GROWERTALKS

Features

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Geothermal: The Steady Heat

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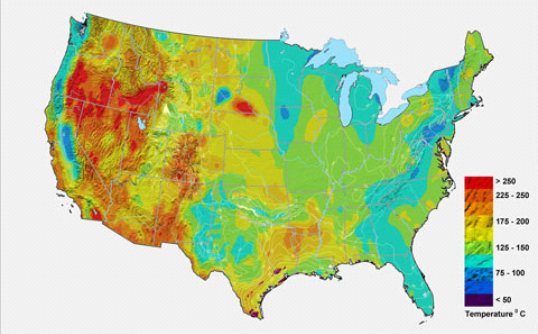

In 1876, not far from the geysers of Yosemite, on a piece of property now known as Chico Hot Springs in Pray, Montana, a miner erected a few hot houses for his garden. Water from the hot springs, warmed by geothermal heat, flowed underneath the crops and created a prime growing environment. He wasn't the first, either; farmers in Italy have used direct geothermal heat for centuries. The basic tenets of those systems still work for growers today; only, we now have the technology and engineering to use them in more locations and situations.

Not every greenhouse is lucky enough to be perched over a hot spring, or even in a geothermal hot spot, for that matter. Yet, with today's technology, nearly anyone can harness the temperatures below the Earth's crust to some degree. Growers in Alaska, Maine, New Mexico, California and the states in between have found a new efficiency with geothermal systems.

While a geothermal plant can match the electricity production of a much larger solar or wind farm, geothermal's growth has been slow next to wind and solar in the U.S. According to the Geothermal Energy Association (GEA), the U.S. currently has 3,444 MW of installed geothermal capacity, up from 3,153 MW in 2009. That slow creep is partly due to geology; most big geothermal projects, particularly geothermal plants, depend on specific geothermal conditions. But uncertainty in U.S. policy towards renewable energy has also played a role.

Worldwide, the GEA is more optimistic. At the end of 2013, GEA Executive Director Karl Gawell said, "We are seeing new technology developments move forward and new projects being announced in every region of the world. Despite slow growth in the U.S., the global market continues to gain steam. So, many American geothermal companies are using their industry know-how in friendlier economic and political climates overseas."

How it works

The topsoil may freeze, snow may fall and the sun may scorch tender leaves, but down below, there's a steadier temperature. Geothermal systems harness this heat from the earth to provide continuous, 24-hours-a

-day, clean, sustainable energy production. While the degree of warmth under your greenhouse will depend on the geology of your area, heat continuously flows from the core of the Earth outward, mostly by conduction. As well, closer to the crust, solar energy is stored in the top 100 meters.

The reservoir advantage: Much of the Earth's core heat is trapped below the crust and heats rock and water. If that water or steam is trapped under a layer of impermeable rock, it can form a geothermal reservoir, which can be harnessed for energy.

Without a reservoir: Even without the presence of geothermal water, technology can take advantage of the constant temperature 10 ft. to 300 ft. below the surface, using it for heating in the winter and cooling in the summer.

Geothermal electricity: Wells are drilled into a geothermal reservoir, the geothermal water is brought to the surface and a geothermal power plant converts the heat energy into electricity.

Direct geothermal heating/cooling: Uses the geothermal water from a reservoir directly, without a heat pump.

Geothermal heat pumps: Geothermal heat pumps (also known as ground source heat pumps) make heating/cooling available for almost everyone. Instead of using a hot-spot reservoir, they utilize those moderate temperatures (usually 50 to 60F) of the Earth 10 ft. to 300 ft. below the surface. The pumps circulate water or other liquids through pipes buried in a continuous loop, either horizontally or vertically or in a pond. To heat, the pipes pull heat from the earth, through the loop and to the structure, where it can be used as hot water heat or distributed through a conventional duct system. To cool, it just reverses the loop, extracting the heat from the structure back through the earth loop, where it cools.

In the greenhouse

Steve and Kris Van Haitsma at Mud Lake Farm in Hudsonville, Michigan, put a geothermal system in their house 15 years ago, and it worked so well, they put one in their greenhouse, too, in 2009. When they built a new range in 2012, they added yet another geothermal system.

"We grow hydroponically and the geothermal was a perfect system for us since we were interested in primarily heating water and water-to-water systems are incredibly efficient," says Steve.

Cozy Acres in North Yarmouth, Maine, was consuming about 10,000 gal. of propane each year. They added one geothermal heat pump system in 2012, and in December 2013, they fired up another 10-ton heat pump for a new range. Owner Jeff Marstaller says, "For the next two weeks we had the coldest and snowiest stretch we've had in years. Many nights below zero and one night went to 20 below."

Cozy Acres' has a horizontal, closed-loop system of piping that heats their new greenhouse floor through 3,200 ft. of radiant floor tubing set in a 5-in. concrete slab over 2 in. of Styrofoam. The floor is continually fed with water that has a high temp of 112F. The geothermal system also provides supplemental air heat via a Riznor air fan when the air temperature drops below 50F.

For the first 14 days, Jeff says the system ran continuously. “Once the days became sunny and 20F or more, the floor temp would reach the set temp of 75F and the system would rest.” After seven weeks of “brutal cold,” Jeff says he’s confident they won’t need any backup heat for this greenhouse as long as they’re growing cold-tolerant crops.

Cozy Acres also draped old poly sheets around the perimeter of their wire benches, forcing the floor heat to rise toward the root zones. With lettuce growing, Jeff says, “By monitoring the air temp as well as the temp inside the ‘tents’ we achieve a 10-degree temperature rise. Though the end wall air temp is often in the 35F range, the air temp under the tents is normally 10 degrees higher. Our leaf crops totally enjoy the 45F root zones.”

