Citrus
In The Snow

“He proved the Professors wrong”

The greenhouse in the snow with virtually no heating or cooling costs, and you can duplicate it virtually anywhere in the world...

- Russ Finch

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Introduction

In my college communications class I learned the person to write a Forward or Introduction to a book should be the person who is the biggest fan of either the author or his topic. In both cases I'm certain I rank among the most excited fans of both Russ and his very significant accomplishments in "geo-air" type geothermal research.

I am especially impressed with Russ and his "geo-air" research concept since I am one of the millions of people who believed in the logic of this type Geothermal technology back in the early '70's. But like everyone else, I sat back and believed the cynics who said it couldn't work efficiently.

Since I was not the one who actually stepped up and tested these theories, I decided to at least be one of the key people to promote the incredible and humble man who really did this. ...that visionary man is Mr. Russ Finch and his research needs to be seen.

I am not blindly pretending to believe Russ or his innovative geo-air energy concept. My family and I have been involved in geothermal energy use, research and production for more than 50 years. So when I saw what Russ had actually done I knew and understood well the significance from experience, and not simply as an enthusiastic novice now that "green energy" has become the trend.

Russ's accomplishments are simply phenomenal and I sincerely believe his research will soon become the heating/cooling standard for homes, business and greenhouses, not only this year but also in the decades to come.

I remind you, this is not some futuristic, experimental concept you read about every day. Right now, ...today, ...this simple "geo air" technology is more affordable to install and use annually than solar cells, wind turbines, bio-fuel or any conventional geothermal exchange system.

Unlike solar, wind and most geothermal, the "geo air" system can be used in virtually any climate, anywhere in the world without a large investment. Additionally, the "geo air" system can be easily installed by any licensed building contractor or brave DIY consumer with a little skill.

This Report is not just inspiring but it gives you all the information you need from a real person who has already been using it successfully for decades.

If you think this Report and new technology is only meant for greenhouse growers you are very mistaken.

This new "geo air" technology could very easily become the most profitable new technology in 2018 and for many years to come. The variations and applications are endless.

(Update: As of January 2018 it's becoming everything I expected it would)

Barry Naef, co-author
GreenCube Publishing

Quotations from Russ's original publication and updates are written in this blue text throughout the entire publication. Below is the first example.

Originally we built the "Orange in the Snow" unit to prove the feasibility of "low grade" geothermal energy (the use of the earth's heat at the 8 to 10 foot depths). Over the past 16 years we have proven the system is far more efficient than we had ever imagined. With the energy from one 3/4 hp motor, that runs only on the coldest days, we are growing tropical and sub-tropical plants that thrive. The most exciting discovery was citrus production at a level that could prove very profitable for direct marketing. Some of our findings:

- Energy conservation
- Very low water usage
- Alternative crops
- Low cost growing units
- Off the shelf technology
- High monetary return
- Organic and/or low chemical use
- Zero pollution
- Can use poor crop land
- Can be "Stand alone" with wind and solar

- Russ Finch

It should be noted that Russ Finch's geothermal concept was actually not originally intended for use as a greenhouse.

The greenhouse concept didn't begin until 1992, another 12 years after they had been using "geo-air" to efficiently heat their home and atrium....

The Beginning: Planning Our Dream Home

Russ was quite a visionary in many things he has done. So when he, Darlene, and their two children decided to build their dream home it was not only large for those days but it was a somewhat futuristic "A" frame design that would sit in the rolling plains of Nebraska.

Our home is located 6 miles north of Alliance Nebraska, right in the center of the panhandle of Nebraska. It is flat farm land on the west edge of the Nebraska Sand hills. The Sand hills are rolling ridges of sand dunes similar to the Sahara Desert except they are covered with green grass and the valleys are dotted with lakes and lush meadows.

There are few trees in the area to slow the cold winter winds. The winters can be very cold, an average January high is 36F degrees the average low is 10°F degrees. The mean annual number of days with temperatures below zero is 20°F. We have days colder than -20°F degrees most winters.

The average first frost date is September 27 and the average last frost is May 15th.

The average number of overcast days in January is 15. Our summers are hot and dry with an average high in July of 87°F degrees and with several days over 100°F degrees during the summer.

Due to the long cold winters there, Russ and Darlene wanted to have an atrium and garden built into their home design. This would hopefully provide them with a vegetable garden, flowers and also a comforting summer view even during the coldest winter months.

Their plan was to include a large "atrium" type patio on two sides of the home so they could be in the kitchen, dining room, or living room and enjoy the peaceful beauty of the green, as well as the snow. They would always have a choice to fit their mood.

As they planned their unique home design it didn't take long for them to realize the exorbitant costs of heating. Altogether they would be heating more than 4,000 sq/ft including the atrium glass and window areas. With winter temperatures always below 32°F and often -20°F to -25°F the heating costs could become quite prohibitive.

It was at this time Russ looked into every new technology possible, including heat pumps and solar panels. There had to be some creative solution to cut the high heating costs in snow country like this.

Heat Pump Limitations

Propane was the standard in Rural America but it would be quite costly for such a large home and atrium. Solar was an option but what about the nights and winter clouds? Russ had heard of the "heat pump" technology which had been gaining popularity in the 1970's and did his very best to research it's practical use via libraries and magazines.

My interest in "earth heat" began in 1979, when I was planning the heating system only for the "A" frame home I was going to build. Originally I wanted to use a heat pump as the only source of heat but found that heat pumps are not suitable for colder northern areas unless an additional electric heat unit is also used. The heat pumps at that time lost their efficiency at 32° degrees and then switched over to electric."

Although he wanted the heating/cooling efficiency a "heat pump" offered, this was simply not a realistic technology for use in colder climates. Back in the '70's, and even today, heat pumps are primarily used in hot climates. In fact, even in warmer climates the heat pumps are programmed to switch to electric or gas heating soon as they reach 45°F. I guarantee this is true for 99.9% of our readers.

If only Russ could find some way to have a "heat pump" sucking up warmer 45°-50° degree air in sub-zero weather.

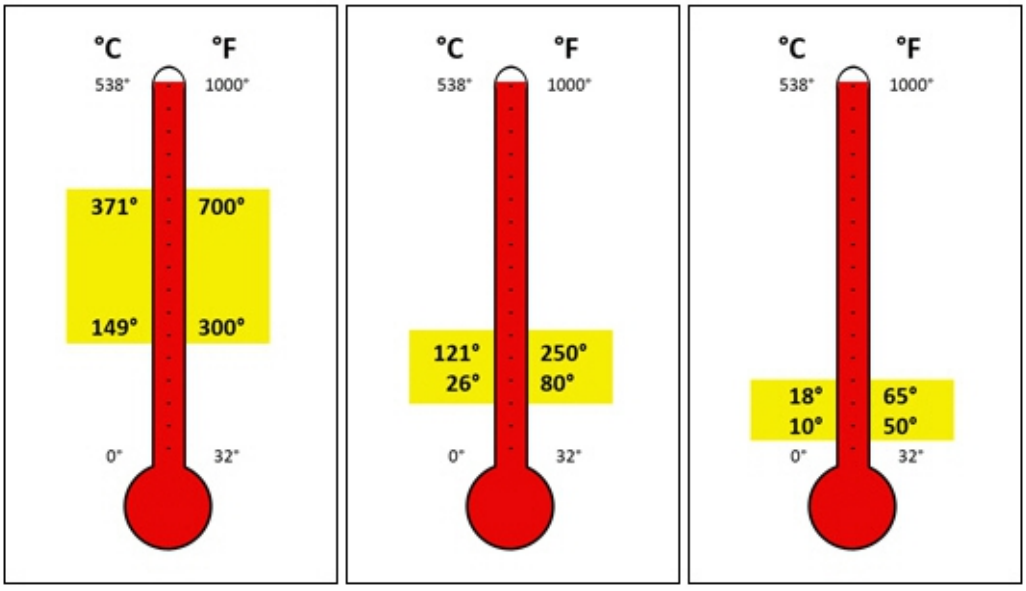
Geothermal Overview

Before we continue with the solutions Russ has developed, it is important to understand the basics of geothermal energy technology in general.

There are three basic types of Geothermal energy throughout the world.

Many people are confused with what Geothermal Energy actually is. The simplest definition is that it is "heat" from the "earth", however it is important to understand there are three (3) basic types and not just one:

High Grade- 300°F to 700°F
Medium Grade- 80°F to 250°F
Low Grade- 50°F to 65°F (available everywhere in the world)



Types of Geothermal Energy

To most people in the world, "geothermal energy" is steaming hot water in very isolated areas that heats tourist hot springs, resorts, commercial complexes or maybe even some greenhouses. One thing we know for certain, "geothermal energy" is very rare. ...or is it?

The use of "Geothermal Energy" for home, greenhouse and offices is one of the fastest growing trends globally.

Available In Every Country Of The World

High grade and Medium grade geothermal are quite rare in most of the world, however the "Low grade geothermal" is common and available in virtually every country of the world and in every climate of the world.

"Low grade geothermal" is plentiful, stable, renewable and virtually available everywhere there is dirt, sand, rocks or vegetation. It's this simple, "If you have earth under your home you also have unlimited geothermal energy".

This low-grade "earth heat" is no new discovery or invention. Most of us understand the basics of "earth heat", or at least we know that home basements remain warmer in the winter and cooler in the summer than the rest of the home. We also know that for centuries, and even today, that cellars, just below the ground are very efficient for year around storage of fruits and vegetables.

The fact is, that at a depth of 6' to 8' the constant temperature of the earth remains at 50°F - 65°F year around whether you live in sub-zero weather or in hot deserts.

This consistent temperature is called "low grade *geothermal" energy, ...and it's free! The most economical way to use this energy is by geo-air, and not geo-liquid.

* The word "geo-thermal" simply means "earth-heat": GEO (earth), THERMAL (heat)

Geo Air 'vs Geo Liquid

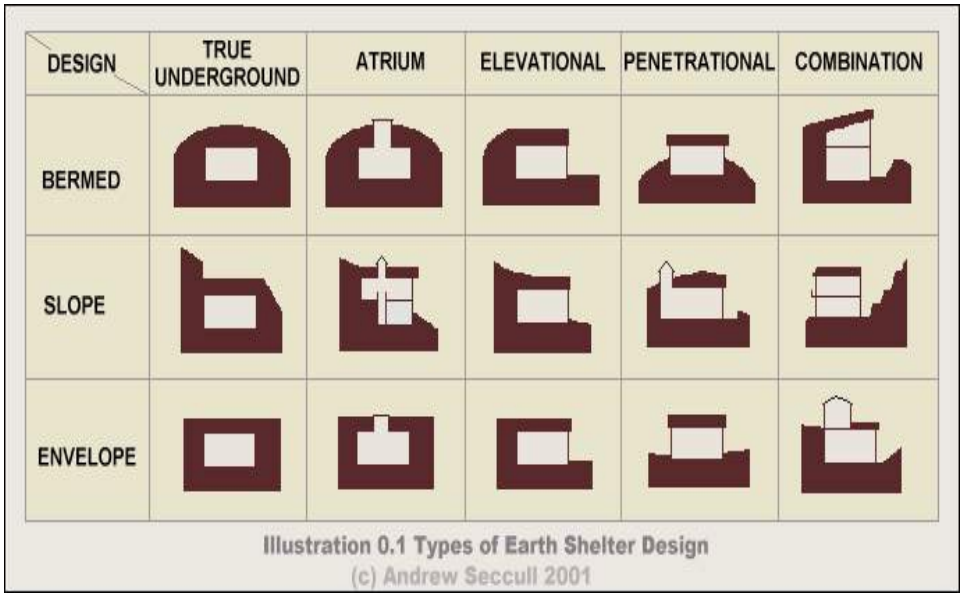
How can we efficiently extract and use this constant, plentiful and free "earth energy source" ? The three basic options are.

- Live underground
- Geo Liquid exchange
- Geo Air exchange

Living underground is not exactly realistic for most of us and it is quite limiting in very many ways. Two of the most obvious limitations are:

- The initial construction cost for re-enforced concrete roofing for such a large area is a major consideration.
- The lack of natural solar UV light is another.

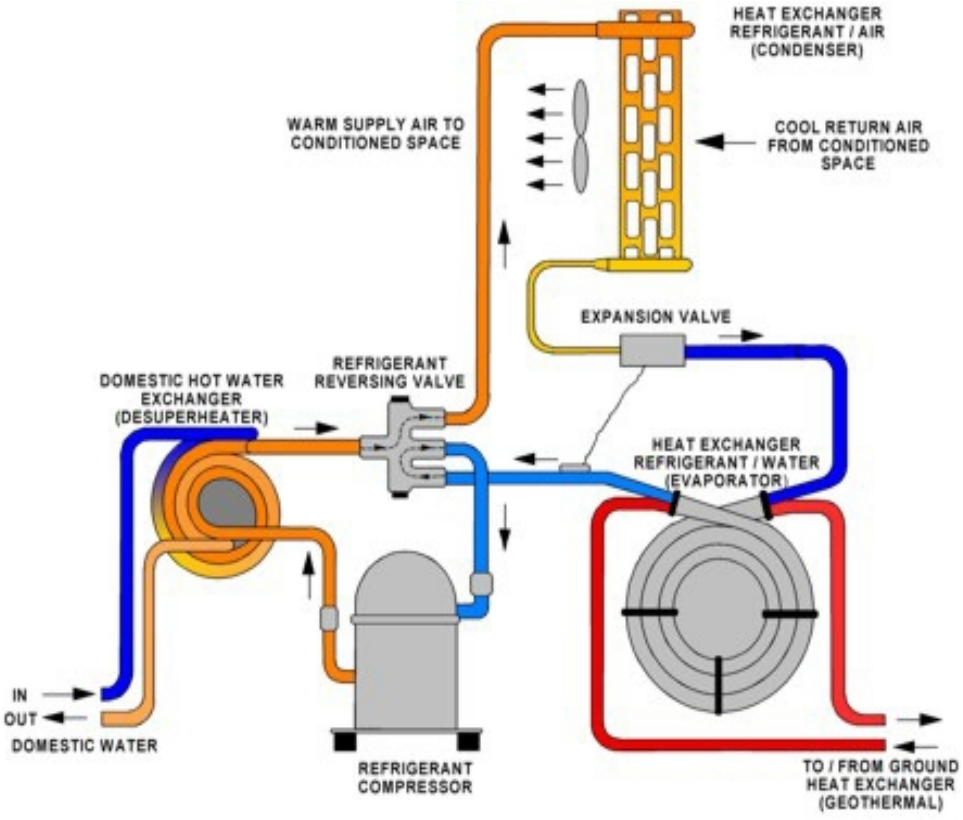
With an "underground home", the more natural sunlight you have, the less efficient your geothermal heating/cooling is. Most often an underground home requires larger construction space.



Underground Home Designs

Both "geo liquid" and "geo air" offer a more versatile and realistic solution than underground for optimal geothermal energy, and solar energy use.

Geo-Liquid exchange has become quite highly promoted and is said to be the most energy efficient means to absorb, move, and transfer the earths energy.



Geo-liquid Exchange Process

Geo-liquid is an extremely complicated and expensive system to install and maintain.

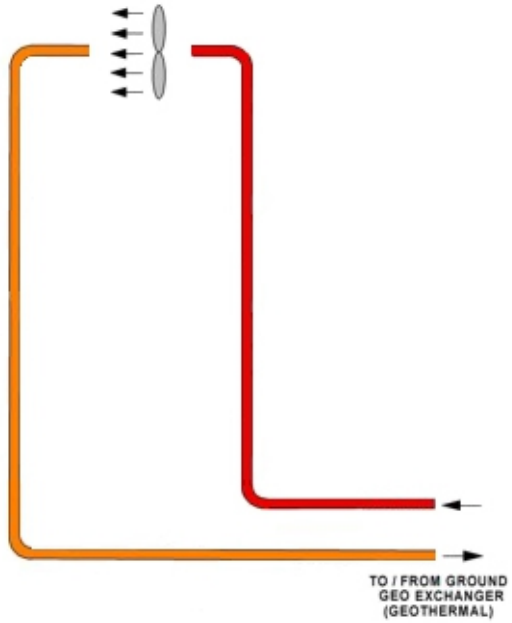
It is a liquid solution made of water and anti-freeze which is circulated through 1" tubing in either the earth or water sources such as ponds or wells. The liquid is then circulated through a heat exchanger which transfers the heat/cool temperature to air, water heating, or a geothermal heat pump.

Geo-liquid:
Method #1: Lateral tubing 1" tubing coils if you have enough property width for the lateral trenches in the earth.

