Greenovation : Heating and Cooling

PLEASE NOTE:

Everything included in "Greenovation : Heating and Cooling" has been transposed directly from the website. That includes references to the PlayHaven Farm LLC and Green Building Project (PHF&GBP) website pages, external websites, links to documents, etc. Because of how quickly things change on the internet, there are NO links from this document.

Sealing up the Ductwork (December 2009)

Here is the hubby using a caulking gun to seal up the small gaps in the ductwork. He also used a water-based mastic to seal up the big gaps in the ductwork.

What is mastic? Its a liquid sealant that stays somewhat flexible when it dries.

So, did it help? Sure Did!! When the hubby started working on the obvious gaps, it got him ready to check out the rest of the ductwork and he found some places where the ducts lead to nowhere and others where they had pulled apart. So he was able to seal off the unused ones and fix the others before putting sealant on those.

The end result was more warm air blowing out of the registers where it was supposed to be going.

FYI: Our house has ductwork that splits off of the furnace to go in 2 separate directions. And inside those 2 ducts are baffles that we can open or close in greater or lesser amounts so that we can control how much air is being blown into each direction. Because one of them leads to the 2nd story, we can reduce the flow of heated air to that area in the winter (since heat rises from the first floor) and increase the flow of cooled area in the summer. This is not as efficient has having zone heating and cooling... but its better than not having the option at all!

Time to Update the Heating and Cooling (November 2011)

This summer (late June), we discovered water on the floor of the basement around/under the hot water heater and furnace. The water heater is pretty old and we have figured we'd need to be replacing it sooner than later, so we assumed that was the reason for the water on the floor. I called the plumber and, luckily for us, they had another job out our way, so they sent their man to our place the same day I called. He agreed that the water heater was nearing the end... but, lo and behold, it wasn't the reason for the water.

Nope, instead it was the Air Conditioning. Due to low freon, our coil froze and the water was the result of it thawing out. That means we must have a leak somewhere. Unfortunately, we were not in a position to replace the AC or even spend the money to find the leak and have it repaired. So, while it pained me to do it, we had him recharge the system and just had to live with a leak for the time being.

OK, we knew the next BIG project to tackle would be the Heating and Cooling. We were simply hoping to have another couple of years to find the money and/or sponsors.

I started researching and called the person I trust the most when it comes to Heating and Cooling: Eric Kjelshus (http://ericsenergy.com/). Since I really just wanted to pick his brain... I left a message for Eric and asked him to call me when he had time to chat. He called me back and we talked for a while (mostly I rambled, I'm pretty sure) about new problem, the PHGBP, and whatnot.

Eric offered to come out and evaluate the house. And that is what he did on July 16... one of the hottest days of the year. He brought his energy audit equipment and did a blower door test, used the hood to check the supply and return, and even had his infrared camera.

Long story made a little shorter... the house performed a bit better than it had originally, but in order to get an adequately sealed house and effective ductwork, it still needed:

- the crawlspace under the master bedroom insulated,
- the crawlspace under the front hall insulated,
- the rim joist in the basement insulated,
- a return added in the master bedroom,
- a return added from the 2nd floor,
- correction of the supply ducts to the master bedroom.

After my research, Eric's visit and talking with the hubby, it became more and more apparent that it didn't make sense for us to spend a bunch of money to do a partial solution.

Thankfully, there are several rebate/tax incentive programs in place through our electric company, State and Federal programs that will help us recoup a small portion of our upfront expenses.

I have always wanted to go with a geothermal system (ground-source heat pump). We priced the difference between an air-source and ground-source system and figured in the various incentives for each. Either way, we would have to take out a loan to pay for the thing, so we decided to get what we want and spend a little more upfront so as to save more in the long run with the geothermal system.

We investigated several financing options... this is a bit of a sore subject for me. I won't get on my soapbox now, but will delve into that in a blog post sometime. What we ended up doing (**and I don't recommend it if you can avoid it**) was to take a withdrawal from my IRA. We had to pay the income tax due on the amount plus a 10% penalty tax for the early withdrawal. The plus side is that we won't have to make monthly payments on accruing interest which (depending on the loan) could be about the same amount in the end.

First though, the insulation and venting improvements had to be done in order to get the full benefits of the new heating and cooling equipment.

