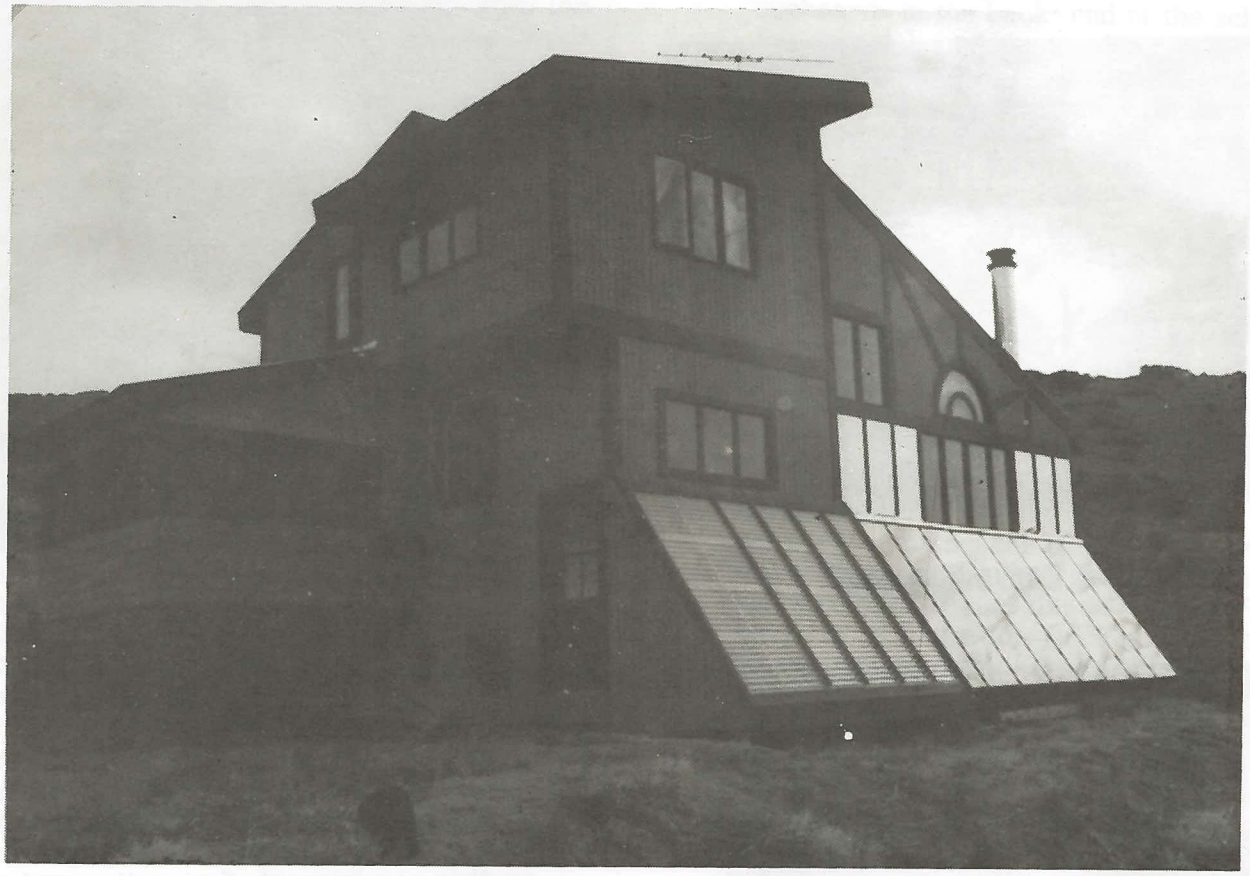
Power From the Sun... Solar Heating

Special thanks to Judy Walden and Tina Touchet for their help.

By Steve Roehrs



Pete Hofmann's active solar house

With the cost of fuel rising very rapidly, today's nation is forced to look to new sources of energy. On the east coast fuel oil is getting more expensive and in the West, coal is in great demand. There is also a shortage of natural gas. It has been known for years and years that the sun gives off much energy. For instance, the cliff dwellers in Mesa Verde were some of the first people to take advantage of the sun's energy. They selected a southern exposed cliff and dug into the rock. On a sunny winter day, the sun would hit the rock and the rock would store the heat, sometimes for days at a time.