Method #2: Horizontal drilling which are generally low temperature wells which circulate the water or tubing within
the water.

Method #3: Ponds are the third method whereas the tubing coils are placed inside the pond which absorbs the energy from the the pond water, then circulates it back to the geothermal heat pump. Although "Geo-liquid" systems are relatively efficient, they are also quite technical, complicated and expensive. Their initial cost of equipment and installation are extremely prohibitive for most home owners and commercial property owners. The high initial cost and annual maintenance costs make the "Geo Liquid" exchange quite impractical for most of the US consumers and the global population.

Geo Air exchange is the type Russ Finch has been using with much success for the past 30 years. The "geo air" principle uses only "air" to absorb and circulate the geothermal energy, thus simplifying the installation, equipment, maintenance and system costs.



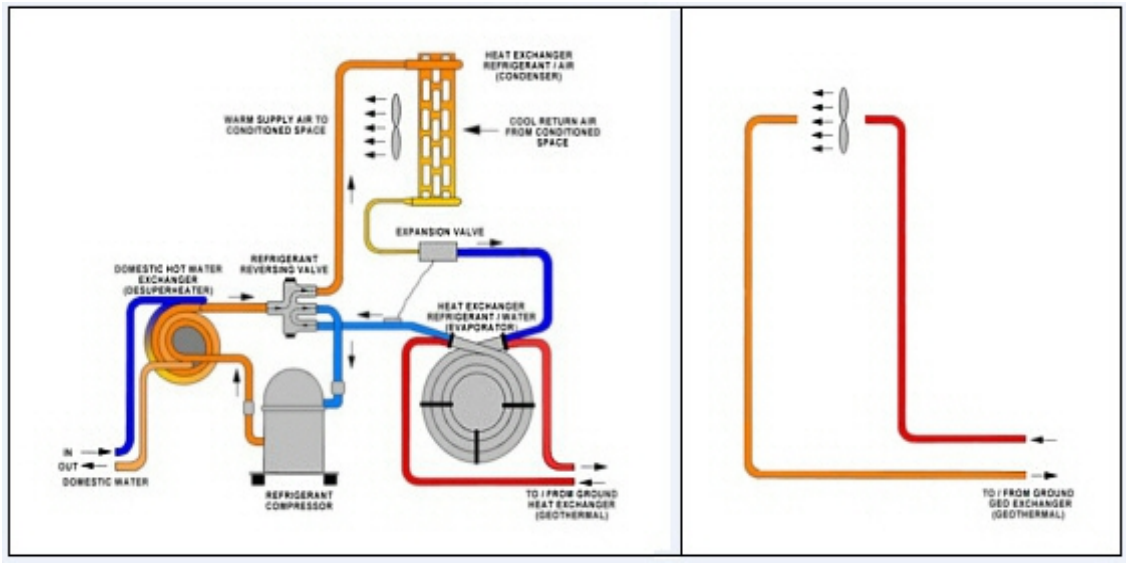
Geo-air Exchange Process

This type system "does not" require a heat exchanger or a geothermal heat pump. If a heat pump is required it can utilize the standard type heat pump which is much less expensive and complicated.

Russ's projects are very significant researchers, building contractors, and government since they prove the technical myths regarding the efficiency and limitations of "geo air" technology are simply not accurate.

A "geo air" system offers a few options in it's construction and technology depending on it's use and also the climate where the system is located.

Method #1: tubing and a circulation blower only
Method #2: tubing and a standard heat pump only
Method #3: tubing, blower, and standard heat pump combination



Geo-Liquid system 'vs Geo-Air system

The comparison between the two systems is quite accurate so both the installation and maintenance are very obvious. Should your climate require a standard "heat pump" it is much less complicated to install.

Significance Of This Research

The importance of Russ's research is quite a long list and extremely significant information for HVAC contractors, building contractors, architects, engineers, USDA, heat pump manufacturers, agricultural organizations, LEED programs, local grown food, greenhouse operators, solar equipment manufacturers, and the average DIY consumer.

Geo Air short list-

- This proves expensive geothermal systems are not necessary
- Systems can last decades longer than Geo liquid exchange systems
- The systems are nearly maintenance free and highly sustainable
- Extremely efficient and cost effective
- Heat pumps can function well in sub-zero climates
- Simple technology
- Versatile in any climate
- Low cost installation
- 100% Eco friendly

This 30 year report on three (3) geo-air system types proves that low cost geo-air is affordable and can be used in virtually and country, climate or economy whether rich or poor.

The geo-air technology could, and should easily become the "base energy system" for residential and commercial building construction globally. The by-product of this technology, being a stable base for use in local agriculture.

The Professors Said No

Russ needed some lower cost solution to heat/cool his large home and atrium and was obviously disappointed to learn of the "heat pump" limitations.

Solar cells were too expensive; solar heating panels had many limitations; wind energy we too expensive; and Geo-liquid was very costly to install and required much maintenance.

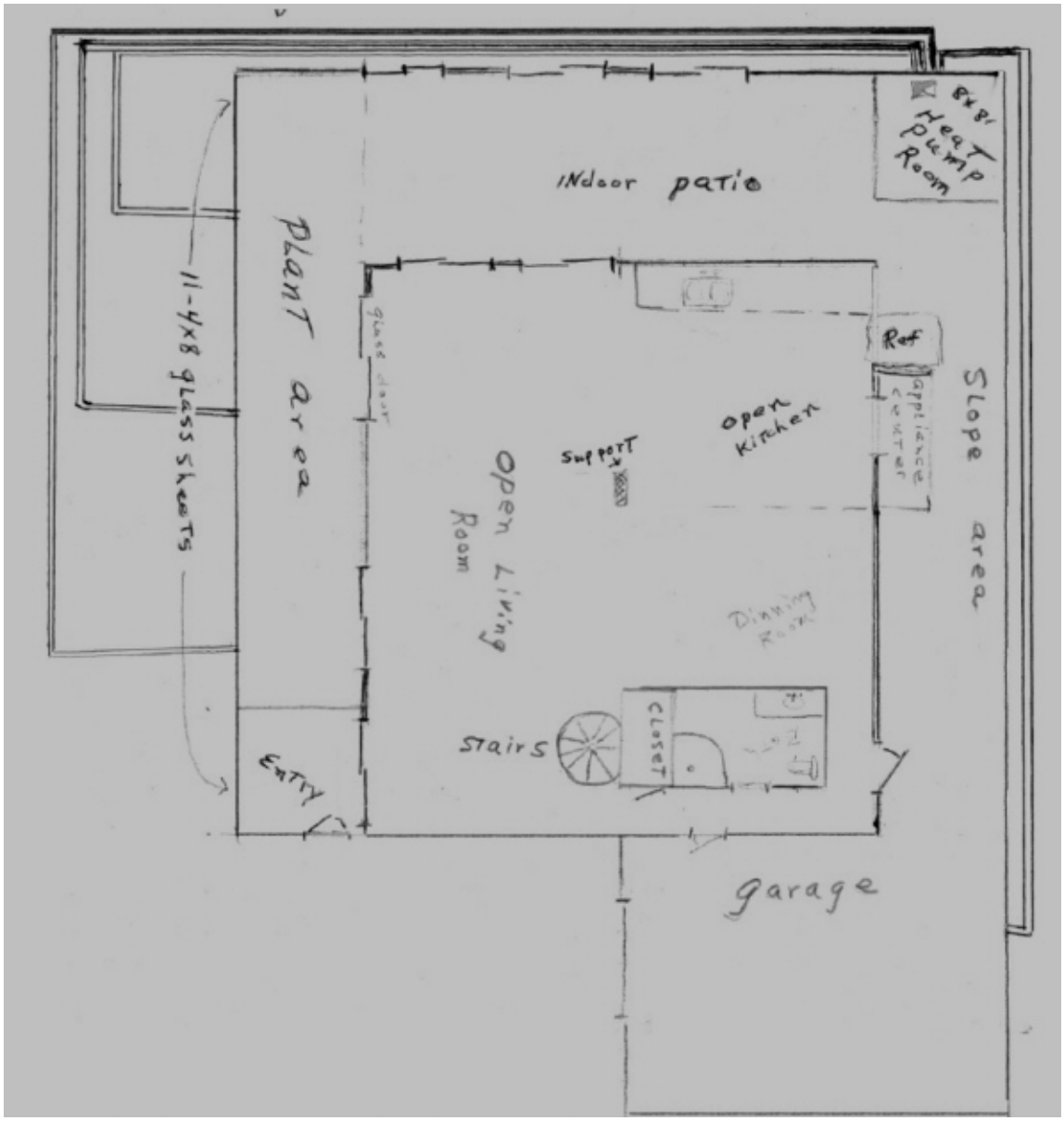
After much research of "heat pump" technology and "low-grade geothermal", Russ decided he should be able to use a combination of "geo air" and "heat pump" to solve his problem. His idea was to build a small, insulated room "inside" his home. Warm it with 50°F geo-air from below the ground, then put a "heat pump" inside this small room that will remain at 50°F-55°F even in Nebraska 's sub-zero temperatures.

In 1979 I had read that the temperature of the ground at about 8' is stable at nearly 52° F degrees in most of the northern United States . I reasoned that if the heat pump was in a small room, and air passing through tubes buried 8' deep was blown through the room, the heat pump would think it was in a warmer southern climate.

I contacted the University of Nebraska and was told by two professors there that "the idea was not feasible". This was the most important lesson I have learned in all the years of developing this system. Don't believe anyone that tells you something won't work if they haven't actually tried it themselves.

Luckily I didn't believe them and I still couldn't understand why this system wouldn't work so I contacted the heating division of the Coleman Company in Kansas.

An engineer at Coleman listened to my idea, and unlike the university professors in Nebraska, he agreed it should work very well, ...I wasn't really surprised.



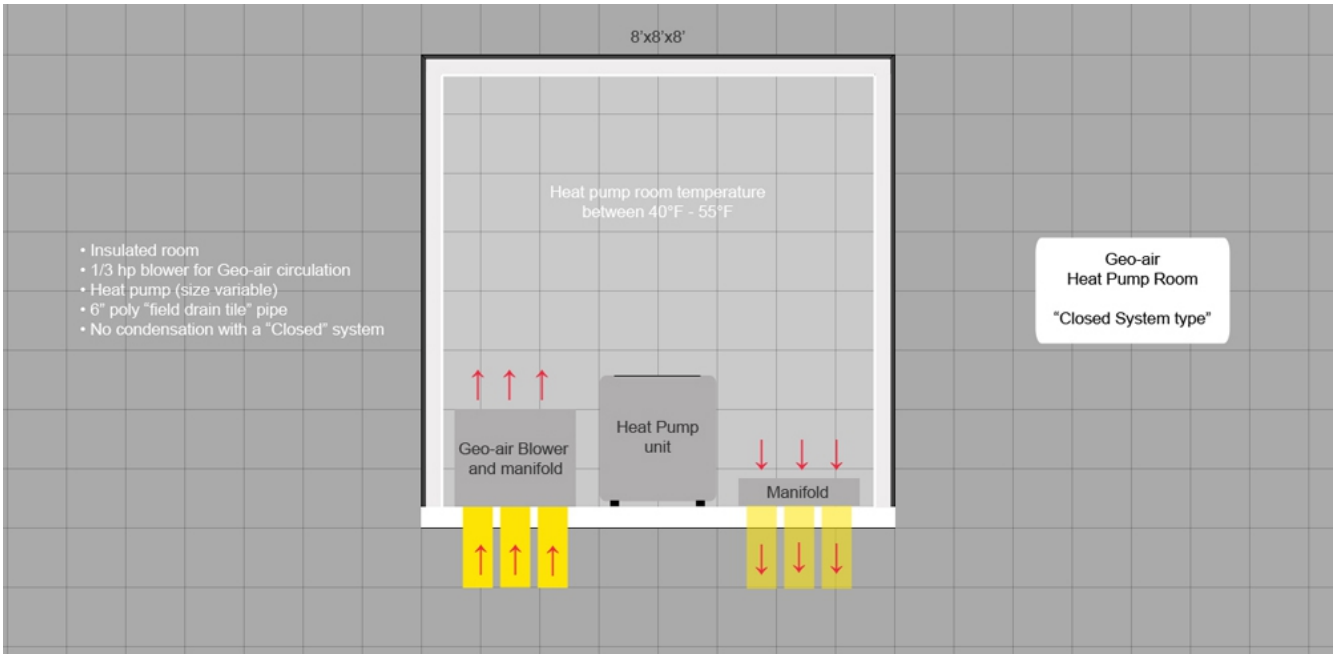
House plans of 1979 "A" frame geo-home sketched by Russ

The geo-air tubes supplied geo-energy to the large 3 level home, atrium, garage and heat pump room.

The Gamble Paid Off

It is somewhat amazing that Russ even continued past his conversations with the professors at the university. Most of us tend to believe and trust everything that comes from professors, engineers, and industry professionals.

Most professionals do mean well, and are attempting to offer advice to save you time and money. But sadly, many of these well educated people are only repeating what they have heard or are possibly issuing some very biased logic and wisdom.



Russ's theory to use "geo-air" and a "heat pump"

He reviewed his simple design many times and still couldn't understand why such educated people would doubt his concept Russ showed great tenacity and belief in himself to even continue with his theory and contact the people at Coleman.

Coleman was interested enough to furnish the heat pump to me at dealers cost. The unit was installed at my new "A" frame home and has worked flawlessly without any alterations for all these years.

The system also uses a 1/3 hp blower moving air in a closed circuit underground and comes out through 4 outlets in an 8' x 40' atrium and patio area on the south slope of the "A" frame house. The air then flows into the heat pump room which is now being heated to 52°F + degrees by geo-air from the earth below. Then out again through the blower, and again through the tubes which go back to the atrium area.

With the encouragement he gained from the Coleman representative, Russ went forward with his design using geo-air energy.

His theory has now been in use very successfully for more than thirty years....

Note: The original Coleman "heat pump" was finally replaced in 2006, after nearly 30 years of being tricked into believing it was in Florida .

Extremely Efficient

Russ never doubted whether his concept would function. However he and others were not certain how efficient his geo-air system would be overall.

He exhibited a great deal of faith in his concept to invest the time and thousands of dollars to test it.

- Were his tubes deep enough?
- Were the runs long enough to absorb the energy during long term use?
- Would the empty tubes hold the weight of 8' of earth?
- And for how many months or years before they collapse?

It is a known fact that water can absorb and conduct more energy than air, so how efficient will Russ's "geo-air" system be?

Remember, university professors and "geo-liquid" proponents insist that "geo-air" cannot absorb enough energy to heat or cool efficiently. Are they correct?

Although Russ wanted to believe in his concept, everything seemed too easy. The installation was easier than "geo-liquid" exchange system and even the equipment cost was less than 50% of a "geo-liquid" exchange system. ...this un-tested system was all quite a gamble for Russ.

The Big Test-
By spring 1980 the home and entire system was finally installed, and to his relief it all did exactly as it should. ...the tubing; the geo-air theory; the blower; and especially the standard heat pump. It functioned exactly like it was living in a warm climate. Whether it was hot summer days or sub-zero winters, the "geo-air" system worked perfectly.

The system functioned so well in the atrium they began to use the atrium as a greenhouse and not just an atrium/patio. In their atrium/greenhouse they began experimenting with many tropical flowers, fruits and vegetables.

A small portion of the geo-air atrium/greenhouse *within the home*.
Note again: This is the home atrium, not the main greenhouse.

Our first greenhouse which was created from the atrium, was not really planned but became a by-product of the houses heating idea.

From the beginning we could see that the greenhouse, which we thought would only be usable during warmer weather, was actually able to support many types of plants year around.

It was not just efficient and easy to use, but super efficient.

The Real Greenhouse-

The geo system was so extremely efficient and maintenance free, that in 1992, 12 years after he built his home and atrium/greenhouse, he decided to expand and build an actual greenhouse adjacent to his home.

With 12 years of the geo-air system evaluation and satisfaction, he decided to build and heat the new greenhouse "without" a heat pump.

That's correct, the new system was 100% "geo-air" and functioned completely without the use of a "heat pump"!!

The new greenhouse was 16'x85' and only included the 6" underground tubes and a 3/4 HP blower for circulation, ...but no heat pump! This was a 'stand alone' greenhouse with about 60% Lexan panels.

After building the new greenhouse *without a heat pump*, he decided to add a propane heater to the greenhouse just in case the "geo-air" system could not handle some of the sub-zero days.

The first winter in the new greenhouse turned out to be the best in years because it showed what the system would do in severe weather.