As much as I like to spread the work around... I was SO happy with the job Eric Butler from Comfort Solutions did for us with the attic insulation, I opted to contract with him to do the rest.

After we got rid of the water in the crawlspace under the master bedroom (visit Plumbing Project page for that story), Eric sprayed the closed cell foam on the crawlspace exterior walls (from the wood floor above to the concrete floor below) and on the rim joist in the basement. Then he came back another day and filled the cavity between the old concrete floor and the wood floor of the front hall with dense packed cellulose (high borax content to eliminate any critter infiltration). (Visit the Insulation Project page for more.)

Next the trench was dug, the tubing laid and the holes drilled through the foundation walls (and sealed again after the tubing was inserted, of course). This part of the project was SO fascinating to me... there are LOTS of pictures, but I've tried to restrain myself for the sake of loading time. Because we have LOTS of land to work with, our installation was very straigtforward and simple. Do not be discouraged if you have much less land to work with... it is possible to put in a geothermal system almost anywhere these days due to advanced drilling and trenching techniques. Get a few quotes and find out what is possible for you!

Lastly, Eric's crew came out and fixed the duct work and installed the equipment.

The propane company (Magruders, http://www.magruderpropane.com/) came and picked up the propane tank. We are officially all-electric now... just a matter of time before we can harvest our electricity from the sun and wind.

Ductwork, Correct Old and Install New (October 2011)

Like with the PEX plumbing project... you can't really get good pictures of ductwork corrections in progress. I don't even have before pictures to compare with after pictures. So, I'll just have to tell you about it and put a couple of pictures here. The crew member in charge of the duct work was George. (He's the tall guy with the smooth head in the pictures of the furnace).

After hauling in boxes of sheet metal and tools, etc., George went to work shaping the metal into an extension of the main return to add the return vent from the master bedroom. We had him put it in the wall between the bedroom and the living room where we knew it would not be affected by future remodeling.

The top 2 photos are of the new return: from the basement view and from the master bedroom where he had to block up the wall cavity. Luckily it happens to be where the access to the crawlspace is, making that a bit easier (I hope).

Then he had to cut through the rim joist between the crawlspace and the basement to get enough space to add the three separate runs of ducting to the three supply registers. (Previously, there was one run with a "T" to divide the supply to one register in the bathroom and the two registers [using a 2nd "T"] in the bedroom. See the water in the crawlspace pictures.)

He then added the round metal runs in the basement that go into the space made for them. On the other side of that wall (in the crawlspace), he used insulated flexible tubing to each register. One complete run for each register off the main supply in the basement. The flexible tubing was hung from the floor joists.

Once everything was connected and done, George sealed everything using a special caulk designed specifically for sealing ductwork.

We can certainly tell the difference in the air supplied to the master bedroom now!

After the propane water heater was removed (it was left in place as they installed the furnace and removed just before putting in the electric water heater tanks), the chase where the vent stack went up to the roof was available to turn into an additional return duct from the second floor. George went up into the attic and capped the vent stack from inside. Normally, they would cap in on the outside, but with our TPO roof, I don't want anyone but the roofers to mess around up there. I'll have the roofers remove the vent, plug the hole and "repair" the roof at a later date.

Since the chase is open not only to the attic (photo at left), but the wall cavity and space between each floor as well; they inserted an insulated flexible tube and put a boot at the vent (like you would a supply register) so that it would work as a return correctly. That was connected to a metal duct that connected into the main return in the basement. (bottom picture at left)

Once everything was connected and done, George sealed everything using a special caulk designed specifically for sealing ductwork.

Install Geothermal Tubing (October 2011)

Anytime you are going to be digging in your yard, you should be sure to find out where any buried utilities are located. In Missouri, if you do not do this and you break through a utility's lines/property, you are not only responsible to the utilities for the damage, but can be prosecuted by the State as well. To help prevent this, Missouri has a "Call Before You Dig" service.

Since we are out in the country, I was unsure if we needed to do this... the answer is a resounding YES! (Besides which, the system is entering our house very close to the electric meter, so knowing the exact location of the line is critical.)

First I tried to use the on-line form, but our project requires hiring contractors with heavy equipment, so I ended up contacting them by phone. In addition to needing to know where the digging would occur, they wanted the name of the company doing the digging, what kind of equipment they use, how deep they would dig and when the project would start. You have to call a week to 10 days ahead to give the utilities time to be contacted and get their lines marked.

