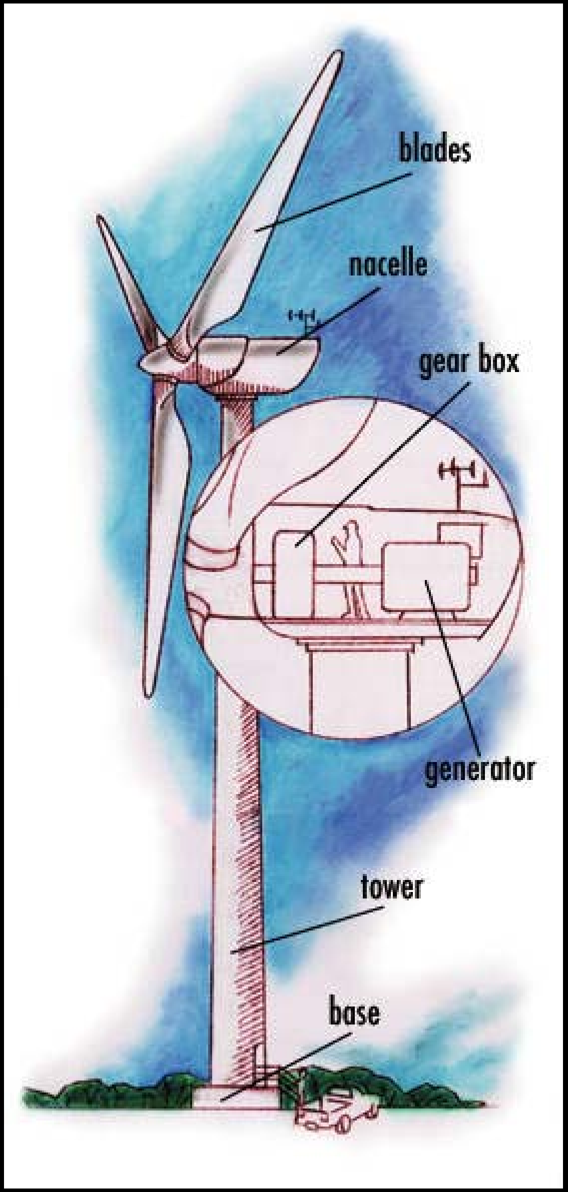
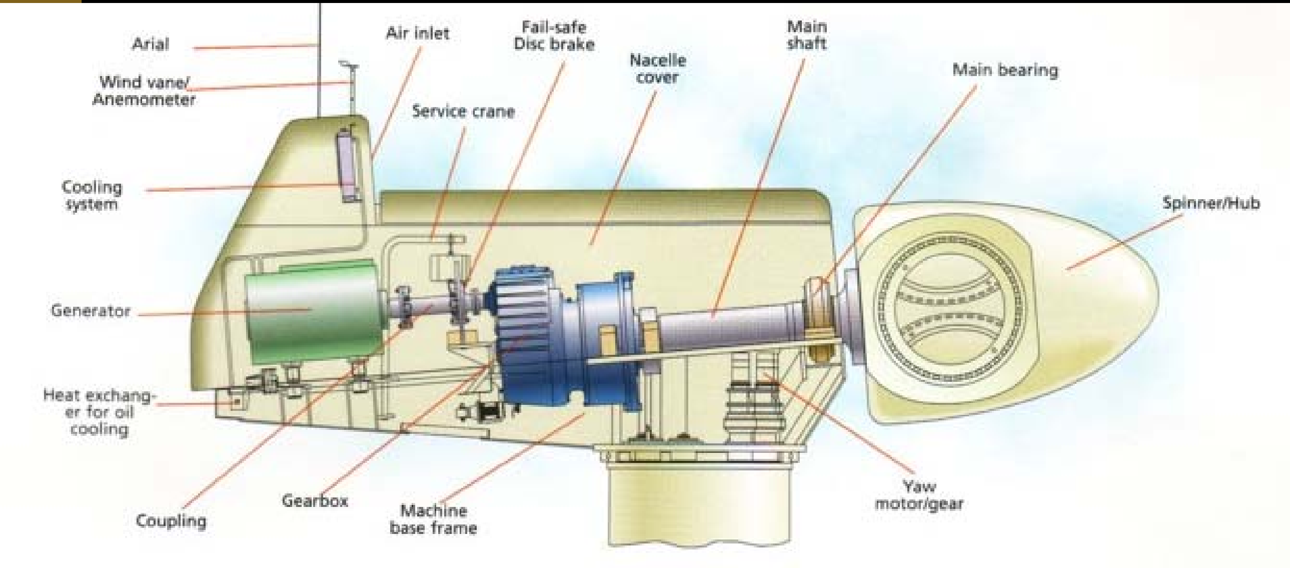
Wind Systems

Wind Systems:

There are four main parts to a wind turbine: the base, tower, nacelle, and blades. The blades capture the wind's energy, spinning a generator in the nacelle. The tower contains the electrical conduits, supports the nacelle, and provides access to the nacelle for maintenance. The base supports structure.