In February of that year the temperature dropped to 40F below zero. I was visiting in Nevada when the cold weather set in. But before leaving on our trip we set up a propane shop heater with a thermostat set to turn on at 35°F degrees. In the five weeks of cold weather the heater only used $8 worth of propane.

It was that very important test that reassured Russ the new greenhouse could survive quite well with only the simple "geo-air" system. Neither a "heat pump" nor supplemental heating was ever added to the 16'x85' greenhouse.

Surviving a sub-zero winter of -40°F degrees was the only test he needed. Now he was extremely certain of how really powerful his "geo-air" concept was. ...it has now been 18 years.

His Three Geo-Air Systems

Most people do not realize that Russ has actually developed and built three (3) "geo-air" systems during the past 30 years and each one uses a slightly different "geo-air" technology.
For easy reference we will name them GS-1, GS-2, and GS-3.

- **GS-1** is his original system which is used to supply geo-energy to his home and atrium. This is comprised of: geo-air tubes, circulation blower, and a standard heat pump. (Built 1979)

- **GS-2** is the second system was created for his 60'x75' workshop and is comprised of: geo-air tubes, and a standard heat pump. His creative split room design eliminates the need for a circulation blower. (Built 1980)

- **GS-3** is the 16'x85' greenhouse system and it simply consists of: geo-air tubes, and the circulation blower. No heat pump is used in this system. (Built 1992)

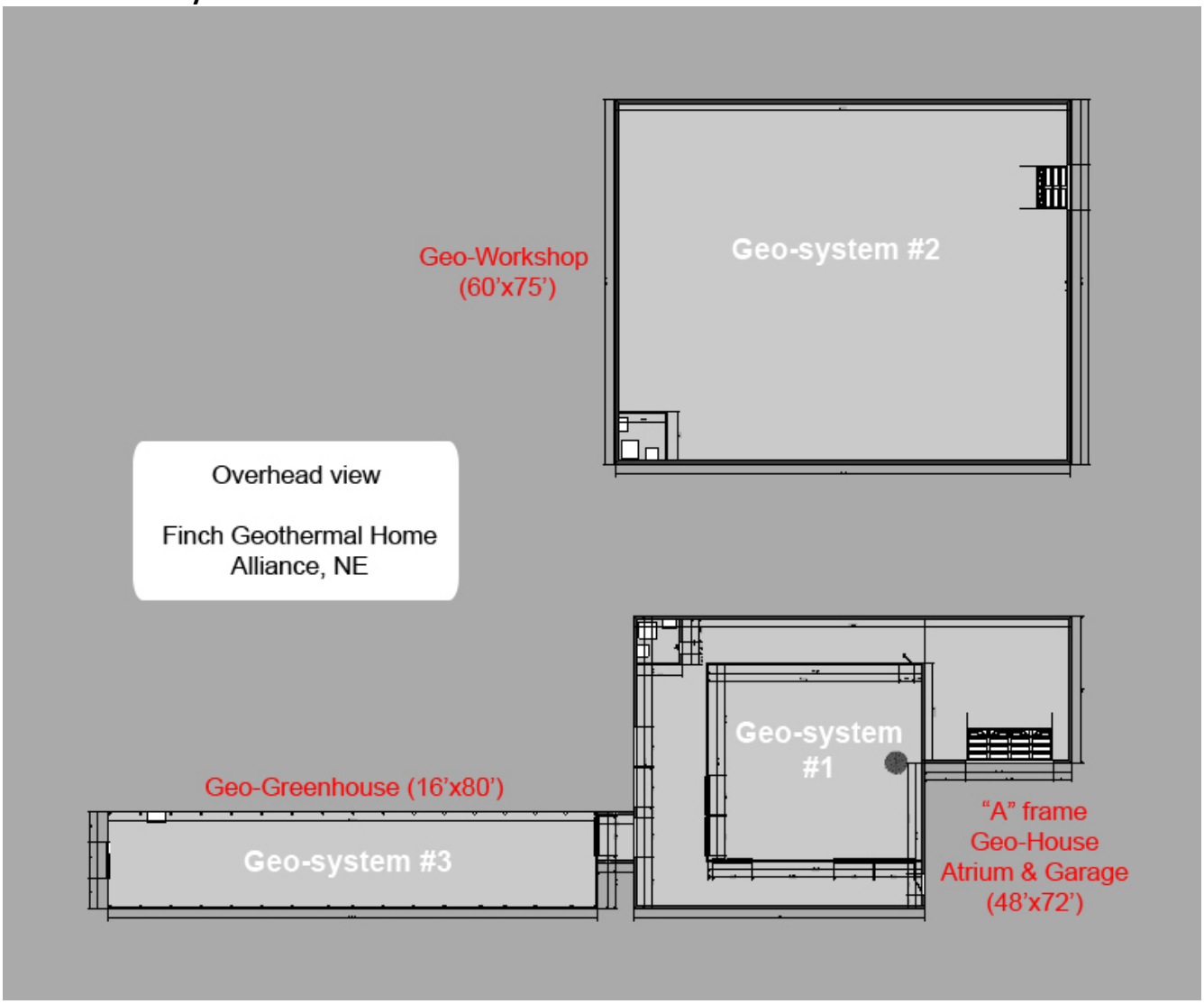
Each system is not just a different experiment, but each "geo-air" system can be used for completely different applications.

We will discuss each of these geo-air systems is basic detail because each system will have certain features that are more suitable for each climate and project.

His use of all three systems in one climate is a clear indication as to their individual technical importance and diversity.

Additionally, each "total" system is made of separate components. This allows for easier equipment sourcing, maintenance, and overall cost reduction throughout the years.

Three Geo-Air Systems



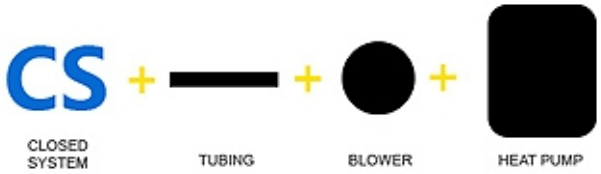
Three separate "geo air" systems. All of which are quite efficient.

Details of these three experimental systems can be seen on the following pages.

System Basics-

GS-1 is a closed system which circulates the same filtered air through the tubes, heat pump and back. This system is especially suited for climates with high humidity. This is a great deterrent for condensation.

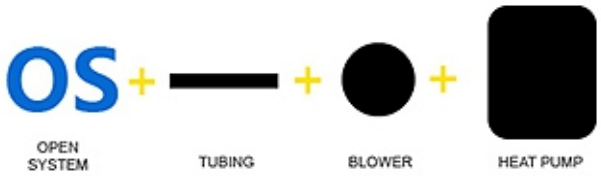
Preferred for homes and offices.



GS-2 is an open system which means it continuously draws fresh air from the outside, through the geo-air tubes, then through the heat pump.

This system does not use a circulating blower; instead it uses a "split-room" concept which utilizes the heat pump fan to circulate the air through the geo-air tubes.

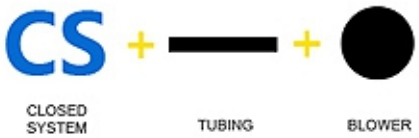
This open system can cause condensation in a building if it is enclosed and has a humid climate. It is best adapted to buildings such as workshops or garages.



GS-3 is a closed system which circulates the same filtered air through the tubes. This is the simplest and most cost effective system and does not need a heat pump.

It is best suited for homes and offices in hot climates, workshops in extreme cold climates, and also certain type greenhouses.

This is the type system Russ used for his Citrus Greenhouse.



Home, Workshop, Greenhouse

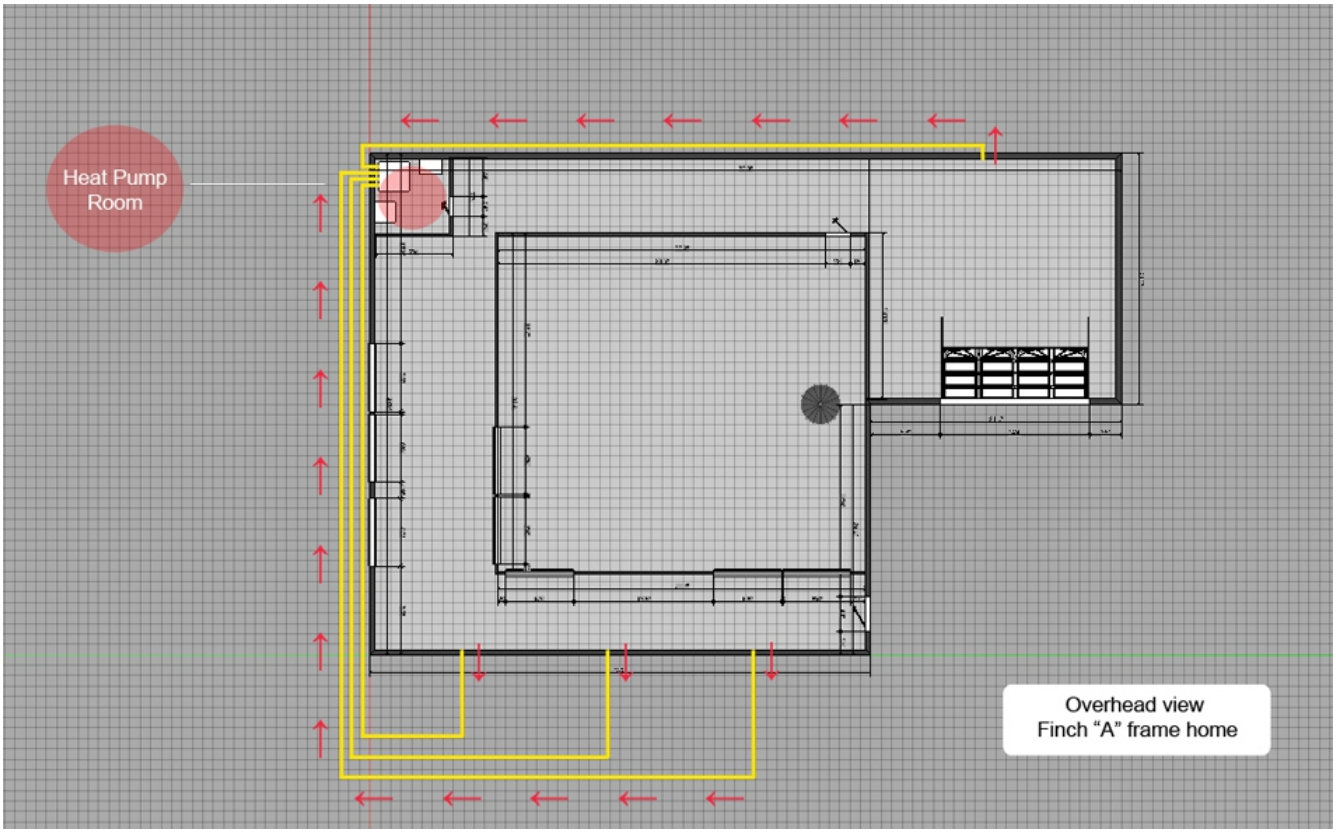
This section gives detail as to how Russ used each of his "geo-air" based systems efficiently

"A" frame Home (CS-1), with white Workshop (CS-2) on left

Greenhouse (CS-3) with House, and also Workshop in background

See drawings with the system details and comments of of Geo-Air designs CS-1, CS-2, and CS-3 on the following pages.

CS-1 was used in his home and atrium/greenhouse. The diagram also shows the circulation continuing also through the attached garage.

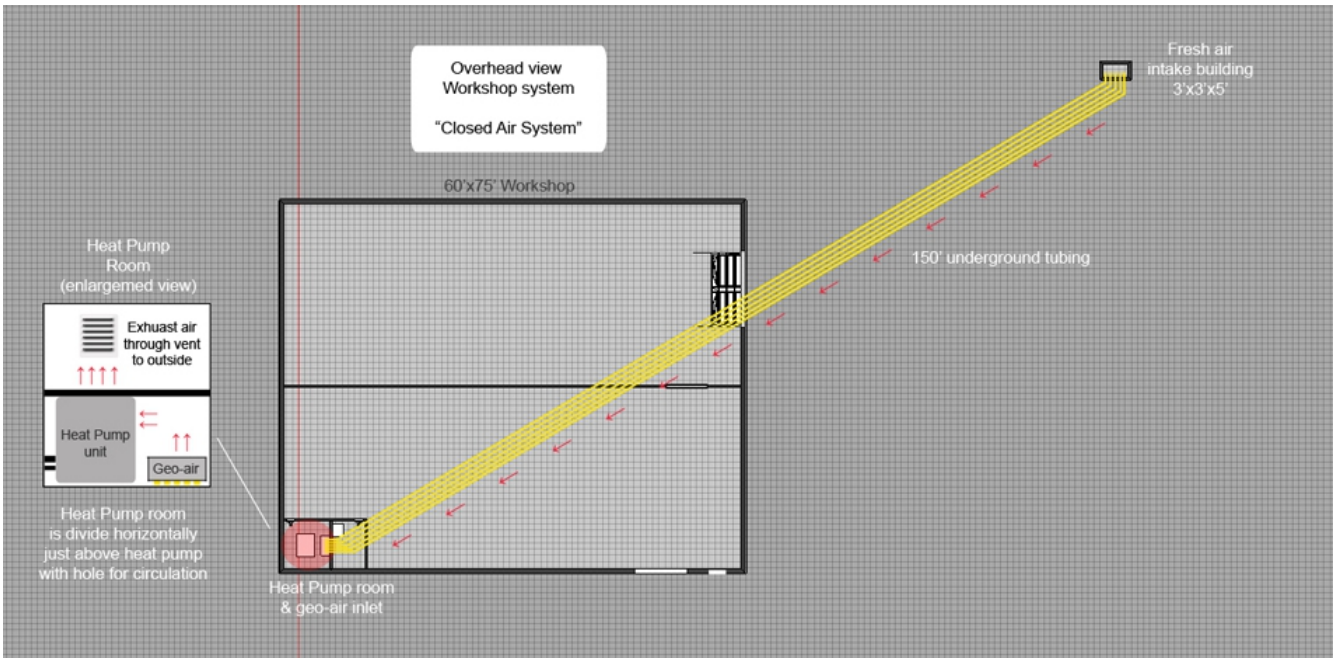


The system uses a 1/3 hp blower moving air in a closed circuit underground and comes out through 4 outlets in an 8' x 40' atrium/patio area on the south slope of the "A" frame house. The air then flows into the heat pump room which is now being heated to 52+ degrees from the earth below. Then out again through the blower, and then through the tubes which go back to the atrium/patio area.

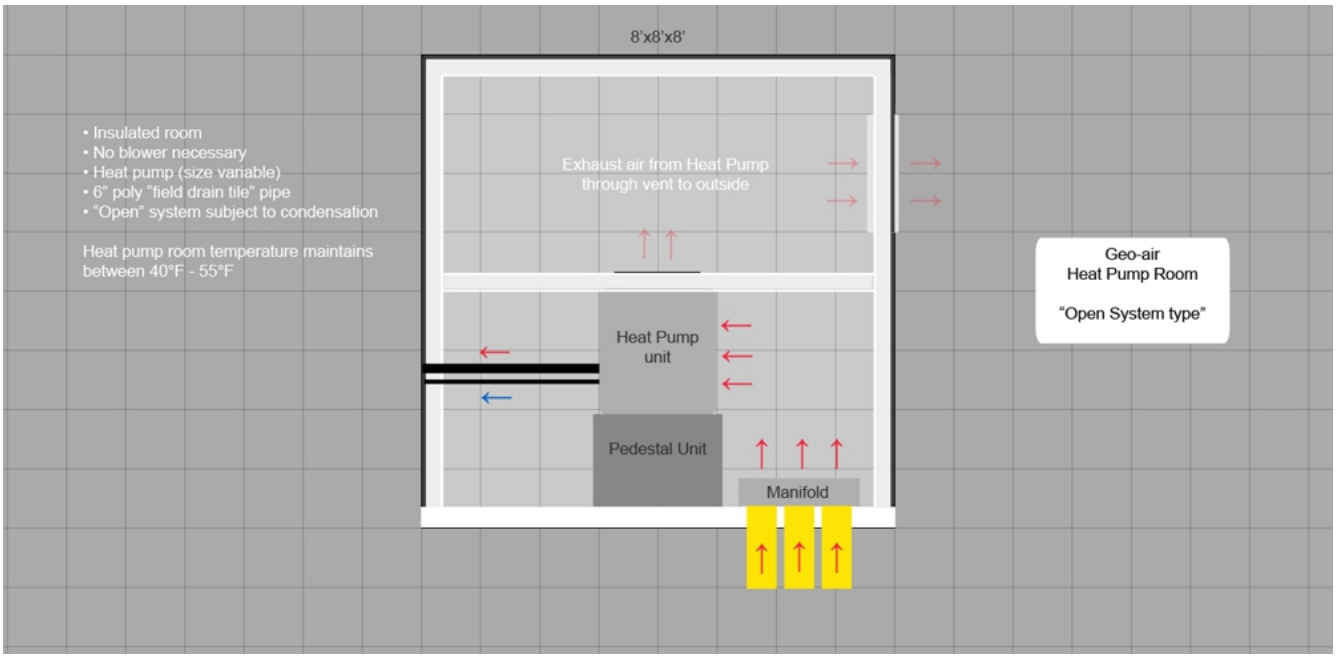
CS-1 Summary- House/Atrium:

3500' sq/ft, Heat Pump room, 1/3 hp blower, 4 circuits of 6" HDPE tube, 250' total length.

