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**Plus low-carbon
leaders that “get it”**

The Low-Carbon Connection



Climate—both natural and commercial—means everything when it comes to the growth of investment in low-carbon energy technologies over the last few years. Of the major greenhouse gases that contribute to global climate change, carbon dioxide (CO₂) accounts for most of the recent increase in the heat-trapping ability of the atmosphere. ■ ■ ■



ENERGY SERIES 2007

Human-produced emissions have resulted in CO₂ concentrations that exceed pre-industrial levels by a third. Of all human activities contributing to the increase, fossil fuel combustion is estimated to account for more than half the greenhouse warming caused by people.

Leaving a smaller carbon footprint has rapidly become the goal of companies large and small. Since the turn of the millennium (and especially within the last 36 months), changes in the global and business climates have driven interest and investment in energy production via lower-carbon technologies and processes, including renewable energy, intelligent grid management, distributed generation, and ever-cleaner fossil fuels. "Our society is waking up to the notion that to build a low-carbon future requires a whole range of products and services," says Christopher Hunt, who heads BP's power generation business. "The magnitude of impact on the broader economy in terms of the type and number of new businesses that will be needed to support a low-carbon world is far greater than anyone ever anticipated."

The need for more and better is driving government and industry to develop a portfolio of low-carbon technologies for electricity generation and distribution and, in turn, opening up new opportunities. What very recently was a business space entered into only by the adventurous and visionary has become, due to an inflection point in environmental and national security concerns, a major business opportunity for a much broader population of entrepreneurs and investors. Moreover, governments are finding that a lower-carbon life and good business can indeed go together. "Spain has reduced its carbon dioxide emissions by more than 4% in the last year," says Enrique Alejo, trade commissioner of the Chicago Trade Commission of Spain. "This was achieved when the economy grew 3.9%, clearly demonstrating Spain's ability to become more efficient in terms of energy consumption."

Many businesses are showing their eagerness to put money into clean energy and low-carbon investments by urging Congress to pass climate-change legislation that clarifies the investment outlook. Low-carbon has become a high-stakes business.

Using It Without Losing It

Companies of all sizes are riding a wave of optimism and investment in renewable energy. The International Energy Agency predicts (conservatively, say many) that \$1 trillion will be invested in renewable energy by 2030. Much of that investment will come from companies that "get it," such as those listed in our sidebar to the right. BP's Hunt says that achieving an energy mix that includes 20% renewables within the next 20 years will require much technological advance and efficient use of capital: "I'm bullish on the future of renewable energy, but we need more technologies

BP An increasing amount of this energy multinational's business is made up of low-carbon solutions, including natural gas, solar, wind, and even hydrogen. In 2005, BP received the "Low Carbon Leader" award from the Climate Group for its leadership on climate change.

FedEx With its chairman and founder, Fred Smith, co-chairing the Energy Security Leadership Council, FedEx has taken a stand on higher standards for vehicle fuel efficiency, incentives to manufacture hybrid-electric vehicles in the U.S., and funding for research on alternative fuels.

Oakland International Airport / Port of Oakland This transportation hub's achievements include increasing the use of alternative fuel vehicles, applying for LEED certification for its \$300 million improvement project, developing a recycling program, and working with FedEx to install a solar power system on the roof of its airport facility.

Pacific Gas and Electric Co. PG&E has added renewable electric power resources to its supply of delivered power, developed innovative customer energy-efficiency programs, and built the largest natural-gas utility fleet in the nation. PG&E remains committed to reducing waste streams and using resources more efficiently.

Southwest Windpower This Flagstaff-based company is leading the charge in small, residential wind energy. Its new Skystream generator was designed in conjunction with the National Renewable Energy Laboratory and provides utility-connected wind energy for the home or business.

3TIER This Seattle-headquartered company provides core weather data for investors making moves into wind, solar, and hydro projects. It uses a sophisticated computer modeling system to provide the crucial time-dependent information required by renewable-energy-project operators, developers, financiers, marketers, and others.

Timberland This company's environmentally friendly packaging asks, "What kind of footprint will you leave?" It places a "nutrition label" on shoeboxes that tells consumers how much energy was needed in their manufacture and the amount of Timberland's energy generated from such renewable resources as the sun, wind, or water.