The blades
Designed like airplane wings, modern wind turbine blades use lift to capture the wind's energy. Because of the blade's special shape, the wind creates a pocket of pressure as it passes behind the blade. This pressure pulls the blade, causing the turbine to rotate. This modern blade design captures the wind's energy much more efficiently than old windmills, which use drag, the force of the wind pushing against the blades. The blades of a large turbine spin at a slow rate of about 20 RPM, although the speed at the tip can be over 240 km/h.

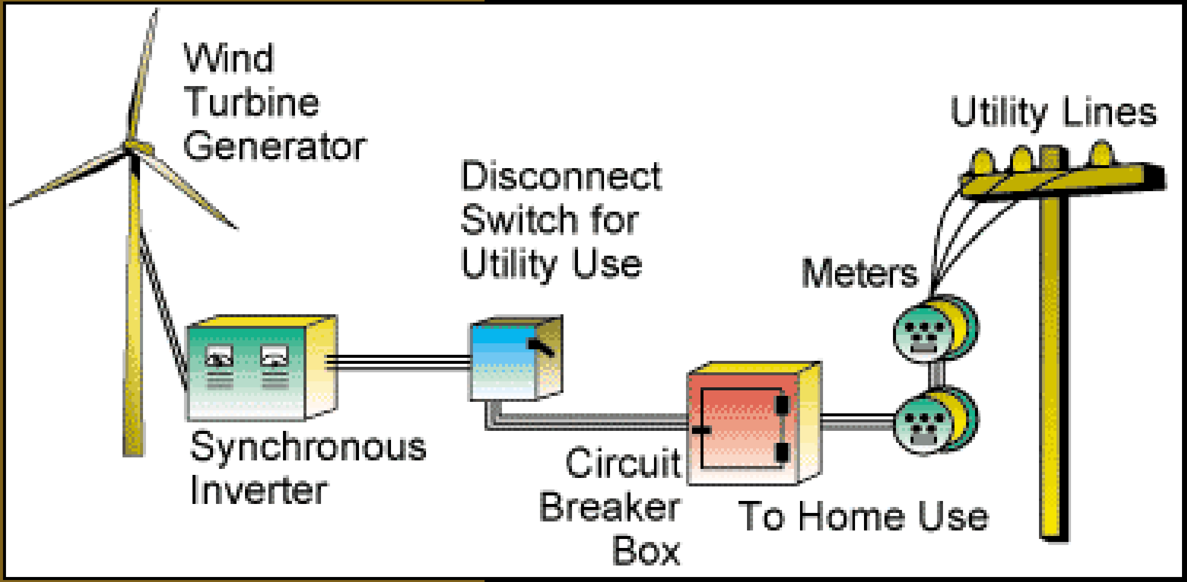




The nacelle

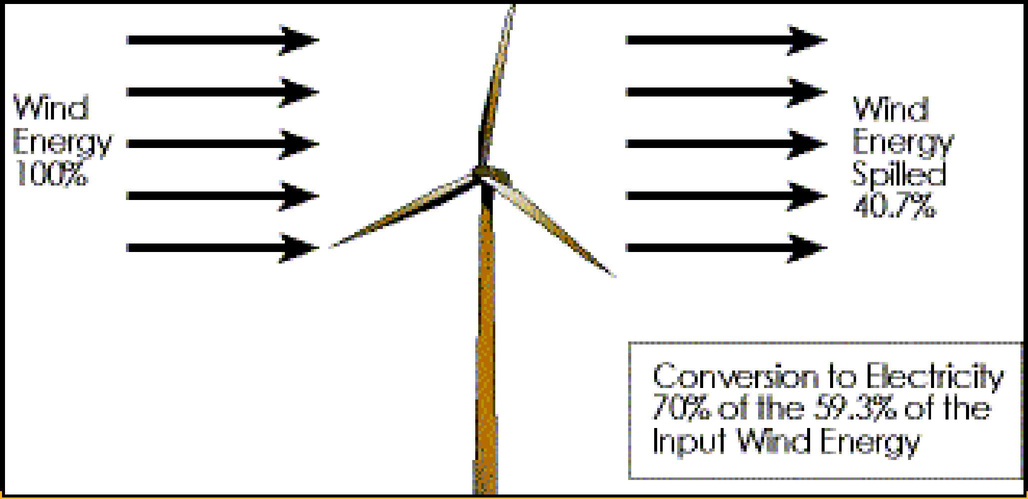
The nacelle houses a generator and gearbox. The spinning blades are attached to the generator through a series of gears. The gears increase the rotational speed of the blades to the generator speed of over 1,500 RPM. As the generator spins, electricity is produced.