CS-2 was used in his workshop and was designed to draw fresh air from the small building outside. (upper right corner of graphic)



Overhead view of entire workshop and air intake building



CS-2 Heat Pump room detail

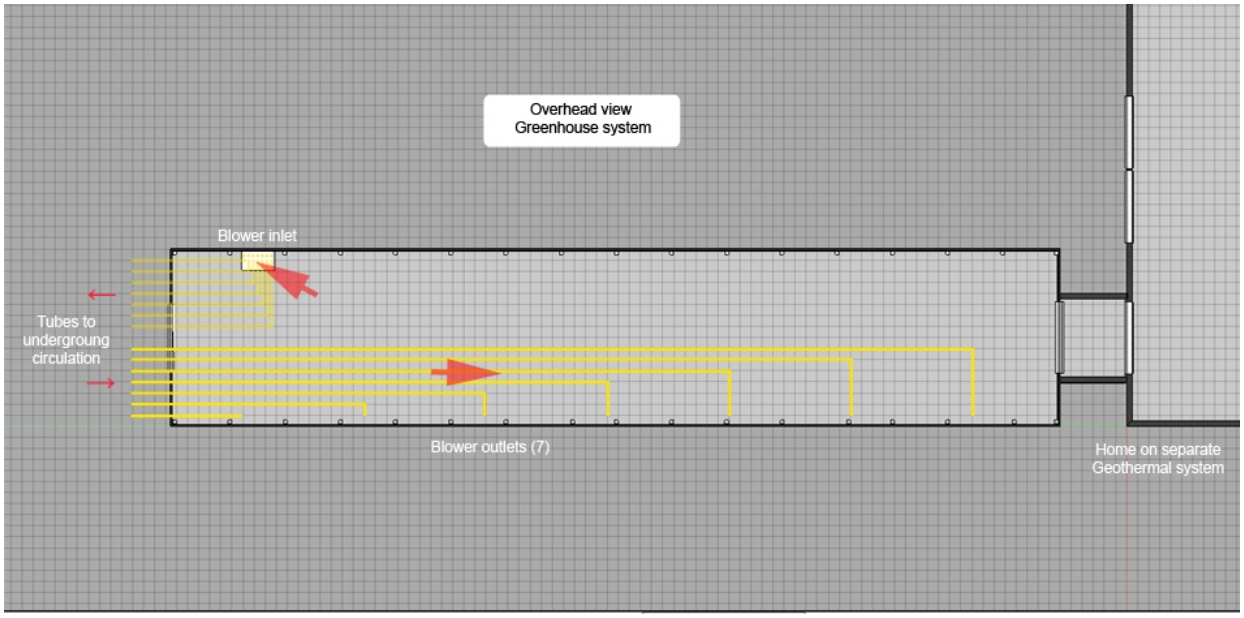
The workshop was built about a year after the home/atrium. Although Russ didn't know the long term of his first "geo-air" system, was fairly confident of the basic principle and it's energy efficiency.

The workshop system (GS-2) was still somewhat of a gamble and experiment since it was and "open system" this time but he needed to know the absolute facts for each system and not draw any inaccurate prejudgments as did the professors and some other professionals.

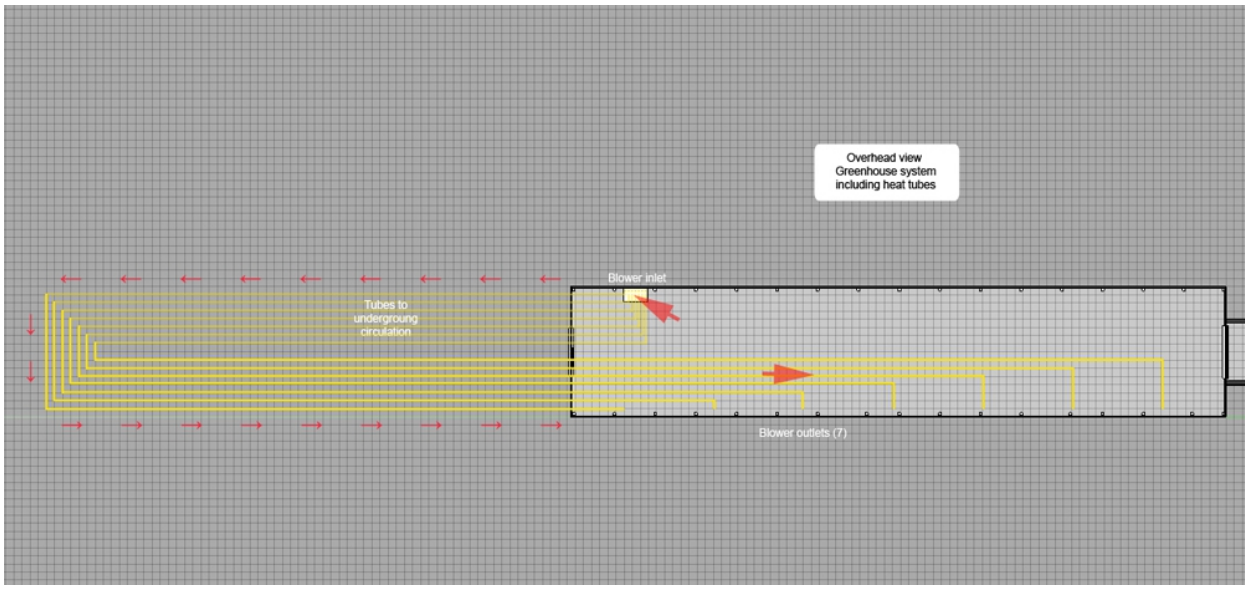
His logic was correct and it also functioned efficiently, especially for a workshop with large doors opening and closing regularly to the outside. Which was not particularly the case with the CS-1 in his home.

CS-2 Summary- ***Workshop:***
4500' sq/ft, Heat Pump room, (Uses HP blower only), 5 circuits of 6” HDPE tube, 750' total length.

CS-3 is the very simplified the system used in the greenhouse. This uses only the geo-air tubes and blower but without the heat pump. This system functions perfectly even to -30°F without supplemental heating units. The system also cools the greenhouse during the summer.



Overhead view of greenhouse with focus on the connection to the home/atrium



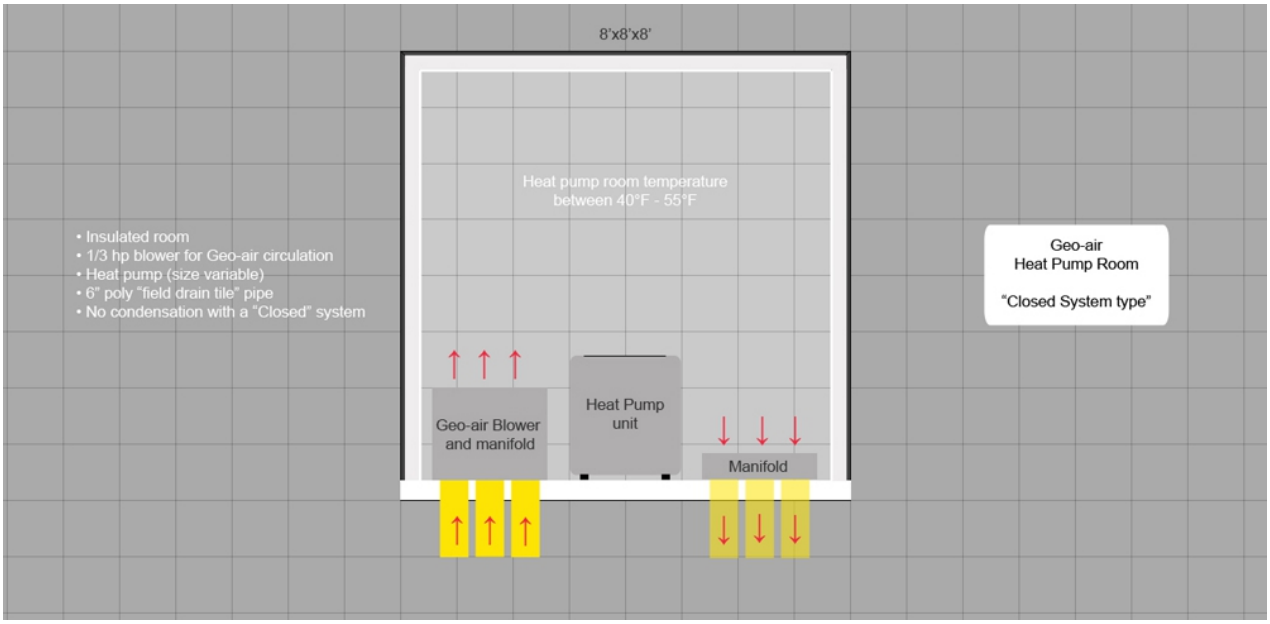
Overhead view of greenhouse with focus on the entire geo-air system and tubes

CS-3 Summary- Greenhouse:

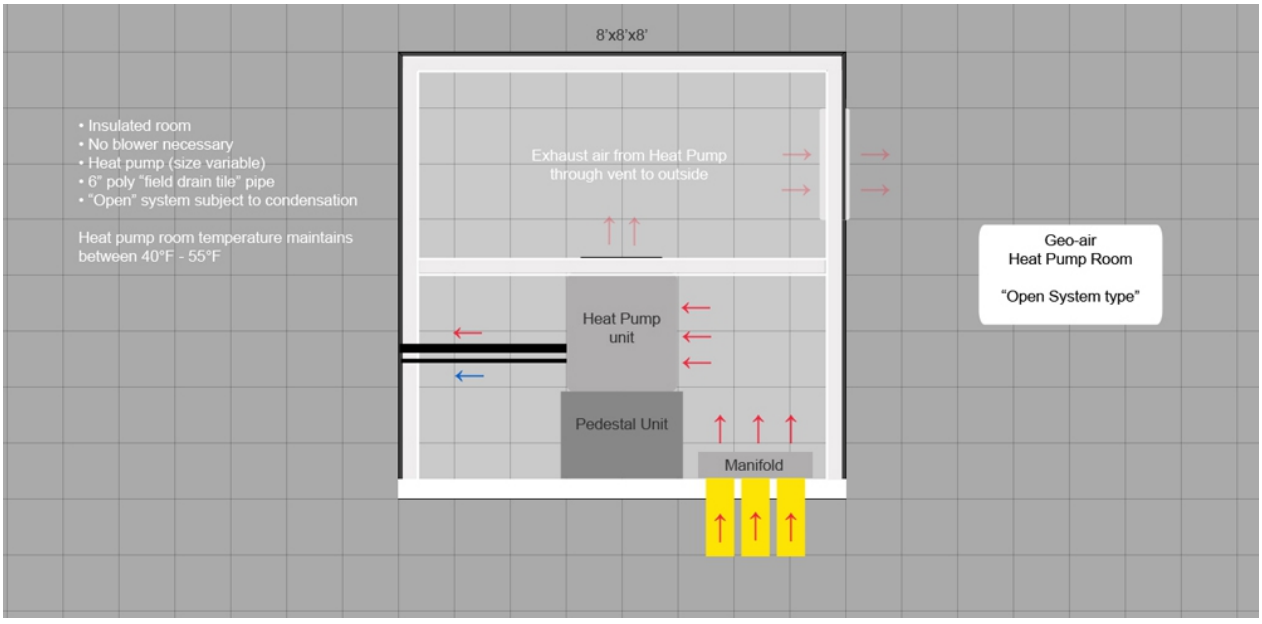
1300' sq/ft, 1/2 hp blower, 7 circuits of 6" HDPE tube, 1050' total length.

Geo-Air Heat Pump Rooms-

For the two "geo-air" systems utilizing "heat pumps", Russ has built 8x8 service rooms for each. The details are show below.



CS- Geo-air "closed system details"



O**S-** Geo-air "open system details"

No Mold or Fungus

A common belief among educators and HVAC professionals is that a "geo-air" system will promote the growth of "molds" and "fungus". Russ has proven this to be inaccurate and there are some very logical reasons for this.

None of the three "geo-air" systems that Russ built have these issues. Of course any plants or foliage inside or out can be subject to molds and fungus, yet his greenhouses have virtually none of these problems.

It is important to note that the home and atrium system, which has been running for 30 years have not produced any detectable molds and no musty odors. Even so Russ treats the blower occasionally with a fungicide powder. The underground tubing appear to have no mold or fungus either. This will be quite a surprise to researchers.

Russ relates some comments from horticulturists he had spoken to.

We have very little fungus and I've never seen mold.

After talking to some horticulturists they thought maybe the reason for such little fungus is that fungus needs a fairly constant temperature and this system cycles through a wide temperature range daily. We have found that fungus (and probably mold) is very easy to control, and if necessary you can pour about a 1/2 cup of Bordeaux fungicide into the blower and in about 30 seconds the entire unit is treated.

Why No Mold?

Additionally Russ discussed the principle of moving air. This principle is based upon the fact that moving air, ventilated or not, is seldom subject to molds. We know this well when speaking to professionals who live in extremely humid and hot climates such as Asia or Latin America. Homes and building with moving air are seldom subject to molds and fungus.

When we consider the "moving air" principle and also the "fluctuating temperature" it is quite logical why a "geo-air" system can remain so clean. Researchers have probably not considered these principles. Nevertheless, in 30 years and 3 separate "geo-air" systems, the fact remains, ...molds and fungus are simply not an issue.

Note: Any heating, cooling, HVAC system or greenhouse can become subject to molds and fungus in their system. The purpose of this section is to clearly indicate that a "geo-air" system is no more prone to molds and fungus than conventional systems, ...and maybe even less.

What Would I Improve

In my extensive discussions with Russ he seems to have a difficult time finding much he would change in his systems. What is most interesting is that his main comments refer to the systems being "super efficient" and that if he built more systems he may even shorten the length of the tubes rather than increase their length.

Regarding the greenhouse structure:

In the future I will use metal frame. The wood, even redwood has become a week point in the longevity of the unit. I would also change the roof angle due to snow accumulation.

His changes and comments are relating more to the structures and materials than any changes or modifications to the "geo-air" systems themselves. They are quite simple and should remain as such.

Please check the "UPDATE" section for new comments and project updates.

USDA Interest

In the US, the United States Department of Agriculture (USDA) has many different departments and functions.

Most US consumers only think of the USDA as inspectors of our various food sources, however they provide many other services than protecting our foods and health.

Among their various functions, USDA promotes agricultural production and assist in trade and commerce within the US and also abroad.

In addition to food safety, the USDA works to protect our natural resources, and encourage rural growing programs and "local grown food" networks in the cities. They assist small rural farmers and growers with technical information and also assist with financial aid programs for bonafide farmers.

USDA Delegation--The Visit

In the spring of 2009 Russ was surprised to learn that a delegation from USDA wanted to visit his home and greenhouse.

We had 10 people from the USDA Natural Resources office here today. They are interested in the very low water usage. Also some interest from California because of their water problems. More overall interest than ever.

It was Russ's hope the delegates were there to offer solutions for his further research and expansion.

The USDA was not only there to offer suggestions, but to better learn and understand how his phenomenal project could function so well. The information Russ has proven can have quite an impact on growers and agriculture basics throughout the US and globally.

What was learned:

· His enclosed geo-air system proved to consume only a fraction of the water consumed by a conventional greenhouse or by field crop production.
· Mold and fungus not an issue with his geo-air system.
· A long list of fruits, vegetables, and other horticulture flourish with geo-air in sub-zero climates.
· Geo-air is a very realistic and economical means of crop production in any climate of the US.

NOTE: The US climates are the same as those in virtually every country of the world.

Green Money Machine

When people hear of Russ's geothermal energy project the first questions are, "does it really work"? But the second question is usually, "How can I make money off this"?

"How can I make money off this"? Quite frankly, here are too many possible answers to that question.

