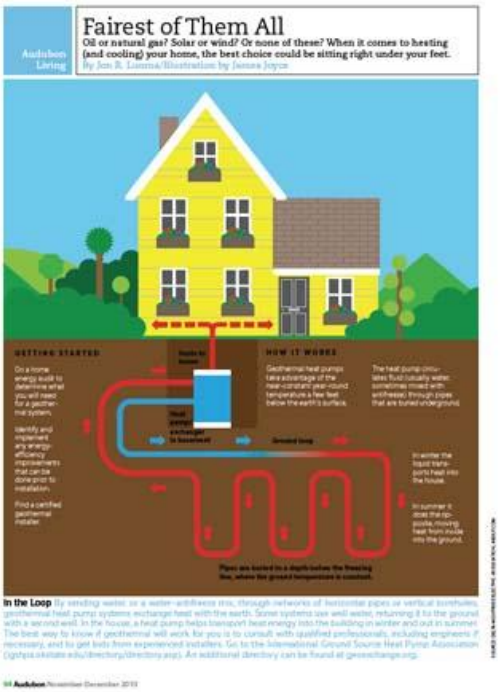


Fairest of Them All

Oil or natural gas? Solar or wind? Or none of these? When it comes to heating (and cooling) your home, the best choice could be sitting right under your feet.

By Jon R. Luoma/Illustration by James Joyce

On a chilly winter day, retired psychoanalyst Harold Clark, 84, tall, bespectacled, with a snow-white shock of hair, pulled open a utility closet door to show me a device he calls his "pride and joy." As world-changing technologies go, it sure didn't look like much: a trim steel box, standard ductwork lacing through joists overhead. But at the moment it was snuggly heating Clark's house, a sprawling 2,500-square-foot, high-windowed modern affair.

A dozen miles away but on a sweltering summer day, organic farmer Jim Brandt, 46, hair buzzed into a brush-cut, wearing calf-long denims and dust-caked boots, met me by his roadside produce stand in rural southern New Jersey, and said, "Let's get out of the heat." Moments later we were in his cellar, inspecting a device that looked much like Clark's gadget, although in this case it was efficiently *cooling* Brandt's 1,200-square-foot, 1920s farmhouse on this steam-bath day.

The two men might seem from disparate worlds, but both happen to pay uncommon attention to issues like energy efficiency and reducing their carbon-emission footprints. For them the geothermal heat pump—a system capable of tapping into the earth's ability to store warmth underground—is king when it comes to heating and cooling their castles.

Persuaded by an increasing body of scientific evidence and personal testimonies, a growing number of consumers are beginning to come to the same conclusion. Some would say it's about time. Seventeen years ago a report from the U.S. Environmental Protection Agency identified geothermal heat pumps as "the most energy-efficient, environmentally clean, and cost-effective space conditioning systems available." In 2000 the agency's State and Local Climate Change Program reaffirmed that geothermal heat pump technology can reduce home heating and cooling bills by as much as "30 to 40

percent." That could mean a savings of $450 to $600 annually even on bills that would otherwise run to a relatively moderate $1,500. And perhaps even more when a system replaces very old, inefficient equipment. (The term *geothermal* can lead to confusion. It is also used to describe unrelated technologies, including those that draw steam from very deep underground to drive electric power plants, and have nothing to do with heating and cooling buildings using the very real, if less dramatic, thermal advantages of the earth just a few feet down.)

Hot spots for home geothermal heat pump installations have emerged nationwide. There's a geothermal system heating and cooling a certain ranch in Crawford, Texas, owned by a recent White House resident. Yes, oil man George W. Bush heats and cools his homestead with one. This puts the former president's house in the company of such environmental buildings as the Greenwich Audubon Center in Connecticut and the Schlitz Audubon Nature Center in Milwaukee, which have incorporated the energy-saving technology into their green buildings.

The geothermal heat pump industry is aiming to grab a third of the U.S. heating and cooling market by 2030. The U.S. Energy Information Administration reported that its most recently compiled data, for the year 2008, showed that despite the recession manufacturers shipped more than 121,000 geothermal heat pumps, a 40 percent increase over the 2007 total of 86,000 and nearly double the shipments in 2006. That exponential rate might not continue until unemployment improves. But the Obama administration's promise to make major investments in renewable energy could help inflame any smoldering market: The 2009 federal stimulus package included a whopping 30 percent federal tax credit on geothermal systems that meet the EPA's Energy Star standard, with no cap on credit size.