Verdant Power Based in New York, Verdant Power is one of a new breed of companies looking to harness the power of oceans, rivers, and streams. Verdant's technology of "free flow" power generates dam-less hydroelectric power from the kinetic energy present in flowing water.

Wal-Mart Both as a consumer of green and clean energy and a retailer making commitments to the environment, Wal-Mart's company goals include increasing the efficiency of its corporate vehicle fleet, reducing energy consumption in its stores by 30%, and investing \$500 million in sustainability projects.

The companies above were selected by independent consultants and the Energy Series 2007 Board of Advisors. The selection process did not involve BusinessWeek editors or staff.



to rely on that aren't there today. We need improvement and acceleration, and that means many waves of advance."

That's why for all the talk of energy independence, industry and policy leaders understand that the energy business is made up of global players delivering power to local consumers. Boardrooms around the world are answering the needs of living rooms from Berlin to Bakersfield, and governments in many countries, including Germany, Great Britain, Japan, Brazil, and Denmark, are supporting the effort. For instance, with some of the largest wind-energy producers in the world, Spain finds itself in the forefront of the global wind market and a major world center for the photovoltaics market. "Spanish companies are expected to invest about \$1 billion in solar power stations over the next three years," says Alejo. "That is a true testament to the country's unwavering dedication to the industry."

The global nature of energy is actually helping renewables. In 2006, high oil and gas prices and the increased efficiency of evolving technologies further reduced the price premium for renewable energy, whether for biofuels or solar power. Ethanol has become the favorite of biofuels advocates, and the number of fueling stations offering the corn-based fuel has nearly tripled in 12 months. Increasing concern about energy security, global warming, and other environmental degradation has made renewable energy even more attractive to all points on the supply and demand chain. Companies coming into the renewable space include solar services firms offering turn-key power solutions to "flat roof" customers such as national retailers, manufacturers of on-site power generators based on ambient resources, and non-U.S. firms purchasing or creating strategic alliances with U.S. renewable energy companies.

On the investment side, venture investment is approaching the \$3 billion mark, and many companies are investing in or reorienting their businesses toward

What's Your Sign? Governments are investing in solar, hydrogen, and wind technologies with the goal of energy independence and a cleaner environment.



renewables. In fact, according to Clean Edge, a research and technology company in San Francisco, over the last seven years venture investments in energy technologies have increased from less than 1% of total investments to nearly 10%—while utilities, energy companies, and other traditional energy industry players broaden their portfolios to include renewable energy.

Meantime, non-governmental groups are joining to move renewables into the mainstream. In September 2006, former President Clinton announced the launch of an investment fund expected to raise more than \$1 billion for renewable energy. The Green Fund will focus on reducing dependence on fossil fuels, creating jobs, cutting pollution, and helping to reduce global warming, all while making a profit. Clinton made the announcement at the Global Initiative Conference, a day after British mogul Richard Branson pledged \$3 billion to battle global warming.

On the government side, for 2008 the Bush Administration requested \$1.2 billion be allocated to the Office of Energy Efficiency and Renewable Energy—up \$60 million, or 5%, from 2007. The budget also calls for expansion in key energy programs that focus on developing clean and renewable energy including the Solar America Initiative (\$148 million), hydrogen technology (\$213 million), and wind projects (\$40 million). The new budget would also allow the U.S. Department of Energy to guarantee up to \$1 billion in loans for projects using new technologies for electric transmission facilities or renewable power generation systems. One example of the government's alternative energy push includes an effort to develop advanced wind-energy technologies that can compete with conventional forms of electricity. "In 2005, the United States installed more new wind energy capacity than any other country in the world," says DOE Assistant Secretary for Energy Efficiency and Renewable Energy Andy Karsner. "We are eager to see wind become a more integral part of our nation's energy mix."

Managing the Grid

Because the world is increasingly concerned about the price, availability, and environmental consequences of high-carbon energy, the electric power system is ripe for a profound transition. From blackouts to the need to feed in power from multiple points, experts agree that the U.S. electric power grid is dangerously fragile and inefficient. Smart—or smarter—grid management will be required in order to meet the challenges of the U.S. energy future. There are major technical, regulatory, and commercial



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Energy security begins at home. We're investing \$15 billion over the next decade to find and produce new energy supplies in the Gulf of Mexico. We're also investing up to \$4.6 billion in Wyoming and in Colorado's San Juan Basin to increase production of clean burning natural gas. It's a start.



