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THE JOURNAL REPORT: ENERGY

Producers

The New Math of Alternative Energy

Does going green finally make economic sense?

By REBECCA SMITH
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The numbers are starting to look promising.

For years, the big criticism of alternative energy was cost: It was too expensive compared with energy based on traditional fuels like coal and natural gas.

Even though the fuel was often free -- such as wind or the sun's rays -- alternative-energy producers had to plow lots of money into finding the best way to capture that energy and convert it into electricity. Fossil-fuel producers, on the other hand, could draw on billions of dollars in infrastructure investments and decades of know-how.

THE JOURNAL REPORT

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Governments struggle[2] to find policies that will spur renewable-energy industries -- without coddling them. Plus, buy efficient appliances, unplug your TV[3], and read other tips for reducing your thirst for power.

Video:[4] WSJ's Rebecca Smith says there has been a boon in wind power in the last two years while solar power has been a very costly source of renewable energy.

Now the equation is showing significant signs of change. Costs are falling for some alternative-energy sources, driven by new technology and renewed development interest.

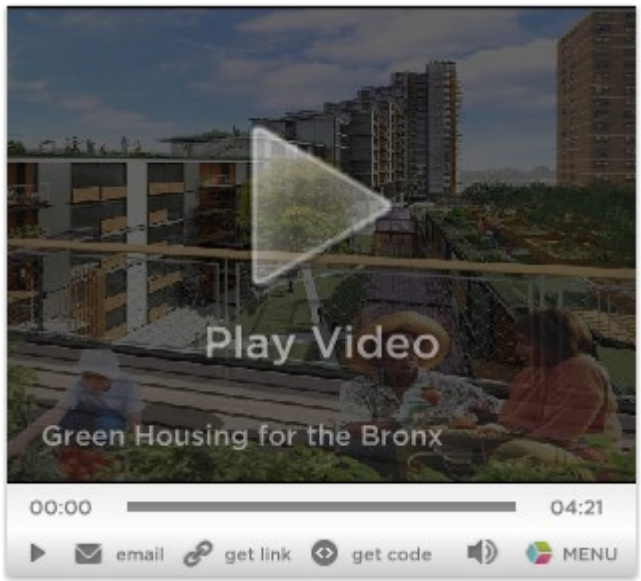
Alternative energy still can't compete with fossil fuels on price. But the margins are narrowing, particularly since oil and gas prices have been rising. The math looks even more favorable if you consider the environmental cost of fossil fuels -- which most purely economic calculations don't.

Alternative energy still faces obstacles to mainstream success. Many projects need government or utility subsidies and incentives to be viable. Generating costs have risen recently for some types of renewable resources, pushed by higher materials prices, labor costs

• See the complete Energy[5] report.

and demand. Supply chains are prone to hiccups, and wind and solar-energy resources need backup sources of power to compensate on windless or cloudy days.

For all its promise, relatively little electricity currently comes from renewable sources, other than hydropower. According to the Energy Information Administration, renewable resources produced 2.3% of the U.S. electricity supply in 2005. Bio-mass was responsible for 1.5%, wind for 0.44%, geothermal for 0.36% and solar power for a scant 0.01%.



Ed Crane takes a look at how New York City is trying to merge affordable housing with environmental stewardship by sponsoring a green housing development.

In contrast, coal-fired generation produced 49.7% of U.S. electricity supplies in 2005, followed by nuclear power at 19.3%, natural gas at 19.1%, hydropower at 6.5% and oil-fired generation at 3%.

But alternative energy stands to gain a larger share in years to come. Driven by concerns about global warming and energy security -- as well as the rising cost of electricity generated by fossil fuels -- regulators are forcing electric utilities to broaden their resource mix to include more "green" power.

At the same time, the federal government is requiring oil companies to blend more plant-based biofuels like ethanol with gasoline. Equipment makers are expanding their production lines, which should ease recent shortages of some materials -- like the polysilicon used in solar panels -- and take pressure off prices.

Here's a look at the economics of the various alternative-energy sources -- how much they cost now and what developments could make them more competitive.

