Clean Power Guide

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Introduction

The landscape of alternative energy technologies for home and commercial use today is very different than it was a decade ago. Thanks to innovations in technology and a growing awareness of the importance of producing cleaner forms of energy, there is a wide array of options, including wind, solar, fuel cells, geothermal and biomass (by-products). Unlike traditional fossil fuels like oil and coal, these alternatives produce little or no greenhouse gases, which is good news for the environment. And there's good news for home and business owners as well: clean energy systems can help them save money on their utility bills.

Some clean fuel types are best suited for large open areas. Some work well in urban or suburban settings. Some require fairly substantial initial investments, but the return on investment is getting shorter thanks to new technology, federal and state tax breaks and utility incentive programs. Some utilities will even buy back power you make but don't need.

Choosing whether to go to clean fuels may be easier than choosing which system to use. That's where this *Clean Power Guide* comes in.

Making clean power or heat at home or at work is not new. We've relied on clean energy for most of human history. Early civilizations were built entirely on the power of biomass, wood, water and the sun; our reliance on fossil fuels — coal, oil and natural gas — dates back only to the 1700s. Today, in the United States we get nearly 90 percent of our electricity from fossil fuels. Just 2 to 4 percent of our electricity in the U.S. comes from clean and renewable energy, but adoption of alternative energy sources is growing. Fossil fuel production and supply is projected to decline, even as demand for electricity dramatically increases around the world. Governments and even utilities realize the need and are encouraging us to reduce our dependency on fossil fuels.

Unpredictable supplies and escalating costs of all fossil fuels have sparked intense interest in clean energy by individuals, businesses and governments around the world. Growing concern about global warming, as well as escalating costs and declining reliability, are among the factors driving this increased interest. Many families and business owners are now finding it desirable, if not essential, to transition to cleaner sources of energy and electricity.

The *Clean Power Guide* provides a concise overview of several different clean energy fuel choices available today, including basic information on how each system works and the benefits and limitations of each. The guide includes information on financing and incentive programs and on the environmental impact of each fuel type. There's a short glossary to help decode the terminology, and links for further information.

Please consider the environment before printing this guide.

Comparison Chart

ADVANTAGES	WIND	SOLAR	FUEL CELLS	BIO-FUELS	GEOTHERMAL
Clean fuel	●	●	●	●	●
Lowers your utility bill	●	●	●	●	●
Provides power	●	●	●	In large-scale use	In large-scale use
Directly provides heat		Some types	●	●	●
Directly heats hot water		Solar hot water heaters but not solar cells	●	●	Heat pumps in summer; direct-geo year round
Provides cooling	Via generated electric power	Via generated electric power	Via generated electric power	No	Yes for heat pumps
Viable throughout the U.S.			●	Best when near biomass source	
24X7 operation			●	●	●
Provides power during grid outage	●	●	●		
Allows selling power to your utility		●	●		
No additonal fuel source required	●	●	Natural gas	Wood pellets or other	May require electric pumps or fans
Does not require combustion (burning)	●	●	●		●
Special permits or zoning rarely needed	May be needed	May be needed	●	●	May be needed for drilling
No impact on wildlife	Possible impact	Possible impact	●	●	●
Compact footprint			●	●	Some types
Very quiet or silent operation		●	●	●	●
Purchase and installation cost for properly rated residential units qualify for federal tax breaks (as of summer 2009)	30%, At least until 2016	30%, At least until 2016	Up to 30%, at least until 2016	$1500 Limit, through 2010, combined with all your other efficiency credits	30%, At least until 2016
May qualilfy for state or local incentives	●	●	●	●	●
May qualify for utility rebates	●	●	●	●	●
Typical initial investment (equipment and installation)	$40,000	$35,000–$50,000	$50,000	$3,000 plus variable installation costs	$17,500–$37,500
Typical return on investment (though ROI varies for each site)	Less than 15 years	8–12 Years	4 years or less	Will vary depending on installation costs	5–10 Years

Fuel Cells

Fuel cells are a great way to cut your electric bill and trim greenhouse gas emissions. They're quiet and compact, adaptable for home and business use, and efficiently and safely convert small amounts of fuel into both power and heat.

Early fuel cells date back to the mid-1800s. The process was perfected in the late 20th century to generate both electricity and water in spacecraft. Today's state-of-the-art fuel cell technology can be used in down-to-earth ways in vehicles, homes, and businesses.

How it works

Ever hear someone refer to batteries as "AA *cells*" or "C *cells*"? Fuel cells are a bit like batteries. They produce electricity and heat by processing hydrogen and oxygen, without burning anything, in a clean chemical reaction. In addition to this combined heat and power (CHP), fuel cells also create a little water. Since fuel cells, like batteries, do this neat trick through an "electrochemical" process, the cells are clean, quiet and two to three times more efficient than burning fuel, without making greenhouse gases.

"Micro CHP" fuel cell systems, like the ClearEdge Power's 5000 watt CE5, process the fuel to extract hydrogen from natural gas or other fuels, making it very cost effective. Power conditioning parts of the system convert the fuel cells' "direct current" — the type of electricity in batteries or solar panels — into the "alternating current" we use in homes and offices and get from utilities. When properly integrated, this production of electricity and heat can have efficiencies up to 90%, higher than any other clean energy solution.

Benefits

Fuel cell CHP systems are most cost-effective when used continuously to provide the basic power, heating, cooling and hot water needs in homes with larger than average requirements. They also are suited to customers with demanding requirements such as hotels, athletic clubs, hospitals and nursing homes as well as multi-tenant apartment or housing communities. Though the cells don't use a lot of fuel, they do need some; you'll need access to natural gas, propane or other fuels.

