What is a Biosphere?

by Day Chahrohdi

The notion of the biosphere is to make heating and growing food integral functions of a dwelling through the use of solar energy. This would be two large steps in making a swe lling a parent plastic membrane which lets sunlight in but does not let heat or infra-red radiation out. The membrane is a solar energy trap.

See Figure 1 for a possible (rather unimaginative) biosphere configuration. The membrane covers and is stapled to the plywood grid. The walls of the enclosure are covered with aluminum foil to increase the intensity of light falling on the ground.Here it is either absorbed by the plants (the increased light intensity compensates for the short winter days) or else is absorbed as heat in the ground. The heat storage capacity of the ground is greatly increased by laying clear plastic film tubes that are filled with water in between the rows of the garden (see Figure 2). The temperature inside the enclosure is maintained at about 100 degrees F by venting excess heat. Whenever heat is needed inside the living area, the door is opened and air convection removes heat from the ground level and distributes it in the living area.

According to calculations, three overcast days with an average temperature of 25 degrees F or below are needed before the temperature inside the house drops below 70% and then only at night.

The usable garden area is 400 square ft., more than adequate to produce all the fresh fruit and vegetables an average family can eat. (Fruit trees are sold which have five different kinds of fruit on them) The garden is in a tropical environment, but since the system is closed, almost no water is consumed. The garden is self-sustaining and independent of the outside environment with respect to temperature and water. All it needs is sunlight.

The membrane consists of three layers. First, an outer skin of 16 mil clear vinyl. This is the protection against the wind and rain. The angle of the membrane allows it to shed snow and dust. Then, thermal insulation is provided by a 3" thick layer of clear acrylic foam. The cell (bubble) size is ½" and the cell walls are very thin, so that at least 70% of the sunlight gets through. The thermal conductivity of the foam is less than .2 BTUs per hr. square ft. F. The third layer is a paint that is clear to visible light but white to infra-red radiation. This traps the infra-red radiation inside the biosphere.

The estimated cost of materials for the biosphere breaks down as follows. For a house with 1,000 square feet of floor space, the membrane area required in New Mexico is 700 square feet:

plywood grid	11¢
16 mil vinyl	9 sq. ft.
acrylic bubbles	5
infra-red paint	2
aluminum foil	3
fasteners	2
miscellaneous	4
TOTAL	36¢ per sq. ft., or $250.00

FIG. 2
END VIEW OF GARDEN ROWS:

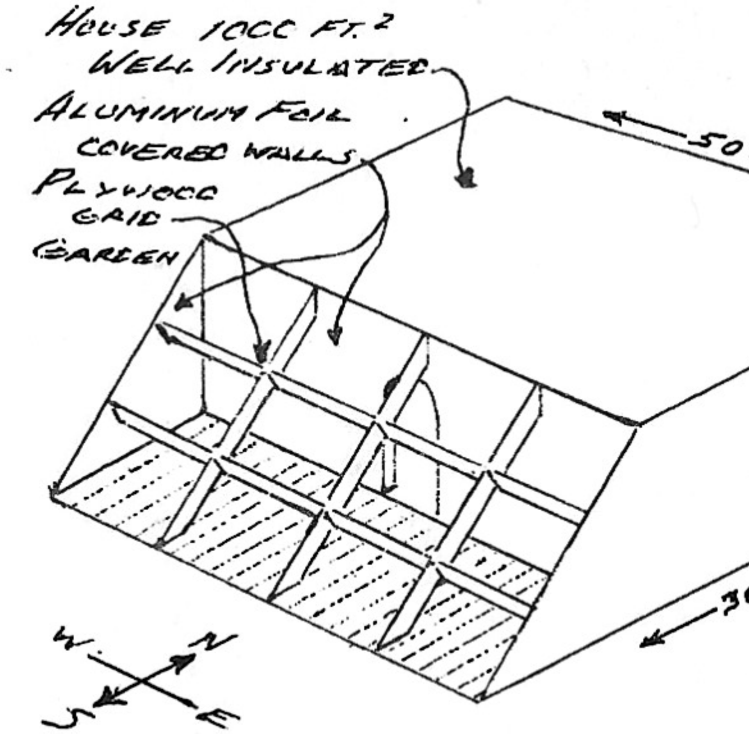

FIG 1

For a lifetime of 10 years, this is $25. per year. Except for the vinyl, the lifetime is at least 10 years. It should not be difficult to find a substitute for the vinyl, glass if nothing else.

The work to be undertaken is to make the acrylic foam and the infra-red paint. I have been in touch with people at the Rohm and Hass labs who are making acrylic foams with a much smaller cell size. I have made foams of uniform ½ inch cell size and very thin walls from gelatin, soap and water. They look just like frozen soap bubbles that don't pop when you touch them and last for months. I have reason to believe it will not be difficult to translate the foaming or bubble blowing process into acrylic, which may be processed in most of the ways plastics can be processed.

The Russians have made a tin oxide coating for glass that is transparent to visible light yet a mirror to infra red. An acrylic paint with a tin oxide pigment would probably be a cheap and satisfactory infra-red paint but this must be experimentally investigated.

A PROPOSAL

Solar energy and hydroelectric power are the only non-polluting energy sources. Hydroelectric power is near its capacity and solar energy has not been widely used because of the high capital investment of solar heating.

The biosphere is designed to provide solar heat and food for a dwelling in below freezing weather. It consumes no water, so areas that are uninhabitable because of lack of water or fuel or short growing season would be habitable. The estimated lifetime is ten years. For a 1,000 square foot house (average family size) this comes to $25. per year for heat, fresh vegetables and fruit. This cost is less than one-third the cost of the cheapest solar heaters now in operation.

The problem in building a biosphere is essentially the problem of how good a membrane can be built that is transparent to light yet is also a thermal insulation. The aircap used in the growhole which is now functioning at Lama Foundation is adequate for a solar heated greenhouse but a more efficient membrane is required for the biosphere, which must also heat a house.

I estimate it will cost $1,800. to make the first piece of this material. The expenses are as follows:

$100. per week, salary
30. per week, phone

(The making of acrylic foams is a state of the art process, which means it's in people's heads, not in print. Thus the phone bill.)

$20. per week, supplies and equipment (This figure is low because the manufacturing process is fairly simple and involves no expensive machinery - This technology will be cheaply accessible.)

TOTAL $150. per week.

The study should take about 12 weeks (although it is hard to know exactly) for a total expense of $1,800.00. Two problems will be investigated: the blowing of acrylic bubbles and the finding of a good material to make the bubbles opaque to infra-red radiation.

I would guess the odds for success at about 3 to 1. If it is successful, it will then be possible to build a biosphere.

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