



## Alternative Energy Systems and Their Risks

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When exploring alternative energy options, it is important to understand the property and liability risks of alternative energy systems and their controls.

Governmental entities may use such alternative energy systems to supplement their heating, cooling or electrical systems and to help educate the public about alternative energy options. Grants and tax credit programs have made some technologies more desirable and obtainable.

### Common Terms

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The term “green” has become a buzz word when describing products and processes that are in theory more natural or environmentally friendly. When talking about energy, the terms “alternative energy,” “renewable energy,” “green energy” and “clean energy” are often used interchangeably; however, they can have substantially different meanings.

It is common for individuals and the media unintentionally to misuse key energy words and phrases. Energy terms may also be defined differently as part of public and private energy programs, grants and incentives. For example, some may consider fuel cells to be a renewable technology, whereas others do not.

**Alternative energy** is energy from fuel sources that are not derived from fossil fuels and, therefore, do not have high carbon dioxide emissions. Sources can include hydrogen fuel cells, wind, solar, geothermal, moving water, biofuels and nuclear.

**Renewable energy** is energy that comes from resources that are continually and naturally replenished, including sunlight, wind, rain, tides and geothermal heat. Biomass (including peat, grass and wood) and some biofuels can also be considered renewable energy sources.

**Green energy** refers to energy sources that are both renewable and environmentally preferable. To be truly green, there must be a minimal environmental impact due to the energy production and use. This includes any byproducts or waste, and the development and manufacture of production equipment through the use and eventual disposal of the equipment. Solar, wind and geothermal are considered green because they are renewable and have a low environmental impact. Most hydroelectric power is generally not considered green because of the significant effect it can have on the local ecosystem.

**Clean energy** is energy that does not or minimally pollutes the atmosphere when generated. The term can also be used to define energy that is generated in a way that carbon dioxide emissions are captured and stored. Clean energy includes renewable energy, qualified renewable biomass, natural gas, hydropower, nuclear power and qualified waste-to-energy systems.

# Common Alternative Energy Types and Equipment

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## Wind

People have been harnessing the power of wind for thousands of years through boat sails for transportation and windmills that pump water or mill grain. Small-scale wind turbines have been used for decades to generate inexpensive electric power in rural areas. Today, there are several styles of both large-scale and small-scale electric generation wind turbines.

### Large-scale Wind Turbines

Large-scale wind turbines are used to produce large quantities of electricity (100 kilowatts or more), which is typically fed into the commercial electrical power transmission grid. Such turbines can have 60-foot blades, be more than 300 feet tall and are often placed in interconnected groups or “farms.”

Because of physical land requirements and capital needed for the infrastructure and maintenance of large-scale turbines, their use is typically limited to large electric utilities.

### Small-scale Wind Turbines

Small-scale wind turbines are used to produce small quantities of electricity (less than 100 kW), which typically power or supplement a single home or small business. Small-scale wind turbines that produce less than 10kW are defined as residential turbines. Small-scale wind turbines are typically less than 80 feet in height and can be either attached to a building or on a freestanding tower or pole.

Small-scale turbines may have the capability to feed surplus electricity into the commercial electrical grid (sold to the utility company) or can charge batteries during times when more electricity is generated than is consumed. On the other hand, because wind speeds fluctuate, wind turbines cannot always run at 100 percent power. Operators typically must have a backup electrical generation system or be connected to the electrical grid.

### Wind Turbine Types

**Horizontal axis wind turbines (HAWTs)** have a main rotor shaft, a gearbox and an electrical generator at the top of a tower. These turbine blades must be pointed into the wind to operate. Small units accomplish this through the use of a wind vane, whereas larger units use a wind sensor coupled with a motor to mechanically position them.

Advantages of HAWTs include high efficiency and high power outputs. Disadvantages are that they have to be spaced far apart from each other and may be noisy due to high rotation speeds. In addition, HAWTs need to be high in the air, which can make them difficult to maintain.



Horizontal axis wind turbine example

## Vertical axis wind turbines

**(VAWTs)** have the main rotor shaft set vertically, and the main components are located at the base of the turbine. They do not need to be repositioned to meet the wind direction.

Advantages are that they are easily maintained, quiet, can be placed lower to the ground and closer together than HAWTs, as well as operate with little wind. Disadvantages include decreased efficiency compared to HAWTs, they can be subject to component fatigue due to torque and can stall in gusty winds.