Fuel cells and systems which generate power at the point of use are called "distributed" power systems. They eliminate expensive and wasteful transmission of energy over long distances from "centralized" power plants. Because of their high efficiency and continuous operation, fuel cell systems can greatly reduce the overall consumption of fossil fuels and significantly reduce a building's carbon footprint.

Limitations

The lack of hydrogen refueling stations has slowed the spread of fuel cells for vehicles. That's not an issue for home and business owners who have natural gas but want to use less for cost and environmental reasons. A 5,000 watt system produces more than 40,000 killowatt hours of electricity per year, more than average homes require, though ideal for larger homes and commercial buildings.

Compared to other systems

Fuel cells:

- Produce no or very low pollutants.
- Are highly efficient and reliable and do not require extensive maintenance.
- Provide combined heat and power. Other clean fuel residential systems often provide only one or the other.
- Provide heat and power reliably 24/7, all year long, unlike systems which may be subject to the whims of wind, shade, cloud cover, geography or darkness.
- Unlike wind turbines, fuel cells are small, quiet and installed at ground level, eliminating sometimes lengthy battles for special zoning or neighborhood permission.

- Unlike solar panels, fuel cells do not require a lot of rooftop or yard space.
- Limits need for natural gas

You should also know...

Fuel cell systems are flameless and self-contained, with no impact on people, pets or wildlife. The systems have proven to be both reliable and durable, powering radio, cell phone and 911 towers, as well as supermarkets and hospitals and others which demand high-quality, uninterruptable power.

With available fuels, the systems can provide continuous power and heat in the event of a disaster or during a major utility outage. Fuel cells are cleaner, quieter and more efficient than emergency diesel generators and can work year-round to lower costs and emissions.

No burning means no toxic emissions; fuel cells' highly efficient operation yields significant net reduction in CO_2 emissions, with "footprints" 40 percent less than typical heating and cooling systems. As with all on-site power systems, energy is not lost and wasted over long transmission lines. Fuel cell CHP systems have little to no visual impact on their surroundings; typical systems are about the size of a refrigerator and can be installed in a closet, basement, mechanical room or backyard.

Costs and return on investment

Combined heat and power fuel cell systems are competitive in price with solar. Including incentives, a typical 5kW residential fuel cell system can be installed for around $50,000.

Federal tax breaks of up to 30 percent are available for energy efficient systems installed in homes or businesses through 2016. Installation and equipment costs both count; there are no income caps. State and utility incentives and rebates can further lower the upfront cost, for a return on investment in as little as three years, according to ClearEdge Power. "ROI" for a specific location can vary depending on how much power, heating and cooling you needed, how high utility rates are in your area, what your utility will pay you for "net-meter" power you send back to them, and other factors. Fuel cell systems can reduce utility bills by around 40 percent.

The same capital investment in a fuel cell CHP system generally delivers many times more power than other alternative options, and provides space heat and hot water as well. A 5 kW fuel cell system can deliver about 80 MWh hours of electricity and provide heat, compared to approximately 5 to 8 MWh generated by a 5 kW solar system.

Alternative power systems like micro CHPs provide a hedge against unstable energy prices. Operating costs are as low as 6 cents per kilowatt hour, less than most utilities and half the cost of electricity in many parts of California, New England, New York and elsewhere. As with all alternative power sources, you'll be able to be credited for sending the excess electricity you don't need back to your utility, a process called net metering. Unlike wind and solar, fuel cells can turn out excess power night and day, all year long.

Many systems meet requirements and goals of state climate change incentive programs.

Your accountant or tax advisor can provide specific information on available credits.

Links/Resources

- www.ConsumerEnergyCenter.org/renewables/fuelcells
- www.epa.gov/chp/
- www.nrel.gov/hydrogen
- www.fuelcells.org
- www.ClearEdgePower.com
- www.usfcc.com
- http://www1.eere.energy.gov/hydrogenandfuelcells/fuelcells/basics.html

Wind

The power of wind has been harnessed for centuries. We had sailboats long before motor boats. Farmers used windmills to power water pumps long before diesel engines or electricity. Wind power faded as fossil fuels were developed. But as an endlessly renewable power source, wind power is making a 21st century comeback, spurred by federal tax breaks and other incentives.

Today, while farmers and others harness wind power for their own use, commercial wind farms are providing power to cities and towns. Modern rooftop mounted turbines can provide or supplement power for commercial and residential buildings; yard-mounted generators can power individual homes. Businesses and homeowners can sell excess wind-generated electricity back to the grid, balancing the amount purchased on calm days.

How it works

Think of a child's pinwheel. Moving air spins the wheel. On a larger scale, wind rushing over angled blades creates high and low pressure breezes that make the blades spin. Wind is converted to electricity by channeling energy from the spinning blades to turn a generator.

The blades of a commercial utility wind turbine can be as wide as a football field is long. Towers housing these windmills can be as tall as a forty-story building. But turbines can be small, too. A series of small fans can line the corner of an apartment or office building to catch breezes that naturally sweep from the side of a building to the top. Wind turbines for single family homes are often mounted on towers in a remote part of a yard or field and are often no more than 12 feet wide from center to tip. While commercial wind turbines get larger, the newest designs for homes are smaller and quieter than ever before.

A 10 kilowatt turbine with winds averaging 12 miles per hour can generate enough to power a typical home. A large commercial turbine rated at 5 megawatts can power 1,400 homes for a year.

