

Geo-Thermal, Hi Tech Bubble Roof and New Generation Wood Boiler for Greenhouses

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Geo-Thermal Heat

After much research we made the decision to construct a geo-thermal ground source heat pump greenhouse to produce warm season crops all year round at our farm in Minnesota. Tomatoes are the main crop that we raise in this greenhouse, along with some cucumbers and pole beans, mainly for rotational purposes. These crops are planted directly into ground heated with geo-thermal heat tubes.

The greenhouse is a 46' x 126' two bay gutter-connect purchased from Poly Tex built with 90 lb. steel and originally covered with two layer inflated 6 mil plastic. The greenhouse is set on insulated 4' frost walls. Twelve to fourteen inches of soil sit atop 2" rigid insulation. Heat tubes filled with anti-freeze are attached to the insulation at 1' intervals. Soil temperatures at the tube depth are kept at a constant 65 degrees Fahrenheit and the soil temperature at the surface stays around 60 degrees during the winter while warming a little more during the summer months.

The geo-thermal heat pump that we purchased is a 20 ton Econar system manufactured in Minnesota. It consists of two 7 ton heat pumps in the greenhouse, one in each bay that can be regulated separately. A 4 ton pump is located in the pack house for in-floor heating and cold storage. About a year later a 3 ton forced air pump was added to the greenhouse. If all units are running at the same time the system can become overtaxed.

Earth loops feeding the heat pumps are located outside the greenhouse in a field. Twenty-one hundred foot lengths of eight hundred feet of coiled tubing are buried eight feet underground connecting to the heat pumps. These are filled with anti-freeze and bring in the temperature moderated liquid to the pumps. As a perk, when the cold storage is running, heat is transferred back to the earth loops warming the ground up to 65 degrees Fahrenheit in the summer. This is much higher than the 45 to 50 degrees that we would normally begin with in the fall.

Most of the ground above the earth loops is covered in sod surrounded by an earth berm. Waste water from washing produce in the pack house is piped into the bermed area keeping the soil consistently moist which aides in using soil heat more efficiently.

The original plan for backup heat was to install some type of gasification system. Because of cost overruns and difficulty in finding the type of system that we wanted, backup heat for ambient air in the greenhouse was provided by two 300,000 btu propane heaters. These were in use much more than anticipated because we found that while the geo-thermal unit heated the

ground nicely, it could not also heat the ambient air up to the temperatures that were needed to get optimum yields from the tomatoes.

Cost for the original geo-thermal system and installation was approx. \$60,000 and the addition of the forced air pump added another \$8,000. The cost of the greenhouse itself came to approx. \$65,000.

Since we don't have the electrical cost of the geo-thermal separated from lighting costs and other electrical needs such as fans, etc., we cannot say for sure how much the geo-thermal costs to run. We can say, however, that our winter electrical costs usually run about \$700 a month more than summer.

Sola Wrap Greenhouse Film

After operating the greenhouse for four years the greenhouse film needed to be replaced. Because of the design of our greenhouse, the two layer inflated poly did not stand up to our needs. We are located on a ridge top with a lot of wind and the multi-section design would constantly tear or pull loose, losing inflation which in turn compromised insulation properties and integrity.

Because of this we looked into different greenhouse coverings. Rigid poly was too expensive so that was not an option. After attending a conference in 2014 and seeing a sample of Sola Wrap greenhouse film we looked closer into bubble wrap film, and chose that option to recover our greenhouse.

Since the Sola Wrap comes in 4', 5', and 6' wide roles, installation is much different from regular greenhouse film. Replacing the covering on each section of our multi-section greenhouse had to be carefully planned out so a lot of time was spent in the replacement. In the end though, we have a nice, neat tight cover that looks like it will hold up well to the wind. Since this is our first winter with the Sola Wrap have yet to see how it stands up to snow load.

Cost of the Sola Wrap came to about \$24,000 with a 10 year guarantee against UV degradation.

The Log Boiler

Since the geo-thermal heat pump did not heat the ambient air as well as we had hoped, the cost of the propane heat was much, much more than anticipated, sometimes \$15,000 to \$18,000 per year. We again searched for a gasification system and finally found the Log Boiler.

The cost of the Log Boiler was quite high, approx. \$64,000, so we applied for and received a Minnesota Department of Ag Bio Fuel grant to help pay for the system. Part of the requirements of this grant is monitoring emissions to be sure that it is a clean burning system.

The Log Boiler consists of a very large fire box that holds up to 1 ¾ cords of wood that are loaded from the top. Logs can be up to 8' long. Burning temperatures are computer controlled to burn gasses at the most optimum temperatures and, depending on the outdoor temperatures, can

burn for up to a week without reloading. On the coldest days it should only have to be loaded once every 24 hours.

This unit is rated at 2,500,000 btu's and will be used not only for the geo-thermal greenhouse but two smaller greenhouse as well. This should insure that we have the tomatoes growing at optimum temperatures all winter long.

We do have some wood available on our property, but we estimated that the cost of wood, even if all of it is purchased, would be much less than propane. The cost of the propane could reach up to \$18,000 for the year at \$1.89 per gallon. We estimate that even using up to 50 cords of wood, our cost would only be about \$5,000 at the rate of \$100 per cord if purchased by the semi load. This would mean a savings of \$10,000 to \$13,000 a year.