Vertical axis wind turbine examples

## Wind Power Point of Reference

The average U.S. household consumes about 8,000 kilowatt-hours of electricity each year. According to the American Wind Energy Association, a typical American home would require a small turbine with at least a 5-kilowatt generating capacity to meet all its electricity needs.

A turbine of this size has a diameter of approximately 18 feet and would be mounted at least 30 feet off the ground. The exact size needed to power a home is based on a home's energy use, average wind speeds (12 mph average required), and the turbine's height above ground.

## Wind Turbine Risks

With proper maintenance, the average life expectancy of small-scale wind turbines is 20 years. Wind turbines are subject to the same types of losses as building structures and electrical equipment, including hail damage and internal damage due to water infiltration.

Due to their height, turbines and supporting towers are especially subject to damage from lightning and windstorms. Proper grounding, tower supports and electronic or mechanical systems to stop or limit speeds of turbines are important loss prevention features.

A braking or speed limiting system is also important due to exposures from ice and snow. Ice and snow buildup on



A wind turbine tower collapsed because the turbine blades became unbalanced when one of its blade weights fell off.

blades can create a situation where the turbine becomes unbalanced to the point where catastrophic damage can occur due to improper harmonics.

When wind turbines are tied into the electrical grid, special controls must be in place to prevent injury and equipment damage. For example, during an electrical outage on the grid, third-party wind turbines must automatically stop delivering electricity to power lines.

Continuing to supply electricity could result in utility line workers or the public being hurt or killed due to the belief that the line is de-energized and, therefore, people do not take normal precautions.

Power from a private wind turbine must properly synchronize with the utility grid and match the utility's power in terms of voltage, frequency and power quality. Failure to do so can lead to "dirty power" (abnormalities including surges, sags, spikes, fluctuations or interruptions) being fed into the electrical grid and potentially causing damage to infrastructure or even electrical devices and systems that share the same line.

Wind turbines can be the subject of controversy due to aesthetics, noise and real or perceived threats to wildlife. Consideration of these factors must be given when planning or approving wind turbine projects.

## Solar

Solar energy in the form of radiant light and heat from the sun is the most abundant form of energy available throughout the world. Solar energy technologies use the sun's energy and light to provide heat, hot water and electricity.

### Solar Collector Types

**Photovoltaic systems** produce electricity directly from sunlight. Silicon cells are mounted under nonreflective glass and are linked together to form photovoltaic panels. The system collects photons from the sun and converts them into direct current (DC) electrical power. The electricity created then flows into an inverter where it is transferred into alternating current (AC) electrical power. Panels are rated by their DC power output and typically range from 100 to 320 watts.

Like wind turbines, photovoltaic solar collectors may have the capability to feed surplus electricity into the commercial electrical grid or can charge batteries during times when more electricity is generated than is consumed. Solar collectors are less effective under cloudy conditions and not operational at night; therefore, also like wind turbines, operators typically must have a backup electrical generation system or be connected to the electrical grid.

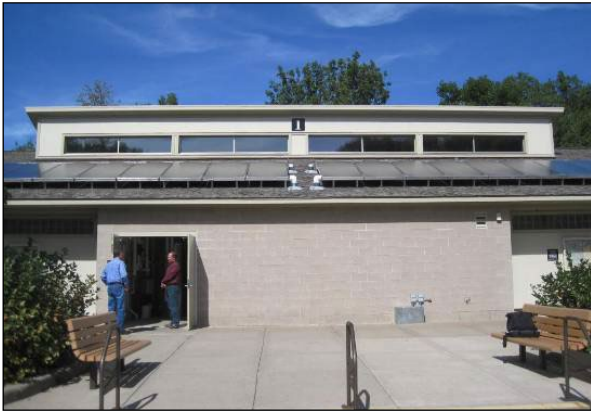
**Solar water heating systems** heat water for the building's domestic water or for use in a heating system. System components typically include solar collectors, piping and circulating pumps and storage tanks.