Benefits

Tower systems work for those with at least an acre of land, where winds average 10 mph or more over the course of a year. Wind power grows exponentially as speeds go up; small differences in wind speed can make a large difference in the amount of power you make. The wind need not blow strong all day long; most turbines run at full power only a tenth of the time.

Wind is generally best along coastlines, on hills and in northern states, but can work in other areas, too. The US Department of Energy offers national and state maps and the National Renewable Energy Lab offers an interactive Atlas of Renewable Resources. Wind can be fickle: what works for your neighbor may or may not work for you — wind characteristics change dramatically with terrain. If you're thinking wind power, have a qualified contractor study your site to determine if it's the best alternative energy source for you.

Limitations

Whether you have adequate wind is just one issue you should consider. Building or zoning codes may apply. And if you don't consider the visual impact of a wind generator, your neighbors may do so for you. Will the turbine dominate your local skyline, or become the dominant part of your neighbors' view?

There's also potential noise to take into consideration. There have been cases of neighbors of commercial wind farms suing to block the whirring sound. Smaller turbines, like those scaled for a home, generate smaller amounts of noise; some newer models claim to be almost silent. In busy commercial areas, or homes with large areas of land and distant neighbors, noise and visual concerns may not be an issue at all.

Wind power can't be called-up on-demand when you need more power. Battery technology to store wind or solar power for later use is still in its infancy. Wind power probably won't get you off the grid, but will let you both buy from and sell to your utility, ideally making you at least "net-zero."

Compared to other systems

Wind power:

- Is less predictable than solar, but is generally available more hours per day (and night).
- Compares favorably in cost with solar for larger homes and businesses. Unlike solar, where the per-watt cost remains fairly constant as an array gets larger, the cost of wind per watt generally goes down with larger installations.
- Can be a more economical choice than solar for larger homes which use between 800 and 2,000 kWh of electricity each month, if both resources are available, and if visual and noise issues are not a controlling factor.
- Does not directly provide heat or hot water, unlike fuel cells or geothermal.

You should also know...

Wind power, like solar panel systems, can continue to generate power if the utility grid goes dark after a storm or other emergency. Modern small wind turbines can run for five years or more without needing major maintenance.[7]

Wind, like other clean alternatives, produces virtually no greenhouse gases and lowers the amount of fossil fuels utilities burn. Wind generators can be harsh on bird life, though proper siting can minimize the impact.

Cost and return on investment

The energy produced by wind is free and you can sell excess energy back to your utility. But there are upfront costs. Small wind energy systems cost from $3,000 to $5,000 for every kilowatt of generating capacity, or about $40,000 for a 10-kw installed system, according to the American Wind Energy Association. Once installed, wind energy is one of the lowest-priced renewable energy technologies available, according to the U.S. Department of Energy.

Rebates, tax credits and special deals from utilities can speed the return on investment for equipment and installation. The federal government offers tax credits of up to 30 percent for small wind turbines (not more than 100 kilowatts) installed by 2016. There are no income caps; tax breaks apply to primary or second homes.

Small, well-sited wind turbines can pay for themselves within 15 years or less, or about half of their expected lifetimes, according to the American Wind Energy Association. Return on investment for specific sites varies based on available tax credits, local utility costs, how much of your current electric bill is used for heat, and other factors including "net-metering" credits you may get for sending power to your utility. Your accountant, tax advisor or state environmental office and the American Wind Energy Association can provide more information.

Links/Resources

- www.dsireusa.org/
- www.ConsumerEnergyCenter.org/renewables/wind/index.html
- www.awea.org/faq/wwt_basics.html
- www.WindPoweringAmerica.gov/wind_maps.asp
- http://mapserve2.nrel.gov/website/Resource_Atlas/viewer.htm
- http://www1.eere.energy.gov/windandhydro/wind_basics.html

Solar

We all know the sun gives us light and heat. It can give us electricity too, with a little help.

The familiar silvery panels that turn sunlight into sunpower were initially a product of the "space race," in the late 1950s for America's then-new satellite and manned space program. Today, we see solar panels wherever the sun shines: in large desert sun farms, on a neighbor's roof or powering the lights of a highway sign.

Sunshine, after all, is free.

How it works

Most of the time, when sunlight hits an object (say, your face), the light energy turns into heat. But when sunlight hits certain special solar photovoltaic ("PV") cells, the sun's photo (light) energy can be turned into volts (electricity).

Solar PV panels are made of silicon crystals or similar materials. Some can take the shape of roofing shingles or home siding. But the idea is the same no matter the shape: when sunlight strikes a solar cell, electrons inside the crystal catch the energy, start moving and break loose. The energized electrons start to flow between the bottom and top (positive and negative) layers. Wires attached to either side catch the flow. The result: electricity.

To be most effective, solar panels must face south to catch the bulk of the day's light. More elaborate systems are mounted on tracks that follow the sun. Solar cells are measured by their efficiency — the amount of the sun's rays they can convert into electricity. Older cells could turn only about 4 percent of light into power; newer cells convert 15 percent or more.

Large arrays of panels can produce enough to power a house with enough left over to sell electricity to your utility. The aim for many is to be at least "net-zero;" that is, to make or sell as much or more electricity during the day than you have to buy from the utility grid at night or on cloudy days. But even smaller solar arrays can give your electric bill — and the atmosphere — a break.