No matter who you are or what line of business you are in, you can easily benefit financially from the contents of the "Citrus In The Snow" Report. This is "free" dependable energy anyone can have!

As you may have noticed, this really isn't only about building greenhouses with no energy costs. This is really about the new technology called "geo-air", and the uses are unlimited.

Building & Construction

-New home construction
-Remodeling and retrofit of older homes
-Offices
-Warehouses
-Workshops
-Schools
-Wine cellars
-Government buildings
-HVAC remodeling

Agriculture

-Greenhouses, commercial & residential
-Barns, stables & shelters
-Food processing areas
-Root cellars
-Local Grown Foods
-Aquaculture
-Water conservation

Citrus $$ Crops-
Although there are endless possibilities for the use of "geo-air" technology which Russ has proven beyond doubt, one can't help but notice Russ's new passion--"Citrus crops".

As noted previously, Russ and Darlene have tested literally 100's of fruits, vegetables and tropical plants during the past 30 years. It is quite obvious what has caught his attention the most.

Russ's passion for "geo-air" energy technology, is only surpassed by his passion for Citrus crops.

I really hesitate to say much about the profit potential in this area for citrus because people wouldn't believe me.

For example, lemons in the local Wal-Mart are $1.50 a pound now and a tree takes about 8' circle, and the mature trees are producing around 125 pounds a year on a bad year. That is $187 a tree or $187 for 1/700 of an acre. That's the way we try to explain it to the Ag people in this area, they understand production per acre.

The chance of crop failure is very low so no need for insurance and if it is grown locally low freight cost. There is no set harvest period as the fruit remains on the tree until needed.

Did you notice his last sentence? *"...fruit remains on the tree until needed".*

This is incredible! No hurry or waste as is common with most garden and greenhouse products?

The orange, tangerines, and lemons in the "geo-air" greenhouse can remain "un-picked" on the trees for more than a year without deterioration! A grower can simply pick them fresh according to the local demand. Russ has been using this particular method for more than 5 years.

His secondary excitement is for grapes, Asian pears and figs.

We have several varieties of California grapes. I think this type greenhouse has a lot of potential for grapes that can't be grown in the colder climates. This type grapes is used in higher priced wine than the northern grapes. It may be that the starting of cuttings would be a commercial use as we have had very good luck with cuttings.

Editors note: January 5, 2010

Today, the national news here in the US is reporting the *Californian and Florida* orange growers are loosing up to 70% of their crops this week due to freezing temperature in the prime growing areas.

How ironic, "The oranges can't freeze in Nebraska ...."

Growing Test Results: Fruits, vegetables, tropicals

The following pages are evaluations which Russ and Darlene compiled from a few of the hundreds of plants they have tested in the Geo greenhouse.

They have rated them on a scale from 1-10. A #10 being the highest rating.

SUBJECT	SPECIES	RATING	COMMENTS
FRUIT TREES			
APRICOT	Moorpark	8	
ASIAN PEAR	Chojuro	9	
ASIAN PEAR	Hosui	9	
ASIAN PEAR	Shinseiki	9	
AVACODO	Gwen	8	Tub
CHERRY	Compact Stella	10	
FIG	Brown Turkey	10	
LEMON	Meyers Improved	9	
LIME	Mexican	8	
LIME	Ranger	10	
NECTARINE	Mericrest, dwarf	10	
NECTARINE	Nectar Babe	8	
ORANGE	Valencia	10	

ORANGE	Washington	8	
PEACH	Desert Gold	3	
PEACH	Garden Sun	10	Espalier
PLUM	Yellow Egg	9	
TANGERINE	Algerian	7	
TREES & SHRUBS			
PINE (seed)	Austrian	-	
PINE (seed)	Japanese Black	-	
LOCUST (seed)	Honey	5	
LOCUST (seed)	Black	10	
PINE (seed)	Ponderosa	4	
MAPLE (seed)	Amur	8	
ILEX	Burfordi	8	
GRAPE	Various types	9	
GRAPE	Cuttings	10	
RASPBERRY		10	
BLUE BERRY		0	Fungus
STRAWBERRY	3 varieties	10	
PICEA	Blue Spruce	-	

POMEGRANITE (seed)		7	Small
KIWI (seed)		10	
BANANA		0	
PLANTS			
AEONIUM	Bronze Succulent	5	
AGAVE	Century Plant	10	
ALOE	Vera	10	
ALSTROMERIA		0	
ALTHAEA	Rose Of Sharon	5	
ALYSSUM		6	
AMARYLLIS		10	
ASPARAGUS FERN	Fox tail	10	
ASPARAGUS		7	
BEET	Red	9	
BEGONIA	Tuberous	9	
BELLIS	English Daisy	0	Fungus
BIRD OF PARADISE		10	
BOUGAINVILLEA	3 varieties	10	
BROMELAID	6 varieties	8	
CABBAGE	Ornamental	7	

CALLA LILY	Dwarf Pink	2	
CALLISTEMON	Bottle Brush	0	
CAMELIA	3 varieties	9	Nice Bloom
CAMPANULA	Cup & Saucer	10	
CEPHALOCEREUS	Old Man Cactus	8	
CHINESE CABBAGE		8	
CHIVES		10	
CLIMATIS		10	
CLIVIA (seed)		20	
COLUMBINE	Kaffir Lilly	8	
CYCLAMEN		7	
DAISY	Daisy Painted	0	
DANDELION		10	
DAYLILY		8	
DELLPHINIUM		10	
DIANTHUS	Various varieties	10	
DICENTRA	Bleeding Heart	1	
ECHEVERIA	Hen & Chicks	10	
ECHINOCACTUS	Barrel Cactus	10	

ECHINOPSIS	Lily Cactus	9	
EICHHORNIA	Water Hyacinth	10	
EPIPHYLLUM	Orchid Cactus	9	
EQUESTUM	Horsetail	9	
ESCHSCHOLZIA	California Poppy	2	
ESPOSTOA	Old Man Cactus	9	
EUCALYPTUS		0	
FREESIA		9	
FRITHIA PULCHRA	Baby Toes	0	
GERANIUM	Common	10	
GERANIUM	Hanning	9	
GLADIOLUS		8	
HAWORTHIA		8	
HEDERA	Various	10	
HESPERALOE	Yucca, Red	10	
HIBISCUS		9	
HORSRADISH		9	
HOYA		4	
ICE PLANT	Fuchsia, Yellow	9	
ICELAND		0	

ILEX		9	
IPOMOPISIS		8	
IRIS	Carolina	10	
IRIS	Blossfeldiana	10	
JASMINE	Frizzy	8	
KALANCHOE		5	
KALE FLOWERING		8	
LETTUCE	Iceberg	7	
LIATRIS	Blazing Star	6	
LILY	Oriental	4	
LITHOPS		7	
MARIGOLD	Inca Yellow	0	
NANDINA	Heavenly Bamboo	10	
NASTURTIUM	Succulent type	4	
ONION		4	
ORCHID	Various types	10	
OXALIS		8	
PALM	Palm	10	
PALM	Sago	6	

PANSY	Joker	8	
PANSY	Padajara	8	
PASSIFLORA	Passion Flower	10	
PEPPER	Bell	8	
PINEAPPLE		6	
POPPY	Double Oase	1	
POPPY	California	1	
POTATO		9	
PRIMULA	Obconica Canta	4	
PRIMULA	English mix, 2 types	7	
PYRACANTHA	Espaliers	10	
RANUCULAS	Bloomingdale	2	
RAPHIOLEPIS	Pink Lady	10	
RHIPSALICOPSIS		9	
RHODODENDRON		5	
RHOEO		10	
ROSA RUGAROSA			
ROSE	Miediland Scarlet	10	
ROSE	Touch Of Class		
ROSE	Meidiland Alba (White)		

ROSE TREE	Intrigue	10	
ROSE OF SHARON		8	
RUDBECKIA		7	
SCHLUMBERGERA	Christmas Cactus	10	
SNAPDRAGON	Red-White	8	
STAPELIS	Starfish Flower	10	
SWEETPEA	Perennial	10	
TOMATO	Various types	9	
VINCA		7	
VIOLA	Cornuta Yellow	9	
VIOLA	Old Fashion	9	
WATER LILY	Hardy	8	
WATER LILY	Tropical	8	
WISTERIA		0	

BIRDS			
FINCH		10	
FINCH	Gold	10	
PARAKEET	Zebra	0	
WEAVER		10	
SPARROW		10	
CANARY		10	

Notes Through The Years

The following are *notes and comments from Russ* regarding information and events he felt were important with his projects through the years.

I certainly believe they are worth reading.

- Barry Naef

More of his comments and information can also be found in the section labeled **FAQ** (Frequently Asked Questions)

The following information is provided, not as strict rules for an earth heated greenhouse, but is my experience in building two different types of units and using them for 30 years. -Russ

As I've stated before, don't be limited by the information furnished in this report. Every home and greenhouse will be constructed differently because of conditions unique to itself and your environment but "the basic geothermal concept" will remain the same in virtually any location of the world.

The construction methods and measurements I will show here are only meant to be rough guidelines to help you with ideas for building your own geothermal unit, and will probably need to be adjusted to fit your site and projected use for your geothermal unit.

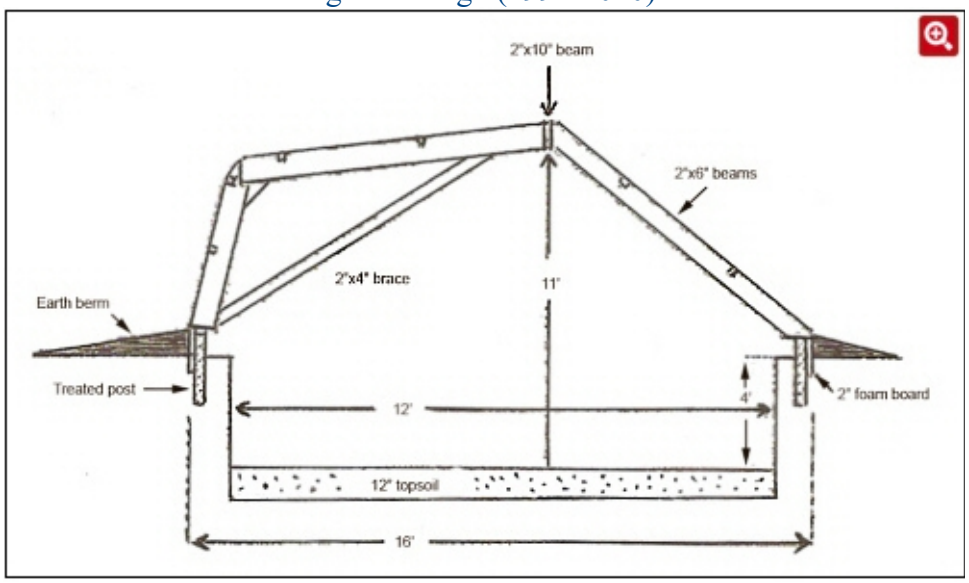
The original atrium/greenhouse was incorporated into the south slope of the "A" frame house. The diagram shows the general layout. This type unit could also be built as an add-on to an existing house or building.

The 'Sun Pit' Greenhouse

For our large greenhouse unit built in 1992 I used wood construction, but if I build another one I will use metal. I believe metal would last longer and need less maintenance. I would stay with the same basic shape but slope the south wall more to allow for more slope to the roof. This would allow the condensation in the winter to flow down the Lexan rather than drip from the roof.

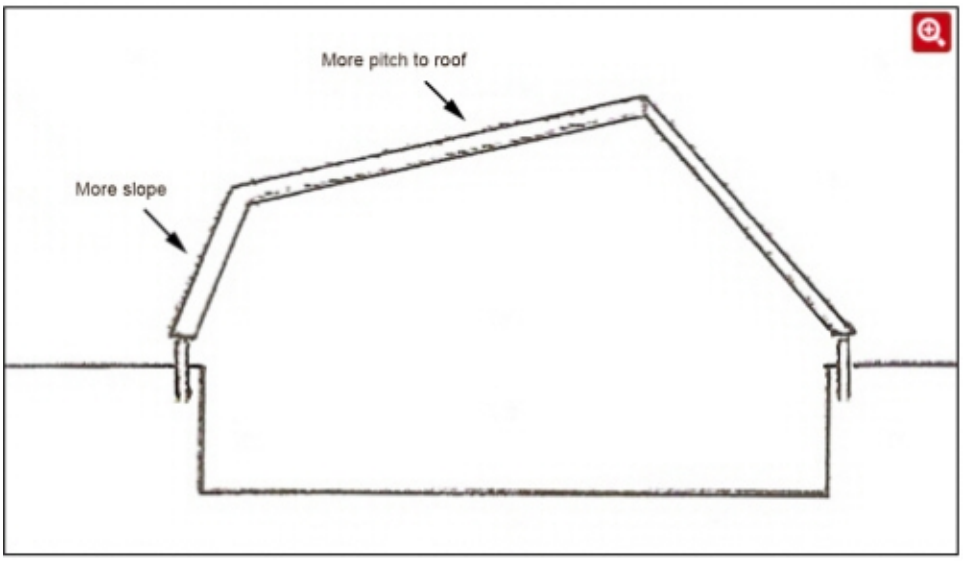
This is no big problem but it could be controlled by more slope.

Original Design (1992-2010) wood



Sketch: Russ Finch

New modifications (Summer 2010) steel tube



Sketch: Russ Finch

These drawings are not to scale. I determined the angles for our unit by plotting it on a concrete floor. You have to plot the angles of the front area covered by the glazing first, as the size of the glazing will determine what the angles are. I found it helpful to use a piece of rope cut to the length of the Lexan to

figure the different possible angles. In our cases, the Lexan was 6'x12' so I used a rope 12' long. It is easy to figure by placing one end of the rope at point on the base plate of the foundation. Conform the rope to the pitch of the front wall and the roof. By drawing a line from the base plate for the back wall to the end of the rope at the peak of the roof, you can determine the height of the back wall. In snow country the back wall shouldn't be too angled. Our back wall is 45° degrees but it would be better to have it about 60°.

This is the greenhouse we call the sun pit unit, and is 80'x16'. A greenhouse of this size is probably about the maximum size a homeowner would build for personal use. This size could also be used for a small commercial unit.

Our cost for the "sun pit" greenhouse was around $7500 for the material and excavation work. I did all of the building and only needed help from my wife handing the 12'*6' Lexan panels. Included in the cost was lumber, 6" tubing, Lexan panels, 4'*8'*2" foam insulation, metal roofing, 10" blower 3/4 hp motor, electric wiring, etc..These are 1992 prices so the cost could be higher now.

We call it the "sun pit" because the bottom is 4' below ground level as you can see in the drawing.

This greenhouse was finished in the fall of 1992 and was later divided into two sections; one 16'x50' for tropical ans semi tropical plants and one 16'x30' that can be shut off from the heated area for northern plants that require a chilling period.

The other unit built into the slope of the "A" frame house has performed well for the 14 years we have used it. I knew from performance charts that the double pane insulated windows weren't allowing as much of the light spectrum to enter as some of the plastics would. (The glass is not greenhouse type glass.) We moved many of the plants from the house slope into the sun pit unit. It is too soon to tell the effect on most of the plants. But some of the plants responded quickly to the different light. Christmas cactus started setting buds and a Cymbidium orchid that hadn't bloomed for 7 years put up a flower spoke within 2 months.

The sun pit unit was finished in October 1992 and the first trees were planted in November and December. Right away I found out that I was on my own. I had planned on finding help from the universities but that turned out to be harder than expected. They could give general information on the plants themselves but there was no way of knowing how the plants would respond to this environment. Another problem was the professors weren't too responsive sometimes to a novice (me) that started asking questions about growing "citrus trees" in Nebraska .

Because of the lack of assistance It would be more than two years before we could show the results to some of the university horticulturists so they would take us seriously.

Our greenhouse is located 6 miles north of Alliance Nebraska , right in the center of the panhandle of Nebraska . It is flat farm land on the west edge of the Nebraska Sandhills. The Sandhills are rolling ridges of sand dunes not unlike the Sahara Desert except they are covered with grass and the valleys are dotted with lakes and lush meadows. There are few trees in the area to slow the cold winter winds. The winters can be very cold; average January high is 36 degrees the average low is 10.7ºF. The mean annual number of days with temperatures below zero is 20. We have days colder than minus 20 degrees most winters. Average first frost date is September 27 and average last frost May 15th.The average number of overcast days in January is 15.

Our summers are hot and dry with an average high in July of 87ºF and with several days over 100ºF during the summer.