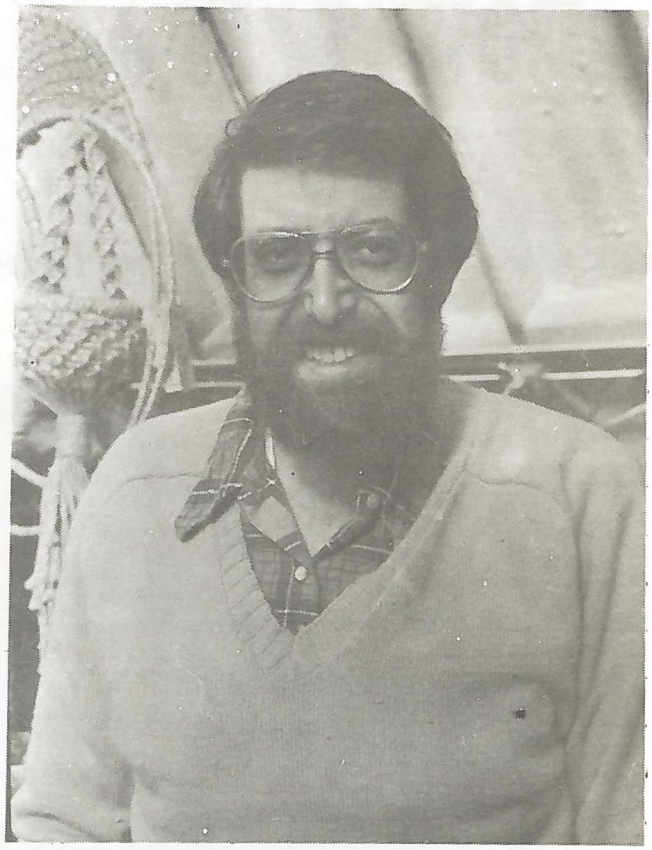
There were other people who used solar energy besides the cliff dwellers, but it hasn't been until recently that people have expanded the solar idea. Now there are many large companies manufacturing solar components that can be used on newly designed and built houses or for existing houses that are converting to solar heat.

I talked to Sally Rawlings, a local solar enthusiast who supplied some basic information. I also interviewed two other Steamboat residents who live or work in solar-heated buildings. Roy Borodkin owns and operates Alpine Floral and Greenery which is located in a solar-heated greenhouse. Peter Hofmann, a local architect, lives in a house he designed and built on the Elk River Road. Both men seem to be pleased with their solar systems, and are anxious to spread their enthusiasm about solar energy to other people. Hofmann commented, "Owning a solar-heated house takes a certain amount of owner participation. One must know the basic concepts of the system and how each component works in order to maintain an efficient system."

What are these concepts? Basically, one must understand that heat must be collected and stored until needed. This can be done with or without the aid of mechanical equipment, the factor that makes a system active or passive. Solar manufacturers and private individuals are making components which collect heat efficiently. They must take into consideration

types of collection, transfer media, means of storage,and effective insulation techniques. The primary consideration always seems to be the cost effectiveness of each component of the system. All the parts working together must produce a cheaper heating system as opposed to conventional means. Let us examine each of the components separately, then review some cost-saving tips.

Peter & Maeva Hofmann



Roy Borodkin

Steve Roehrs and Sally Rawlings

ACTIVE OR PASSIVE?

Sally Rawlings described the active system as anything that has a fan or relies on another outside power source. Hofmann told me that another requirement of an active system is an electronically controlled device which constantly monitors the conditions of collection, transfer, and storage. This mechanical equipment works to help transfer heat from collectors to the storage area, and then later helps distribute the heat to the living area when it is needed.

"In a passive system, you live in your collector," Sally explained. "It is like a car that has been sitting out in the sun. The sun's heat rays come into the car and are absorbed by materials in the car. This is referred to as the greenhouse effect, and is another term used for a passive system." In a house,this effect simply happens on a larger scale than in a car.

