



# Renewable Energy – Bit Player or Key to our Future?

April 7, 2006

\$65 a barrel oil. Natural gas at \$12/MMBtu. Proposed electricity rate increases as high as 72%. Recent events in the world of energy have left the U.S. struggling to clearly define our energy future. One scenario is to just improve what we're already doing – tap new sources of oil and natural gas, build a new generation of coal and nuclear units, and push for more efficiency in our end uses. But is there an alternative? Do renewable sources – long a favorite of the environmental community – offer us a realistic alternative? And are they available in large enough quantities to be meaningful?

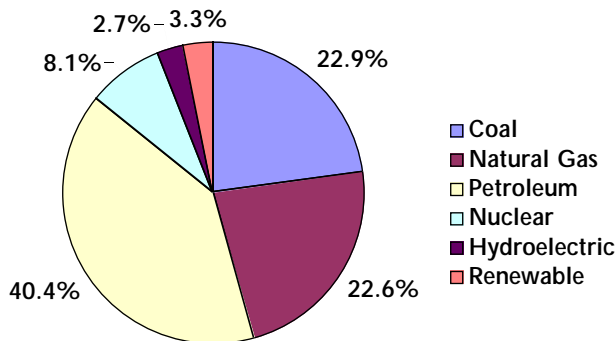
Renewable energy, including conventional hydropower, currently makes up 6.0% of total U.S. energy consumption and 8.9% of electricity generation. Remove conventional hydropower, and the numbers dwindle to 3.3% and 2.2% respectively<sup>1</sup>. Despite these small per-

centages, renewable energy use in the U.S. is growing. Especially in the electricity generation sector where use of renewables, fueled by an increase in wind energy, has grown by 21% in the last ten years. (see chart on page 2). Most projections suggest that use of renewables will continue to grow. But scenarios range from modest growth to gains so large they would result in renewables becoming a major source of energy supply.

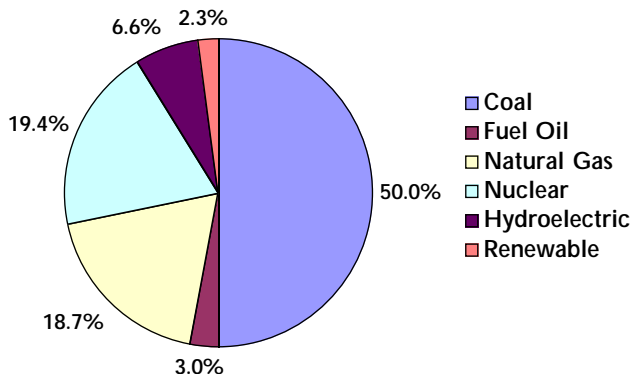
## What is Renewable Energy and Why Should We Pursue It?

Renewable energy is energy that comes from the wind, sun, flowing water, plant matter and other non-fossil and non-nuclear fuels. The U.S. Energy Information Administration (EIA) defines renewables as energy resources that are "naturally replenished in a relatively short period of time." Unlike fossil and nuclear fuels, renewable fuels are not depleted by use over the long run. Though renewable energy is the most common term applied, related terms include green power, alternative energy and clean energy. Green energy suggests an energy resource with few negative impacts on the environment or on human health. Often, conventional hydro is excluded from the definition of green energy due to the environmental impacts on downstream waterways. Alternative energy simply refers to energy that is different from that commonly used, although lately the term is often used synonymously with green energy. Clean energy refers to energy sources that have less environmental impact than common sources (e.g., petroleum, coal, natural gas and sometimes nuclear energy). But it's important to note that "clean energy" can mean various things depending on who is using the term – some use it to include clean coal technologies and new generation nuclear as well as green energy sources, while others use it simply as another term for green energy.

## Energy Sources – 2005

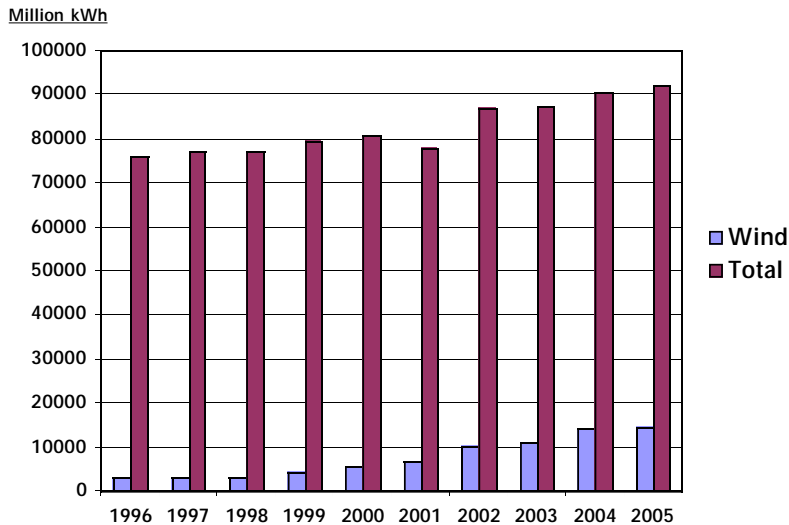


## Electric Generation Sources – 2005



<sup>1</sup>Data in this newsletter is from the Energy Information Administration (EIA) [www.eia.doe.gov](http://www.eia.doe.gov).