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BP Alternative Energy Leads the Way to Low-Carbon Power

To protect our planet, humanity must move toward a low-carbon power future. The science and technology are at a point where governments and industry know what needs to be done and now must begin committing to significant policies and projects to build the future energy mix.

One of the world's first businesses dedicated to the development and wholesale production, marketing, and trading of low-carbon power, BP Alternative Energy, a new BP business focused on delivering cleaner energy, is building for the future today. By investing \$8 billion over 10 years on solar, wind, hydrogen, and natural gas and cogeneration energy solutions, BP Alternative Energy intends to make low-carbon power the center of a viable business strategy.

The company has initiated several critical projects that will generate power in cleaner, greener ways. In California and in the U.K., BP Alternative Energy is developing hydrogen power projects that will use natural gas and petroleum coke, a byproduct of the oil refining business, to produce carbon dioxide and hydrogen. The hydrogen from the project in California will be used to power 500 megawatts of new capacity—enough for some 325,000 homes. The carbon dioxide will be sequestered and permanently stored underground in deep geological formations.

BP also has created one of the industry's largest wind development portfolios. Five wind power generation projects scheduled to begin construction



BP has been capturing and storing around one million tons of CO₂ a year at the In Salah gas field in Algeria.

this year will deliver a combined generation capacity of approximately 550 megawatts across three continents, and BP has up to 100 ongoing additional projects that will substantially increase its capacity every year for the foreseeable future. BP is also on target to meet its promise to triple its solar capacity in the next three years.

Yet BP is not going it alone. Recognizing that fossil fuels are necessary to support global economic growth, BP is partnering with companies on gasification, carbon capture, and sequestration technologies to reduce carbon dioxide emissions and make low-carbon power efficient, reliable, and economical.

“Building a low-carbon power future requires action today,” explains Christopher Hunt, head of the BP power generation business. “With so many new technology advances, we are proud to be in the position to lead the energy industry toward a cleaner environment.”

This investment is a wind-wind.

BP is investing in wind to provide cleaner electricity. Our wind power project in Colorado, to be completed this year, is expected to generate enough electricity to power 120,000 homes. When operating, wind power produces zero carbon emissions. It's a start.



beyond petroleum®

implications of connecting significant amounts of distributed (on-site) generation—like solar panels or hydrogen fuel cells—to the national electric grid and managing the addition of such energy at both the local and system level.

Investors are taking a closer look at the entire electricity distribution chain, from point of generation to point of use. Sector deregulation, antiquated systems, real-time pricing demands, the need to increase grid efficiency, and the clamor for lower-carbon system inputs are driving increased activity among those who see great profits to

are conventionally financed, leased, and serviced.”

DG technologies and processes enable energy users to generate electricity for themselves and send surplus electrical power back into the grid. Heat can also be produced and even shared via a distributed heating grid. DG combined heat and power (CHP) systems are very efficient, turning up to 90% of the fuel they consume into electricity. Two simple examples of modern DG power systems are a residential solar power installation and a commercial hydrogen-fuel-cell system.

Bright Ideas on Following Through

Investors are looking closely at not only generating solar and hydrogen power, but how it is regulated and dispersed.



be had in rewiring the grid. The grid of the future will be made up of sensors and switches giving system operators the ability to monitor and manage issues that might otherwise cause outages or blackouts.

Distributing the Power Responsibility

The World Wide Web is a perfect example of such distributed system management. Using a system spread among nodes rather than concentrated in a few locations reduces system vulnerability and the potential of a system-wide shutdown. Distributed generation of power (DG) refers to electricity production at or near the point of use—on the grid and off—regardless of size, technology, or fuel used.