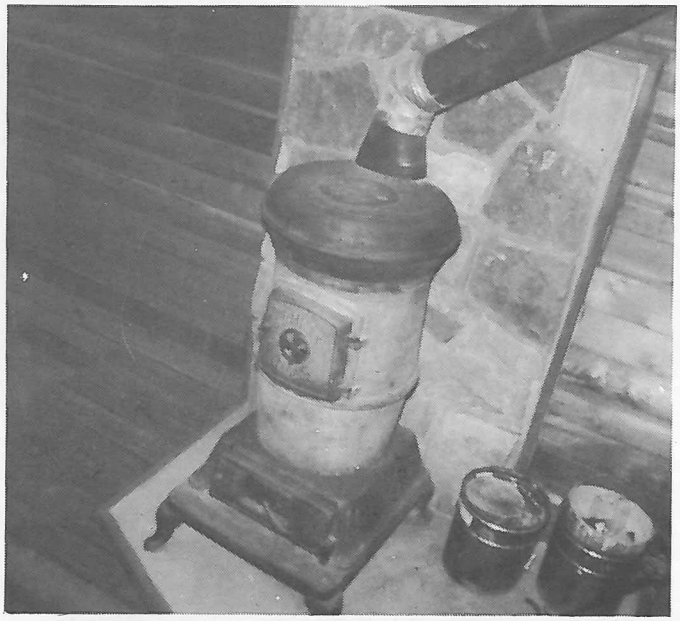
A house that utilizes a passive system must be oriented toward the south so it can collect as much sun as possible. Preferably, the north side should have very few windows, be well insulated, and may even be backfilled with dirt. In order to utilize such a plan, one must maximize heat gains and minimize losses.

Another passive technique can be seen in Borodkin's greenhouse. The benches that hold his plants are supported by 55-gallon drums which are stretched out end-to-end along the sunny side of the greenhouse. They are painted black to absorb heat and filled with water to store heat.

Hofmann's house is a fine example of the active system. He has a computerized device, like he mentioned earlier, which monitors the conditions of his system. It automatically turns on the fans which blow heated air where it is needed, even if no one is home.

A building doesn't have to be strictly active or passive, techniques can be used from both methods. For example, Borodkin's greenhouse, which is primarily passive, also uses a Stratotherm heat pump to suck hot air out of the peak of the roof and blow it back down to the floor where it can be reused (an active technique). Hofmann's house, which is primarily active, has large southerly-exposed windows, a small greenhouse, and spaces designed so the heat flows easily throughout the house. Sally Rawlings pointed out, "Before Pete even had his collector, fans and electronics hooked up, he could get a lot of heating for his house with just his greenhouse, simply by opening doors part of the time and closing them part of the time." And so, neither system is strictly active or passive.

Most solar systems, especially in severe climates, use some form of back-up heating for cloudy or cold conditions. Popular methods are coal furnaces (in which the same ducting can also be used to transport solar-heated air), conventional gas heaters, electric heaters, or wood-burning stoves.

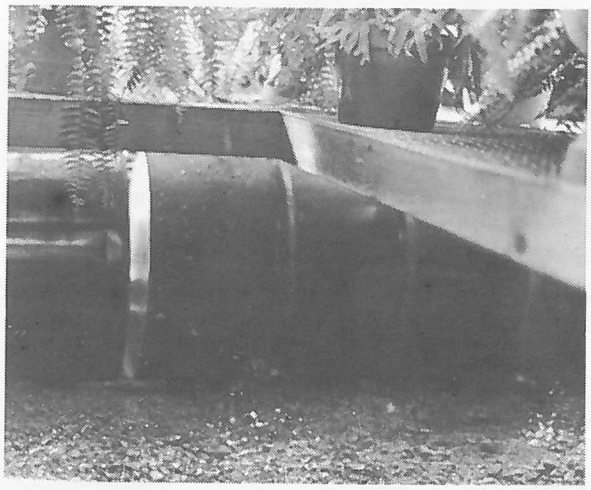


Wood burning stove used for back-up heating

COLLECTION SYSTEMS

There are two options for collecting heat: placing the storage area so that the sun hits it directly, or designing a specialized area that will intensify the sun's heat to be moved to a storage area. An example of the first method would be to place a mass of rock, sand or water in a place within the house where the sun is allowed to hit it directly. People have used barrels of water, rock fireplaces, and interior concrete walls in this way.

The most common example of the second method is a flat plate collector which can be hand-made or purchased from a manufacturer. This plate of metal is usually painted flat black and placed in an insulated box on the sunny side of the house. The angle at which the sun hits the collector affects the number of rays that are reflected. The purpose is to position the collectors so the greatest number of rays are collected. Commercial companies have started to offer collectors that mechanically track the sun as it moves across the sky. This is an example of a sophisticated, expensive, active collection system.