Geothermal heating and cooling works like the more familiar "heat pump" you rely on every day: your refrigerator. A fridge captures unwanted heat in its interior and transfers it to the coils on its backside (which is why they feel warm to the touch). The process uses energy to overcome a paradox: heat naturally moves toward cold. The cold fridge must remove heat by pumping it "uphill" back into the warmer kitchen, using a special compound called a refrigerant along with energy (electricity powering a compressor) to perform this magic.

An air conditioner uses the very same principle, cooling rooms by pumping heat "uphill" to the hot outdoors. Some buildings are both heated and cooled by a two-way version of an air conditioner called an air-to-air heat pump that also warms the interior in winter by scavenging heat from chilly outdoor winter air (yes, there's heat in cold air) and pumping it indoors. (These systems tend to be most cost effective in climates with mild winters.)

Amplify this concept even further so that the system interacts with the heat energy stored a few feet below the earth's surface, and you have a geothermal heat pump. On this scale, the heat pump circulates a fluid (usually water, possibly mixed with a bit of antifreeze) below ground level, where the earth in most of the United States remains a near-constant 55 to 75 degrees. That flattens the enormous hill created by large temperature differences that the pump would otherwise have to overcome.

Consider this: When it's 100 degrees outdoors, it's still just 60 or so degrees underground. It takes far less energy to move heat from a building into that cooler environment than into sweltering 100-degree summer air. And it's more efficient to pump heat from the same 60-degree underground environment than from cold winter air. In fact, the heat transfer is so effective that geothermal is almost always more

energy efficient than conventional heating and cooling systems using fossil fuels or electricity.

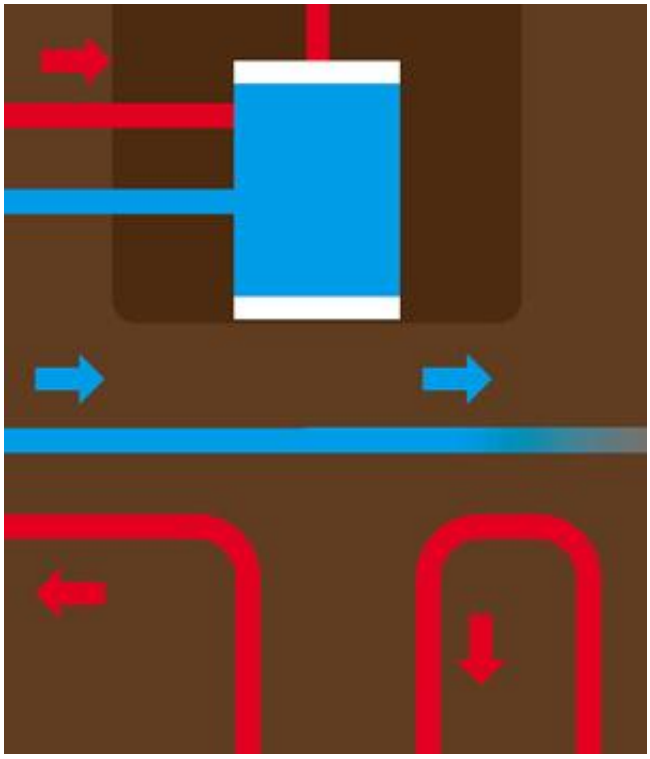
These systems also tend to be long-lived. The heat pump often lasts 25 years or more, subject neither to the wear from a furnace's flames nor the weathering suffered by an outdoor A/C compressor unit. The durable plastic piping typically used to move water through the outdoor "ground loop" should last at least a half-century.

The hitch: Installing the ground loop means drilling or trenching, so geothermal costs more up front. Currently the U.S. Department of Energy estimates that an installed three-ton capacity geothermal system for a "typical" house (think three bedrooms, mid-latitude) might run about $7,500, versus about $4,000 for a conventional one. In the real world, expect costs for systems to vary widely based on a host of factors, including regional climate, soil types, and local labor costs.

Harold Clark's system for a larger, high-ceilinged house totaled $12,000. But he points out that he chose top-of-the-line equipment, with no apples-to-apples comparison bids for a similar conventional system. Farmer Jim Brandt's system initially cost him almost nothing; he scrounged up an old used heat pump and installed it himself. When it later broke down, he replaced it with a new pump, about $6,000, installed.

Both Clark and Brandt say they're satisfied they're getting the sorts of major efficiency gains cited by EPA research. But it's difficult for either to be precise because, like many energy-efficiency enthusiasts, they've gone on multifaceted crusades, such as adding solar photovoltaic panels, solar hot water panels (to help heat a pool, in Clark's case), and, on Brandt's farm, windmills and more. Clark says his best guess is that the geothermal system alone has been saving him "conservatively $2,000 a year." To compound matters further, Clark says he actually netted a positive $1,500 last year on electricity, thanks largely to generous solar renewable energy credits in New Jersey. Brandt happily just points to an average monthly total electric bill of $135 for heating, cooling, and providing power to the house and farm. (That includes his wood and welding shops, as well as commercial refrigerators he added since the heat pump went in.)