DG power generation includes high-efficiency cogeneration of heat, power, and cooling (from large industrial-scale plants to micro residential systems), on-site renewable energy (including solar photovoltaics, biomass, and on-site wind generation), and energy recycling systems powered by waste gases, waste heat, and pressure drops to generate electricity and/or useful thermal energy on site. “What’s most interesting,” says Scott Sklar, president of Washington, DC-based consultancy The Stella Group, “is that as the space matures, companies are beginning to offer standardized, modular products which can be plopped and dropped anywhere for on-site power production, and

The idea of distributed power generation is gaining traction, although experts see risks in a system vulnerable to disruption and destruction. They also cite the fact that the global efficiency of the electricity sector is less than 35% and point to inefficiencies of centralized, fossil-fired plants when selling the idea of DG. Advocates of DG argue that such plants are unable to put heat to use, thus wasting 50% to 70% of their fuel energy.

One such enterprise creating self-contained products for on-site power generation is SkyBuilt Power, an Arlington (VA)-based company that has gained international attention from investors and potential customers alike for its mobile power station. The MPS is a complete power station in a standard shipping container. Transported by truck, train, or plane, the MPS employs solar panels and wind turbines to self-generate multiple kilowatts of power using nothing more than ambient resources—anywhere on earth. “I call it the clean, green power machine,” says Dave Muchow, SkyBuilt’s president. “Generating clean, renewable power on site defines low-carbon power generation.”

Future Fossils

Private and public interests are marching together to develop technologies and processes for generating cleaner power from the large and geographically wide-

Ignacio Cruz, Enrique Soria and Francisco Martín,
CIEMAT Wind Energy Unit Team.

saturday night in the testing plant

Spain is a country that enjoys high standards of well-being and quality of life. It is a reflection of a first-rate level of socio-economic development. Spanish businesses are very aware of environmental and sustainability issues and are also outstanding in their achievements in technological research and development.

Spain currently has the second largest installed wind power capacity in the world (*), and is one of the most advanced countries in the renewable energy sector.

Spain is the world's second largest producer of windpower.*

(*) Source: EWEA (European Wind Energy Association). Data: 2005



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spread resource base available in the form of fossil fuels. After 150 years, fossil-fuel-based technologies are increasingly efficient, reliable, and, in the current energy economy, affordable. Fossil energy supplies more than 80% of the world's energy needs, and the infrastructure that exists for converting black rocks, sticky liquids, and invisible gases into electricity ensures fossil dominance for some time to come.

The difficulty lies in the need to find ways of cutting greenhouse emissions without affecting the growing demand for energy, in both developed and developing countries. In the past 20 years, a number of processes have been introduced to capture the pollutants trapped in coal before the impurities can escape into the atmosphere. The DOE says today's technology can filter out 99% of particulate matter and remove 95% of acid rain pollutants. New technologies also exist that cut back on the release of carbon dioxide by burning coal more efficiently. The family of energy systems called "clean coal technologies" represents more than \$6 billion in public and private investment in cleaning up the largest non-renewable energy resource in the U.S.

Natural gas, which for many years was thought so worthless as to be burned off, provides 20% of U.S. energy today. Cleaner-burning than coal, natural gas is either burned in a boiler to produce steam for turning a turbine, or in a "combined-cycle" process, in which the gas is burned in a combustion turbine whose exhaust is then used to make steam to drive a turbine. Combined-cycle technology achieves a higher efficiency by using the same fuel source twice. While burning natural gas at a power plant does produce nitrogen oxide and carbon dioxide, it does so in lower quantities than burning coal or oil, and with less particulate matter.

Natural gas in the form of LNG, or liquefied natural gas, is an increasingly important part of the U.S. energy pie and natural gas mix. In fact, 19% of the country's electricity generation is based on LNG. While the DOE projects that by 2030 there will be a significant gap between demand and supply of natural gas in the U.S., a good portion of the shortfall will be filled by LNG. In 2005, LNG made up only 2.8% of the natural gas supply, but the DOE estimates that by 2030, that number could reach 16%. Power plants are leading the increased use of natural gas, with more than 90% of new plants using it.

Many experts believe that Americans will be able to have both energy production and environmental protection at the same time if cleaner fossil-fuel technologies are fully employed. "We cannot meet the world's energy demands right now without a heavy reliance on fossil fuels," says BP's Hunt. "But we need to figure out how to use them in as environmentally benign a way as we can. We see the benefit. We see the opportunity. It's important that we get moving and start pushing to make it happen, as a company, an industry, and a society."

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