Barrels used to collect heat and support plant shelve

TRANSFER MEDIA

A transfer medium circulates through the collector, absorbing heat which it then moves to a storage area. A transfer medium can be either a liquid or a gas, which will circulate naturally or mechanically. Liquid media are usually contained in plumbing that will resist the deterioration caused by chemicals or water. Plumbing materials commonly used are copper, other metals, or plastic tubing. The liquid transfer is usually a chemical or a combination of water and antifreeze.

Gas transfer media circulate through tin ducting. The air is either forced by fans, or moved naturally by the properties of convection. For example, hot air tends to rise, and cool air sinks. In an active system, the medium is pumped to the storage if it is liquid, or blown through the storage with a fan if it is air.

Hofmann explained, "A transfer medium is only stimulated or circulated when ideal conditions come about, such as when the collector gets a certain percentage hotter than the storage. Then the transfer medium will go into circulation, pick up the heat, and move it to the storage area. When conditions are below ideal, the transfer medium stops circulating."

For a climate like Steamboat's, air seems to be a better transfer medium, because when it gets severely cold, one often has to drain the liquid from the tubing so it doesn't freeze and burst the piping. Roy Borodkin predicted that in the next few years, solar manufacturers will come up with some kind of liquid chemical that will hold heat at a higher temperature for a longer period of time than water is capable of doing.

STORAGE

Thermal mass is anything that can absorb heat and hold it longer than air. People usually use rocks or water, because both substances can change temperatures easily. The larger the mass, the more slowly the temperature will change. For example, a glass of water with sun shining on it will heat up very quickly. As soon as the sun goes down, however, it will give off this heat very quickly. On the other hand, if the sun heats a 55-gallon drum full of water, it will take more time to heat, but after the sun goes down it will release heat into the room for a good part of the night.

What is the most efficient thermal mass to use for storage? Hofmann has a room in his basement which is filled with one and two-inch river rock, explaining that there is more surface area exposed to heat than there would be with larger rocks or a barrel of water. Borodkin's choice of water storage is based on the fact that a mass of water releases heat more slowly than the same mass of rock.

How does one decide how much storage area is sufficient? Sally commented, "Pete Hofmann, whom I think is the local expert, says it is really pretty hard to get too much storage. It comes down to a question of how much storage you have room for." Hofmann supported this, explaining that if he could afford it, he would build enough storage to store summer and fall heat for use in the winter. This project would also take a great deal of insulation.

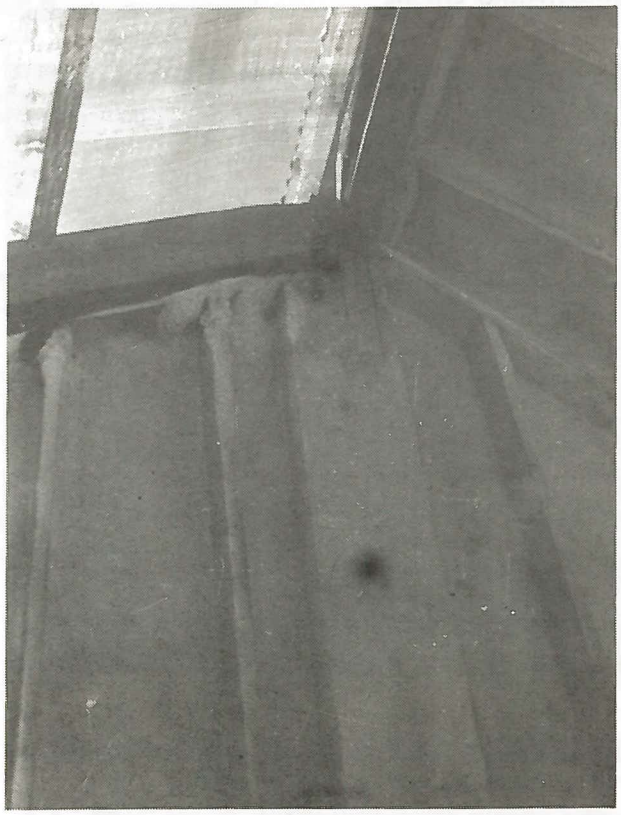
INSULATION

In order to keep heat in the storage unit, as well as to keep it from escaping from the house, one must use some form of insulation. In most buildings, windows and poorly insulated roofs account for the largest amount of heat loss. Storm windows and doors, weather stripping and tight construction all help insulate a building. How does one decide what materials to use to stop the flow of heat?