Roof-mounted photovoltaic solar power system



Double-sided, ground-mounted photovoltaic solar power system



Roof-mounted direct solar hot water system



Ground-mounted indirect solar hot water system

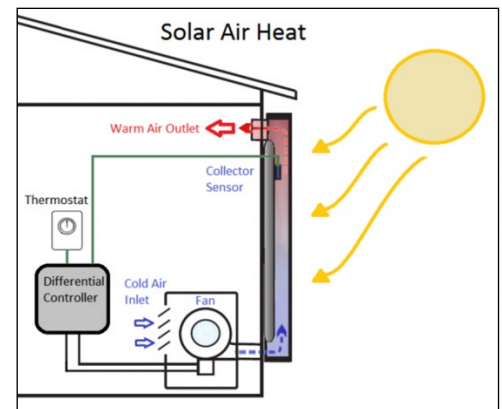
Solar water heating systems are either direct or indirect circulation. Direct circulation systems use pumps to circulate water through the collectors and into the building. They are mainly used in climates not subject to freezing. Indirect circulation systems are pumps that circulate an antifreeze, heat-transfer fluid through a collector and a heat exchanger.

The efficiency of solar water heating systems is lower on cloudy days and during the winter, so a backup heating source is usually required.

**Simple solar air heat collectors** operate similarly to conventional recirculating forced air furnaces. An energy-collecting surface absorbs the sun's thermal energy and transfers the heat to air via conduction heat transfer. This heated air is then ducted to a building space. This style of collector is often mounted on a building wall but can be mounted on the roof.



Building-mounted solar air heat collector



This simple process can be effective in specific applications; however, it is rarely used as a primary heat source. Solar air heat collectors can also be combined with photovoltaic panels to create a hybrid solar collection system.

## Solar Power Risks

The life expectancy of solar power equipment varies greatly based on the size, type and placement. Like wind turbines, solar power equipment is subject to weather and exposure to the elements, including water infiltration. Electrical shorts or power surges can damage internal silicon semiconductors, transformers, inverters, batteries and monitors.

Due to large surface areas and the materials from which they are made, solar panels are especially vulnerable to hail and wind damage. In severe wind, panels attached to roofs can cause damage to the roofing material or the building itself due to the force on mounting brackets.

The weight of snow and ice can also damage solar panels, as well as any attached mechanical sun-tracking equipment.

Solar electrical panels have the potential to generate electricity whenever they are exposed to sunlight; therefore, in some situations, they could create an electrocution exposure to people servicing or responding to an emergency, such as a fire. Set procedures must be in place and followed by anyone working near electrical solar panels.

Solar panels can be a target of vandalism (e.g., people shooting them with guns or throwing rocks at them). The component parts (such as copper wiring or piping) are also attractive to thieves, so consideration has to be given to the security, placement, visibility and accessibility of solar panels.

## Geothermal

The generic term “geothermal” is used to describe energy captured from the earth; however, there are two distinct forms of geothermal power.

### Traditional Geothermal

Traditional geothermal is energy derived from heat deep under the earth’s surface that originates from the formation of the planet and from radioactive decay of minerals. The extreme temperatures melt rock to form magma. Water in the earth’s crust is heated when it comes in contact with magma or rocks the magma has heated. Hot springs and geysers are examples of geothermal energy that reaches the earth’s surface.

Ancient Romans used naturally heated surface water for heating buildings. Modern large-scale power plants, generally located near active volcanic areas, drill into the ground to capture the superheated water and use it to power electrical turbines.

### Geoexchange, Ground Source, Earth-coupled Geothermal

Due to stored solar energy, the temperature 5 to 8 feet beneath the Earth’s surface maintains a nearly constant year-round temperature between 50 degrees and 60 degrees Fahrenheit, depending on the latitude. Geoexchange, ground source and earth-coupled geothermal are synonyms for capturing and using this stored energy.

Using the thermodynamic rule that heat moves to cold, a ground source heat pump is used to extract heat from the ground during the winter and dissipate heat into the ground during the summer. This is done by pumping a fluid through a series of underground interconnecting pipe loops, either horizontally or vertically.

Ground source geothermal uses significantly less electricity compared with traditional heating and cooling systems, because the electricity that powers them is used only to collect, concentrate and distribute rather than for production. It is estimated that for every \$1 put into operating the pumps and compressor on a geothermal unit, somewhere between \$4 and \$5 worth of heating or cooling capacity is generated from the system.