The first winter turned out to be the best in years to show what the system would actually do in severe weather. In February the temperature dropped to 40ºF below zero. I was in Nebraska when the cold weather set in. Before leaving, we set up a propane shop heater with a thermostat set to turn on at 35ºF. In the five weeks of cold weather the heater used $8 worth of propane. Right away we found that we were going to have more trouble chilling the cold area of the unit than heating it. We divert the heat tubes, in the area the cold climate plants are planted, into the tropical plant area. The northern plants need 900 to 1200 hours of temperature below 45°. We thought that when we closed the cold room off

and cut off the underground heat, the room would cool off but it didn't. When the temperature at night was in the teens the temperature in the room would drop to the high 30s or low 40s. But in the daytime, if the sun was out even for a short time, the temperature would rise to
the 60s and 70s.

During the necessary "chilling period" we installed a small 6" blower with a thermostat set to turn on at 40°F degrees to blow cold air into the room. This helped but could not deliver enough air on sunny days to cool sufficiently. It was still too warm. We now have installed a 3'x3'screened door on the end of unit. We opened this in all but the worst weather. This helped so now we are working to automate it. The ideal situation would be to keep a constant 35° F degrees for the entire chill period.
Because of our weather in western Nebraska we wait until the 1st of December to start chilling the northern plants. It is usually too warm to start earlier although it could probably be done earlier in other areas. It is fascinating to watch the transformation as most plants will drop all of their leaves in 7 to 10 days. Some plants such as roses sometimes will not shed their leaves easily so you need to strip the leaves from these plants so they will go into a dormant period. We have chosen to chill for 900 hours, because most of the trees we are growing require no more than this. We open the door and the air tubes in the chilling room on January 12th and within 7 to 12 days most of the plants will come into full bloom.

A greenhouse with this type of heating system can't be used as you would a typical greenhouse because most of the time it is too cool for most seedlings, although there are plants that will do very well in a cool setting. Most seeds require a warmer more stable temperature to germinate. A large percent of the plants we are growing seem to thrive at temperature in that 40ºF and 50ºF range. Some of our plants are at a disadvantage because we have so many varieties we can not have the environment that is best suited for each variety. In a production unit used to produce a specific plant or crop, it would be easier to adjust the exact conditions.

All of the equipment we have used in the heating and cooling system can be purchased from most hardware stores and electric motor supply catalogs. The motors are controlled in such a way that they start on the temperature rise and fall. This can be done with one thermostat just for this purpose, but we have found it less costly to use two thermostat in the same electric line. All that is needed is a thermostat that closes on temperature rise and one that closes on temperature drop. These thermostat can be set to turn on and off at the temperature desired. I have found that most of the year it works best to have the blower turn on when the temperature drops to around 45ºF degrees and rises to 80ºF degrees. We also use a 1/3 HP 4' whole house type fan that is on a temp, rise thermostat to ventilate the greenhouse when the temperature inside rises to 95ºF degrees. This fan is mounted at one end of the unit and a vent area needs to be installed in the other end to allow air to flow through.

This will not cause problems during the "chill period" because the temperature, at least in the northern areas, will not get hot enough to need this much ventilation. If the facility was to be used only for crops that required chilling, the ventilating fan with a thermostat set to keep the temperature between 35ºF and 45ºF degrees should work well. There are several types of roof louver vent system that open

sections of roof to cool, but I don't like to have any more openings in the ceiling than are absolutely necessary because of heat loss.

The first plants in the new "sun pit" greenhouse were planted in November of 1992. The criteria used by us to stock the greenhouse was very simple; we would try any plant from anywhere in the world. Because of costs, most of the plants were seedlings or young smaller plants. The main purpose of the greenhouse was to prove the ground heat system, and there was no information available for a system of this type. I called several agricultural schools and talked to many, many experts, ..."when they would talk to an amateur". Some of the professors were very helpful though, and tried to help with problems we were having within their expertise. But most told us flat out that it just wouldn't work especially if they found out I have no horticultural background. I knew that to stimulate interest in the system we would have to prove we could raise plants that were completely out of their element.

Although I didn't get a lot of in put, the answer was simple. I partitioned the unit into two rooms 55 feet for subtropical and tropical plants 30 feet for cold climate plants that would need chilling.

Some of the first trees planted in the warm area were Valencia Oranges, Meyers Improved Lemon, Gwen Avocado, Brown Turkey Fig, hibiscus, Pyracantha, bougainvillea, yucca, agave, cacti of all types, and many succulents. For the cold plant or northern plant end of the house I was fascinated with the possibility of forcing plants such as Asian Pears, peach, apple, apricot, sweet cherry, grapes, European Plums, red raspberries, roses and many other small plants.

Looking back on the last 3 years I am amazed at the success of this geoair unit. My knowledge when we began was a background of hobby gardening and wheat farmer. None of the plants we used have been especially developed for this environment.

We had no idea how the heat system would work during extremely cold weather. I had no experience with tropical plants. The first winter was the ideal one for testing out the underground heating theory. I wanted to learn more about the subtropical plants so took a 5 weeks trip to southern California in February. During this period the temperature dropped to minus 40 degrees in Alliance .

We had rigged a propane tube shop heater with a thermostat set to come on at 35°. The heater had burned less than $8 worth of fuel in the 5 weeks. Since then we have left the greenhouse unattended, except for a once a week watering, and the heater has not come on even though the temperature has dropped to -20° or colder. We have lost no plants due to cold temperature in 3 winters, but there are some plants that can't tolerate continued cool temperatures.

The first winter the warm climate plants did very well, and the weather warmed up early in the spring. The citrus trees especially likes the daytime temperature of 70 to 90 degrees and nights around 45 degrees. The first winter I had trouble getting the proper amount of chill for the cold climate plants.

We closed the door to the cool end of the unit, and installed a 6" squirrel cage blower with a thermostat

set to come on at 45 degrees and shut off at 38 degrees. This would have been the ideal setup, except the sunny days even when only 5 to 10 degrees outdoors it built up temperature of 60 degrees or more inside even with the blower running.

We didn't get enough chilling hours and the trees didn't produce a normal amount of blossoms. In hind sight I'm not sure the lack of full blossom was an insufficient chill. It could have been partially due to small recently transplanted trees. Nevertheless the peach, Asian pears and nectarine all produced some fruit of normal size and good quality. The warm area plants were all pretty small but they developed at about the same rate they would in their own zone. The pond plants did exceptionally well. The water hyacinth multiplied from 100 to 204 between the 1st of December to the end of March.

During the first summer we continued to add new plants and propagate other plants. I put a 3'*3' opening in the west end of the unit and used a simple 3' whole house blade fan with a 1/3 hp motor to draw air through the greenhouse to cool it. It comes on at 80 degrees. Low humidity has been no problem so we don't use water pads in the window but if humidity drops too much we have a mist nozzle in the 3'x3' opening.

We added plants whenever we found something we thought would do well in this setting. I was told by a commercial roses grower that he thought we had too much humidity to grow roses. We tried one large tree rose "Intrigue" just to see if it would survive. This rose has been amazing. It has grown to 6' and has produces dozens of large perfect long
stemmed flowers. I now have many roses of different types and all have done very well.

In the three years we have used this unit we have introduced hundreds of plants. It is inevitable in this setup that we would bring in some disease and pests. We have the standard problems that most greenhouse have, white flies, slugs, mealy bugs, aphids, etc. As this was originally planned to prove the environment system we didn't worry too much about sterilized soil and pots or trying to obtain a high degree of disease control.

We had very little problem with fungus disease and couldn't figure out why it wasn't a bigger problem because of the humidity. From what I have read of fungus life cycle, I believe the answer is in the temperature swing of the unit. Fungus needs a temperature around 70 degrees. The temperature in the greenhouse moves from the 50s and 60s at night to the 80s and 90s in the daytime. It doesn't stay long enough in the optimum temperature for the fungus to become established. By the fall of 1996 we had introduced several types of birds; zebra finches, goldfinches canaries and 100 tree frogs, to help control white flies and aphids. They seem to help but the new ultra fine oil sprays seem to do a very good job of controlling white flies, aphids and complete control of scales. The ultra fine oil is safe to use around the birds and frogs. March of 1996 we purchased several varieties of orchids including Cymbidums, Cattleyas, Dendrobiums, Phalaenopsis, Bletillas, Vanilla, etc.

We found they will grow very well using one 125 watt heat lamp with a thermostat set to come on at 60 degrees. One problem was that slugs seem to love the thick tender leaves, especially of Phalaenopsis.

We tried all of the recommended remedies of beer traps, bait, and Diatomaceous earth all with poor results. We solved the problem by using Off and Repel brands of mosquito repellent. These sprays are very effective and seem to leave a residue that the slugs don't care for, but we found that the Off damages the plants. Our neighbor had a real problem with a patch of Prickly Pear Cactus that she had tried to get rid of for years, she sprayed them with Off and got rid of them fast. So we found that we could kill both slugs and cactus.

Raising Birds-

The greenhouse has proven to be a ideal setting for breeding certain species of birds. Care must be taken to choose birds that are not destructive to plants. We mistakenly placed a pair of parakeets in the area. In very short time they can strip the toughest plant of its leaves. I think any of the parrot types are a poor choice. A lot of the finch, weaver, sparrow, canaries, and many others will thrive in this environment, but they must be introduced at the right time of year to be able to become acclimated to the cold weather. Zebra Finches breed freely and are very entertaining to watch. Goldfinches are reproducing nicely and their lemon yellow and black coloring is beautiful in the green foliage.

Plant Evaluation-

The attached list of plants and their performance just show how an individual plant performed. In some cases it was just one plant, and could have been weak to begin with. Just because it didn't do well for me doesn't mean you would have the same outcome.

One of the most time consuming aspects of this project has been finding the building material. We are in the process of becoming dealers or factory representatives for some of the harder to find material.

Note: most of the previous comments were written in 1992 when I began writing a booklet for people who were interested in our project.

The next pages are the Updates as reported to me by Russ since 2009. All are important.
- Barry Naef

Update: February 2013

After our greenhouse roof collapse in winter 2009, and by the late winter of 2010 the wood frame of the original greenhouse structure was rotted away to the extent the 18 year old Lexan glazing was actually the only thing supporting the North wall.

We were at the point where we had to completely rebuild the structure, or destroy the entire greenhouse I had built in 1992.

In 2010 we researched and hunted on the internet extensively and found there are were no commercial structures sold that would meet our needs. It required a metal frame that had a profile that would allow the low winter sun to reflect light off a solid north wall into the pit, be able to withstand very high wind gusts and have 3” of foam insulation in a strong north wall.

I decided to design the frame and build it in our shop here. We developed a very simple unit using the same interior volume of air but changed the angles to get more light into the greenhouse. I also added 24” onto the length of the Lexan glazing making it 6' wide and 14' long, we have no seams in the glazing sheets to eliminate air leakage.

Keeping the greenhouse as air tight as possible important in this type unit. It took me 4 months to design weld and erect what has turned out to be an amazing improvement. We wanted a frame that could be built with very little help. So I decided to do as much as I could be myself although I had offers of assistance.

Re-designed Finch geo-air greenhouse. Completed 2011

We figured we would market the frame and lexan system, and if I could say a 79 year old can do it by himself it would make a good selling point. It took me 2 months but I did it.

I wouldn't recommend that anyone do it, I received lots of black and blue and weight loss. To do it right it would take 2 people or more. The response from the plants in the greenhouse has been remarkable.

The 3 oldest citrus trees require an 8' circle of floor space and average over 125# of fruit each. The fig has from 80 - 100 lbs. of fruit on it. For the first time we have sold lemons, oranges and figs through the Li'l Ladybug Nursery Farmers Market.

The lemons and oranges were priced at $3.50 lb. The figs $4 lb. They sold out every week, they run a market in 2 other nearby towns and wanted citrus and figs for them but we did,t have enough. You have to remember this is western Nebraska so local citrus and figs bring a high price. If you figure the commercial value of each 8' circle and you sold all of your produce (which we don't) each tree would bring in around $435. Because of this we have added more trees and now have 23 trees total.

Since the completion of this structure we have built 2 more units, both at high schools.

The one at Garden County High School in Oshkosh Nebraska is 9 panels long or 54'. It doesn't have the under ground tubes yet but they can be added at any time.

The newest one being used by students is at the Alliance, Nebraska High School starting this week (March 11, 2013) This unit has everything I have learned in 35 years of development and is perfect for commercial use. It is the same upper structure as the 2010 unit and the same 78' length. With this unit we have developed a climate as good as any citrus growing area in the world.

Alliance High School geo-air greenhouse. Completed 2013

This greenhouse has 1050' of 6" tube about the same as my original greenhouse but we simplified and reduced cost of the design by routing the tubes differently. This unit has a 7' wide floor area with 16 citrus trees, 12 different types in the ground at floor level. The both sides have 4' high planting areas that are 76' long the south side is over 4' wide and the north over 3' wide. The walls of the planters are decorative blocks but any type block could be used.

The sun hits directly on the south wall in the winter and the reflective north wall reflects on the the south wall. The February sun is hot enough to record temperatures of 117 degrees. As soon as the unit was closed in we planted some plants in the cracks of the wall to see if they would survive, they have flourished. At that time the geo-air tubes hadn't yet been installed.

We have removed 99% of the cost of energy in this unit since during the 33 days February 4 when the meter was installed we have used 16 Kilo Watts, it has cost $2.77 for the entire energy. The service charge from the utility Co. is about 6 times the cost of the electricity used.

The walls store enough heat and the blower that circulates the air through the tubes only takes 5.5 amps. The blower is set to start at 40 degrees so it only runs for a short time at night. Most of the energy we are using is during the day for cooling.

Incidentally during the time of the $2.77 energy cost our night temperatures were around 8 to 13 degrees with 2 nights of 4 below zero and 1 of 17 below. On the 17 below night the temperature low

was 37 degrees. The entire greenhouse is automated the east end has a 2' square motorized shutter at the peak that opens at 70 degrees to drain off built up heat. When the temperature reaches 80 degrees the 36" fan at the west end and motorized shutter on the south side of the work room are activated.

The only part we didn't automate was the watering. With the closed circuit system the small amount of water used especially in the winter and short time (about 20 minutes every week) wouldn't justify the cost.

The early days of February the greenhouses are at about the stage of growth they would be in late April in this area.

We have proof that 12 month commercial production greenhouses can be very profitable in the high plains area. This area is wasting millions of dollars a year in the abundance of sunshine, water, and available low cost land. In this area the favorite theme of nearly every politicians campaign speech is “We have to find a way to keep our young people from moving where the jobs are” or “our young people can no longer enter the agriculture field due to the high cost of land and machinery”.

Here is the answer, and anyone can get into horticulture agriculture for less than ½ the cost of a large tractor.

The cost of the greenhouse at Alliance High School was around $28,000 the cost was much higher than a private owners cost due to the government regulations related to student use.

If a person was to build the same size unit and could furnish their own labor it would cost around $17,000.

In most areas of the country there are small towns drying up that have vacant lots with access to power and water and aren't near grocery stores that would probably donate land and help construct these units.

At first I thought of producing the "Greenhouse in the Snow" as a kit that could be assembled in any length divisible by 6' but that didn't make sense because everything but the frame and Lexan system is available off the shelf locally. So we are going to manufacture the frames here, and drop ship the Lexan to the point of construction. Also we plan on geo-air greenhouse kits with complete plans, and instructions on how to use the growing system.

For this update I should point out the prices received for produce will probably go down as more growers and the novelty of locally grown citrus becomes common. But the price would be kept higher as the units lend themselves to organic production, at this time we no longer use toxic products anyway as we have found ultra fine oil works better than anything for insect control and insects never become immune to it.

I have to wonder if any projects awarded grants for energy efficiency have even close to what we have attained here without outside assistance.

Update: January 2012

The project at Garden County High School in Oshkosh Nebraska didn't go as expected but gave me a wealth of information and ideas. I got photos but they won't be good for the report.

I had gone to Oshkosh to make sure they knew what we needed in excavation and to make sure they knew what materials they would need on site before we put the metal frame up.

The day I went down to erect it they didn't have any material there and the excavation was 1' wider than it was supposed to be. The needed material was going to be delivered the next day. We went ahead and set it up and everything went came out perfect.

The machine shop that is going to fabricate the units did a great job and we got our part (frame and Lexan covering) done in 1 day.

Everything went as I had planned. Because the pit wasn't right though we can't use most of the pictures, but we are going to build a larger unit with the geo-air at the Alliance High School as soon as the weather warms up. It will incorporate all of the upgrades we have learned from this unit.

As for our home greenhouse, the results we are getting from the new design and angles have been fantastic. These trees before the redesign were producing and average of 175# of citrus per tree each year. This will be the first full year with the new structure and it looks like they will produce over 200# per citrus tree.