WIND

Wind power stands out as one of the splashiest success stories in renewable energy. Over the past 10 years, as wind farms sprouted around the world, the cost of generating electricity from wind has fallen dramatically.

In 1980, wind-power electricity cost 80 cents per kilowatt hour; by 1991 it cost 10 cents, according to the International Energy Agency.

Today, production costs at the best on-shore sites have dropped as low as 3 cents to 4 cents per kilowatt hour, but are more typically 6 cents to 9 cents, not counting subsidies -- getting closer to the cost of generating electricity from burning coal. In fact, costs are approaching the point where wind power may be able to prosper without subsidies -- currently 1.9 cents a kilowatt hour in the U.S. -- particularly if natural-gas prices stay high.

JOURNAL REPORT PODCAST

PODCAST:[6] Wall Street Journal reporter Rebecca Smith discusses the reasons why renewable power is expanding. She also tells why alternative energy needs to be combined with energy efficiency and conservation to get the greatest benefit.

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The Department of Energy's Energy Information Administration has concluded that there isn't much difference between the cost of new power plants using wind and other traditional fuels, such as nuclear, coal and natural gas, if you take into account a broad array of expenses. A plant entering service in 2015, the administration said in a 2006 report, could make electricity from wind for 5.58 cents a kilowatt hour -- versus 5.25 cents for natural gas, 5.31 cents for coal and 5.93 cents for nuclear. The report didn't quantify the differing environmental impacts.

A host of factors have brought down the cost of wind power. The materials used in wind turbines have improved, and the turbines are now much larger and more efficient: 125 meters in rotor diameter, compared with 10 meters in the 1970s. The cost of financing wind farms also has dropped as financial markets become more comfortable with the risks involved.

Governments have also given wind power a boost. In Germany, the largest wind-power producer, the government has been giving grants to builders of wind farms since the late 1980s, and requires utilities to buy electricity generated from renewable sources at premium rates. The extra cost is passed on to consumers.

In the U.S., the extension of the federal Production Tax Credit -- which gives tax credits to alternative-energy companies -- has spurred record development over the past two years, as have state renewable-procurement targets. The nation's wind-power generating capacity increased by 27% in 2006 to 11,603 megawatts, according to the American Wind Energy Association. Only gas-fired generators added more megawatts of capacity in the U.S. The association expects wind-power capacity to increase by an additional 26% this year.

By the end of 2005, there were about 59,000 megawatts of total installed capacity of wind power world-wide, enough for the needs of roughly 20 million homes. Two-thirds of that capacity is in Europe; Germany, Spain, the U.S., India and Denmark are the top five producers of wind power.

Wind power faces hurdles. Factors like location, wind speeds and capital costs have a big impact on the cost of generating wind power. The price of 3 cents to 4 cents per kilowatt hour only holds at sites with the best wind conditions. In some places with less wind, costs can still be as high as 20 cents per kilowatt hour. Meanwhile, a shortage of turbines the past couple of years has pushed up construction costs in the U.S., as has a weak dollar.

The turbine shortage, at least, could be easing soon. **ABB** Ltd., a big equipment vendor based in Zurich, says it has boosted production of transformers used by the wind industry at its plants in Virginia and Missouri. And in January, American Superconductor, of Westborough, Mass., completed its purchase of Windtec, a wind-turbine designer that recently inked deals with South Korean and Chinese manufacturers to build the machinery.