The geothermal tubing is layed 6 feet down so that it is well below the freeze line (around 3-1/2 to 4 feet in our area).

In our case, the utilities involved are: 1) electric, 2) phone (although we have never had it connected, we still don't want to interfere with the line), and 3) water. We have a septic waste system and know where that pipe is (not close to the digging). The previous owner had a satellite dish (which we do not use and have just never removed) and we already know the line from it has been cut.

All the lines were marked within three days... plenty of time before the digging started.

A few days later the digging company arrived. Eric sub-contracted Paul Werning (Higginsville, MO) to dig the trench and lay the tubing. I really enjoyed talking with Paul (and Dennis) and learning about making trenches and putting in the tubing.

Paul was AMAZING to watch using with the Ditch Witch! At first it made me nervous seeing how close he had the bucket to the foundation, but that fear soon disappeared. He is truly a master!

As Paul unloaded outside, Dennis went work inside. That is one powerful drill (and noisy). He drilled both holes before heading outside to work with Paul.

He moved the bulk of dirt out of the way, but there was still some hand work to uncover the holes.

The theme appeared to be along the lines of: don't disturb more dirt than you need to. (It's more cost effective, safer and smart.)

While Dennis was digging, Paul turned the machine around so he could use the trencher. Like a chain saw for dirt, it cut that 6 ft. trench with clean sides slowly but surely; leaving a small mound of dirt on either side.

See how Paul avoids both the electric line (on the left) and the Persimmon seedlings (to the right).

Because of the small area near to the house, the electric line and our trees and fencing, they dug a single trench along the north side of the fenced yard. The two lengths of tubing share that trench (with about a foot of dirt between them to insulate the one from the other) and will branch off into their own trenches heading south along (and past) the fenced yard.



The tubing is tightly wound and acts very much like a spring, so the manufacturers bind it so that the first half can be unrolled before the second half is released.

After the first section was inserted into one of the holes, it was unwound into the trench by unrolling it as they walked along the edge.

At right, you see Dennis pushing dirt into the trench on top of the first section of tubing (in addition to his foot, they also used a shovel) before rolling the secnd section of tubing in the trench.

Ideally, the two sections would have their own trenches from where they enter the foundation. But the world is not ideal, so we do the best we can with what we have.

Once the tubing is inserted through the foundation (with several inches showing on the inside), cement is packed in around each one as far as it can be. This special cement adheres to both the concrete and the plastic tubing to form a solid seal. It cures quickly and expands a bit as it cures.





This section of trench ends about ten feet beyond the fenced yard. At this point, Paul turned the machine again to use the bucket to make a corner large enough for the tubing to change direction and also so he can cut two trenches from it without either of them collapsing on the other.

Paul then turns the machine around and makes the first trench heading south (for 450+/- feet).

Once the trench is long enough, Paul turns the machine and uses the blade to pour half of the dirt removed from the trench onto the tubing that has already been layed... as he heads back to the split.

There he turns again and makes the second trench (carefully not damaging the tubing in the first trench).

Dennis manuevers the tubing so it makes the turn without being damaged. Then he uses the forked 2x4 to makes sure it stays at the bottom of the trench. Finally, he shovels some dirt over the tubing (in the new trench to hold it in place while he continues unrolling it.

As Paul continues making the second trench, Dennis repeats the process at the corner... unrolling and manuevering the tubing, pressing it into place with the forked 2x4, and shoveling dirt over it to hold it in place while he continues unrolling the rest of the section.

There is more trench than tubing at this point and so they have to connect more.

Here is a close-up of the connector.

First, the outside and end of the tubing is heated at the same as the inside and end of the connector. The special channel lock both protects Paul's hand and shows how far the heater inserts into the tubing.

In this example, they are attaching the connector to the new roll first. Below left: heating the connector in Paul's right hand and the tubing in his left.
Below center: the unrolled tubing is in his right hand and the connector/new roll is in his left.

Dennis removes the heater and Paul quickly pushes the pieces together as shown in the photo below right. They cool quickly and become one.

Once all the necessary tubing has been connected and rolled into the trenches, it is time to connect the two trenches to make one loop.