Commercial sun-power "farms" often rely on concentrating solar power. Long rows of mirrors catch and concentrate the rays, heating liquids in closed tubes which then make steam to turn an electrical generator. It's the same way oil, coal and nuclear power make electricity with steam turbines, only solar fuel is clean, renewable and free. Costs and financing for transmission lines from distant wind and solar farms still remain a major concern.

Solar water heaters are making a comeback as new high-efficiency technology and our need for cleaner, less expensive fuel make them a viable option once again. A transparent flat-plate collector catches the sun's energy, heating small tubes filled with antifreeze-like liquids. The sealed tubes run down to a storage tank, transferring heat to the water within.

Benefits

While those naturally in sunnier climates have the edge over others, homeowners and businesses in northern or cooler climates need not ignore solar options. Improving technologies make solar increasingly practical. What doesn't work for a neighbor might work for you, as access to sunlight varies greatly from site to site. Clear views of the southern sky are important, at least from 10am to 2pm daily. Other factors to consider include how much power you need and how much rooftop or other space you have to dedicate.

On-line calculators can help you determine the feasibility of solar power at your home; a qualified contractor can help you make the final call.

Limitations

Even with improvements in solar technology, building owners

in areas that are perpetually overcast for major parts of the year may only be able to harness a small part of their energy needs from the sun.

Solar PV panels need lots of space; some applications may require arrays that are impractically large. Homeowners with irregular or unusable rooftops may need to find other locations or turn to newer and sometimes expensive options such as solar-panel siding. There's a fairly high initial investment. And neighbors and others may be concerned about "visual pollution" from large reflective panels.

Compared to other systems

Solar power:

- Is more predictable than wind, but generally available fewer hours in a day.
- Costs per watt remain fairly constant as systems get larger, while wind costs generally decrease per watt with bigger installations.
- Requires less land than wind and is less likely to require special zoning or permits.
- Like geothermal, may not be practical in dense urban settings.
- Generally requires rooftop installations, unlike fuel cells which can be installed indoors or at ground level.
- Can be used to provide power or to heat water, depending on the type of system installed.

You should also know...

Solar panels are considered safe, reliable and relatively maintenance-free. They can continue to provide electricity when the utility grid is knocked out by storm or other incident (though storing large quantities of electrical power for nighttime or off-grid use continues to be a technological challenge). And while solar power takes from the sky, it generously does not send anything back: no greenhouse gases are generated in the solar process.

Cost and return on investment

Experts say you should expect to spend $35,000 to $50,000 or more for a system that can provide half the electricity needed in a typical home, measured in peak power of at least 7 to 8 kilowatts (kW). Tax credits, state incentives and utility rebates or rate breaks can trim thousands of dollars off that cost. New federal stimulus funds can give you a clean energy tax credit of 30 percent of equipment and installation costs for solar power and solar water heaters by 2016. There are certain efficiency requirements, but no income limits.

The rule of thumb for solar projects has been a return on investment in 8 to 12 years. The "ROI" for any specific location will vary based on available tax credits and incentives, on how much electricity you use for power, heating and cooling, on how high utility rates are in your area and other factors such as the rate your utility will pay for excess power you send back to them. Some contractors will finance solar or other alternative power installations, helping you pay your upfront costs in return for a share of your savings from reduced utility power consumption.

Online sites offer tools and calculators to help you figure your investment. Your accountant and state or local tax officials can provide more precise information. Qualified contractors can also provide incentive and rebate guidance.

Links/Resources

- www.solar-estimate.org
- www.dsireusa.org
- www.findsolar.com
- http://apps1.eere.energy.gov/solar/cfm/faqs/

Geothermal

Think of the warm waters of Old Faithful, the geyser at Yellowstone National Park. Or think of a hot spring, bubbling up from underground. There's warmth and heat down there under the Earth. Geothermal energy lets us channel that to our homes and workplaces for space heating, and hot water. Larger systems that generate electricity exist but are not commonly used in homes or small businesses.

How it Works

Geothermal energy comes from the earth's natural subterranean heat. It is a vast resource, most of which lies deep within the Earth. When it comes close to the surface, geothermal energy can be economically tapped.

As in a cave, the temperature underground remains warmer than outside air in winter and cooler in summer. The underground temperature doesn't even need to be very high — just fairly constant. In many parts of the country, underground temperatures remain even at anywhere from 45° to 75°F, only ten feet below the surface.

For a geothermal heat pump, a contractor drills holes underground and then inserts and buries a system of pipes called the ground heat exchanger. A fluid such as water or a mixture of water and anti-freeze circulates through the pipes, down underground and then back to your house.

In the winter, the heat pump removes heat from the exchanger and pumps warmed air through indoor ducts. In the summer, the process is reversed as the pump moves heat from the building air down into the heat exchanger. It's the same process used less efficiently by traditional heat pumps, which simply exchange indoor and outdoor air. An added fuel-free bonus for geothermal systems: heat removed from indoor air during the summer can be used to heat water.

Geothermal heat pumps use far less energy than conventional heating systems. They save energy, save money and reduce air pollution which would otherwise be generated by conventional fuels.

In some areas of the country, higher temperature geothermal heat can be tapped directly, without need for a heat pump. In these "direct-use" systems, a well drilled into a geothermal reservoir provides a steady stream of hot water that's pumped or flows directly to where it's needed. Cooled water is either injected back underground or disposed of on the surface. Under the right conditions, direct-use systems can heat individual buildings or even entire towns.

