DOE/R4/10312--T1

ENVIRONMENTAL ALTERNATIVES, INC.

Urban Alternative Homestead

DOE/R4/10312--T1

DE84 000774

SUMMARY

The three main areas of Appropriate Technology Grant No. DE-FG44-80R10312 were in redesigning and correcting the design flaws of the active heating system, the passive solar heating system, and the furnace controls, so that the building would heat and cool itself more efficiently and evenly than it had before.

The active system was re-plumbed, fixing leaks, and adding joints and parts needed to work properly. Its tanks were insulated and new pumps installed.

The passive system was reworked by adding a shadescreen to the outside of the greenhouse for summer cooling, and by adding ductwork to remove excess heat from the greenhouse and office, and redistribute it to the rest of the building, or to the outside. To help heat the north rooms, this recycled heat was very helpful. Also, insulating the floor under the north rooms was very helpful in providing more even heating.

In order for the heating system to operate more efficiently, the electronic controls had to be reworked so the proper messages could be sent to the furnace about when to use each kind of heat.^{1/2}

The lowered gas usage of the house told the story about how much better the active and passive systems were when the grant was completed. Moreover, the house was much more comfortable, not only from the overheating in the summer, but from a more even distribution of the heat to the north rooms. The fact that the electrical usage increased reflected the fact that the new pumps took more electricity to run them, and that the active system did not have all of the flaws worked out.

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BODY OF REPORT

Appropriate technology Grant no. DE-FG44-80R10312 was sought and carried out because of the design flaws which occurred when the Urban Alternative Homestead was being built (retrofitted) by unprofessional volunteers of Environmental Alternatives, and a group of engineering students at the University of Louisville. When the solar greenhouse was added, several design flaws occurred, including the design of the active solar heating panels, which were homemade, and not properly constructed. In order to use the greenhouse for food production, for passive solar gain, and for active solar heat for the entire building, these design flaws had to be corrected. There were other considerations which were needed in order for the above corrections to be effective: weatherizing (insulating) the floor under the north room, adding new controls to the existing furnace system, and adding new ductwork in the office to remove excess heat due to overheating of the passive solar system, and adding a shade screen to the outside of the greenhouse glass. Two other measures were included in the original planning, but were not completed because of lack of funds: activating a heat pump and well system for solar cooling, and adding insulated window cover for night protection.

The work was let to several contractors. One contractor reworked the active solar panels, which were plumbed incorrectly, and replaced valves, fixed leaks, insulated tanks, etc.

Because of the 45° angle of the greenhouse, the passive system had a severe overheating problem, which was corrected by adding a shade screen to the outside of the greenhouse, and by adding ductwork

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which would remove excess heat from the top of the greenhouse and office, and recirculate it to the rest of the house during the winter, and remove it to the outside during the summer.

In order for the active solar heating system to work better, a new control system had to be devised which would electronically tell the furnace when to use the excess passive heat, when to use the active solar heat, and when to use gas.

When all of the work was completed, there was a definite improvement in performance of everything, although insulating shades for the greenhouse probably would have made a bigger difference. It would not be fair to say that the active system worked perfectly, but there was definitely an improvement in the workings of the system. The total energy consumption of the building was considerably lower, with less natural gas used than ever before. However, there was an increase in the electrical use because of the added pumps for the active solar heating system, so the benefit to the system was not as great as it might have been if electrical costs had not risen so drastically. The north rooms were definitely warmer in winter, and the office was definitely cooler in summer than it had been before.

CONCLUSIONS & RECOMMENDATIONS

It was a very worthwhile project, overall. The results of reworking the passive system have helped tremendously in keeping the building cooled during the summer, and of transferring the heat to the north side of the building during the winter time. Insulating the floor of the front (north) side of the building helped with the overall temperature comfort level. The furnace controls have worked properly since installation, and the overall comfort of the building is much improved. The active system is improved, and we have used less total gas for heating the building, but because of the large pumps to circulate the water, the cost of electricity has risen out of proportion to the amount of gas saved.

Since we did not have enough money to put in night cover for the greenhouse, it is still recommended that we consider that alternative. Also, current thought indicates that we should take down a few of the active panels in the greenhouse to allow for more passive gain, reducing the size of the water tank and the amount of water which needs to be moved around, leaving the panels up in the office, and running the upper panels only.