Below you see that Paul has set up the Ditch Witch to use the bucket. I wish I had used the video camera, because this was amazing to watch... stills would not do it justice. He was able to connect these two trenches without collapsing them at all. If you haven't seen this done, you will not understand no matter how hard I try to explain it.

There was still a bit of work to do with the sharp shooter shovel and the hoe and then it was time to connect the tubing again, but in a 6 ft hole.



Once connected, the forked 2x4 helped to manuever it into the bottom of the trench and it was time to fill everything in. First using the blade on the Ditch Witch and then by hand.



When it was all done, we were left with a single mound on top of each trench (like in the above right photo. Paul instructed us to NOT try to compact it, but to let it settle all winter, that way the rain and snow will compress it from the bottom up. To do otherwise could leave air trapped in pockets and that could make the loop less effective. We certainly want our system to be as effective, efficient and money saving as possible! So, for the winter, it looks like we've had a REALLY big mole (hee hee hee).

Paul also suggested that we document exactly where the tubing is so in the unlikely event we have to dig it up, we will know where to dig. And, for that matter, where NOT to dig for other purposes.

p.s. I was so excited about getting the geothermal system, I completely forgot there are peony bushes next to the fence where they dug by the house. You can see one of them near the end of Dennis' shovel that got pulled out entirely. We have it wrapped and stored in the garage to be planted in the early spring... it needs to be divided anyway.

Install Ground Source Heat Pump and Water Heater (October 2011) -

I am not at all technically minded when it comes to heating and cooling. When Ken Riead and I co-authored "The Green Building Decision Kit", you can be assured that Ken wrote all the technical information in that area. I have a basic understanding of how things are supposed to work and I know how to talk with the people who know what they are doing; but other than that, I'm pretty clueless. SO, just like anyone else, I had to make sure I was hiring people I trust to do the best job possible.

Here are links to information about ground source heat pumps:

- http://en.wikipedia.org/wiki/Geothermal_heat_pump
- http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=HP

That being said, I really can't tell you what they did to make it work.

I can tell you that the J.R. (and George) hauled in the equipment... connected everything mechanical, electrical, etc... installed the two water heaters... filled the tubing with the water/glycol mixture... installed the new (programmable) thermostat... check and double checked everything... tested everything... fine tuned stuff...

and VIOLA! we have a working heating and cooling system that also gives us hot water!

Removing the old Air Conditioner (electric)

Removing the old Furnace (propane).

Out with the OLD... In with the NEW!

For once, something goes well... it fits! The unit sits on a plastic (recycled, no less) base and it fits where the old furnace did! That means they can use the metal part above it with just some minor corrections.

FYI, they waited to take out the propane water heater until they were ready to plumb the new electric ones.

Working hard!

All done!

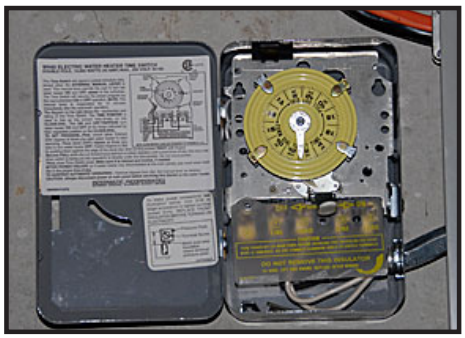
Isn't it just BEE-U-TEE-FULL!!!

All the tubes and plumbing insulated, wire encased, water heater and desuperheater insulated.

This system takes a special (really big) custom filter, but the cost is about the same as a quality filter and they don't have to changed as often (about every 3 months). Eric is going to order us some so we can keep a stock handy.

They installed a separate circuit breaker for the auxilliary heater (it's strip heat for if we get colder temps than the heat pump can manage. It's expensive to use, so we will consciously have to flip the breaker to activate it. Thanks, Eric!

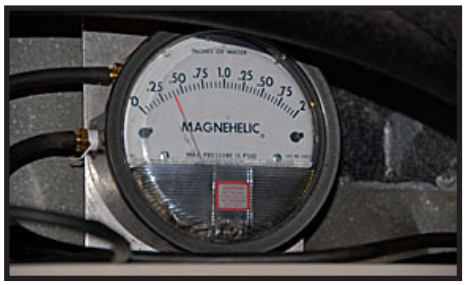
This is the thermostat we now use. It took a little longer to get used to than I expected, but that's probably because it can be programmed for more detail than we have used in the past. It's also nice to see what the outside temp is... we made sure they put the outside sensor in a sheltered spot on the north side of the house so we get an accurate reading.



