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Home Improvement » Energy

The energy we use every day—from natural gas for heating to electricity for lighting our buildings—is a large contributor to greenhouse gas emissions and other pollution problems. Reducing your energy consumption as well as choosing greener ways to power your life are just two ways to reduce your carbon footprint.

Renewable energy sources

More than just wind and solar, the renewable energy mix includes several other technologies with great clean energy potential. At this time, however, of the nearly 100 quadrillion Btus of primary energy consumption in the US, only 6.8 percent comes from renewable energy.[1]

Solar

Solar energy is the direct or indirect source of most other renewable energy sources, including wind, hydropower, biomass, and ocean energy.[2]
Solar energy can be collected and used in a variety of ways, including photovoltaic systems, concentrating systems, water heating, daylighting and passive heating.[3]

Photovoltaic systems consist of solar cells made of semiconducting materials that absorb sunlight, causing electrons to flow which produces electricity.[4]
Solar cells can range in size from one-half inch to 4 inches, each producing between one and two watts. When connected to other solar cells into a single module they form an array.[4]

Concentrating solar power systems use the heat of the sun to focus the sun's energy, which in turn heats a liquid that can then produce steam, which rotates turbines to produce energy.[5]

There are three types of concentrating systems: parabolic-trough which uses curved mirrors to focus sunlight onto a liquid-filled pipe, a dish/engine with mirrored dishes that concentrates heat onto a receiver that transfers the heat to a fluid-filled engine, or a power tower which employs mirrors that concentrate sunlight onto a tower filled with molten salt.[6]

Using similar principles, solar energy is used to heat water used in homes and other buildings. Solar collectors with transparent covers allow sun to pass through to tubes filled with water (or another fluid), which is passed to an insulated storage tank.[7] Passive solar heating occurs when building direction and materials are utilized to capture and store the sun's heat.[8]

Currently, solar energy provides less than 1 percent of the energy needed by electricity users in the US.[9]

Wind

Like most other forms of renewable energy, wind energy is a form of solar energy.[10] The amount of solar energy received by the earth

varies throughout the day, and water and land absorb and reflect solar energy at different rates. These two factors work together to form pockets of air with varying degrees of temperature. As these air masses interact, they create wind.[11]

The most ideal (and attainable) conditions for wind energy generation occur at about 100 feet above ground, where faster, more stable wind can be found.[12] Turbines can be installed on land (often in farmer's fields) and offshore (where winds are even stronger).[13] These huge units consist of a tower onto which a rotor blade is mounted.[11] As the wind turns the rotor, it spins a shaft which feeds energy into a generator.[14]

The US Department of Energy (DOE) estimates that wind power could potentially supply 5,800 quadrillion Btus of energy worldwide every year, which is 15 times more than the current energy demands of the world.[15] In fact, one large-scale wind turbine can provide energy for between 225 and 300 homes.[16]
Wind energy is clean and renewable, can be produced locally which decreases dependence on foreign oil sources, is very economical, and can provide extra income for farmers since turbines are often installed in agricultural fields.[17]

Geothermal

At the core of the earth, temperatures can reach 9,000 degrees Fahrenheit (F) or more.[18] This heat, which is expected to flow continually for billions of years, emanates outward, eventually heating rock and water near the earth's surface.[19] The upper 10 feet of earth's surface sustains temperatures between 50 and 60 degrees F nearly all of the time.[20] The heat within this thin upper layer has the potential to provide 50,000 times more energy than the combined resources of all the world's oil and gas resources.[21]

Geothermal energy can be used to provide direct heat, can regulate building temperatures (heating and cooling), and can be used to create electricity.[20]
In electricity applications, natural hot water or steam reservoirs are drilled into create wells. The heated liquid is pumped to a power plant on earth's surface where it is converted into electricity.[19]

Three main types of power plants are used to create electricity: dry steam (the simplest, using steam to rotate a turbine), flash steam (which depressurizes very hot water into steam, which drives a turbine), and binary cycle (where hot water heats a secondary liquid, which boils at a lower temperature and is then converted to steam).[22] Geothermal energy is clean, reliable, uses smaller parcels of land than most other energy sources, and has great potential to reduce dependence on foreign oil supplies.[23]