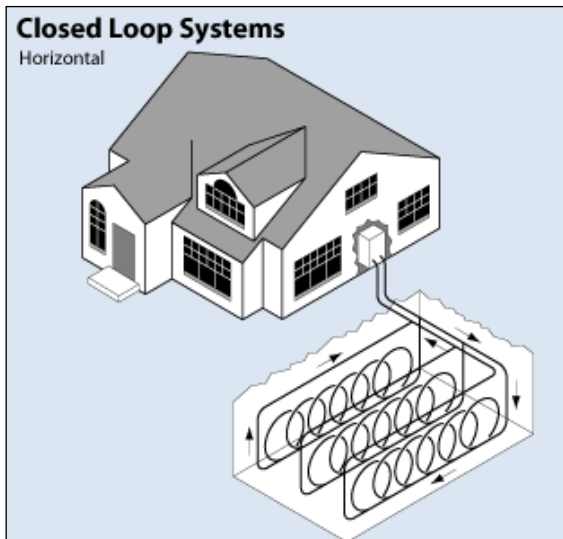
Ground-source heat pump

The U.S. Department of Energy defines the types of geothermal systems as follows.

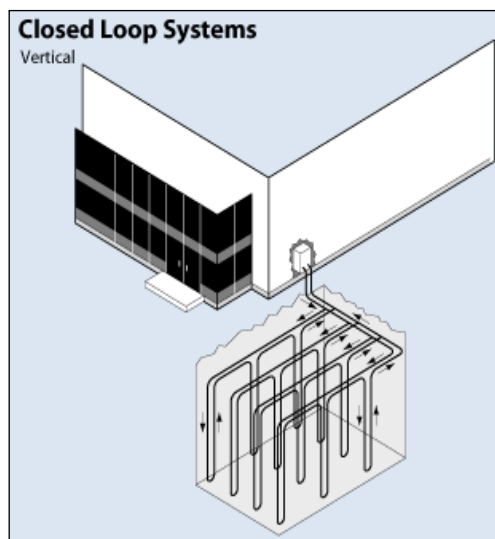
#### Horizontal

This type of installation is generally most cost-effective for residential installations, particularly for new construction where sufficient land is available. It requires trenches at least 4 feet deep. The most common layouts either use two pipes, one buried at 6 feet and the other at 4 feet, or two pipes placed side-by-side at 5 feet in the ground in a 2-foot wide trench.

The Slinky™ method of looping pipe allows more pipe in a shorter trench, which cuts down on installation costs and makes horizontal installation possible in areas it would not be with conventional horizontal applications.



Horizontal closed-loop system. Source: Energy.gov



Vertical closed-loop system. Source: Energy.gov

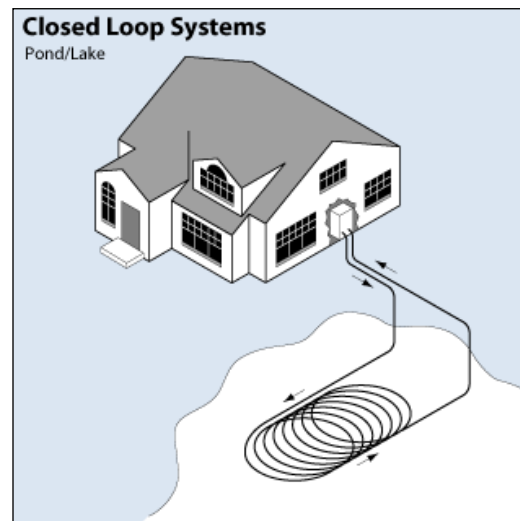
### Vertical

Large commercial buildings and schools often use vertical systems because the land area required for horizontal loops would be prohibitive. Vertical loops are also used where the soil is too shallow for trenching. They also minimize the disturbance to existing landscaping.

For a vertical system, holes (approximately 4 inches in diameter) are drilled about 20 feet apart and 100 to 400 feet deep. Into these holes go two pipes that are connected at the bottom with a U-bend to form a loop. The vertical loops are connected with horizontal pipe (i.e., a manifold), placed in trenches and connected to the heat pump in the building.

### Pond or Lake

If the site has an adequate water body, this may be the lowest cost option. A supply line pipe is run underground from the building to the water and coiled into circles at least 8 feet under the surface to prevent freezing. The coils should only be placed in a water source that meets minimum volume, depth and quality criteria.



Pond or lake system. Source: Energy.gov

### Open-loop System

This type of system uses well or surface body water as the heat exchange fluid that circulates directly through the ground source heat pump system. Once it has circulated through the system, the water returns to the ground through the well, a recharge well or surface discharge.

This option is obviously practical only where there is an adequate supply of relatively clean water, and all local codes and regulations regarding groundwater discharge are met.

### Geothermal Risks

Properly designed geothermal systems and properly maintained above-ground geothermal equipment have similar electrical and mechanical loss exposures as traditional heating and cooling systems.