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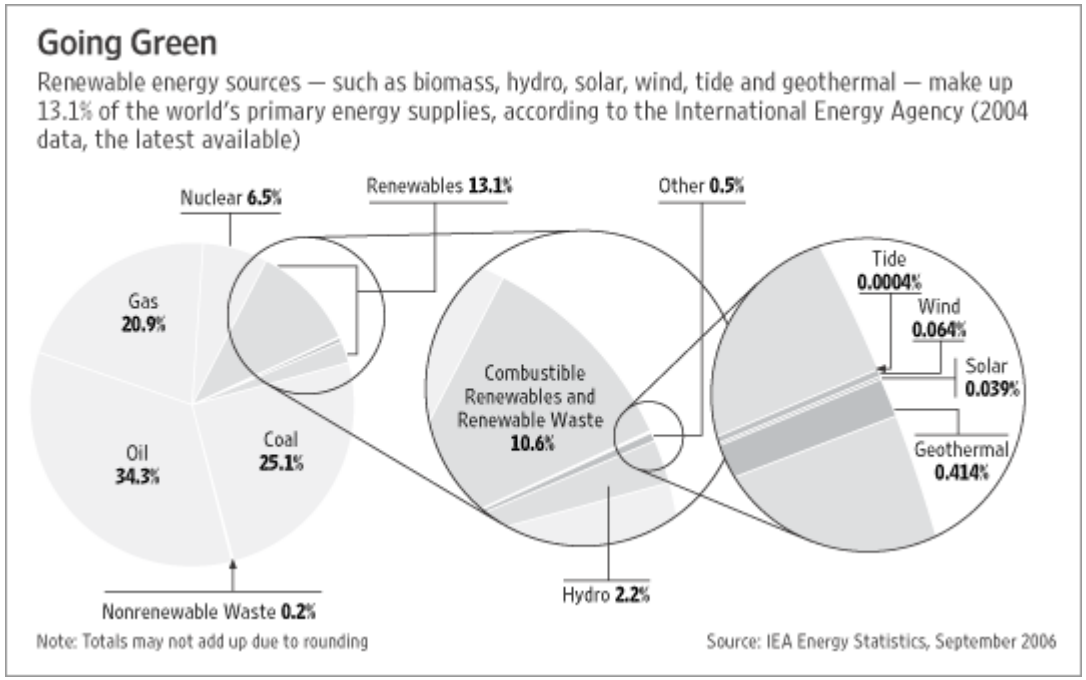
Which alternative form of energy will play the biggest role in the U.S. energy supply in 2030? Participate in

"As more companies manufacture wind turbines, we think prices will come down," says Jason Fredette, spokesman for American Superconductor, a maker of advanced electrical devices.

the Question of the Day.[12]

SOLAR

For decades, solar power has endured cycles of booms and busts as investors made big bets only to watch the technology fail to achieve its promise. Solar power still accounts for less than 1% of the world's power generation, with 5,400 megawatts of capacity on line, enough for the daytime needs of 2 million to 3 million homes. (Solar power doesn't generate electricity at night, meaning backup energy sources are needed.)



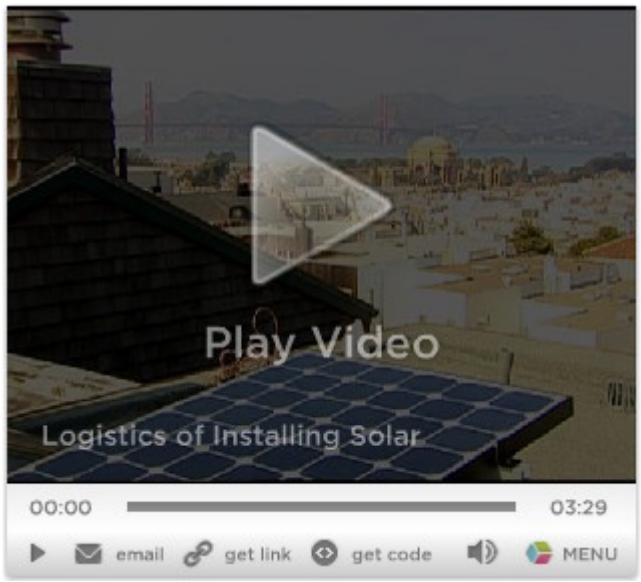
One reason there's relatively little solar electricity is that traditional solar panels aren't very efficient at converting sunlight to electricity. So most solar electricity is made and consumed at a single site -- and in many cases isn't even enough to meet the needs of a single house. A recent study by the New Jersey Board of Public Utilities found that it cost about $77,500 to install a 10 kilowatt-capacity system on a house. Without subsidies, it would take 50 years to pay for itself. With subsidies, it dropped to 9.6 years.