We are getting a lot of interest from State departments, especially rural development, tourism, etc., also USDA, Natural Resources, and Job Corp.

Update: May 2011

We are nearly finished building the first greenhouse structure, aside from the units at our home.

This one has been approved at Garden County High School in Oshkosh Nebraska. I have all the structure and fabrication done and had the first unit fabricated by a local machine shop. They did a great job. I have learned an awful lot with this first unit.

Update: March 2011
We Will start getting fruit from the lemons in about 3 months. (Around mid June)

Usually we would have a steady supply of of citrus for sale but the trees were damaged this past winter (2009 – 2010) when the original roof collapsed. It takes about 1 1/2 to 2 years for the crop to recover.

We have replaced the old structure leaving the trees in place and when they come back into production we should have a continuous supply. We have been adding new trees also.

We knew we wouldn't have enough fruit at first to supply the farmer market here.

Interest in our growing system is getting a lot of attention in this area lately and we will be building more greenhouses this spring. We have lots of interest in the Meyer lemon, they aren't sold outside their growing area due to their shorter shelf life. Google "sigonas Meyer" it has some good information on this type lemon.

Update: February 2010
Our main greenhouse, the Sun Pit, had some fairly serious damage this winter. The roof panels in one section collapsed under heavy snow. It was more than 10 years old.

I've designed a new greenhouse with more slope and more pitch to prevent this from happening again. Also it will be constructed from steel tube this time instead of wood.

UPDATE: Workshop System (OS)
We manufacture riding cabs for trucks in a 60x75 foot building with a 10 foot ceiling. 30'x75' is heated with a 55,000 BTU Coleman Heat Pump similar to the one in the house. The system we use in our shop building is a little different in that we have a room 8'x8' room in which we placed the outdoor unit of the pump. We partitioned this horizontally. We have buried four 6" tubes of drainage tile each 150' long that come into this room at floor level. The top portion of this room has a 4' square exhaust louver in the wall. The horizontal partitioned sets on the top of the outdoor unit and has an opening in the top the size of the exhaust fan on the pump unit. When the pump starts the air moving through, the unit draws it's air through the under ground tubes. This unit has been very efficient over the last 16 years and has needed absolutely no repairs and hardly any maintenance. This room must be well sealed between the top half and the bottom so the only path for the under ground air is through the unit. This system eliminates the need for the 3/4 hp blower used in the house and green house. But this variation can't be used in the other applications because of the high volume of new air, it would build up too much humidity.

UPDATE: February 2008
This winter has been by far the coldest of any so far. We have had winters that had much colder nights but only for a night or two. Since the first of January it has rarely been above 20 degrees in the daytime and nearly every night it has been around zero or below. We were gone for a month from Jan. 20th to Feb. 18th. For the first time since 1994 I set up a propane tube heater with a thermostat set at 28 degrees. The 40# tank was gone by the 4th night.

I was sure all of the citrus trees would be frosted as they can take only 26 degrees. I knew by the time we got home all the leaves would have dropped and the fruit would be on the ground. I was surprised to find everything was in good shape. We lost a couple orchid cactus in hanging baskets but everything else was in very good shape. It seems that the citrus benefits by being close to the lower safe limit. It will be interesting to see how much fruit sets this year as the 2007 crop was a little smaller than in previous years. The greenhouse is really showing it's age and older it gets shows the mistake of using wood in the construction.

We are getting some real interest in this system and the production of citrus as a money crop. A farmers market nursery near us is very interested in putting up units of this type. We had no idea 16 years ago that citrus could become a money crop in Nebraska, but with the destruction of fruit orchards for housing development, the price of citrus has skyrocketed. This coupled with the lower risk of crop loss and much lower land prices in our area has made citrus growing seem a lot more feasible.

UPDATE: December 2007
The greenhouse structure is showing it's age, 16 years and will need to be abandoned or replaced probably in the next 2 or 3 years. It isn't as air tight as when it was newer. This will be the first year we will use a propane tube type heater with a thermostat set at close to 30 degrees. We used this setup the first winter after the unit was built because we didn't know what would happen. That winter the unit never turned on so we haven't used it since. I have preliminary plans for a unit that would have 6' modules of 3 panels that would be hinged and open like a book to form the top. Each module would attach to the next and could be used to cover any length of pit. In our case it would be 13. The largest section would be 8'x6' and probably fold for shipping to 6" thick. The north module would be 2" foam with fiber or metal exterior. The other 2 panels would be twin wall polycarbonate glazed.

When we started this project the idea was to prove the system by growing citrus. There was no plan to grow citrus as a money crop. Over the years the cost of citrus especially lemons has gone up a point that makes it very feasible to grow them as a commercial crop. They would probably be best suited for a farmers market typesetting. The destruction of citrus groves for developments will likely cause the price to remain high. Another crop that has possibilities is figs. The thing that makes citrus attractive for this type market is it can be picked when needed, most will hang and not deteriorate until picked.

UPDATE: July 2006
In the last year we have tried to cut energy costs. The cost of electricity has gone up by about 1 cent a kilowatt hr. We are trying to find out the effect of using the blower just for heat, we had been using it for air circulation. So far the energy cost is lower and no sign of any adverse effect on any plants.

Last winner we lost the first plants due to frost. We have seen a lot colder days but the cold set in and was near zero for 10 days, very little sun and it didn't warm up in the daytime. After a week the temp fell to around 35 degrees I could have used a propane tube heater but decided to find out what the damage would be by relying on just the Geo heated air. When the sun finally came out there was signs of some damage but only in hanging plants. The plants in the ground planted in the ground even though they were the same height as the hanging pots showed no effect. We only lost about a dozen plants (out of hundreds) all of the thicker leafed types, most were Epiphlyum. The cold seemed to be beneficial to some plants, the roses were larger than usual and they are normally large anyway. Maybe it would be good to chill the unit each winter if one could control the amount of cold air to near 32 degrees for 4 or 5 hours.

The citrus seem to produce very heavy every other year. Last year was the large crop and the crop for this year is going to be large but not as many as last year. I don't know if this is typical of citrus.

We have 5 varieties of grapes planted to see how the warm area types would grow. So far Golden Muscat, Thompson Seedless, Flame, and Globe are outstanding. Also a very large Japanese Kyho grape that hasn't set fruit yet. I think there are commercial possibilities for grapes especially the fancy large Japanese types.

Last year we decided to replace the heat pump in the house as the original pump was 25 years old. We replaced it with the same size but the new one is much more efficient than the old one. The cost to run the new "heat pump" is about 25% less than the original heat pump.

Update: March 2004
This spring the plants seem to be developing better than the last 2 years. The citrus trees are all producing more and better looking foliage and a lot of blossoms. We have several more varieties of California grapes. I think this type greenhouse has a lot of potential for grapes that can't be grown in the colder climates. This type grapes is used in higher priced wine than
the northern grapes. It may be that the starting of cuttings would be a commercial use as we have had very good luck with cuttings.

The Asian Pears look like they will set heavy this year, they could be a good money crop as they are high priced in the stores.

We are having very nice response from several varieties of Camellias they thrive in this unit, grow fast and produce many flowers. The first one started to bloom in January and is still blooming the end of

March several others are just starting. The south side of the greenhouse at the base of the wall has been a problem due to the heavy shade. I have found Camellias and Clivia do very well along the wall.

The Cymbidium orchids are blooming and as usual are very nice and last over 2 months.

We had some organic gardeners through the greenhouse and told them I was having a problem with white flies. They told us to use 2 table spoons of Tabasco sauce to a gallon of water. It seems to work. I added a little soap and it seems to stick.

We have been using a lot of Coir with perlite for potting orchid cactus, they seem to do well and with banana peel in the mixture for zinc they look like they will bloom heavy. The Coir works for seed starting too.

I have attached the plant history from the early 90s, things changed a lot over the years and I know some of the plants failed because I didn't know enough about their cultures. One important factor was the use of our native clay for planting. I have learned it has to be amended with compost and perlite. Also we now leave the blower on all the time, not so much for the heat and cooling but the air circulation is important.

We have never had any fungus or mold problems, don't know the full reason for this but I think the temperature fluctuation and maybe the scrubbing of the air through the perforated tubes is the reason.

UPDATE: June 2003
We have learned a lot about roses in this climate. They do very well from April through November, with the first bloom being heavy in May. To raise them commercially you would have to have backup lighting. When there is a period of four or five days in a row of heavy clouds they will stop producing, it takes about ten days before they will start blooming again. This happen three or four times a year so the cost of the power wouldn't be much of a cost factor. I don't know what type light would be best but during the times you would need them it is cool enough that the heat generated by the lights would be no problem.

We have found a flat roof with a steeper pitch would be better for production crops. The floor space would be increased and condensation in the winter could be channeled into a drip channel at the bottom of the Lexan.

In the last 3 years we have stopped chilling the west end of the unit as the trees were getting so large they were causing too much shade for other plants we wanted to grow. We thought the cold weather trees would loose vigor over the years and slowly die but so far they have survived and look pretty good. We have pruned them radically to allow light to get to roses, grapes and orchid cactus. They still bloom and fruit some and would do even better if we had pollinators.

This type greenhouse has a lot of potential for growing production crops but it will take people with the time, equipment and plant expertise to develop it.

UPDATE: December 1998
We have replaced some of the original plants with roses from Weeks Nursery located in Upland California . Over the years we found that roses grew very well and are a fun crop to grow because of the abundance of cut flowers for our home.

We planted about 80 plants. We found that some roses seem to perform differently in this environment. Her are some of the varieties. Lynn Anderson: Large white blossom with bright pink fringe on the petals. Nice rose but not as many flowers as some.

Sonia: Pink, medium size, lots of flowers, very good greenhouse rose nice shape.

Fragrant Cloud: Nice orange-red medium size, very strong but great smell. Double Delight: We have seen this variety in Las Vegas the color in that climate was a dark cream with close to maroon edges. We didn't care for the color but the smell was great. In our environment Double Delight produce a beautiful near white with deep red tips on the edge of the petal. It has lots of smell and lots of large flowers.

Candy Stripe: Is suppose to be a light purple with darker lines. It has turned out to be a solid red-purple with no lines but lots of flowers.

Pascali: Turned out just like it is supposed to be, medium size, pure white and perfect shape, good producer.

Electron: Bright pink, lots of medium size flowers.

Red Gold: Lots of small to medium sized bright orange with red tips. These are very nice.

Today: Heavy producer of pure orange, medium size, close to 60 petals, very tightly formed. Lasts along time as cut flower.

St. Patrick: Large green-yellow blossom. Not a lot of flowers.

Charlotte Armstrong: Great rose lots of large bright electric pink very fragrant flowers on large plants. Will extend up to 10' tall and lots of beautiful flowers.

Touch Of Class: All around near perfect rose. Large bright salmon scalloped edge fragrant , large hardy plants.

Intrigue: Profuse producer nice medium, deep red, nice smell, each flower has one small white line in one outer petal.

Some of these plants aren't a year old yet but from the performance of our previous roses, I's sure they will do well Aphids seem to be the only pest that bothers them. We haven't seen any decease so far. I have used rose dust to get rid of the aphids and guard against decease. I doubt if these roses even in the cold end of the unit will drop their leaves on there own so I will probably have to strip the leaves off by hand to force dormancy.

The cost of the green house could be dramatically cut by building it on the surface, instead of excavating the 5 foot of earth. If this was done you wouldn't be able to grow some of the taller plants.

The wood construction of the greenhouse is weathering fairly well but metal would be desirable. If I build another unit I am going to build it using chain link fence top rail, it is galvanized and can be bent to shape.

Photo Gallery

The Finch geo-air home, interior and exterior.

3600 sq /ft., three level "A" frame, built 1979.

Remember, this massive three level, 3500 sq/ft home, the garage, and huge atrium have been heated and cooled completely with this inexpensive Geo-Air/Heat Pump system for more than 30 years.

Impressive!

Atrium/patio heated and cooled year around with geo-air.

Results of geo-air heating/cooling in sub-zero climate.
All photos are fruits, vegetables, trees, and shrubs grown in the atrium and greenhouse.

Anyone Can Do It Anywhere

Editors Note: There is no purpose for Russ to explain every part, piece, and procedure of his projects. We have had many discussions regarding this and because every project and climate is different; because Russ may not have done it the most efficiently; because there are so many other ways of building a system; that is why we made the decision to ONLY explain the basic concept, result and function, because that is really all that is necessary for success with your project, in your particular climate.

Here are the limitations to the "geo-air" technology which Russ has been using all these years:

1) Earth you can dig into 6'-8' deep. (2-3 meters)
2) The ambition to simply do it.

No matter where you live or what your climate, those are the only two things necessary to build a "geo-air" energy system.

Parts & Equipment-

Here is the complete list:

1) Excavation tools and equipment to dig your trenches
2) Insulated utility room for blower and/or heat pump
3) 4" - 6" PE field drain tubing, either solid or perforated
4) Blower, 1/2, 1/3 to 3/4 depending on your system size
5) Simple manifold and support to connect tubing to blower
6) Air vents for each geo-air tube
7) Simple thermostat(s) to automatically turn on blower

Optional:

- Heat pump (standard) depending on area and home/office sq/ft. (cu/m)
- Greenhouse structure
- Greenhouse supplies
- Creativity and imagination

PE Tubing-

One of the key components in Russ's geo-air system is the simple and inexpensive tubing he is using to absorb the geo-energy and move it to the home, workshop or greenhouse.

This key component is the biggest mystery to most researchers and professionals regarding his efficient geothermal system.

PE corrugated tubing is quite common. It is readily available to farmers, ranchers and building contractors. The 4" size is cheap and available in every Lowes, Home Depot, and Ace hardware store. Russ used the 6” size.

Surprisingly, this cheap tubing it is strong enough to withstand the weight of wet earth, rocks and sand even at a depth of 8-10 feet, and more. That is much deeper than it's common use of 2-3 feet.

After 30 years at this depth the PE tubing has not collapsed under the weight of the soil, rocks, cars and trucks. It's very durable even though some bias engineers and professionals will say otherwise. They are simply wrong, ...again!

This unique tubing has various names and grades, but the simplest solid, single wall corrugated is very sufficient for and project.

Other names for PE (polyethylene tube):
- Corrugated drain pipe, PE tubing, Field drain pipe, Field drainage tile.

They come in two types; solid and perforated. Amazingly, Russ has had his success with the "perforated" type.

How many feet of tubing?
Many readers are asking how to calculate the amount of tubing to lay. For example, how many feet of tubing should I lay or each 1000 sq/ft of home, office or greenhouse?

No matter how much research one could do, they will never be a firm answer since every home will have different insulation, cubic feet, and soil conditions.

You could only be exact if you built a sub-division in the same location, with the same design, same insulation and same soil. There are many variables.

Here is the most important point. Russ had success by guessing & logic. As he has said, the actual cost of the tube was not significant compared to the cost of the overall project. Whether he used 1000', or 1500' may not matter.

He decided to simply put down a guess length, then add more if it wasn't sufficient.

Therefore, Russ has used approximately 1000' for each project, and he has been successful with that rule of thumb. This is by no means scientific but it is a starting point for his readers.

- House/Atrium: 3500' sq/ft: 250' total 6" tube
- Workshop, 60'W x 75'L x 20'H: 750' total 6" tube
- Greenhouse, 16'W x 85'L x 12'H: 1100' feet total 6" tube

All in moist, gravel and sandy type soil.

Note #1: The extra length for the greenhouse since it does not use a "heat pump" assist.
Note #2: If using 4' tube instead of 6' tube you will need 40% more to have the same surface area.

Example: 1000' of 6' 'vs 1400' of 4' corrugated tube.

What's Next

Many are asking what Russ is doing now, and what will be be doing next?

Although he is very satisfied with the geo-air systems and their solid performance over the years, Russ isn't one to sit still for very long. Russ has made this very clear regarding his work to this point:

- There is nothing to change with his "home/atrium" system.
- There is nothing to change with his "workshop" system.
- The only changes for his "greenhouse" system is to repair and upgrade the greenhouse roofing and structure.

His greenhouse has done very well when you consider it is now 18 years old and was build with a wooden frame.

Since the frame and Lexan roofing are beginning to deteriorate he intends to replace the entire greenhouse with a tubular frame with slightly different angles on the roofs to better accommodate the snow loads.

The geo-tubing and blower system remain in very good condition.

Russ certainly knows the efficiency and durability of everything, and most important he knows how to grow and work with his citrus and other fruits. The new system will be larger and is intended for commercial growing and not just an experimental hobby anymore.