## Electric Generation from Renewables



mental mitigation. As always there are trade-offs. Capital costs of certain forms of renewable energy are high. And in the electrical sector, power operators are challenged by the intermittent nature of many renewable sources. Before we consider the potential of renewables, we'll take a look at the various types of energy sources that make up renewables. We will then revisit the question of whether renewables can become more than a bit player.

### Types of Renewable Energy

#### Wind Energy

Air moves from areas of high pressure to areas of low pressure, creating the wind that flows across the earth's surface. Windmills have historically tapped this resource to pump water and crush grain. Today, wind turbines use it to generate electricity. To do this, the spinning blades of a wind turbine drive a generator that converts the mechanical energy of the high-speed shaft into electrical energy. There are several different kinds of wind turbines, but the most familiar are the horizontal axis generators we typically see mounted on tall towers.

These towers can be installed both on land and offshore, and the largest can reach heights of 100 meters and generate up to 5 MW of power. Because offshore winds blow strongly even at lower heights, offshore towers may be shorter than land-based towers. The

installation of many wind towers at a site is called a "wind farm" or "wind plant" while smaller-scale installations (from one to about eight turbines) are called "wind clusters." Smaller horizontal-axis wind turbines (used for both off-grid and grid-tied applications) can generate power in the range of a few hundred to a thousand watts.

#### Solar

Solar energy is energy from sunlight that is used directly to create useful work or for conversion into electricity. Solar energy breaks into three distinct types: passive, thermal and electrical. Passive solar uses the sun's heat directly (without any active devices) for applications such as space heating. Solar thermal uses devices that concentrate direct heat from the sun.

Applications for solar thermal can include hot water heating and creating steam for generating electricity. Solar photovoltaics are devices that use semiconducting materials like silicon to convert sunlight energy directly into electricity. Like batteries, solar cells generate direct current (DC) which is then converted to alternating current (AC) using inverters. There are two types of solar photovoltaics: panels and concentrating solar systems. PV solar panels comprise a number of PV cells – the type seen on roofs of homes and commercial buildings. Concentrating solar PV systems focus solar energy on an expensive, but very efficient, PV cell which can tolerate more intense solar energy. Other PV technologies with promise include thin-film, a term referring to the process of applying semiconductor material in thin layers. Thin-film PV may in the future be applied directly to building windows or roofing materials.

#### Geothermal

Heat from the earth's interior core continuously emanates outward, heating rock and water below the earth's crust. When water is trapped underground near a source of heat, a geothermal reservoir is created. By drilling wells into these reservoirs, a geothermal power plant can use this heat, water or steam to force a turbine to spin and generate electricity. Several different technologies are currently used on commercial applications with additional more advanced technologies under development.

The term geothermal also applies to non-electricity energy uses. One use (for moderate to low-temperature geothermal resources) is space and district heating. Heat pumps are another use for geothermal energy. These are electrical devices that transfer the ambient temperature of the earth to living spaces for heating and cooling.

#### Biomass/Waste

Biomass can be broadly and most simply defined as an energy source from plants and/or waste. It has an array of applications from transportation to electricity generation. Biomass can be plant-derived (organic) material, but by definition it is also municipal and industrial waste, residue from forests, mills and livestock operations, and other agricultural and animal wastes.

Biofuels are transportation fuels created through biochemical or thermochemical processes, and include methanol, ethanol, biocrude, biodiesel, and biogas. Biofuels like ethanol are derived from the starches and sugars (the carbohydrates) of plants such as sugarcane, sugar beets, corn, switchgrass, barley, hemp, kenaf, potatoes, cassava and sunflower. The sugars are fermented and turned into fuel. Additional biofuels can be produced from other parts of the plant.

Biodiesel is derived from soybean or rapeseed oils, animal fats, waste vegetable oils, or microalgae and fish oils. These organics are combined with alcohol (ethanol or methanol) in the presence of a catalyst to form biodiesel.