Materials are rated for their insulating qualities by the use of an "R-factor" (the R stands for resistance). Hofmann says, "To really stop the flow of heat, you need a minimum of an R-16, preferably an R-20." What types of insulation have such an adequate R-factor?

People usually think of storm windows or thermopane glass to keep the winter cold out. A single pane of glass has only an R-2, and each of the next panes doubles that rating. So: 2 panes equals R-4, 3 panes equals R-8 and 4 panes equals R-16. Therefore, a thermopane window would only have an R-factor of R-4, thus being expensive and relatively ineffective.

Another form of insulation, which is cheaper than glass, is foam. New glass can be as expensive as three dollars a square foot, and foam can be as cheap as thirty cents a square foot. Different commercial foams have a wide range of R-factors. When you shop, look for foam with a high R-factor so you can use thinner foam to achieve the same insulating properties, yet still keep your costs low.



Foam insulation sprayed on walls

Most solar-heated buildings have foam stuffed or blown between walls. Borodkin has anywhere between one and two inches sprayed on the walls throughout the whole building, with the north and end walls being solid. This is not a common characteristic of most greenhouses.

Hofmann had an additional application of foam, which was to design shutters, made of foam, which are manually operated for each of his windows. Thus he allows heat to enter through the windows during the warmth of the day, but prevents it from escaping through the shutters at night.

Plastic products such as visqueen are also useful as insulation. The most common technique is to tack up sheets, creating dead air space. Borodkin created six inches of dead air space throughout his entire building in this manner. That six inches of dead air cut his coal consumption exactly in half.

Insulation seems to be a critical component of any solar system whether it is active or passive. No matter how the heat is collected, or transfered to the storage, insulation always determines the cost effectiveness of the system.

MONEY SAVING TIPS

How may an individual in Routt County conserve energy and money through the use of solar techniques? Basically, tips may be divided into suggestions for new buildings, and suggestions for buildings that already exist.

The major application will be the retrofit of existing houses, retrofit is a term that means to remodel a building using energy-conscious active or passive techniques. The most conspicuous would be the addition of a roof top collector or a southern-exposed freestanding unit, that is detached from the main building. These units can be bought from a manufacturer, but can be fabricated much more cheaply by a Penny-pinching builder or owner.

A more inconspicuous technique which is very important for the retrofit concept, is additional insulation which can be blown in the walls and ceiling to exceed the building code standards for insulation. Another interior insulating technique is the use of foam shutters on windows, as were described earlier. Weatherstripping storm doors and caulking of cracks also help retard heat loss. Exterior insulating can be achieved by totally residing a house over sheets of tacked-on insulation.

One of the biggest sources of energy loss in a house is a poorly insulated hot water heater. One can double-insulate a hot water heater by wrapping fibreglass insulation around it, or by placing a metal jacket over the entire unit.

An active retrofit technique would be the installation of a Stratotherm Heat Pump which pumps the heat from the peak of the roof back down to the floor where it can be reused. These units are not very expensive and have been proven cost effective.

For people who are planning to build a new house, there are many techniques that can be used. Peter Hoffman points out, "If you are not worried about establishing a specific architectural form like Georgian Colonial, and design a house which takes on functional shapes your house alone can passively collect and move a tremendous amount of heat, before you ever spend money on active solar collection."

Large, southerly-oriented windows, and a reduction of window areas on North walls are a good start. Properly placed concrete walls or fireplaces may serve as a simplified collector in the heat of the day. The placements of closets, pantries and cabinets on North and end walls help to insulate exposed walls in a very functional way.

A most important principle to remember is that "heat rises." Therefore, placement of collector panels or a greenhouse should be at the lower end of the building. This is especially effective if the house is to be built on a hillside.

Local solar experts agree that the most cost effective solar application is the heating of domestic water. This can be achieved in two ways: Water storage in the attic exposed to the sun, or water circulating through a storage unit.

In a climate such as Routt County's, a back-up system is a necessity. The use of a cheap, but effective wood-burning stove can save one the expenses of installing a mechanical system like baseboard heaters. An added ecological advantage is that wood is another renewable resource.

These tips for new houses can be used in addition to the techniques mentioned for existing buildings.

GO SOLAR

If solar energy continues to spread, it will be good for the economy of the nation, for it saves us from using our supplies of fossil fuels or buying them from other countries. It can also help one's personal economy, by decreasing the amount of money one spends on fuel. So go ahead. Light up your life!