator of a wafer, cell, and module plant in Patras. California startup SolFocus is helping build Greece's first concentrating PV plant; the 1.6 MW facility is expected to start delivering power by the end of this year. In wind power, Spain's Acciona and Italy's Enel are among other players eyeing Greece as a growth market.

## 2008 Top Headlines

*75 Countries Sign onto New Clean Energy Agency*

*France Sets Ambitious Renewable Energy Targets*

*Acciona Targets Greece for Wind Farms*

*Morocco Launches \$2.9 Billion Renewable Energy Development Program*

*Iberdrola Acquires 1.6 GW Wind Portfolio From Romanian Company*

*Danish Export Credit Agency Guarantees \$60 Million Loan for Caribbean Wind Farm*

*France's EDF Energies Nouvelles Raises \$733.8 Million in PV Capital Increase*

*20-MW Wind Project Being Developed in Serbia*

## Select Organizations to Watch

**Continental Wind Partners**

[www.continentalwind.com](http://www.continentalwind.com)

**EDF Energies Nouvelles**

[www.edf-energies-nouvelles.com](http://www.edf-energies-nouvelles.com)

**Iberdrola Renewables**

[www.iberdrolarenewables.us](http://www.iberdrolarenewables.us)

**International Renewable Energy Agency**

[www.irena.org](http://www.irena.org)

**Solar Cells Hellas**

[www.schellas.gr](http://www.schellas.gr)

## 4. GRID INFRASTRUCTURE GRABS THE SPOTLIGHT

*Transmission capacity is the biggest short- to medium-term barrier to the continued rapid growth of utility-scale wind or concentrating solar power and concentrating PV.*

Governments and companies around the world are finally funding infrastructure innovations and upgrades that will expedite the integration of vastly increased clean power into the grid.

One big challenge: geography. Utility-scale wind farms and solar plants are usually located in lightly-populated areas far from the cities that need the power they generate. Long-haul transmission lines, if they exist at all, lack the capacity to handle all the juice being generated. Transmission capacity “is the biggest short- to medium-term barrier to the continued rapid growth of utility-scale wind or concentrating solar power and concentrating PV,” says Tom Starrs, CEO of Solar Energy Ventures, a solar and smart grid consultancy in Portland, Oregon. With the U.S. surpassing Germany in 2008 as the world’s largest wind generator, the challenge is even more urgent.

Regulators and legislators, from state utility commissions to national governments in North America and Europe, are listening. U.S. President Obama has made upgrading and expanding the antiquated U.S. power grid a top priority of his economic recovery plan. The \$787 billion package he signed in February contains a roughly 14,000 percent increase in grid and transmission spending – some \$17 billion – over fiscal 2009, according to the Center for American Progress in Washington, D.C. Now that’s stimulus.

For an early glimpse at how this may play out, look to the state of Texas, whose 8,000 MW of wind capacity is more than the next three largest wind-generating states (California, Iowa, and Minnesota) combined. Following its 2008 decision authorizing transmission line construction to connect up to 11,600 MW of new wind capacity, the state’s Public Utility Commission

### Profile:

#### ITC Holdings

#### Location

Novi, Michigan  
www.itc-holdings.com

#### Founded

2003

#### Employees

300

#### Technology

*The U.S.’s largest independent transmission company. Serving a peak load of more than 25,000 MW, ITC operates power lines in Iowa, Michigan, Minnesota, Illinois, and Missouri.*

#### The Buzz

*The expansion of clean energy will largely depend in part on traditional transmission firms who see a new business opportunity. ITC leapt to the fore in February with its Green Power Express plan: 3,000 miles of new lines to carry up to 12,000 MW of Midwestern wind power to 3.6 million homes. It’s bold and audacious — with a lot of regulatory and financial question marks.*

#### Brain Trust

*President and CEO Joseph Welch founded ITC after 32 years at Detroit Edison with positions in transmission, distribution, rates, marketing, pricing, and regulatory affairs.*

#### Bankrollers

*ITC is a publicly traded company (NYSE: ITC) with 2008 revenue of \$618 million and profit of \$109 million.*

#### Our Take

*Will the Green Power Express get out of the station? It’s too early to tell, but Welch’s vision has highlighted the huge scale of infrastructure projects needed to bring renewable power to scale in the U.S. ITC estimates a \$10-\$12 billion price tag to complete the project by 2020, and that’s assuming all goes well. Along with regulatory changes and streamlining, ITC will certainly be seeking federal stimulus dollars. Regardless of the outcome, ITC has put a major stake in the ground for clean-energy grid expansion and certainly bears watching.*

awarded seven construction contracts worth some \$5 billion. Dallas-based Oncor, the state's largest transmission and distribution operator, landed a \$1.34 billion contract.