Benefits

Geothermal heat pumps are among the most energy efficient options in regions with extreme temperatures. The US Department of Energy maps likely geothermal areas. The technology is increasingly popular in rural areas where access to natural gas is limited, and where surrounding land is readily available.

Most of the direct-use geothermal reservoirs in the United States are in the western states including Alaska and Hawaii.

Limitations

Drilling is impractical on many sites and in some areas of the country; there can be high upfront costs to drill where it is possible to do so. Geothermal systems are most cost-effective where there are both heating and cooling needs. While the number of geo heat pumps installed each year is growing, the technology still represents a small percentage of heating systems in the United States.

Compared to other systems

Geothermal heat pumps:

- Are often quieter than conventional furnace systems.
- Can provide heating, cooling and hot water, but are not a source of electricity.
- Require less space than wind or solar.
- Like fuel cells or biomass, rarely need special permits or zoning approval.
- Require underground drilling not needed in other systems.
- Like other clean fuel options, geothermal heat can continue to work during utility power outages, though backup power for circulating fans may be needed.

You should also know...

Geothermal heat pumps are considered safe, as there is no exposed equipment, no open flames, potentially dangerous fuel storage tanks or external venting.

Different types of tube systems can be installed depending on your location: some are drilled deep into the ground, while shallower ones may be spread out over more land area. Qualified installers in your area can help you pick which, if any, are right for you. Geothermal heat pumps are considered reliable and durable, with fewer mechanical components than conventional furnaces. All components can be either buried in the ground or located inside the home, protecting them from weather. Indoor components are expected to last 25 years; underground piping often carries a warranty for up to 50 years. Average total maintenance cost is said to be a third of conventional systems.

Geothermal pumps offer significant savings on water heating bills (up to 50 percent) and reduce energy consumption by 20 to 50 percent over traditional systems, though at a potentially high upfront cost. Like fuel cells, geothermal environmental impacts are near zero to very low, as measured by air pollution and climate impacts, land use, water use and wildlife impacts.

Cost and return on investment

Geothermal heat pump systems cost about $2,500 per ton of capacity. An average size home would use a three-ton unit costing roughly $7,500. That initial cost may be twice the price of a regular heat pump system, but once the system is installed, geothermal "fuel" is free. Underground drilling and installation are the largest costs, averaging from $10,000 to $30,000 or more depending on the terrain and other local factors.

Many residential geothermal investments are recouped in five to ten years, according to the California Energy Commission. Return on investment may be shorter with federal tax credits and other incentives. Your ROI will also vary based on your current heating fuel type and costs, utility costs in your area, whether you will need new ductwork in your home, and other factors.

Federal tax credits are available for 30 percent of the cost of buying and installing Energy Star rated geothermal heat pumps. There are no income limits on the tax breaks, which may be installed in primary or second homes by 2016.

Online directories help identify utility, state and other incentives. Heat pump manufacturers, utilities, and lending institutions may offer special financing for homeowners or commercial customers. Consult qualified installers or manufacturers and check with your accountant, tax advisor or local environmental protection office.

Links/Resources

- www.igshpa.okstate.edu (International Ground Source Heat Pump Association)
- http://www1.eere.energy.gov/geothermal/geothermal_basics.html
- http://www1.eere.energy.gov/geothermal/maps.html
- www.dsireusa.org
- www.EnergySavers.gov
- www.ConsumerEnergyCenter.org
- www.GeoExchange.org

Biofuels

The old is new with biofuels — a fancy new word for old fuels made from plants or animal byproducts. We've used biofuels in one form or another ever since people began burning wood to cook and stay warm. Today, biofuels include crops and plants, agricultural residues, lumber scraps and even municipal and industrial waste; these sources of biofuels are known as "biomass."

Biofuels such as ethanol can run cars. Bioenergy from concentrated wood pellets can power and heat our buildings and homes.

How it works

While there are several different systems for generating bio-electricity, most rely on a process called "direct-firing." Biofuels such as pellets made of compressed wood and sawdust are burned, creating steam, which drives a turbine, just as coal, oil, nuclear and other generators make steam to drive generator blades. The steam can also be used for heat, hot water or to power industrial applications. Some paper mills, for instance, now generate electricity and heat as they recover chemicals from pulp, refining a process which once wasted power into one that gives back a great deal.

Benefits

Biomass systems are well suited for those who live near where agricultural byproducts, wood pellets or other biofuels are easily available. Highly efficient and largely non-polluting pellet stoves can be retrofitted into existing fireplaces or replace old-fashioned wood stoves. Most stoves today include automatic feeding systems, eliminating the need to "go throw another on the fire." Biofuels generally burn completely, eliminating buildup on chimney, yet most exterior parts of the stove remain relatively cool to the touch.

Bioheat is often used in homes, while bio-power generation is generally considered usable only in commercial or large neighborhood operations. Most commercial biomass generation plants are in the eastern half of the United States.

Freestanding or fireplace-insert pellet stoves can also be used as supplemental heating for specific rooms or parts of a house.

Limitations

Pellet stoves and similar biofuel stoves are fairly complex, with expensive components that require regular maintenance. They use a small amount of electricity (around $9/month) for fans, controls and wood pellet feeders. Without a backup power system for the fans, loss of electric power during an outage or emergency may cut off heat production and could allow some smoke into your house. Heat from a central fireplace may throw nearby thermostats off track. And you'll also need a place to store the biofuel materials.