Another nice thing that Eric recommended is this timer for our water heater. When we use electricity to heat the water (as in when we aren't using the furnace or air conditioning), we can now set what time(s) we need the water hot and not heat it when we don't. We are still experimenting with what times are best for us.

UPDATE: 12-28-11. We have settled on having the water heater on for about 12 hours each day... 6 hours in the morning and another 6 hours in the evening. Here is the link to the Intermatic website to learn more about the water heater timer. (http://www.intermatic.com)

Below is one of the tests they did on the equipment for those of you who know what this means: the photo on the left is when it was running in the first stage, the photo on the right is when it was running in the second stage. Eric was VERY HAPPY. (It's all mumbo jumo to me, LOL.)



They did a blower door test and measured the air flow at each of the supply and return vents to compare with the tests they did before all the duct and system changes. I'll post the results when I get them.

Remove Propane Tank (October 2011)

Once the propane was turned off outside the house and all the old propane equipment replaced with the new electric components, I called our propane supplier to schedule the removal of the propane tank. They came out a few days later and picked up the tank (Photos below). The following week we received a check for the propane that was still in the tank.

Here is a shameless plug for Magruder Propane in Odessa, MO. What terrific people they are! They have a vast network of contacts in this area and were happy to recommend good people and businesses. They pointed me to the mason who fixed our chimney, for example.

I may not be a customer any more, but I hope there will be other reasons to talk to and work with them again.

2012 QHCA Award by Contracting Business.com (June 2012)

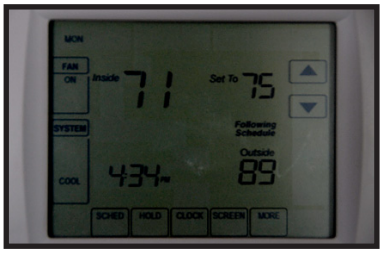
Eric Kjelshus submitted our HVAC installation to Contracting Business.com's Quailty Home Comfort Award competition earlier this year and was recently notified that it was a WINNER!!! Yeah! That should get us some more exposure!

Their professional photographer was here last weekend (Memorial Day weekend) and took photos of the mechanicals area, our living room and my 'meditation room'. We don't know which photos will be used in the NATIONAL magazine article. I understand a reporter will be contacting me for some info and quotes for the articles as well.

More to come... but below are pictures by of Mr. Tim Ryan taking pictures of Eric for the article as well.

(I must tell you how great it was to play assistant to Mr. Ryan! And he was SO nice and complimentary of my photos on this website and my "photographer's eye". There is nothing like getting your ego raised by a professional that you respect.)

Proof: How Great Insulation and New Geothermal System Is! (June 2012)



See for yourself!

It's great to have an efficient heating and cooling system.

It's even better that the house is so well insulated and "tight" that the system doesn't have to work very much.

The Glory of Geothermal Cooling! (August 2012)

Here in the Heartland of the USA, we have been experiencing desert-like conditions; but air conditioning our house has not required taking out a second mortgage. In fact, we used 47% of the electricity usage in July 2011 (another way to put that is 53% LESS).

The image at right is scanned from our electric bill. The first bar on the left was July 2011 (at 1988 kw for the month). The last bar on the right was July 2012 (at 931 kw for the month).

Lest you think that could be attributed to something other than improving our structural envelope (insulation) and changing to the ground source heat pump, here are weather comparisons between July 2011 and July 2012. (Temps are in Fahrenheit.)

- Highs were six (6) degrees higher, on average in 2012 than in 2011 (99 vs. 93).
- Lows were two (2) degrees lower on average in 2012 than in 2011 (72 vs. 74).
- Sixteen (16) days of 100+ temps in 2012 vs. four (4) days of 100+ temps in 2011.
- Two (2) days in the 80s in 2012 vs. seven (7) days in the 80s in 2011.

I'll also tell you (since I believe in full disclosure) that we do water training with our two (2) Newfoundland Dogs on Saturday and Sunday mornings. We fully rinse and/or bathe our dogs after each training session and blow them dry (using a cool air blower), which takes about 2.5 hours each day for both dogs. This practice did not change from 2011 to 2012. We blew dry the dogs the same number of days with the same equipment.