In all, the cost of generating electricity with solar panels is 35 cents to 45 cents per kilowatt hour, according to the International Energy Agency. In the U.S., costs are typically less -- 26 cents to 35 cents -- because there's better sun, says the U.S. Solar Energy Industry Association.

Now, however, a new generation of solar plants is on the cusp of being able to produce electricity on an industrial scale at competitive rates. The new plants use a technology called concentrating solar power, or CSP, which is much more powerful than the classic photovoltaic panels, which use semiconductor chips to convert sunlight into electricity. CSP plants use huge arrays of mirrors or solar dishes to track the sun and collect its heat to make electricity. The plants can generate hundreds of megawatts of power, closer to what fossil-fueled plants make.

The major hurdle remains bringing generating costs in line with those of conventional power plants. It costs 9 cents to 12 cents to generate one kilowatt hour of electricity by CSP -- not counting any subsidies -- compared with about 3 cents to 5 cents to generate the same amount of electricity by burning coal.

Tom Mancini, CSP program manager at the Energy Department's Sandia National Laboratories, says three factors make CSP plants more expensive than a traditional coal plant even though the raw material -- the sun's rays -- is free. Because the technology is so new, the equipment is pricey in itself and costs more to operate and maintain. And financing such projects is costly because of the perceived risk. CSP is a young technology: Only 6% of solar energy is generated by CSP technology, with the lion's share still coming from traditional solar panels that typically are heavily subsidized by homeowners.



What does it take to install solar in your home? Contractor Greg Kennedy of Occidental Power offers a first-hand view.

For now, CSP still needs government support to be viable, either in the form of tax breaks to builders of plants or subsidies to buyers of electricity. The industry scored a major coup in 2006 with the creation of a U.S. tax credit that equals 30% of a solar project's cost. A growing system of state-sponsored renewable-energy credits also gives developers a valuable revenue stream. The credits are bought and sold by businesses and utilities trying to meet greenhouse-gas reduction goals.

But the new technology has inspired a burst of development. Major power companies in Europe such as **Abengoa** SA of Spain and **Enel** SpA of Italy are spending billions on new plants that will be coming on line in the next few years. In California, utility companies **Edison International** and **Sempra Energy** have inked contracts to buy large sums of solar power from proposed projects. In Nevada, Solargenix Energy LLC plans to bring a 64 megawatt solar plant into service this year.

Energy experts argue that as more CSP plants go into operation, the technology will improve and costs will come down. But with current costs high, few companies are willing to take the risk of building without significant government incentives. "It's a chicken-and-egg situation," says Mr. Mancini.

BIOMASS

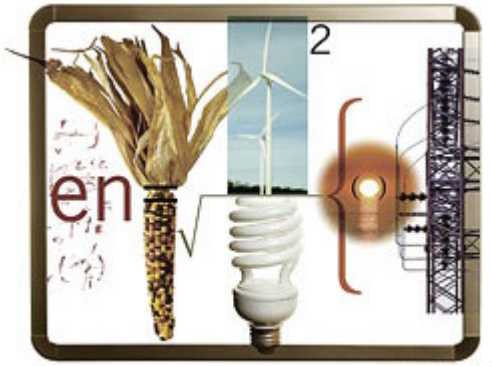
Although it doesn't get much public attention, biomass is the biggest source of renewable electricity in the U.S. today -- producing more electricity than wind, solar and geothermal sources combined.

Biomass refers to the conversion of plant matter into a transportation fuel (biofuel) or electricity (biopower), usually by incinerating waste material or creating combustible gas through chemical processes. A significant amount of electricity also is made by gathering

and burning landfill gas.

It's a growing area of interest because methane, created by decaying organic material, is a more potent greenhouse gas than carbon dioxide -- so people are anxious to put it to use and keep it out of the atmosphere. Many cities also burn solid waste to cut down the volume destined for landfill sites, and they're eager to convert the garbage to something useful.