System appearance:

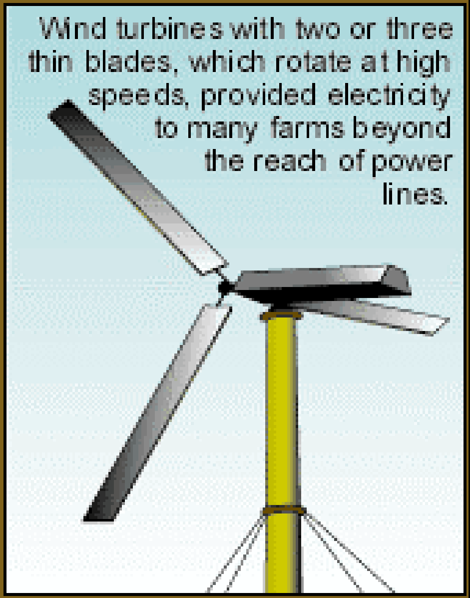


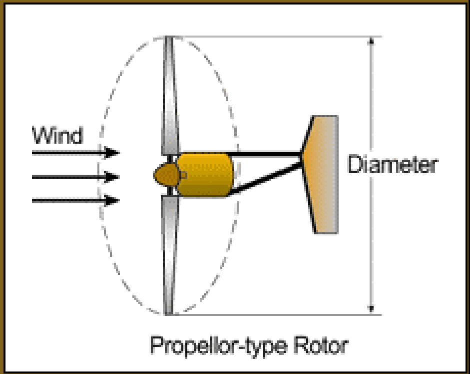
"ingredients" of the system similar to PV. Need an inverter to convert the energy to something "usable".

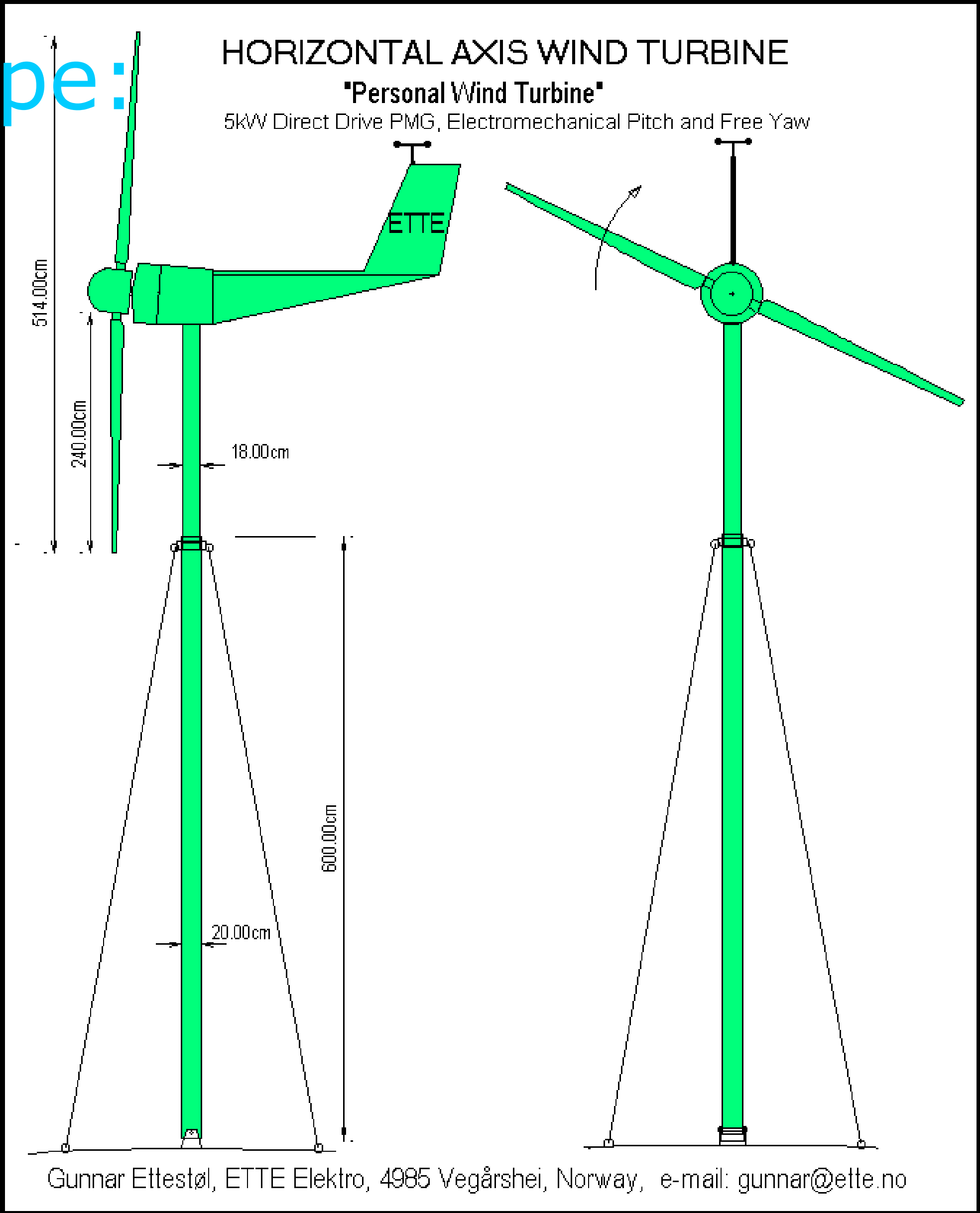
Not all of the incoming wind energy becomes electricity. Some passes by. Some is lost in the conversion process.