Biomass

Biomass energy is derived from the chemical energy contained in organic materials (stored in plants through photosynthesis). Examples of biomass fuels include manure, terrestrial and aquatic crops, manufacturing waste, wood, and garbage.[24][25] Since these materials are abundantly available, biomass is considered a renewable source of energy.[26]

Biomass energy can be used to produce fuel and electricity. The electrical power produced through the use of biomass is often called biopower or biomass power, and includes technologies such as anaerobic digestion, gasification, cofiring, direct-firing, and pyrolysis.[24] Most often, energy is harnessed by burning biomass to produce steam, which turns a turbine that feeds energy into a generator.[27]

The benefits of biomass energy include the use of waste materials (such as paper mill residue, lumber mill waste, and municipal waste), reduced dependence on foreign oil sources, and reduction of greenhouse gasses.[28] Biomass currently provides about 3 percent of the energy used by Americans.[26]

Ocean

Since oceans cover more than 70 percent of the earth's surface, they may contain great potential for energy generation. There are two main sources of energy associated with the ocean: mechanical and thermal.[29]

Mechanical energy from the ocean comes in two varieties: tidal and wave. Tidal energy results from the gravitational pull of the sun and moon combined with the rotation of the earth. These forces work together to create water movement below the surface of the ocean. Tidal energy can be harnessed through several methods. A barrage or dam is made of gates which open and close to allow water to flow through turbines that pump energy into a generator. [30]
Similarly, ocean turbines are installed underwater in rows, turning as water flows through them naturally.[31] A tidal fence spans open oceans between small islands or straits, generating energy as the tidal currents push water through giant turnstiles.[32]

Wave energy is created by extracting power directly from the surface of waves, which are created when wind blows over the surface of the ocean.[33]
There are both offshore and onshore wave energy systems available. Some capture energy by using a pump technique, while others get energy from breaking waves.[34]

Ocean thermal energy generation (OTEC), on the other hand, is a way of harnessing the sun's heat stored in ocean waters, and works best when the temperature difference between surface and deep water is 36 degrees F or more.[35] Three types of OTEC systems exist, including closed-cycle, open-cycle, and hybrid systems, which all operate by using steam to turn a turbine.[29]

Most ocean energy systems have the advantages of being clean, using only small portions of (underwater) land, and producing little if no noise or visual disturbance.[36]

Hydropower

Water constantly cycles through the earth through evaporation of oceanic water into clouds (water heated by the sun), precipitation through rain or snow, and the movement of water through rivers back to the ocean.[37] Using mechanical processes, hydropower (also known as hydroelectricity) harnesses water's energy by directing or channeling it through penstocks and turbines, which rotate to create energy that is fed into a generator. Some hydropower plants require the use of dams to increase the force of the moving water,[38] while others use a diversion technique to channel part of a river through a penstock system.[39]

Offering what many believe is one of the cleanest forms of energy, hydropower does not require the burning of fossil fuels and therefore does not pollute the atmosphere.[40] It is the oldest form of renewable energy, dating back 2,000 years to the time of the Greeks.[41] The first hydroelectric power plant was built in Wisconsin in 1882,[41] and in 2005, it accounted for 73 percent of US renewable energy generation.[42] It is the world's largest source of renewable energy, with over 150 countries using hydropower for electricity generation.[43]

Hydrogen

Hydrogen is the most plentiful gas in the universe and has the highest energy content by weight and lowest energy content by volume of all known fuels on earth.[44]
To harness the energy in hydrogen cells, hydrogen is electrochemically combined with oxygen, which produces electricity and heat. The only byproduct is clean water vapor.[45]

Non-renewable energy sources

Non-renewable energy sources fall into two main categories: fossil fuel and nuclear energy.