The biggest biomass power generators in the U.S. aren't utilities. They're forest-products companies with big sawmill and pulp operations, like **International Paper** Co., **Weyerhaeuser** Co. and Koch Industries' Georgia-Pacific Corp. Weyerhaeuser, for example, makes electricity by reusing waste heat and by burning hog fuel, or wood waste, and black liquor, a pulp-mill byproduct. It sells the power it produces -- equivalent to the annual energy needs of 140,000 homes -- to local utilities.



John Weber

Because biomass plants typically are small -- usually less than 50 megwatts in capacity, or one-tenth the size of a conventional fossil-fuel power plant -- equipment costs are high relative to the amount of power produced. That, in turn, makes generating costs somewhat high -- currently, about 5 cents to 10 cents a kilowatt hour without subsidies.

Power costs are also related to the cost of fuel and the amount of heat embedded in it. As many homeowners know, there's more energy locked in an oak log than a pine log. The same holds true for biomass power generation -- some fuels make more heat and, thus, electricity. Better numbers can also be achieved by mixing plant matter with fossil fuels, like coal, and burning them together at large plants to capture the greater efficiencies.

Costs are expected to come down as technology improves and as more waste material gets redirected to electricity production, providing a cheap fuel stream. Many experts believe biomass will expand dramatically in coming years as more industries look for ways to make electricity out of their waste, diverting more material away from landfill sites.

A recent study by the California Biomass Collaborative, a government and industry group, concluded there are 80 million tons of plant material produced in California each year that could be diverted to biomass use. About 30 million tons are practically available. The study said those 30 million tons could be converted into 2,500 megawatts of electricity, equivalent to five large gas-fired plants, and 1.3 billion gallons of transportation fuel at competitive prices.

Biomass has gotten a jolt from renewable-portfolio standards embraced by nearly half the states, which require utilities to get electricity from renewable resources. In California, for instance, the state's energy agencies have set a rough goal of having biomass sources generate 4% of the state's power by 2010.

GEOTHERMAL

Geothermal energy -- tapping heat deep in the Earth to generate power -- may have more potential, at less impact to society, than any of the other alternative resources. A new study on geothermal energy, produced by an interdisciplinary team at the Massachusetts Institute of Technology, found that geothermal energy could produce 10% of the nation's electricity by 2050 at prices that would be competitive with fossil fuels.

Geothermal heat is turned into electricity through a number of methods. In general, producers drill into the ground to release steam and water that have been naturally heated and, until then, trapped. These are used to power a turbine and generator, making electricity. Liquids are reinjected into the ground to keep the process running.

Currently, geothermal energy costs about 6 cents to 10 cents a kilowatt hour, without subsidies. The main expense is actually drilling the holes and building power plants on top of them. And expertise is needed to properly manage a site to make sure the right amount of liquid is cycled through the geothermal source to extract the heat.

The amount of electricity produced depends on many things, including the size of the geothermal field, water pressure and temperature and how quickly the field can heat and release water.

Geothermal energy is especially valuable because it makes electricity around the clock, unlike solar or wind power that require backup sources of generation. Also, unlike wind and solar installations, geothermal plants have a small footprint -- smaller, even, than many fossil-fuel power plants. Advancements in equipment are making it possible to generate electricity with lower-temperature geothermal resources, and new drilling techniques let producers plumb greater depths.

Today, there's about 8,000 megawatts of installed geothermal capacity globally, with 3,000 megawatts in the U.S., the top producer. Mostly, it has been developed where heat is easily accessed and is accompanied by water and porous rock. The biggest developed field in the U.S. lies 72 miles north of San Francisco at The Geysers. Nineteen of the 21 plants at the site are owned by **Calpine** Corp., which makes 725 megawatts of electricity there, equivalent to one and a half large conventional power plants.

The MIT study found that far more geothermal electricity could be generated if companies -- especially oil companies -- leveraged their knowledge of drilling techniques, geology and hydrology to tackle the problem. An investment of $800 million to $1 billion in research and development would be required, equivalent to the expense of a single coal-fired plant.