Biogas (or methane) is produced when organic biomass like manure, wastewater sludge, municipal solid waste, or any other biodegradable feedstock, decays under anaerobic conditions. This gas can be captured at landfills and wastewater treatment plants and then used as a fuel to generate electricity. Biogas is also referred to as digester gas, marsh gas and swamp gas.

#### Hydro

Like windmills, water mills were historically used to grind grain. Today, hydroelectric power plants use the flow of water to spin a turbine to generate electricity. Hydroelectric plants that are small-scale and have a low impact on the environment qualify as green energy.

While there is no international consensus on the definition of "small-scale," a value of up to 10 MW total capacity is becoming the generally accepted limit. Micro- and mini-hydro plants generate less than a megawatt of power but total capacity is often no more than 100 kW (micro) or 500 kW (mini). These small, micro and mini-hydro plants harness "run of the river" water flows and, generally, do not use water stored behind a dam. They also meet minimum impact levels on river flows, water quality, fish passage and watershed protection.

#### Marine

Another form of hydroelectric power makes use of the energy of waves and sea currents and the rise and fall of tides. These sea-based technologies are relatively new for generating electricity, though tide mills once provided man with mechanical energy. Various means of converting marine power to electricity are being researched and/or developed, but marine power has yet to reach commercialization stage.

#### **Can Renewables Once Again Become an Important Energy Source?**

Man has used renewable energy since the caveman, and until modern times renewables were by far the most common energy source. But in the last 150 years, we have built an industrialized society fueled by more concentrated energy sources such as fossil fuels and nuclear energy. Yet each time we face a crisis point with conventional energy sources, we regain interest in renewables. This occurred during the energy crisis in 1973 brought on by the oil embargo by the OPEC states and is occurring again now.

The drive for new energy sources can come from at least three key forces – governmental policies that favor one source over another, energy producers who see advantages to investments in specific energy sources or consumers who favor certain sources through their purchase decisions. It appears that all three forces are now coming into play to support renewables development.

Although the U.S. government has offered only limited support to renewables (including a production tax cred-

it that is set to expire in 2007) a number of states have stepped forward to fill this void. In fact, 24 states have now put in place regulations that encourage or require electric companies to meet a specific standard for including renewable sources in generation portfolios. Elsewhere in the world, most of Europe as well as Japan have already mandated increasing reliance on renewable fuel for electricity generation.

Renewables are also getting a boost from new environmental regulations that put a cost on emitting greenhouse gases such as carbon dioxide. Since most renewable sources don't emit carbon dioxide, regulations on other sources that do (such as coal and to a lesser extent natural gas) create incentives for the development of renewables. Most of Europe and Japan have also moved forward with implementing regulation of carbon. In the U.S., the federal government has resisted such regulation but a number of states in the Northeast and the West Coast are developing carbon regulation at the state level. Governments can also offer other incentives to encourage renewables development, and such government actions have led Germany and Japan to become world leaders in development of renewables and renewable technologies. In the U.S., California has stepped forward with a \$2.9 billion photovoltaics initiative.

As for energy producers' support for renewables, we are seeing interest driven by cost competitiveness and the desire to hedge future risks. The cost of wind power has recently come into line with other electricity

sources – thus many electric companies now see wind as one of the various options to be used when new generation is needed. While some oil and gas companies continue to focus on fossil fuels, both BP and Shell have become increasingly involved in renewable energy markets. A number of ethanol plants are under development in the U.S. and large-scale biodiesel projects may not be far behind. Meanwhile, the investment community is enamored with alternative energy technology. A number of investment funds have been developed just for alternative energies, companies such as GE Financial Services and Goldman Sachs have each announced billion dollar investments in renewable energy, and in some sectors clean energy is being touted as the next big investment play.

Lastly, on the consumer side, green power programs among utilities have become increasingly popular and owners of large truck and van fleets have begun experimenting with biodiesel as an alternative to traditional diesel. And in Colorado, voters last fall passed a ballot initiative that required the larger utilities in the state to acquire specified percentages of renewable power.

Whether the current interest will translate to renewable power becoming a significant energy source remains to be seen. However, it appears that market factors coupled with growing concerns over our current dependence of fossil fuels may well lead to rapid growth in use of renewable energy and a scenario where renewables could again become a significant contributor to our overall energy picture.

### **Interested in learning more about Renewables?**

Enerdynamics' **Renewable Energy Overview** is available for delivery at your company's site. This one-day seminar covers topics such as Sources of Renewable Energy, Delivery Mechanisms, Key Industry Participants, Value Propositions for Renewables, Regulatory and Governmental Issues, and Market Dynamics. Click here for a detailed outline: <http://www.enerdynamics.com/section03/Renewable.asp>. Please contact us at 866-765-5432 for more information. Also watch for the online version of this course, coming later this year.