Technical Assistance Request

Our project is made up of four major parts which all have opportunities for refinement as well as testing to match the performance of all functions.

The solar collectors are built in place with inexpensive materials and are designed to limit maximum temperatures to safe levels for all the materials while maximizing efficiency at low temperatures and solar angles. Testing of the combinations of cover materials, absorber angles and colors need to be done at extremes to determine how they can be optimized for different climates. The tubing dimensions, placement and spacing would be a good subject for infrared photo analysis. The attic temperature will be impacted by the base design and any insulation that is used between the base surface and the interior. Attic temperatures can affect the cooling load on a dwelling but also provide an opportunity to capture more heat energy in the attic or at vent locations and this effect needs to be profiled at both high and low temperatures. An additional safety feature would be controlled vents to limit maximum temperatures, these would also allow humidity control with appropriate sensors. The vents would further allow the collectors to be used as radiators at night or in cold cloudy conditions. Testing is needed to determine the size of vents needed and also for the size and shape of openings in the purlins in the collectors. The purlin openings are to allow complete venting of the collector and to introduce air turbulence to increase heat transfer to the air. This new style of integrated solar collector will require extensive testing by the proper regulatory agency in order to achieve certification.

The stratified subterranean heat storage consists of inexpensive, low strength concrete separated by insulating layers of cellular concrete and the possible addition of one of several thermal break designs we have developed. The thermal storage capacity and transfer rate of the low strength concrete must be tested in order to optimize the size of the layers and spacing of tubing to absorb the energy produced by the collectors. The cellular concrete used for insulation can be produced in a wide range of densities and strengths. The rate of heat transfer through the cellular needs to be tested to optimize the thickness of the insulation layer and determine if an additional thermal break is warranted. If so, then the thermal break designs need to be tested as well. Because the entire structure of the heat storage configuration can be the structural foundation of the building, the strength and stability of the combination need to be verified. Assistance is requested to identify and ensure proper building code compliance.

The stratified subterranean cold storage is similar to the heat storage but would not be placed under the building in cold climates. With the addition of moisture sensors in the storage medium and a soaker system it would be possible to freeze the storage area for a drastic increase in storage capacity. In this case, the transfer rates would vary and the effect of freeze thaw cycles on the storage material as well as the insulation would need to be monitored.

The control system will have to match the flow of both hot and cold flows to appropriate storage zones while controlling the temperature in the building. A critical feature in preventing overheating of the building is the operation of a buffer zone between the floor and top storage layer. This buffer zone has to be sized appropriately to allow for night time cooling or cooling through an outside radiator or ground loop of tubing to interrupt heat flow to the floor. It also needs to be capable of using heat directly from the collectors when they are warm enough during the heating season. Determining an optimum storage capacity from the buffer zone can greatly improve overall efficiency of the system by bridging high or low temperature periods with direct input from the collectors rather than draining energy from the storage layers.

Establishing the expected outputs and flow rates of the systems will allow them to be matched to each other and sized to meet the energy needs of the building. Because the storage system is constructed of set materials rather than depending on local soil or fill materials, it should be far more predictable and consistent in application.

Previous modeling in Solid Works did not match results of our first Proof of Concept – possibly because the use of cellular concrete has different properties than standard insulation such as thermal mass. We feel the best way to model this test building is to get the data from an actual project. More accurate data will direct the project and improve future models.