The bottom line is that although circumstances vary, formal studies from outfits like the EPA and the U.S. Department of Energy show that geothermal heat pumps can often fully recover their extra costs in several years, rewarding homeowners with energy savings for years afterward. If rolled into a long-term mortgage, they can provide an immediate financial gain, with energy savings easily overcoming higher mortgage payments. The federal 30 percent tax incentive makes the economics even more attractive.



By sending water, or a water-antifreee mix, through networks of horizontal pipes or vertical boreholes, geothermal heat pump systems exchange heat with the earth. Some systems use well water, returning it to the gorund with a second well. In the house, a heat pump helps transport heat energy into the building in winter and out in summer. The best way to know if geothermal will work for you is to consult with qualified professionals, including engineers if necessary, and to get bids fom experienced installers. Go to the International Ground Source Heat Pump Association. An Additional directory can be found at Geoexchange.

James Joyce

One of the first Americans to experiment with geothermal heat pump technology was an inventor named Robert C. Webber, back in the 1940s. His interest was sparked by almost burning his hand on the back of a freezer, after fiddling with dropping its interior temperature. That idea led to others, and soon he was exchanging heat with the ground outside, using the rejiggered freezer to help heat his house. Although scattered ground-linked heat pump systems appeared here and there during the 1950s and 1960s, it wasn't until the energy crisis of the 1970s that the idea began to catch on much at all.

The technology has come a long way since Webber's early trials, but homeowners considering it have much to ponder. Installations make the most economic sense when old equipment is already being replaced, or for new construction. Other variables are myriad. Some homes use a heat pump add-on device called a desuperheater to help heat their domestic water supply, saving energy and money. Economics also vary by building size and style. For effective heat transfer, ground loops in some soils must be larger than in others. If conditions are right, water drawn up a well from an aquifer can economically be used for the ground loop, but that typically does mean drilling a second well to return water to the earth. Technically, a geothermal system can be installed in any region of the country, including in urban areas (boreholes can even be drilled under a driveway). But because of the multitude of variables, homeowners need an evaluation from a knowledgeable contractor. (A good contractor will tell you that it makes bang-for-the-buck sense to first caulk, weatherstrip, and insulate to reduce demand and system size.)

Widely adopted, the technology could be a windfall for efforts to abate climate change. The International Ground Source Heat Pump Association, a nonprofit advocacy, analysis,

and training group, reports that even with growing numbers of installations, only about two percent of U.S. homes currently use the technology. Still, the association notes, existing systems are already eliminating as much carbon dioxide from the atmosphere as would be eliminated by taking 650,000 automobiles off the road.

On the flat coastal plain of southern New Jersey near Atlantic City, geothermal has caught on in a big way, nowhere more than in the little colonial-era town called Port Republic, a pretty burg with only about 1,000 houses.

One sunny winter day Mike Turner and Gary Brill took me on a tour. Turner, owner of a local geothermal business, Mill Pond Mechanical, and Brill, who manages it, pointed at houses, this way and that, as we rolled through Port Republic's newer cul-de-sacs and down its old streets and lanes. "New installation here, new installation there. And that one's a retrofit," says Brill, ticking off three two-story houses, side by side.

"We did this whole row here back in the '90s," says Turner, jabbing a finger at a line of modest ranch houses on one road. "And this whole cul-de-sac," he adds as we wheel past a dozen large new houses.

Altogether, about one-third of all the houses in Port Republic are heated and cooled geothermally. Although there's no national scorecard, it may be the municipality with the highest sheer concentration of the technology in the United States. Turner says the best advertising came from neighborly word of mouth: "People at a backyard barbecue bragging to their neighbors: 'Hey, I put in a geothermal system. You won't believe how much I'm saving on heating and cooling.' "

Jim Brandt, whose farm lies not far from the Port Republic boundary, has reasons beyond saving money. A friend once asked him why he's spent so much in upfront costs for alternative energy around the farm: the geothermal, the solar, the windmill spinning in a nearby field. (He's even been known to scoot around the place on a solar-powered three-wheeler he built.)

Brandt likens his passion for energy improvements to the upfront and ongoing costs of any hobby. He told his friend, an avid angler, "I did it for the same reason you spent money on a boat, and the trailer to haul the boat, and all that fishing gear to catch something you can buy in a supermarket for five dollars a pound. Less pollution makes me happy."

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