One of the largest risks with geothermal systems is performance, especially in retrofitted situations. Such systems need to be sized and installed correctly. This can be difficult due to the large number variables in the system, including the underground heat exchange piping, compressor size, distribution ductwork and the building's energy loss. Incorrectly designed systems may not be able to meet the heating or cooling demands, especially during periods of extreme heat or cold.

To heat a building, ducted geothermal heating systems typically generate lower temperatures for longer periods compared to traditional fossil fuel furnaces. This requires a higher volume of air and, therefore, large ducts. Standard HVAC duct work may not be large enough to meet the needs, leading to underperformance and excess noise from the ductwork.

Discounted electrical rate programs are available for geothermal systems in most areas. Typically to be eligible for such programs, the electric company installs a remotely controlled shutoff switch on the system that allows it to turn off the system during peak demand to reduce the overall demand.

To participate in such a program, the building must have a secondary nonelectric heating source. The overall cost of installing and maintaining a backup system, as well as the potential cost of operating the system, has to be considered prior to installation.

An infrequent but potentially severe loss potential of a ground source geothermal system is failure of the underground heat exchange pipe. A leak in the piping would be difficult to locate, access and repair, especially if the pipe is buried below a parking lot or building.

In addition, the discharge of the liquid heat exchange media (antifreeze) could create an underground pollution issue. Such exposures are typically retained by the building owner (see Coverage section).

## Vegetative Roofs (Green Roofs)

Vegetative roofs do not produce usable energy, rather the soil and plants act as roof insulation to reduce cooling expenses and help minimize heat loss. In addition, such a roof can assist in prolonging the life of roofing materials, control storm water runoff and improve water quality. They are also aesthetic and can serve as a wildlife habitat.

The type and design of vegetative roofs vary greatly depending on the climate and application. Basic designs consist of a 3- to 4-inch layer of lightweight growth medium (e.g., soil) covered with succulent plants and herbs and have no irrigation system. More extensive and complex systems have up to 8 inches of growth medium, are irrigated and support a variety of ornamental plants and grasses.

Vegetative roofs can be added to existing buildings, but due to design and cost considerations, they are commonly found in new construction.



Vegetative roof

## Vegetative Roof Risks

Properly designed and maintained vegetative roofs can last up to 35 years but can create unique risks.

Vegetative roofs can be extremely heavy due to the weight of the growth medium, irrigation system, plants and the water they trap and contain. This has to be factored into the building design and roof drainage features to avoid damage to the building.

Consideration needs to be given to risk management controls while accessing the roof for maintenance or leisure. Restricting access to areas that will not damage the vegetation or irrigation systems is prudent. Also proper guardrails or fall protection equipment needs to be in place to limit fall exposures.

## Coverage

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Property and general liability coverage for solar panels, including those attached to buildings and free-standing, is available through MCIT. Coverage of above-ground components of mechanical systems including geothermal, is also available through MCIT.

MCIT does not provide coverage for underground (buried) equipment, including geothermal piping. Insurance products for coverage of underground geothermal piping are difficult to obtain and typically are cost prohibitive.

Wind power generation equipment of any size or type is not eligible for coverage through MCIT. Wind power systems that are tied into the electrical grid may also require specific liability coverage as part of the agreement with the power company.

MCIT does not provide failure to supply coverage. Such coverage may be required if an organization is providing a consistent source of energy (heat, electricity, steam, etc.) by contract. Typically such coverage is not needed for small-scale alternative energy operations.

Scheduled equipment is covered for breakdown by MCIT through a contract with Hartford Steam Boiler. Equipment breakdown insurance offers protection from the costs associated with insured losses to a facility's covered equipment.

Subject to limitations and applicable exclusions, in the event of damage from an electrical malfunction, mechanical breakdown, power surge or centrifugal force, the coverage applies to:

- Direct property loss (the cost to repair or replace scheduled damaged equipment)
- Extra expense losses when a covered breakdown causes business interruption
- Other expenses incurred to limit the loss or speed the business restoration
- The loss of value of spoiled products or materials

The MCIT coverage referenced above is subject to the terms, conditions, limitations and exclusions of the MCIT Coverage Document and is dependent on the specific facts of the loss. For additional information about MCIT coverage, members should consult the MCIT Coverage Document or contact their MCIT risk management consultant at **1.866.547.6516**.