Horizontal axis type:

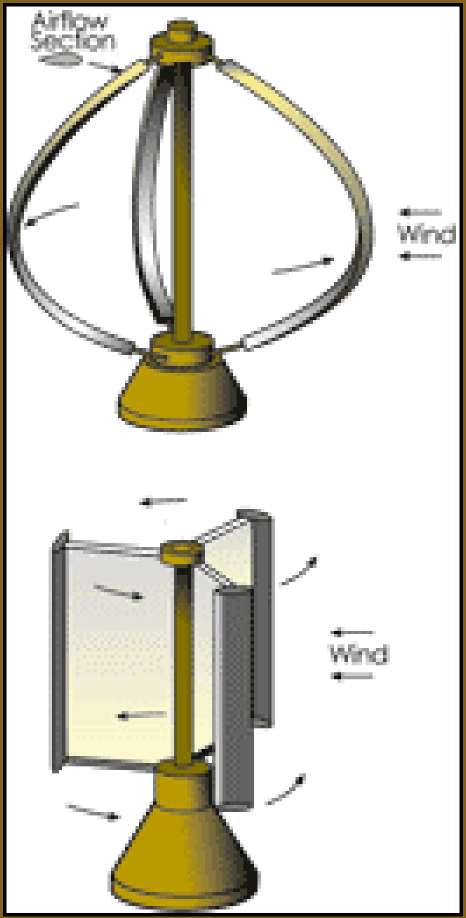


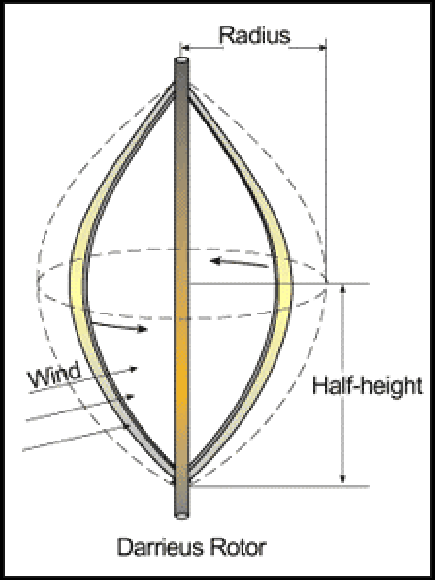


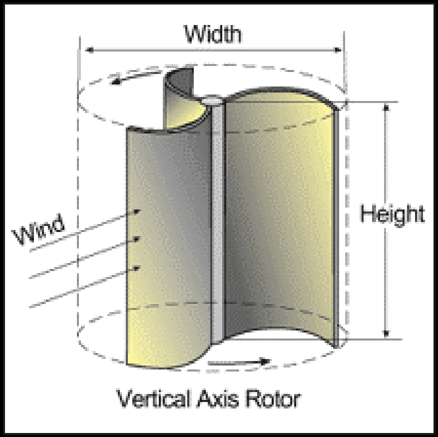


Propellor type

Vertical axis type:

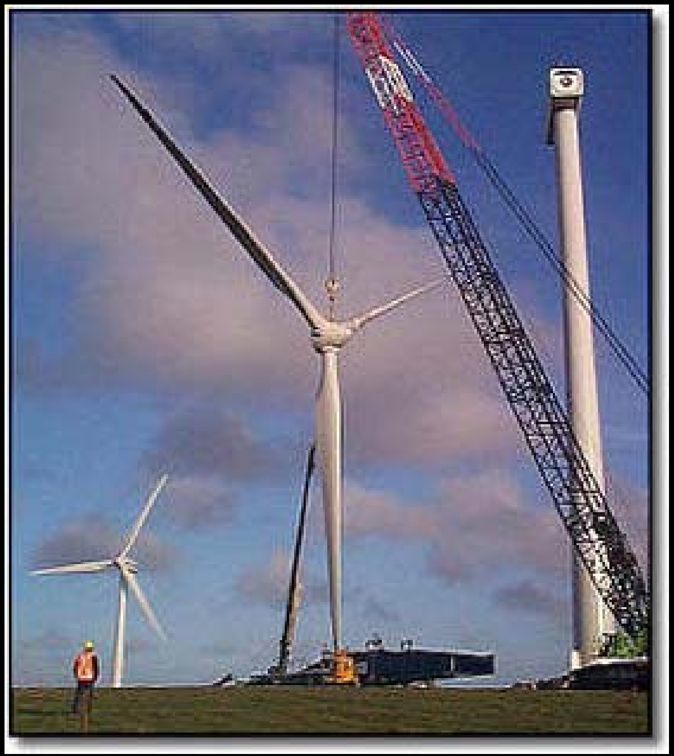




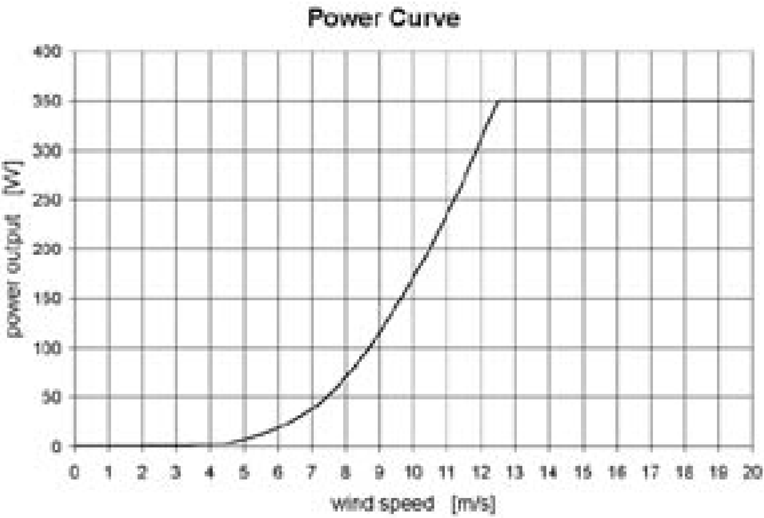


These are known as egg beaters. They are not as efficient as the horizontal axis type, so are less often used.

Egg beaters



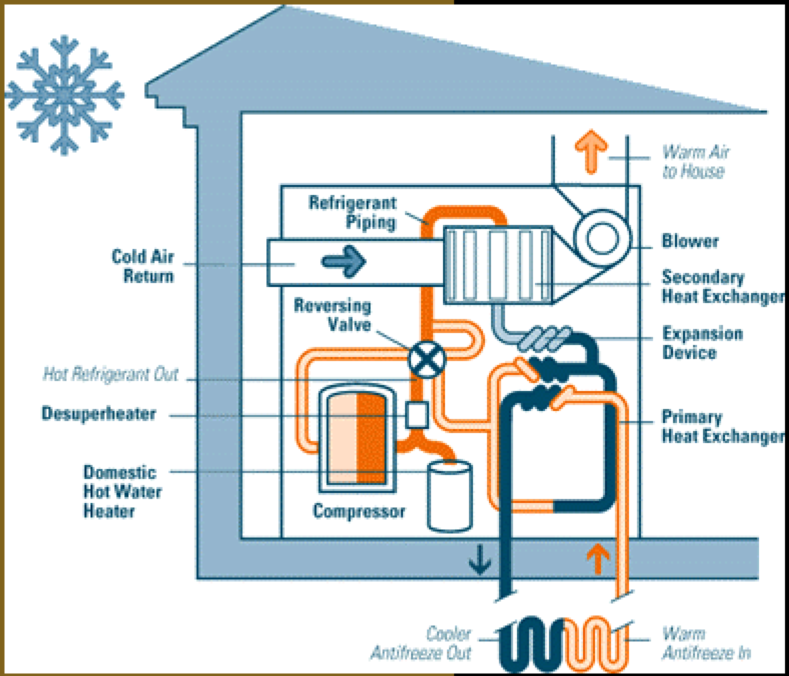
Erecting a wind tower



Power Curve
power output [W]
wind speed [m/s]
0
50
100
150
200
250
300
350
400
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