Compared to other systems

Biofuels:

- Stoves can generate heat and some can make hot water, but not power, and therefore may not be ideal in areas where significant summer cooling is required.
- Require you to purchase fuel supplies and regularly bring them or have them delivered to your home.
- Stoves currently qualify for federal tax credits but only through 2010, while fuel cells, solar hot water and power and small wind systems cells are eligible through 2016.
- Bio-stoves are subject to a $1,500 tax credit limit for combined energy efficiency purchases and just in 2009 and 2010. That limit does not apply to the other types of alternate clean fuel.

With any type of alternative fuel devices, ask your installer or retailer for a "manufacturer's certification statement" as proof you qualify for a tax break.

You should also know...

Not only are biofuels renewable, but the plants which become the fuel help recycle carbon dioxide from the air as part of photosynthesis. Biofuels are sustainable; compared to fossil fuels such as natural gas and coal, which take millions of years to be produced. Biomass is easily grown, collected, used and restored. Some coal generating stations add biomass to their mix to reduce their use of high-emission fuels.

Costs and return on investment

Typical wood pellet stoves cost as little as $3,000, though those with elaborate feeder systems can cost more. Installation costs and the return on your investment vary depending on what's already in your home; some stoves fit in as inserts into existing fireplaces while others are freestanding. Professional installation by a National Fireplace Institute certified installer is recommended. Biofuels are considered a renewable energy resource in many states and the District of Columbia, eligible for combined heat and power tax incentives and rebates.

Biomass heat and hot-water stoves which have a thermal efficiency rating of at least 75 percent are generally eligible for 30 percent federal homeowner tax credits, up to a maximum of $1,500 for stoves placed in service in 2009 or 2010. One thing to keep in mind: that $1,500 limit applies to all of your energy efficiency tax breaks in those years combined. Both equipment and installation costs may be counted.

The tax breaks apply for stoves that run on wood and wood pellets as well as fuels made from plants, grasses, residues and plant fibers. Ask a retailer or installer for proof of eligibility before you purchase a system. Incidentally, homebuilders have incentives to install high energy systems just as homeowners do; builders may qualify for additional rebates for installing these or other high efficiency systems.

There's no income ceiling for federal energy efficiency tax credits, though you can't claim more in tax credits than you paid in federal income tax. Unlike some other renewable energy breaks, biomass stove credits cannot be carried forward to another year. Your accountant or tax adviser can provide more specific details.

Links/Resources

- www.hpba.org/consumers/hearth/fuel-options
- www1.eere.energy.gov/biomass/for_consumers.html
- www.ConsumerEnergyCenter.org
- www.nrel.gov/biomass/

Questions to Ask

When considering which alternative energy system is right for your home or business, it's important to gather as much information as possible before you make a final decision. Below are some suggested questions to ask your local supplier or contractor to help ensure you make a smart choice.

1. How much am I paying per month or per year for electricity? How much for natural gas?
2. Should I be thinking about generating only power? Or combined power and heat?
3. How big a system do I need? How much power should it provide? How much heat?
4. Will my utility buy excess power from me?
5. How much will my electric bill go down?
6. What kinds of federal, state or local tax breaks are available?
7. Do I have enough available wind? Do I have enough land for a turbine? Will neighbors object to the view or the noise?
8. Can I catch enough sunlight for solar power? Do I have enough rooftop space?
9. How might zoning or neighborhood covenants effect my decision?
10. Am I in an area where geothermal is possible? Is it practical to drill underground?
11. Do I have or can I get natural gas for fuel cells?
12. If more than one clean fuel will work at my house, how should I pick which to go with?
13. How long will it take to install? How disruptive will the installation be?
14. Do I have the upfront costs or will I be able to find financing?
15. How much will this reduce my carbon footprint?
16. Is it safe? For kids? For pets? For wildlife?
17. How reliable is it?
18. Who do I call if I have a problem? Is service available 24x7?
19. What kind of warranty is available? Should I/need I buy an extended warranty? How well does the manufacturer stand behind its product?
20. Will I have power in a storm, or during a utility "blackout"?

Glossary: Clean Power Words & Phrases

Courtesy of the U.S. Department of Energy, with additional information from North Carolina State University's Solar Center and other sources.

A

Active Heating System: A solar water or space-heating system that moves heated air or water using pumps or fans.

Alternating Current: A type of current that runs through our electric wiring, so-called because it constantly reverses its direction at regular intervals or cycles; In the U.S. the standard is 120 reversals or 60 cycles per second; typically abbreviated as AC.

Alternative Fuel: A popular term for "non-conventional" transportation fuels made from natural gas (propane, compressed natural gas, methanol, etc.) or biomass materials (ethanol, methanol).

B

Biodiesel: An alternative fuel that can be made from any fat or vegetable oil. It can be used in any diesel engine with few or no modifications. Although biodiesel does not contain petroleum, it can be blended with diesel at any level or used in its pure form.

Biogenic waste: Waste made from materials that were produced by living organisms or biological processes. Some use the term "biogenic" to refer only to organic nonfossil material of biological origin, such as paper or cotton.

Biomass: Any organic (plant or animal) material which is available on a renewable basis, including agricultural crops and agricultural wastes and residues, wood and wood wastes and residues, animal wastes, municipal wastes, and aquatic plants.

British thermal unit (Btu): The amount of heat required to raise the temperature of one pound of water one degree Fahrenheit; equal to 252 calories. British thermal unit is abbreviated as Btu.

Building energy codes: adopted by states and some local governments require commercial and/or residential construction to adhere to certain energy standards, such as found in the US Green Building Council's LEED program. The federal government is considering national energy codes and standards.