Not to be outdone, Michigan-based ITC Holdings in February proposed what would be the world's largest clean-energy transmission network, a \$10-12 billion effort to bring wind from the Dakotas, Iowa, and Minnesota to the population centers reaching from Milwaukee to Chicago to northwest Indiana. The so-called Green Power Express plan calls for 3,000 miles of power lines to handle up to 12,000 MW of power. But ITC needs a slew of regulatory changes to make it fly, including the ability to recoup some expenses before project completion, targeted for 2020. There's sure to be environmental and NIMBY opposition, a perennial hurdle for transmission projects worldwide.

In northern Europe, a big part of the infrastructure game is bringing power to cities from wind turbines miles off the coasts. Ireland's Imera Power is embarking on a \$5.6 billion effort to link North Sea and Atlantic offshore wind farms to markets in the U.K., Ireland, France, Belgium, and Germany. Like clean-energy infrastructure buildouts in the U.S., it will be long, costly, and obtrusive to some observers – but essential for renewable power to achieve significant, game-changing proportions.

*HSBC to Invest GBP100 Million in Renewables*

*Texas Approves Transmission Plan to Serve 11.6GW More Wind*

*California Governor Proposes One-Stop Permitting for Electricity Transmission*

*UK's Energy Regulator Moves to Accelerate Grid-Connection for Renewable Projects*

*Duke, AEP to Spend \$1B on New Transmission Lines*

*Imera Unveils \$5.6 Billion Plans to Link Offshore Wind to Electricity Grids*

*ITC Holdings Plans Network for Wind Power in Midwest*

*Wind Growth Could Cost Eastern US \$80B in Transmission Lines*

## 2008 Top Headlines

**Electric Reliability Council of Texas**

[www.ercot.com](http://www.ercot.com)

**Imera**

[www.imerapower.com](http://www.imerapower.com)

**ITC Holdings**

[www.itc-holdings.com](http://www.itc-holdings.com)

**Midwest Independent Transmission System Operator**

[www.midwestiso.com](http://www.midwestiso.com)

**Oncor**

[www.oncor.com](http://www.oncor.com)

## Select Organizations to Watch



## 5. MICROPOWER SHOWS IT IS NO SMALL THING

*As former U.S. CIA chief R. James Woolsey points out, the current electric grid works well on a just-in-time basis, but is vulnerable on a "just-in-case" basis.*

In a world where central power plants have become ever larger, there's a downsizing of sorts taking place. Small, regional "micropower" grids made up of microturbines, cogeneration, solar cells, fuel cells, geothermal, wind turbines, and other sources are gaining strength. While micropower provides only 6 percent of U.S. electricity, it provides from one-sixth to more than half in a dozen other countries. In 2007, for example, the U.S., China, and Spain each added more wind capacity than the world added nuclear capacity.

As the Rocky Mountain Institute's Amory Lovins points out, the original case for large central power stations once made sense, because they were costlier and less reliable than the grid, "so by backing each other up through the grid and melding customers' diverse loads, they could save capacity and achieve reliability." But this has reversed: central thermal power plants now cost less than the grid, and are so reliable that nearly all power failures originate in the grid.

Networks of local grids also make sense from a security perspective. As former U.S. CIA chief R. James Woolsey points out, the current grid works well on a just-in-time basis, but is vulnerable on a "just-in-case" basis, whether the undermining culprits are thunderstorms or terrorists.

Microgrids create local networks that support the growth of a diverse ecosystem of energy solutions. Beyond that, local grids increase flexibility – for example, disconnecting from the national grid when there is a widespread utility failure, or facilitating a robust and diverse energy storage system, from batteries to back-up generators. The idea is not new – data centers have operated this way for years, combining global grids with independent local nodes. But energy systems are just discovering such benefits.