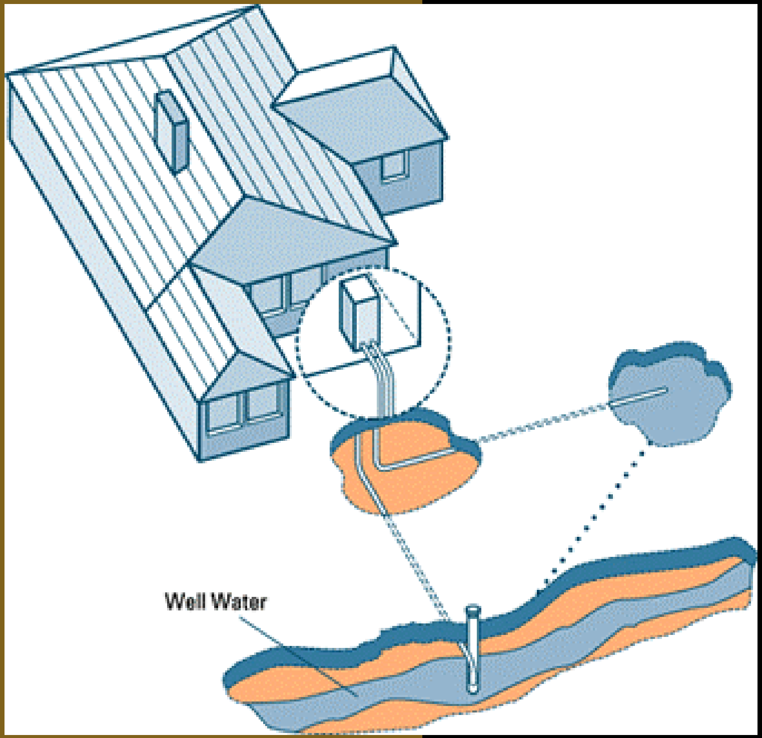
Geothermal Systems

Geothermal Systems: Earth Energy Systems



A ground-source heat pump uses the earth or ground water or both as the sources of heat in the winter, and as the "sink" for heat removed from the home in the summer. For this reason, ground-source heat pump systems have come to be known as earth-energy systems (EESs). Heat is removed from the earth through a liquid, such as ground water or an antifreeze solution, upgraded by the heat pump, and transferred to indoor air. During summer months, the process is reversed: heat is extracted from indoor air and transferred to the earth through the ground water or antifreeze solution. A direct-expansion (DX) earth-energy system uses refrigerant in the ground-heat exchanger, instead of an antifreeze solution.

Open Systems:

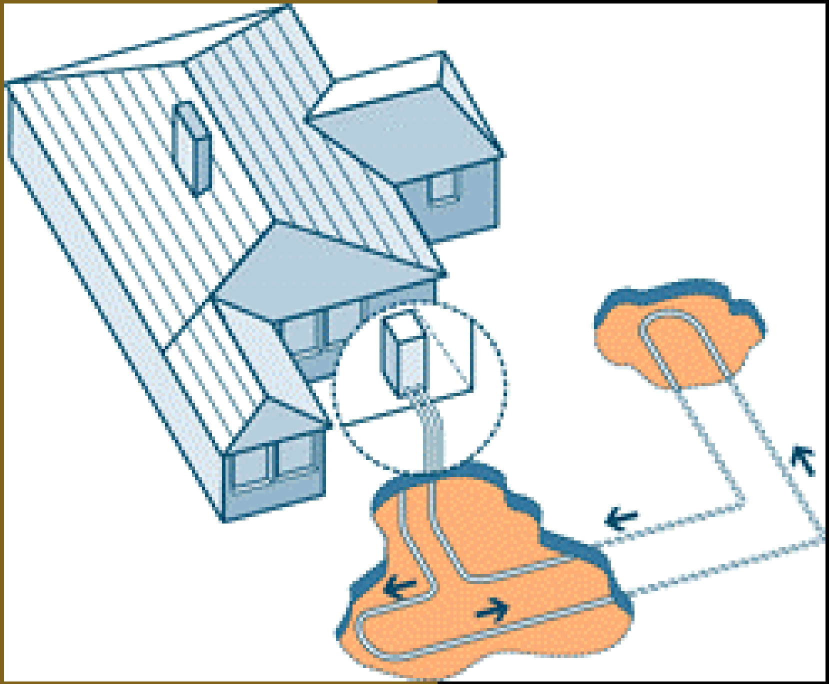


Poor water quality can cause serious problems in open systems. You should not use water from a spring, pond, river, or lake as a source for your heat pump system unless it has been proven to be free of excessive particles and organic matter, and warm enough throughout the year (typically over 5°C) to avoid freeze-up of the heat exchanger.