C

Carbon Dioxide: A colorless, odorless noncombustible gas with the formula CO_2 that is present in the atmosphere. It is formed by the combustion of carbon and carbon compounds (such as fossil fuels and biomass) by respiration, which is a slow combustion in animals and plants, and by the gradual oxidation of organic matter in the soil.

Corporate Tax Incentives: Tax credits, deductions and exemptions available to corporations that install eligible alternate energy sources, high-efficiency equipment, or construct green buildings. The incentive is sometimes based on the amount of energy produced. Some states allow credits only if a minimum investment level is reached; there is often a maximum allowable credit. The federal government has recently offered corporate tax incentives for renewables and energy efficiency.

D

Direct Current: An electric current that flows in only one direction through a circuit, as from a battery.

DoE: U.S. Department of Energy.

E

Electricity: A form of energy characterized by the presence and motion of elementary charged particles generated by friction, induction, or chemical change.

Electricity Generation: The process of producing electric energy or the amount of electric energy produced by transforming other forms of energy, commonly expressed in kilowatthours (kWh) or megawatthours (MWh).

Energy: The ability to do work or the ability to move an object. Electrical energy is usually measured in kilowatthours (kWh), while heat energy is usually measured in British thermal units (Btu).

Energy Audit: Assessing your home's energy use by various techniques including thermal photographs that show

hot or cold air leaking through walls and windows. Some energy service companies will finance improvements and get paid out of the savings they provide you.

Ethanol: A colorless liquid that burns to produce water and carbon dioxide. The vapor forms an explosive mixture with air and may be used as a fuel in internal combustion engines.

F

Flat-Plate Solar Connector: A device designed to capture the suns energy and produce low temperature heat energy. They are commonly used as collectors in solar heating systems.

Fossil Fuels: Fuels (coal, oil, natural gas, etc.) that result from the compression of ancient plant and animal life formed over millions of years.

G

Generator: A device that turns mechanical energy into electrical energy. The mechanical energy is sometimes provided by an engine or turbine.

Generating Capacity: The amount of electrical power a power plant can produce.

Green Building Incentives: Cities and counties may offer financial incentives to those who build "green" buildings that meet or exceed environmental and energy efficiency standards. This may include a waiver or reduction of building permits, fast-track approval of plans, or tax breaks. Check your city or state tax or environmental protection office or website for details.

Greenhouse Gases: Gases that trap the heat of the sun in the Earth's atmosphere, producing the greenhouse effect. Greenhouse gases include carbon dioxide, methane, ozone, chlorofluorocarbons, and nitrogen oxides.

Grid: The commercial electrical distribution system.

H

Heliostat: Flat sun-tracking mirrors used to reflect and concentrate the suns' energy onto a central receiver tower.

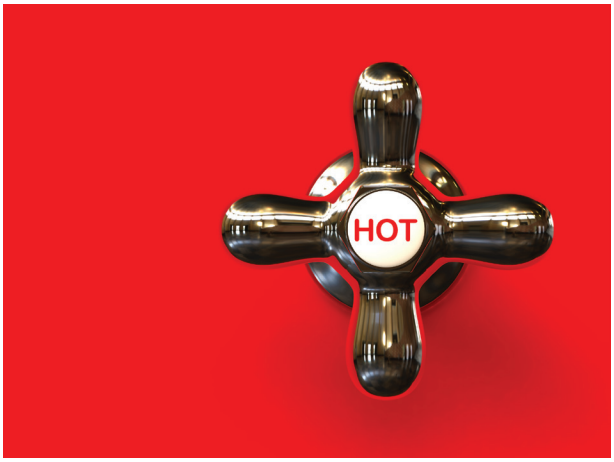
Hydrogen: A colorless, odorless gaseous element. It is the lightest of all gases and the most abundant element in the universe, occurring chiefly in combination with oxygen in water.

Hydropower: Energy that comes from moving water.

K

Kilowatt: A unit of power, usually used for electric power or to energy consumption (use). A kilowatt equals 1000 watts.

Kilowatt hour (kWh): A measure of electricity defined as a unit of work or energy, measured as 1 kilowatt (1,000 watts) of power expended for 1 hour. One kWh is equivalent to 3,412 Btu or 3.6 million joules.



L

Lease-Purchase programs: Some electric utilities offer alternative energy system leasing programs, especially where the cost of extending electric distribution lines to the customer's home or facility is high. In some cases, the customer may choose to purchase the system after a specified period of time.

LEED: Leadership in Environmental and Efficient Design are widely accepted standards for green buildings of all types: new and renovated commercial buildings, homes, schools, hospitals and entire high-performing communities. The standards are established by the non-profit U.S. Green Building Council. Buildings can earn LEED certificates or advanced credit as silver, gold or platinum structures.

Load: The power and energy requirements of users on the electric power system in a certain area or the amount of power delivered to a certain point.

Loan programs (clean energy): Special financing can be available through utilities for the purchase of renewable energy or energy efficiency systems or equipment, as utilities increasingly seek to manage the demands on their system. States and the federal government may offer low-interest loans for a broad range of clean energy and energy efficiency measures.

M

Megawatt: A unit of electrical power equal to 1000 kilowatts or one million watts.

N

Natural Gas: An odorless, colorless, tasteless, non-toxic clean-burning fossil fuel.

Net metering: For electric customers who generate their own electricity, net metering allows for the flow of electricity both to and from the utility, typically through a single, bi-directional meter. When a customer's generation exceeds the customer's use, electricity flows back to the grid, offsetting the cost of electricity consumed at different times. Net metering is allowed by law in most of the U.S.