John Dart at Manley Hot Springs Produce in Alaska is forging his own path in geothermal energy. As the name implies, they’re lucky enough to have a hot springs location. But instead of going for a standard system, he designed what he calls a borehole heat exchanger so he can peak the geothermal water with steam from a biomass boiler. “That way we have steam to sterilize soil and steam to peak the 120F water,” says John.

In the Netherlands, a large project underway will heat several greenhouse businesses. VB Projects is building a geothermal heat network that will lay about 7 miles of heating tubes, connecting to eight large greenhouse growers in the Agriport A7 horticulture area in Middenmeer.

At Brownsburg Landscape Co., a small garden center in Brownsburg, Indiana, a geothermal heat pump supports a radiant bench heating system in their greenhouse. “To tell you the truth, I wasn’t in the market for a new heating system,” says owner Greg Frazee. “But when WaterFurnace approached me with a proposal to serve as a field test site for a new method of heating the greenhouse, I felt I had nothing to lose and perhaps something to gain in terms of significant energy savings, so I agreed.”

Jeff Cross at WaterFurnace explains, “We devised a system in which hot water is carried through HyperLoops or tubes in radiant mats on table tops. Plants sit in pods directly on these mats, so in effect, we are able to provide heat directly to the plants’ roots by concentrating on warming the dirt rather than the air surrounding the plants, which is far more efficient.”

Since Brownsburg already had a pond 200 ft. from the greenhouse, they placed the loops in the pond to capture the energy stored there. One geothermal heat pump provides water that makes its way into storage tanks, which are heated to and held at 120F, and eventually piped into the radiant bench mats. A second pump is used to feed a hydronic air handler, which tempers the air in the greenhouse.

Jeff says, “The function of the air handler is to temper the air in the greenhouse, so it doesn’t get too cold for the plants. However, our main concern is heating the dirt.” With sensors that monitor the soil temperature and five heating zones, they can control the benches by temperature and call for the appropriate amount of hot water.

All in all, Brownsburg is finding that their root development is faster and better, they use less energy and they’re more sustainable.

Cost

“Upfront cost is the biggest drawback with the systems,” said Steve. He reports that a 5-ton system starts around $20,000. However, he concludes, “The electrical power is only used to pump and compress water so it ends up being five times more efficient than using a fossil fuel to actually heat the water.”

Cost estimates and return-on-investment seem to vary widely. In Alaska, John admits that, “Our system is complex and costly in the short run, but should put us in good shape over the long run and maybe we will end up selling electricity to the community.” Before building their custom system, they did an extensive study of their heat and power needs and concluded that local, diesel-generated power was too expensive for the long term in their small isolated community. They’ve invested more than $800,000 so far and expect it will probably total $1 million, though they have been helped with two funding awards, which John says mostly went to create jobs for employees.

Despite the high price tag, John is optimistic. He says, “Payback in three years is likely. Especially if the community buys power.”

For Brownsburg Landscape, the savings have been significant with their new system. Greg says, “I’d say if we spent $1,000 for propane before we installed the system, we spent just $150 the following year. We still use [propane] as a backup system to warm the air when temperatures drop significantly, but we’re saving almost 80% of what we spent in the past and that’s
significant.”

What’s also saving money for Brownsburg is the faster finish time. “Now we’re able to flush out a plant in just three to four weeks versus the five to six weeks it used to take us. As plants get more established, we can take advantage of zoning and reduce the heat to specific tables,” says Greg.

Growers can offset some of the costs of a system with tax incentives, loan programs and grants, such as the USDA’s Rural Energy for America (REAP) program.

Construction

If you’re installing a system, look for expert help.

“There are many things farmers, including me, love to do/fix/build ourselves,” Steve says. “This should NOT be one of them. As a former real estate appraiser, I have heard tons of horror stories of people who had systems put in by folks who had no clue of what they were doing. This is one area to leave to the people who know what they are doing.”

Steve notes that the biggest decision is where and how to configure the earth loop for your system. “Since we had plenty of space, we had them put in six 1,000-ft. coils that stretch across the field from a central hub like spokes in a wheel. If space is more limited, wells are drilled straight down and the loops are run vertically. For our last one, they ran the ground loop before we set the greenhouse and then came after it was up and finished it up in a couple of days.”

Keeping up in extreme cold

This winter of 2014 has put some growers to the test so far.

At Mud Lake Farm, their production beds outpaced the older system. Steve notes, “Our only issue has been that we have maxed out the system with the number of beds we are using, so in winters like this one, it has a hard time keeping up. We recently added a backup boiler to help keep our bed temps where we want them, but this has been an extreme winter in our area.”

However, the newer geothermal system Mud Lake Farm built for a new greenhouse range in 2012 has been able to keep things warm even in Michigan’s extreme cold this winter.

At Cozy Acres in Maine, the new heat pump provided enough heat to the root zone of the plants during an extreme cold snap, but Jeff was also growing cold-tolerant crops. The cooler air temperature did present a few challenges. For one, it was too cold for them to germinate seed. As well, their beneficial insects (*Aphidius colemani* and *Aphidius ervi*) did not thrive in the cold night temperatures.

The U.S. Environmental Protection Agency calls geothermal energy the most environmentally friendly heating/cooling system available. While it doesn’t have the wild popularity of solar power and it certainly requires an upfront investment, it does offer a methodically steady temperature and an impressive savings on your typical heating bill. **GT**