As noted, an open system uses ground water from a conventional well as a heat source. The ground water is pumped into the heat pump unit, where heat is extracted. Then, the "used" water is released in a stream, pond, ditch, drainage tile, river, or lake. This process is often referred to as the "open discharge" method. (This may not be acceptable in your area. Check with local authorities.)

Open System Using Ground Water from a Well

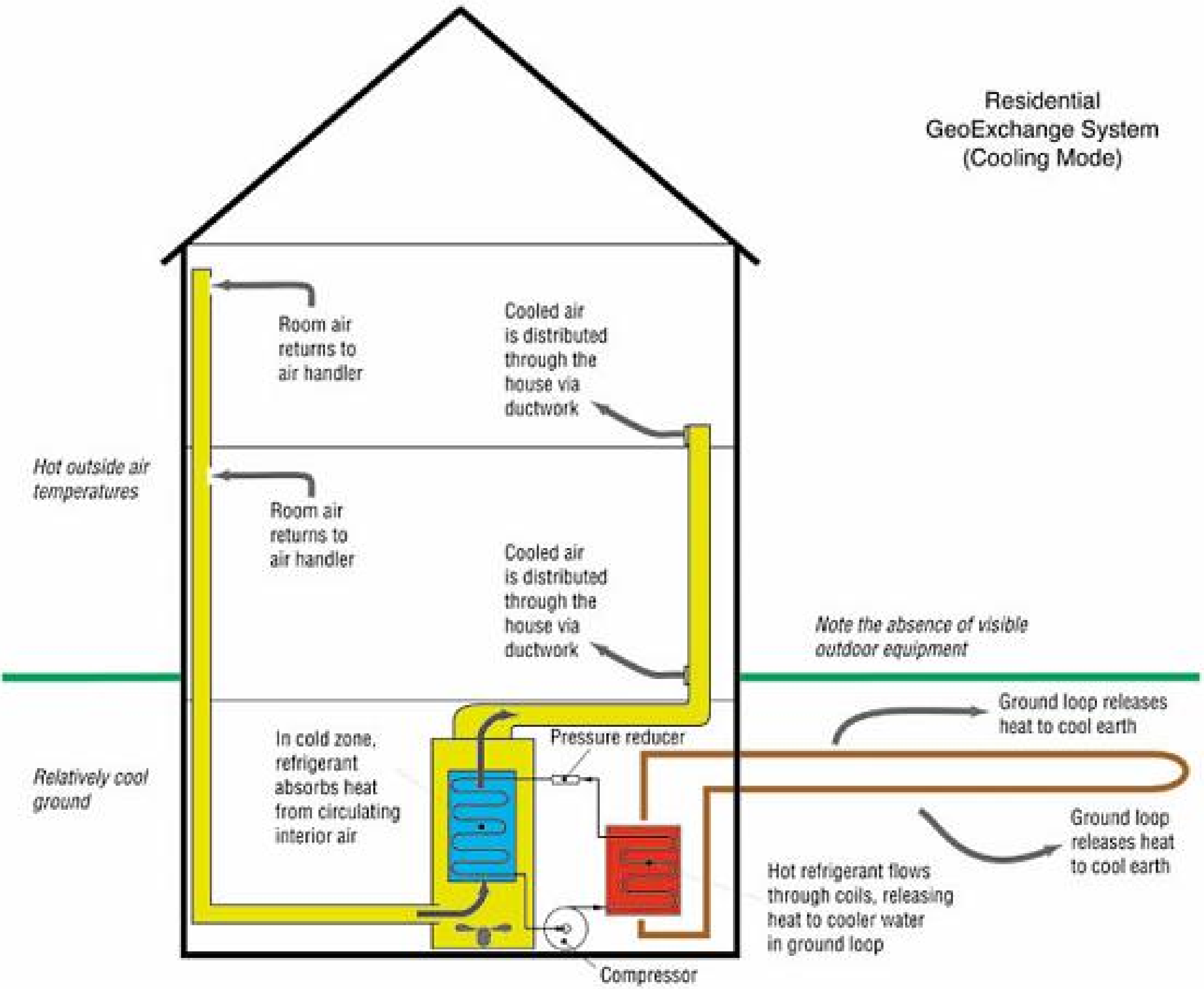
Closed Systems:

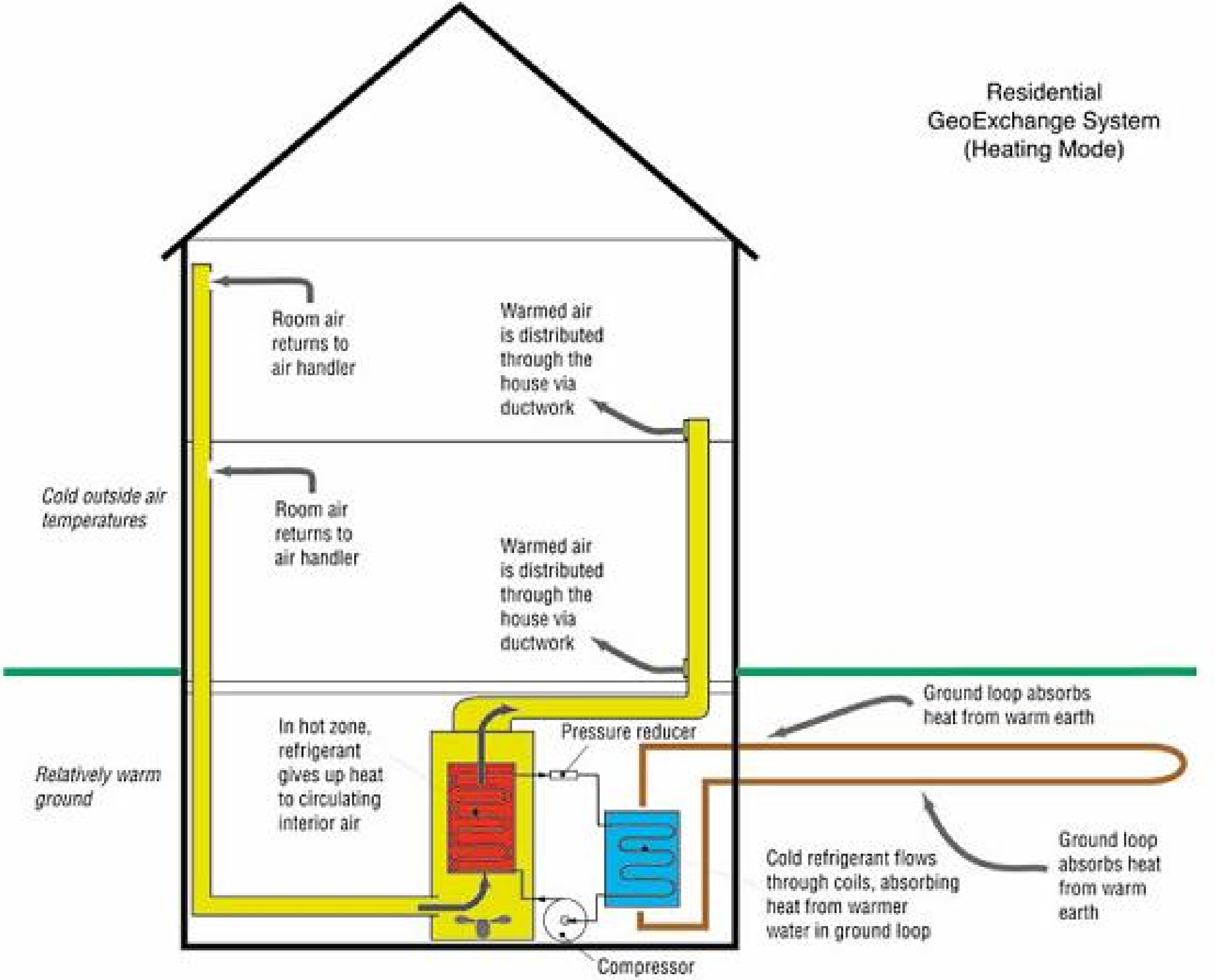


A closed-loop system draws heat from the ground itself, using a continuous loop of buried plastic pipe.

The pipe is connected to the indoor heat pump to form a sealed underground loop through which an antifreeze solution or refrigerant is circulated. While an open system drains water from a well, a closed-loop system recirculates its heat transfer solution in pressurized pipe.

Closed-Loop, Single Layer Horizontal Configuration


Residential
GeoExchange System
(Cooling Mode)
Room air
returns to
air handler
Cooled air
is distributed
through the
house via
ductwork
Hot outside air
temperatures
Room air
returns to
air handler
Cooled air
is distributed
through the
house via
ductwork
Note the absence of visible
outdoor equipment
Ground loop releases
heat to cool earth
Pressure reducer
In cold zone,
refrigerant
absorbs heat
from circulating
interior air
Relatively cool
ground
Ground loop
releases heat
to cool earth
Hot refrigerant flows
through coils, releasing
heat to cooler water
in ground loop
Compressor


Residential
GeoExchange System
(Heating Mode)
Room air
returns to
air handler
Warmed air
is distributed
through the
house via
ductwork
Cold outside air
temperatures
Room air
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Ground loop absorbs
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In hot zone,
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Ground loop
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from warm
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Cold refrigerant flows
through coils, absorbing
heat from warmer
water in ground loop
Compressor