The initial units would make electricity for 10 cents or so a kilowatt hour but later plants would see costs fall to 5 cents a kilowatt hour, probably within a decade, as processes became more refined. That would make geothermal operations competitive with modern gas-fired plants. But backers say that for geothermal energy to thrive, supportive policies are needed, including loan guarantees, depletion allowances, tax credits and accelerated depreciation -- things oil, gas and minerals-extraction companies get.

Still, geothermal energy does come with a caveat: Heat sources can be depleted if not carefully managed. At The Geysers, for instance, operators have had to retire at least half a dozen generating units, even though the field was developed largely only in the

1970s and 1980s.

BIOFUELS

Interest in alternative transportation fuels -- mostly ethanol -- soared following President Bush's declaration a year ago that the U.S. is "addicted to oil." Many potential fuels are being discussed, from biodiesel to hydrogen. Most of the buzz is around what's already by far the biggest alternative transportation fuel in the U.S.: ethanol made from corn.

There's lots of talk about the possibility of using ethanol as a standalone fuel to power cars. But virtually all the ethanol consumed in the U.S. today is used in a less-sexy way: It's blended into normal gasoline.

That's done mostly in parts of the country with bad air-pollution problems, because adding ethanol to gasoline reduces smog-causing emissions from the cars that burn the fuel. Ethanol also is used as a gasoline "extender."

The cost of producing ethanol depends largely on the cost of corn, ethanol's main feedstock. It also depends on the cost of the energy -- typically natural gas -- used to power the process that turns the corn into ethanol. Keith Collins, chief economist at the U.S. Department of Agriculture, estimates that today it costs about $1.60 to produce a gallon of ethanol.

Ethanol producers sell their brew on a wholesale market -- sometimes to gasoline refiners and sometimes to middlemen who sell to those refiners. The price of ethanol typically rises and falls with that of gasoline, which itself is a function of the global oil price. Ethanol typically has sold for up to 51 cents per gallon more than gasoline, because the federal government gives ethanol blenders a 51-cent-per-gallon tax break to encourage production of the supplemental fuel.

Over the past year, the industry that produces ethanol has had a wild ride. Last summer, ethanol prices soared, due to increases in both gasoline prices and ethanol demand. Gasoline blenders who had been using another emission-reducing additive -- methyl tertiary butyl ether, or MTBE -- were switching over to ethanol because of concerns that MTBE was contaminating ground water.

Ethanol's per-gallon price premium over gasoline widened to more than $1. Margins for ethanol producers ballooned. Yet by late last year, the ethanol boom was cooling. The sudden profitability of the ethanol business, combined with increasing federal requirements for the production of alternative fuels, sparked a rush of investment in new ethanol plants.

Meanwhile, gasoline prices, and thus ethanol prices, were falling from their mid-2006 highs. The production costs for ethanol were also rising, largely because the rush to produce more ethanol had driven up the price of the fuel's main feedstock, corn.

On Friday, the price of ethanol for March delivery closed at $2.06 a gallon on the Chicago Board of Trade, and the price of gasoline for March delivery closed at $1.61 a gallon on the New York Mercantile Exchange.

Where ethanol prices will go from here is a matter of debate. President Bush, in his State of the Union speech last month, laid out an ambitious target for the U.S. to consume about 35 billion gallons of ethanol and other alternative transportation fuels by 2017. (The U.S. currently consumes about 5.2 billion gallons of ethanol per year.)

Reaching the numbers outlined by President Bush won't be easy. It probably would require significantly increasing the concentration of ethanol that's blended into gasoline. That, paradoxically, is a move that scientists say raises potential air-pollution problems of its own. Studies show that while ethanol added to gasoline in low concentrations helps reduce certain emissions, such as carbon monoxide, it tends to increase some other emissions.

Another option to meet the government mandate would be to increase the use of ethanol as a standalone fuel. That would require the installation of ethanol pumps at gas stations -- a move that could cost the oil industry billions of dollars.

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