Russ wants to re-confirm the purpose of this report. The report was never meant to be greenhouse 'construction plans', but a documentation of his efforts overall for the past 35 years.

Russ has shown the basic concept of three (3) systems and his basic experience with each system. However, although your particular project will be one of the systems he shows, every project and every climate and region of the world must adjust their exact specifications to fit their needs.

It's not to particularly discuss or promote greenhouses, but to report and confirm the overall ease and efficiency of the geo-air energy concept and systems.

No 'single greenhouse plan' can be successful in every climate and every location globally.

Russ is promoting the feasibility of the concept for any use, not necessarily the designs of homes and greenhouses. Every home, office and greenhouse can utilize and benefit from this geo-air concept.

FAQ- Frequently Asked Questions

Russ is very interested in working on his projects each day but he also understands his many readers have questions that need answering.

Please forward your questions to him and we will post them here, and in the "Update" section.

Questions- email address: vipreaders@greencubenetwork.org

Below are a few of the most common questions and answers to date.

Q- What size system did you install in your home?
A- We installed a 5 ton in home/atrium and also a 5 ton in the workshop.

Q- What are the heating costs for your home?
A- Remember our weather conditions are quite extreme here. Even so, The winter average of the total electricity of our 4000 sq/ft home, etc. is $300-$350/mo. That includes heat, lights, fans, well pump and fans in the greenhouse. Summer is only about $200/mo.

Q- What are the heating costs for your 16'x85' greenhouse?
A- Remember we only use a circulating blower to move the geo-air. The cost is generally $40-45 per month. That is the year around average.

Q- How much do you feel you are saving with your geo-air system in your greenhouse?
A- If we used normal heating to maintain the same temperature it would cost us at least several hundred dollars a month compared to the $42+ we actually pay with geo-air.

Q- Would you change your geo-tube depth or material?
A- The tube is very dependable. The depth is very sufficient for us, but each area and climate can adjust. 8' deep should be adequate most anywhere.

Q- I hear from some Geo-Exchange installers they are successful at only 4' depth for tubes. Why do you and Mr. Naef recommend 6-10' if 4' is sufficient?
A- The key is two-fold: 1) efficiency, and 2) different technology. The Goe-Exchanges systems are much more energy efficient at 8'. They still function at 4' because they are always connected to a Heat Pump so it's not easy to notice how efficient the depth really is. In most climates 4' is not efficient enough. Note that the 'true' Geo-Air and Geo-Liquid are not using the costly 'heat-exchangers' and 'heat pumps', thus the depth is much more important for maximum efficiency.

Q- Do you filter your air?
A- We have air filters as would any conventional home or office.

Q- Why did you rate Bananas "0"?
A- Certainly not everything will function in a low-temp greenhouse, however, to be fair we could do better with bananas if they had their own separate greenhouse.

Q- You mention your large greenhouse is a "sun pit" and 4' lower than grade level. Is that critical for success with geo-air?
A- Certainly the lower in the ground, the better the efficiency. However, the reason for the 'sun pit' was for both energy, and also to keep a lower profile for the greenhouse. The winds are quite strong here in Nebraska.

Q- I see you have use 'perforated drain tile' (tube) rather than 'solid drain tile'. Most agri-professionals and factory reps from the Tubing Industry are warning me to only use the 'solid' tube.
A- They are probably correct. Back 35 years ago I had very limited access to 'perforated tube'. I did have success but I'm told only by luck. My soil is very well drained so the water did not wick-up as it would in most soils. To my knowledge all other projects are using the 'solid tube' to avoid problems.

Updates

The most recent updates will be listed here, and also in the 'Notes Through The Years' section.

Update: March 2013
After our greenhouse roof collapse in winter 2009, and by the late winter of 2010 the wood frame of the original greenhouse structure was rotted away to the extent the 18 year old Lexan glazing was actually the only thing supporting the North wall.

We were at the point where we had to completely rebuild the structure, or destroy the entire greenhouse I had built in 1992.

In 2010 we researched and hunted on the internet extensively and found there are were no commercial structures sold that would meet our needs. It required a metal frame that had a profile that would allow the low winter sun to reflect light off a solid north wall into the pit, be able to withstand very high wind gusts and have 3" of foam insulation in a strong north wall.

I decided to design the frame and build it in our shop here. We developed a very simple unit using the same interior volume of air but changed the angles to get more light into the greenhouse. I also added 24" onto the length of the Lexan glazing making it 6' wide and 14' long, we have no seams in the glazing sheets to eliminate air leakage.

Keeping the greenhouse as air tight as possible important in this type unit. It took me 4 months to design weld and erect what has turned out to be an amazing improvement. We wanted a frame that could be built with very little help. So I decided to do as much as I could be myself although I had offers of assistance.

Re-designed Finch geo-air greenhouse. Completed 2011

We figured we would market the frame and lexan system, and if I could say a 79 year old can do it by himself it would make a good selling point. It took me 2 months but I did it.

I wouldn't recommend that anyone do it, I received lots of black and blue and weight loss. To do it right it would take 2 people or more. The response from the plants in the greenhouse has been remarkable.

The 3 oldest citrus trees require an 8' circle of floor space and average over 125# of fruit each. The fig has from 80 - 100 lbs. of fruit on it. For the first time we have sold lemons, oranges and figs through the Li'l Ladybug Nursery Farmers Market.

The lemons and oranges were priced at $3.50 lb. The figs $4 lb. They sold out every week, they run a market in 2 other nearby towns and wanted citrus and figs for them but we did,t have enough. You have to remember this is western Nebraska so local citrus and figs bring a high price. If you figure the commercial value of each 8' circle and you sold all of your produce (which we don't) each tree would bring in around $435. Because of this we have added more trees and now have 23 trees total.

Since the completion of this structure we have built 2 more units, both at high schools.

The one at Garden County High School in Oshkosh Nebraska is 9 panels long or 54'. It doesn't have the under ground tubes yet but they can be added at any time.

The newest one being used by students is at the Alliance, Nebraska High School starting this week (March 11, 2013) This unit has everything I have learned in 35 years of development and is perfect for commercial use. It is the same upper structure as the 2010 unit and the same 78' length. With this unit we have developed a climate as good as any citrus growing area in the world.

Alliance High School geo-air greenhouse. Completed 2013

This greenhouse has 1050' of 6" tube about the same as my original greenhouse but we simplified and reduced cost of the design by routing the tubes differently. This unit has a 7' wide floor area with 16 citrus trees, 12 different types in the ground at floor level. The both sides have 4' high planting areas that are 76' long the south side is over 4' wide and the north over 3' wide. The walls of the planters are decorative blocks but any type block could be used.

The sun hits directly on the south wall in the winter and the reflective north wall reflects on the the south wall. The February sun is hot enough to record temperatures of 117 degrees. As soon as the unit

was closed in we planted some plants in the cracks of the wall to see if they would survive, they have flourished. At that time the geo-air tubes hadn't yet been installed.

We have removed 99% of the cost of energy in this unit since during the 33 days February 4 when the meter was installed we have used 16 Kilo Watts, it has cost $2.77 for the entire energy. The service charge from the utility Co. is about 6 times the cost of the electricity used.

The walls store enough heat and the blower that circulates the air through the tubes only takes 5.5 amps. The blower is set to start at 40 degrees so it only runs for a short time at night. Most of the energy we are using is during the day for cooling.

Incidentally during the time of the $2.77 energy cost our night temperatures were around 8 to 13 degrees with 2 nights of 4 below zero and 1 of 17 below. On the 17 below night the temperature low was 37 degrees. The entire greenhouse is automated the east end has a 2' square motorized shutter at the peak that opens at 70 degrees to drain off built up heat. When the temperature reaches 80 degrees the 36" fan at the west end and motorized shutter on the south side of the work room are activated.

The only part we didn't automate was the watering. With the closed circuit system the small amount of water used, especially in the winter and short time (about 20 minutes weekly), wouldn't justify the cost.

The early days of February the greenhouses are at about the stage of growth they would be in late April in this area. That's at least a two week jump.

We have proof that 12 month commercial production greenhouses can be very profitable in the high plains area. This area is wasting millions of dollars a year in the abundance of sunshine, water, and available low cost land. In this area the favorite theme of nearly every politicians campaign speech is “We have to find a way to keep our young people from moving where the jobs are” or “our young people can no longer enter the agriculture field due to the high cost of land and machinery”.

The geo-air greenhouse is the answer, and anyone can get into a profitable horticulture agriculture business for less than ½ the cost of a large tractor.

The cost of the greenhouse at Alliance High School was around $28,000. That cost was much higher than a private owners cost due to the government regulations related to student use at the school.

If a person were to build the same size unit and furnish their own labor, it would cost around $17,000. That's a very reasonable investment for such an easy and profitable business.

In most areas of the country there are small towns dieing that have vacant lots with access to power and water and aren't near grocery stores that would probably donate land and help construct these units.

At first I thought of producing the "Greenhouse in the Snow" as a kit that could be assembled in any length divisible by 6' but that didn't make sense because everything.

However the frame and Lexan system is available off the shelf locally. So we are going to manufacture the frames here, and drop ship the Lexan to the point of construction. Also we plan on geo-air greenhouse kits with complete plans, and instructions on how to use the growing system.

For this update I should point out the prices received for produce will probably go down as more growers and the novelty of locally grown citrus becomes common. But the price would be kept higher as the units lend themselves to organic production, at this time we no longer use toxic products anyway as we have found ultra fine oil works better than anything for insect control and insects never become immune to it.

I have to wonder if any projects awarded grants for energy efficiency have even close to what we have attained here without outside assistance.

Update: August 2015

Our original first unit (not to be confused with the home/atrium greenhouse) is 78' x 16' x 12' high which houses 23 citrus trees some over 20 years old. Some of our citrus are in the ground and 12' high. The older trees average 125# of high quality large fruit each. each of these trees require an area of an 8' circle. We also grow hundreds of other plants of all types, figs, cymbidium orchids, roses, cacti, grapes, epiphyllum, black berries, bougainvillea, camellia, etc.

We've learned much from our 'trial and error' over the years, also from some of our reader's projects, and especially from the years of research from Barry Naef's 'geo-air' research projects since 2010.

Changes I've Made In The Greenhouses-

Tube size: I no longer use 6" tubing since 4" is more cost effective these days and more readily available in most areas.

Tube Type: Non-perforated tube should be used, not perforated tube as I used on my original projects. Perforations is what was available to me 30 years ago and I guess I was lucky due to my soil type. Perforated tube 'will not' work in most soil types.

Greenhouse Design: I have changed my greenhouse design to be more energy efficient and sustainable. I have removed all wood, and the 'wall side' should be more slanted and insulated if possible.

Blower Systems: I should note that some readers are not fully understanding my Blower setup. You should note that all greenhouses should have a blower/exhaust system for fresh air circulation from the

outside with louvers. All greenhouses! However, this is 'not' the same as my 'geo-air' air flow system through the earth tubes. They are two completely different air systems with different functions.

Blower Placement: The blower for the geo-air tubes 'should not' be placed a floor level as I did on my original projects due to the possibility of flooding. Newer projects have the Blower elevated at least 2-3 feet above floor level.

Tube Laying: Be careful when laying the tube and especially the 'back-fill'. In 2013 one of my readers had some tubes collapse, and two other readers in 2015 had tubes collapse due to the tamping and back-fill process. Please follow the guidelines of tube manufacturers, or review the directions and diagrams in 'Geo-Air Technology: A-Z' to eliminate costly repairs.

I hope my 35 years of 'trial and error' success, has been able to provide you with useful information and the needed inspiration to use the Geo-Air concept. -Russ

Awards- Russ has finally received much recognition in recent years. Although he only professes to be an inspiration and not a 'technical professional', he has been the inspiration for many projects in the US and globally. Not all of them use his specific 'sun pit' design but still attribute their success to his example and endless trial and error for nearly 4 decades.

Below are two of his recent recognitions- Congratulations Russ!

2014- Nebraska Business Development Center

2015- United States Small Business Administration

About The Co-author

Barry Naef is a Geothermal consultant, researcher, and author of Green Energy and technical publications globally. His expertise includes most facets of geothermal energy, including, the geo-exchange, geo-air, geo-solar, aquaculture, permaculture, energy and the efficient greenhouse technology.

In 2008 Barry also published a news article introducing the revolutionary concept of 'Greenhouses in Shipping Containers". This concept, using LED lighting inside recycled or new modified-shipping containers has become a very viable agricultural trend.

His interest began in high school when he actively gardened and constructed ponds and waterfalls stocking them with fish and plants to survive his cold Sierra-Nevada climate.

During high school Barry assisted his father with the research and installation of a 100% geo-heating project which still functions today heating the 5000 sq/ft recreation facility. That opportunity began to combine his interest in gardening and geo-solar energy.

After university Barry became an Ag and Greenhouse consultant serving farmers, growers, greenhouses, and various government entities throughout Wyoming, Utah, Colorado, Nevada, Idaho, and Arizona.

His research includes projects with the US Department Of Energy (DOE), USDA, Scripps Institute of Oceanographic (aquaculture), Lawrence Berkeley National Laboratories, (1975 to 1981) and more recently with Oak Ridge National Laboratories, consultation and research in various provinces of China (2004 to present) on geo-solar greenhouses, aquaculture, and geothermal.

His geothermal research and persistence in Northern California led to a controversial government approved geo-heating project for 126 homes. That project began in 1980 with a grant from the US DOE, and finally went online in 1981 using his technology with much success.

Since 1978 Barry has built and owned numerous geothermal and geo-solar greenhouses, as well as heading very detailed geo-air and geo-solar research projects in Oak Ridge Tennessee since 2009. His years of research has been very thorough.

In 2008 Barry learned of a man named Russ Finch. While Russ' technology in Nebraska was not so fined-tuned, Barry was very taken by Russ' vision, simplicity, and tenacity.

Although the geo-air technology wasn't new to Barry, he was very impressed with his success with growing Citrus and other fruits in such a cold greenhouse. Russ was the one who took the time and money to patiently prove it.

Russ had proven something Barry had always wondered about, **...could Citrus survive and produce properly year-around in greenhouses?**

After 24 years of great success, there is no mistake this a proven and simple technology. It was all this that prompted Barry to choose the name, **"Citrus In The Snow".**

Soon after the "Citrus In The Snow" publication, a group of researchers from USDA visited the greenhouse in Nebraska that was now becoming famous. Even the group from USDA was impressed with with the Citrus in this snow covered greenhouse.

Hopefully Barry's involvement has allowed Russ Finch and the "Citrus In The Snow" technology to become better known to gardeners, and professional growers as a credible growing technology.

Barry is Director of the GreenCube Research Institute and supervises it's global projects.

Glossary

Here are a few terms that are relative to our projects

Earth heat:
Another term for geothermal energy.

Earth tubes:
Another term for 'Geo-Air' tubes

Geothermal:
Any heat generated from within the earths surface.

Geothermal grades:
Grades, or ranges of geothermal energy which vary from 50°F -1000°F.

Geothermal sources:
Any place that generates geothermal energy. Earth, water, etc.

Geo-air:
The principal and technology of using air to absorb and carry the energy.

Geo-exchange:
The act of converting geothermal energy to usable household energy with heat exchangers. There are two principle types of Geo-exchange, 1) Geo-air, and 2) Geo-liquid.

Geo-liquid:
The use of water or anti-freeze liquid to absorb and carry the energy.

Heat exchanger:
A device or technology that converts liquid energy to air energy.

Heat pump:
A heating unit which uses the air temperature to generate hot and cold energy. The technology is similar to the principal of an air conditioner, but utilizing the energy from both coils.

Low-grade geothermal:
Geothermal energy at shallow, readily available depths of the earth s such as 8'. These usable energy temperatures generally range from 50°F - 65°F.

PE tube:
The letters PE mean "polyethylene". PE tubing is manufactured is various sizes and thickness for many applications.

Solar energy:
Energy from the sun.

Solar cell:
A micro-electric cell which converts sun light to electric energy. Photovoltaics (PV).

Solar collectors:
Generally tubes or channels filled with air or liquid that absorb the heat from the sun. The heat can be used for room heating or water heating.

Split Room heat pump:
A technology developed by Russ Finch that places a "horizontal" wall on the top of the heat pump thus creating a sealed and separate lower room and upper room for use with a geo-air system. This is considered and "open system" and can eliminate the need for an additional circulation blower.

Wind energy:
Any technology that is moved or rotated by the wind, such as propellers. This movement of wind can be used to create electricity through a turbine, or pump water. Moderate efficiency is obtained at speeds from 12 - 20 MPH.

BizGuide: "Citrus In The Snow"

Geo-air Energy: He Proved The Professors Wrong