MATERIALS AND EQUIPMENT

PLANS AND EVALUATION OF WORK BY CONTRACTOR

I. Active Solar System

A. evaluation of Existing Active Solar System

1. Solar Panels
 - a. Manual Air Release (not maintained)
 - b. 3/4" Pipe Furnishes Five 1/2" Outlets
 - Overload on Two Panels
 - Underload on Three Panels
 - c. No Provisions for Summertime Overheating
 - d. Leak in One Panel
2. Circulation to Solar Panels
 - a. Tries to Push Hot Water from Panels Down into Hot Water in Storage
 - b. Night Time Back Thermosiphon Cancels Daytime Storage
 - c. Poor Intake and Exhaust Manifold Design
 - d. Leaks in Plumbing
3. Circulation to Heat Exchanger
 - a. Pump Bad
 - b. Take Off is Well Below Max. Heat
 - c. Poor Manifold Design
 - d. Leaks in Plumbing
4. Cold Water Make-up
 - a. Dumps Cold Water into Storage and Cancels Heat Storage
5. Total system
 - a. High Pressure Operation
 - (with Thermo Characteristics of System, High Pressure makes System Prone to Leak Failure, and Allows Solar System to Dump Heat and Pressure Overload Back into City Water System Along with Debris of Working Components)
 - b. Insulation Poor and Incomplete

B. Presentation of ~~Prop~~osed Active Solar System

1. Solar Panels
 - a. Six Automatic Air Release Valves
 - b. Monoflow Fitting at Each Panel with By-pass for Each Bay
 - c. Drain Down for Summer (manual)
 - d. Fix Leak
2. Circulation to Solar Panels
 - a. Bring Hot Water in Lower Than Max. Heat Level
 - b. Check Valve to Prevent Night-time Recirculation
 - c. Balance Manifold at Intake and Exhaust Areas
 - d. Fix Leaks
3. Circulation in Heat Exchanger
 - a. New Cheaper Pump
 - b. Take off at Max. Heat Level
 - c. Balance Manifold at Intake and Exhaust Areas
 - d. Fix Leaks
4. Cold Water Make Up
 - a. Cold Water to Come In at Bottom of Storage
5. Total System
 - a. Pressure Reducing Valve Allows System to Operate at Much Lower Pressure Thus Eliminating Failures Due to Pressure
 - b. Pressure Reducing Valve Prevents Dumping of Solar Water Back into City Water
 - c. Expansion Tank on Main System, Two Temperature and Two Pressure Relief Valves Allow system to Blow Off Excesses to prevent damage to system

C. Evaluate Existing Domestic Hot Water System

1. DHW Heater is not Solar Type
2. DHW is Taken Directly from The Solar System along with any Debris from Working Components in System
3. Make-Up DHW which is cold is Dumped into Storage in the Max. Heat Area of Storage Tank and Cancels Much of the Storage

D. Proposed DHW System

1. Use Existing DHW Heater but Isolate it from Solar System Water
2. By Wrapping Coils of Type "L" Copper around the Max. Heat Area on the Storage Tanks and Insulating on the outside of These Coils, The Water in These Coils will be heated to near the Storage Temperature. When Hot Water is used the supply to the Heater will be Hot instead of Cold

II. Passive Solar System

A. Evaluate Existing Passive Solar System

1. The Two Greenhouse Areas Accumulate Excessive Hot Air in Late Fall, Winter, and Early Spring, But have no way of Storage or distribution to other areas of the house where Heat may be needed
2. The Two Greenhouse Areas Accumulate Excessive Hot Air in Late Spring, Summer, and Early Fall, and have no automatic means of Venting it out of the house
3. No provision for Shading in the Summer or Insulating in the Winter

B. Proposed Passive Solar System

1. One New Duct System with Controls will determine if Excessive Hot Air is Present in the Greenhouse areas. This Hot Air will then be Removed and Distributed to other Areas of the House Where and When it is Needed
2. Another New Duct System Will Determine if Excessive Hot Air is Present in the Greenhouse areas and exhaust it to the Outside if it is not needed anywhere in the house.
3. Shading and insulation to prevent Summer Over Heating and Winter Night Time Heat Loss, should be considered (these would have to be Manually Controlled, Personal Involvement)

III. Heat Pump

A. Evaluate Existing Heat Pump System

1. The Heat Pump is of the Ground Water Type and was originally meant to be used in conjunction with an outside Water Fountain for Cooling
2. The Heat Pump is in Place but the Plenum design is incorrect. No water hook-ups are in place but electric is in place
3. Considering all assets and liabilities of the original plan, it seems evident that a new direction should be pursued for the following reasons:

- a. A Fountain Cooling System has all the Liabilities of a Cooling Tower... 1. Algae build-up in cooling coils;

- b. Plus some additional problems: 1. seeds from surrounding garden area; 2. air borne dirt from local area; 3. Winterizing provisions
- c. Heat Disipation of fountain is Poor
- d. Cost is High

B. ~~Propo~~osed Direction for Heat Pump

1. Considering the fact that Ground Water is probably within 60' and it would cost less to drill a shallow well than build a Fountain, This seems like an obvious direction for air-conditionin
2. A Ground Water Heat Pump System will also make a sizable contribu to Winter Heating when needed (a better BTU/Dollar Than Gas)
3. Ground Water is clean thus requires much less Maintenance
4. Although the system is on the bottom end of the priority list, Provisions have been made in the control system for it for very little additional money.
5. The Ground Water would be dumped into the City Sewer System as the pump was used
6. This Ground Water Heat Pump System has many other long range Local assets too numerous to mention at this point (local grant should be explored)

IV. Controls

A. Evaluate Existing Control System

1. Differential Thermostat now in place but is not opperating with intelligence because Solar Panel Sensor is on panel that has beer shut down for some time.
2. Differential Thermostat in place is of the Home-Grown Variety which makes it non-servicible from a normal service company

B. ~~Propo~~osed Control System

1. The Main Component of the New Design is a Step Phase Control
 - a. This control will stand ready in the null position when the house is satisfied
 - b. As the house cools in the winter time, This control will progressively bring "on line" sub-systems that will provide potential heat to the house, starting with the least Dollar/BTU and progressing in steps to the most Dollar/BTU sub-system
 - c. As the house warms in the summertime this control will bring "on line" cooling sub-systems again with progression relative to the best dollar value
2. Sub-System Circuit Description
 - a. Heating
 1. AS the control switches to the first stage of heating, all Solar Systems will be surveyed and any systems that can provide heat will be called on to do so. If there is sufficien heat available in this system, the needs of the house will be satisfied and the control will return to the null position. If there is not enough heat available in the solar systems, the control will bring in line the Heat Pump. The next step would finnally be the Gas Furnace.
 2. Cooling
 - As the control senses the need for cooling, the first stage will be ventilation, the second is the Heat Pump, which will

I Other Areas of Concern

A. Insulated Curtains

(The needs for these are great and they will serve two purposes)

1. Shading for summer sun to prevent over heating
 2. Insulation for night time winter heat loss
- note: demands manual operation thus personal involvement

B. Weatherproofing of House

1. the most important area is under the floor in the front room
2. Every effort should be made to find any other heat loss area and remedy ... cost is low and the benefits are high

C. Cat Walk

1. There appears to be no structural problem with the greenhouse rafter system
2. A sub-contractor stated that a cat walk would make very little difference when servicing the solar panels

C. Appearance

Considering the above improvements are to be made, some consideration should be given to appearance. Hiding the working parts would be costly. The work should be done with every effort to keep the finish appearance as neat as possible and still leaving every thing in clear sight for educational reasons

VI. Cost Break-Down (in order of presentation)

A. Active System

1. Rework solar system	\$1500
2. Armaflex Storage Tanks	500
3. New DHW System	475
Total (Long's Plumbing)	<u>\$2475</u>

B. Passive System

Duct work	\$645
Total (Hettinger & Shuck)	<u>\$645</u>

C. Heat Pump

1. 60' Well, pump and tank (Kingsbury Well Service)	\$2000
2. New Plenum System (Hettinger & Shuck)	900
Total	<u>\$2900</u>

D. Controls

1. Components	\$784
2. Labor (installation)	600
Total	<u>\$1384</u>

E. Insulating Curtains

1. Material	\$1785
2. Labor (Efficiency Systems)	600
Total	<u>\$2385</u>

F. Weatherproofing (under front room)

1. Labor	\$190
2. Materials	305
Total	<u>\$495</u>

VII. Priorities (recommended)

- First--- Active System
- Second--- Control System
- Third--- Passive System
- Fourth--- Heat Pump

The insulated curtains and weatherproofing should be done in parallel with the above. These are elements of conservation. The above priority list is based on the potential of the house as a teaching instrument but heat loss in winter costs money.

SECTION

ENVIRONMENTAL ALTERNATIVES, INC.

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