Petroleum and natural gas

Crude oil was formed over millions of years by applying heat and pressure to the remains of plants and animals in ever-deep layers of the earth's surface. Refining crude oil by separating it into its constituent parts produces liquefied petroleum gas, heavy fuel oil, jet fuel, diesel fuel and heating oil, and gasoline.[46]
These products are often called fossil fuels. Burning them creates several environmentally harmful gasses, including carbon dioxide (CO_2) which is the most predominant greenhouse gas, methane (CH_4), a less common but more potent greenhouse gas, nitrogen oxides (NO_x) which contributes to smog and acid rain, and sulfur dioxide (SO_2), which has been linked to several respiratory problems as well as acid rain.[47]
Additional downsides to developing petroleum and natural gas include disruption of land and ocean habitats, oil spills which can kill wildlife, and pollution of water supplies.[46]

Perhaps the most troublesome trend in petroleum energy is the development of the oil sands (also known as tar sands), especially those in Alberta, Canada, said to be the largest known oil reserve in the world.[48] With global demand for oil set to increase nearly 40 percent by 2030,[49] and oil prices following this rising inclination, this previously over-priced energy resource is becoming a viable option,[50] and oil-hungry countries are clamoring to get their hands on some in an effort to decrease their dependence on Middle East supplies.[51]

But tar sands are no solution to the looming energy crisis. Conventional oil naturally flows underground and can be pumped out. Oil sands extraction, on the other hand, involves strip mining vast areas of land, then processing the sand with water to separate the sludge from the oil. It takes an 80-meter-deep open pit to produce just one barrel.[48] Producing this barrel generates three times the greenhouse gases (GHG) compared to conventional oil (Canada's biggest contribution to GHG emissions), using enough daily energy to heat three million Canadian homes.[52] Described by Environmental Defence
as "a giant slow motion oil spill," this industry is filling rivers with carcinogenic poisons that deform fish and cause serious ailments in humans, raining acid on neighboring communities,[53] creating air pollution equivalent to that in areas like New York and Shanghai,[54] and chewing through unique boreal forest land.[52]
These environmental concerns are drawing the attention of many environmentalists who are trying to pressure the US government to uphold a ban on oil sands fuel purchases.[55]

Coal

Coal power plants generate over 50 percent of the electricity used by Americans.[56] Coal, which is another type of fossil fuel, must be mined through a process that can hamper local ecosystems and harm wildlife.[57] The mining of coal is a highly dangerous job, causing serious health problems for many workers.[58]
Burning coal is the single largest source of mercury emissions and emits 59 percent of total sulfur dioxide and 18 percent of nitrous oxide in the US each year.[56] It also is responsible for huge additions of CO_2 into the atmosphere, which poisons the air and eventually lands in water, harming fish and passing onto humans.[57]

Uranium (nuclear)

Energy can be released from atoms through nuclear fusion (fusing atoms together) or nuclear fission (splitting atoms apart). Most nuclear power plants use uranium (in a fission process) as a fuel source, which is a non-renewable resource, although fairly abundant around the world.[59]

Nuclear fission processes result in radioactive nuclear waste which is very difficult to dispose of safely.[60] They also have the potential for disastrous accidents (such as Chernobyl) and can cause serious radiation poisoning for workers and those living in close proximity to the plants.[61]
Though many claim that nuclear energy is relatively cheap, they often fail to consider the full costs of building and maintaining nuclear facilities, as well as the enormous cost of disposing of nuclear waste.[62]

Controversies

Solar

Though clean and abundant, solar energy is intermittent and variable, making it less stable than other sources of renewable energy. Collecting solar energy also requires large areas of land or ocean.[5]

Wind

Despite the fact that wind power is abundant and clean, renewable, and local, there are some downsides to this source of energy. The most important consideration of wind power generation is bird migration routes. Some environmentalists believe that ill-placed turbines are death traps for migrating birds, which have been known to die when they strike wind towers.[63]

The biggest functional drawback to wind energy is its intermittence. Since wind blows sporadically, turbines cannot provide a constant, stable source of energy, and therefore it must be supplemented with alternate forms of energy.[17] Others' complaints are more aesthetic, stating that wind turbines detract from the beauty of natural landscapes and create unacceptable levels of noise and shadow.[64]

Biomass

The most popular biomass crop in the US is corn. As a conventional agricultural crop, it requires heavy doses of fossil-fuel-derived fertilizers and pesticides, the production of which produces nitrous oxide (a greenhouse gas much deadlier than CO_2) and requires large fuel inputs for running machinery and transportation purposes.[65] Even if all of the corn grown in the US were used as a biofuel, it would only make a 15 percent dent in annual gasoline usage.[66]