### Profile:

#### NextEnergy

#### Location

Detroit, Michigan  
www.nextenergy.org

#### Founded

2002

#### Employees

22

#### Technology

*One of the nation's leading research catalysts and business accelerators for clean energy and microgrids, helping bring promising technologies to maturity and to market.*

#### The Buzz

*The nonprofit incubator, sited amid Detroit's doom-and-gloom economy, is becoming ground zero for the greening of the Rust Belt, garnering money and mojo to accelerate development of advanced vehicle batteries, wind turbine components, and biofuel standards, among other things.*

#### Brain Trust

*CEO Keith Cooley joined in late 2008 after directing Michigan's Department of Labor and Economic Growth under Gov. Jennifer Granholm. Chairman Chris Rizik is founder of venture capital firm Ardesta, LLC and CEO of Renaissance Venture Capital, a fund of funds that support the growth of venture capital in Michigan.*

#### Bankrollers

*NextEnergy develops and sells projects to the federal government, for which it receives 60-65 percent of its revenue. The balance comes from state and foundation grants.*

#### Our Take

*The massive U.S. stimulus for clean energy will shine a bright light on Michigan, where Gov. Granholm has been a leading clean-energy champion. Combined with President Obama's and congressional concern over the failing auto industry, Michigan will become a make-or-break test case of whether clean energy can be a pathway out of our economic woes. As goes Michigan, so goes NextEnergy, which will take on increasing prominence as a center of the green economy's promise and potential.*

Microgrids also facilitate micropower – small generators of electricity such as buildings and electric vehicles. In a microgrid, the power production can be close enough to the end users so that there is little need for electricity to be produced at higher voltages, eliminating step-down losses. Add to this the recapture of waste heat, and overall system efficiency can reach 90 percent.

Microgrid adherents are growing. Wal-Mart has two stores running on microgrids, one in Texas, another in Colorado, drawing energy both from on-site resources and the grid. The European Commission has funded more than half a dozen microgrid demonstration sites in different countries. Sandia National Labs is looking to deploy microgrids on military bases, such as Ft. Sill in Oklahoma. And Michigan-based NextEnergy is developing what it calls an “advanced mobile microgrid” to serve the needs of military bases and battlefield encampments. Sandia’s Rush Robinett says microgrids mean coming “back to the future” – military bases, used to co-manufacture energy, but now are entirely dependent on the grid.

“Back to the future,” indeed: If microgrids continue to marshal momentum and investment, they will vindicate one of history’s most staunch proponents of local power generation: Thomas Edison.

*New Microgrid Network Proposed For More Dependable, Cheaper Power*  
*NEDO Signs MOU with Thailand for Microgrid Stabilization Research Project*  
*Fuel Cell Microgrids in the Real World*  
*Researchers Propose Flexible Power Microgrids*  
*Stamford City Hall May Soon Power Itself*  
*Sandia and Mesa del Sol Enter Sustainable Energy Agreement*  
*Contractor to Help Power Troops in Battle Zones*  
*Maryland Industrial Partnerships Program OKs Microgrid Project*

**Consortium for Electric Reliability Technology Solutions**  
[certs.lbl.gov/certs-der-micro.html](http://certs.lbl.gov/certs-der-micro.html)

**New Energy and Industrial Technology Development Organization**  
[www.nedo.go.jp/english](http://www.nedo.go.jp/english)

**NextEnergy**  
[www.nextenergy.org](http://www.nextenergy.org)

**Rocky Mountain Institute**  
[www.rmi.org](http://www.rmi.org)

**Wal-Mart**  
[www.wal-mart.com](http://www.wal-mart.com)

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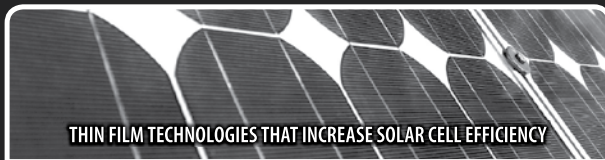
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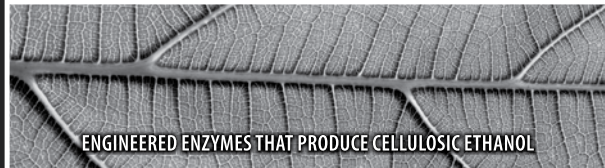
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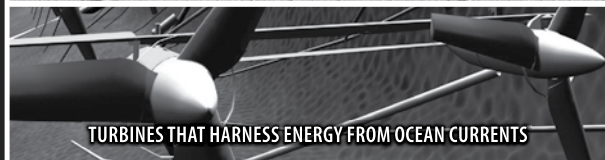
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**Clint Wilder**, contributing editor for Clean Edge, is an award-winning technology and business journalist. His book *The Clean Tech Revolution* (with co-author Ron Pernick) published by Collins in June 2007, has been called "the best clean tech book" by ClimateProgress.org and has been translated into six languages. Wilder is a frequent speaker at industry events and business schools, and writes a blog on clean tech for the Green section of The Huffington Post. Before joining Clean Edge in 2002, he covered the high tech and Internet industries for more than 15 years for *Information Week*, *Optimize*, *Computerworld*, and *Corporate Computing* magazines.

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**ACKNOWLEDGMENT**

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