Net zero: selling as much electricity back to your utility at as you buy from them, so your net demand on the power grid balances out at zero.

O

Organic Waste: Waste material of animal or plant origin.

P

Passive Heating System: A means of capturing, storing, and using heat from the sun.

Photovoltaic Cells: A device, often made from silicon, which converts some of the energy from light (radiant energy) into electrical energy. Another name for a solar cell.

Photovoltaic Conversion: The process by which radiant (light) energy is changed into electrical energy.

Power Degradation: The loss of power when electricity is sent over long distances.

Property tax incentives: include exemptions, exclusions and credits. Many allow the added value of alternative energy systems to be excluded from the taxation value of the property.

R

Renewable Energy Sources: Fuels that can be easily made or "renewed." We can never use up renewable fuels. Types of renewable fuels are hydropower (water), solar, wind, geothermal, and biomass.

S

Sales tax incentives: an exemption from the state sales tax for the purchase of a alternative energy systems, energy-efficient appliances, or other energy efficiency measures. Several states have annual "sales tax holidays" for energy efficiency measures, allowing temporary exemptions for equipment purchases.

Solar Cell: An electric cell which changes radiant energy from the sun into electrical energy by the photovoltaic process.

Solar Dish: A device that receives radiation collected by motorized collectors which track the sun. The collectors focus the radiation the energy at a focal point of the dish.

Solar Energy: The radiant energy of the sun, which can be converted into other forms of energy, such as heat or electricity.

Solar Thermal Heating System: Systems using concentrating collectors to focus the sun's radiant energy onto or into receivers to produce heat.

Space Heating: The use of energy to generate heat for warmth in housing units using space-heating equipment. The equipment could be the main space-heating equipment or secondary space-heating equipment.

T

Transformer: A device which converts the generator's low-voltage electricity to higher-voltage levels for transmission.

Transmission Line: A set of conductors, insulators, supporting structures, and associated equipment used to move large quantities of power at high voltage, usually over long distances between generating stations, intermediate substations and customers.

Turbine: A device with blades, which is turned by a force, such as that of wind, water, or high pressure steam. The mechanical energy of the spinning turbine is converted into electricity by a generator.

U

Utility discounts: Some electric utilities offer rate discounts to encourage residential energy efficiency. Discounts may be awarded for using Energy Star rated equipment and appliances; reduced rates may be available for power consumed at off-peak times. Utilities may also buy excess electricity from customers who generate more power than they need or can use at one time.

V

Volt: The measure of electric potential or electromotive force.

Voltage: The difference in electrical potential between any two conductors or between a conductor and ground. It is a measure of electric energy.

Voltaic Electricity: Electricity produced by chemical action.

W

Waste Energy: Municipal solid waste, landfill gas, methane, paper, wood and wood pellets, sludge waste, tires, agricultural byproducts, straw and other once-discarded items which are instead used as fuel.

Watt: A metric unit of power, usually used in electric measurements, which gives the rate at which work is done or energy used.

Wind: The term given to any natural movement of air in the atmosphere. A renewable source of energy used to turn turbines to generate electricity.

Wind Tower: Devices, some as tall as 120 feet, which lift wind turbine blades high above the ground to catch stronger wind currents.

Wood Energy: Wood and wood products used as fuel, including wood chips, bark, sawdust, pellets, charcoal, and paper pulp waste.

Federal Tax Credit Chart

FUEL TYPE	ALLOWED FEDERAL TAX CREDIT	AMOUNT	NOTES
FUEL CELLS residential microturbine systems	Efficiency of at least 30% and must have a rated capacity of at least 0.5 kW.	30% of equipment & installation cost, up to $500 per .5 kW of rated power capacity	Must be placed in service before December 31, 2016.
WIND small residential systems	Units must have a rated "nameplate capacity" of not more than 100 kilowatts.	30% of equipment & installation cost	Must be placed in service before December 31, 2016.
SOLAR photovoltaic power systems	Photovoltaic systems must provide electricity for the residence, and must meet applicable fire and electrical code requirement.	30% of equipment & installation cost	Must be placed in service before December 31, 2016.
SOLAR water heaters	• At least half of the energy generated by the "qualifying property" must come from the sun. Homeowners may only claim spending on the solar water heating system property, not the entire water heating system of the household. • Water must be used in the dwelling; the credit is not available for expenses for swimming pools or hot tubs • The system must be certified by the Solar Rating and Certification Corporation (SRCC).	30% of equipment & installation cost	• All ENERGY STAR solar water heaters qualify for the tax credit. • Must be placed in service before December 31, 2016.
GEOTHERMAL heat pumps	ENERGY STAR standards apply; minimums vary based on system type.	30% of equipment & installation cost	All ENERGY STAR geothermal heath pumps qualify for the tax credit. Must be placed into service before December 31, 2016.
BIOMASS stoves (heat or hot water)	• Allowed for stoves which burn biomass fuel to heat a home or heat water. • Must have a thermal efficiency rating of at least 75% as measured using a lower heating value.	30% of equipment & installation cost, up to $1,500 for combined efficiency credits for all purchases in 2009 and 2010.	For units installed in 2009 or 2010 only.

Source: ENERGY STAR/U.S. Environmental Protection Agency (August 2009)

- Information applies primarily to residential installations; incentives for businesses may vary.
- Save receipts and the required Manufacturer's Certification Statement.
- This information is intended to provide general information and not specfic financial advice.
- Consult your tax advisor or the IRS for further details.