The most troubling side-effect of increased interest in biomass energy comes as a result of increased demand for biomass materials. In many tropical countries, including places like Brazil, Columbia, and Indonesia, rainforests are being cut down at alarming rates to make room for soy and palm-oil crops.[67]
This trend could result in a serious decline in biodiversity of plant and animals species throughout the world.[68] And because of this increase in demand for biofuels, the price of crops such as corn have skyrocketed. Since corn is a staple food for many of the world's poorest countries, high prices for this crop drive them further into poverty as they become unable to afford the basic necessities.[69][70]

Ocean

It requires a tremendous amount of energy to pump water through OTEC systems and then onto land, making this option rather inefficient.[33]
They are also relatively expensive to build and pose some additional environmental drawbacks. OTEC systems often deposit cold water near the ocean's surface, which releases CO_2, a greenhouse gas.[71]

Hydropower

Though the potential for increasing the capacity of US hydropower systems is great,[72] critics maintain that it is fraught with environmental downsides. The most obvious environmental concerns are the disruption of fish migrations to spawning grounds and the displacement of land-dwelling plants and animals resulting from flooded areas.[38] Additional drawbacks include decreased water quality due to low oxygen levels,[40] increased sedimentation from erosion, and leaching of chemicals in reservoirs,[38] changes in local climate,

disruption of socially sensitive areas, and risk of dam breaks due to system failures or military attacks.[73]

Hydrogen

With current technology, the cost to build hydrogen fuel cells and power plants is extremely high, which will likely be the biggest deterrent to development of this energy source in the immediate future.[43] Some also believe hydrogen energy generation to be unsafe since the possibility of power surges and explosions are relatively high and sufficient safety mechanisms have not yet been developed.[74]

Incentives

Check out the Database for State Incentives for Renewables and Efficiency website for information on whether your state provides incentives for renewable energy users.

Glossary

- **anaerobic digestion**: Bacteria decompose organic matter (biomass) without oxygen, which produces a gas that can be used for power production.
- **Btu (British thermal unit)**: A unit of energy used universally in the heating and cooling industries. It is defined as the unit of heat required to raise one pound of water by 1 degree Fahrenheit.
- **cofiring**: Coal-fired power plants use high temperatures in an oxygenless environment to convert biomass into gas, which is mixed with fossil fuels, creating what is known as syngas. This reduces the sulfur dioxide emissions of the plant significantly.
- **direct-firing**: The most common type of biomass production, this method burns biomass materials to produce steam, which moves a turbine and generates energy.
- **gasification**: Biomass is converted into a gaseous fuel comprised of carbon monoxide and hydrogen, which is then used in gas turbines or internal combustion engines.
- **penstock**: A pipe used in hydropower systems.
- **pyrolysis**: A thermochemical process which converts biomass into a liquid which can be burned to generate electricity.

External links

- US Energy Information Administration - Emissions of Greenhouse Gases Report
- International Energy Agency - Key World Energy Statistics 2005
- IEA Bioenergy: An International Collaboration in Bioenergy
- Low Impact Hydropower Institute
- US National Renewable Energy Laboratory
- Sierra Club's Clean Air Campaign
- US Department of Energy's Biomass Program
- US Environmental Protection Agency - Green Power and Renewable Energy
- US Environmental Protection Agency - Guide to Purchasing Green Power

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Footnotes

1. US Energy Information Administration - Energy Overview, 1949-2006
2. US National Renewable Energy Laboratory - Learning About Renewable Energy
3. US National Renewable Energy Laboratory - Solar Energy Basics
4. US National Renewable Energy Laboratory - Photovoltaics
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6. US National Renewable Energy Laboratory - Concentrating Solar Power
7. US National Renewable Energy Laboratory - Solar Hot Water
8. US National Renewable Energy Laboratory - Passive Solar

9. US National Atlas - Renewable Energy Sources in the US
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32. US Department of Energy - Ocean Tidal Power
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34. US Department of Energy - Ocean Wave Power
35. US Department of Energy - Ocean Thermal Energy Conversion
36. Alternative Energy - Ocean Energy Bionics
37. US Department of Energy - How Hydropower Works
38. Union of Concerned Scientists - Clean Energy: How Hydroelectric Energy Works
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47. US Environmental Protection Agency - Why Buy Green Power?
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