SOLAR GREENHOUSE TRAINING PROJECT
FINAL REPORT

PREPARED FOR

THE ENERGY EXTENSION SERVICE
STATE OF NEW MEXICO
ENERGY AND MINERALS DEPARTMENT

THROUGH

ENERGY EXTENSION SERVICE

951 0075

BY

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SPECIAL THANKS:
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GHOST RANCH

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DISCLAIMER

INTRODUCTION

As a result of interest and demand from other states, the State of New Mexico Energy Extension Service, a branch of the Energy and Minerals Department, sponsored a Department of Energy Special Project. New Mexico is one of ten pilot Energy Extension states. The New Mexico State Department of Energy and Minerals Community Solar Workshop Training Program was designed to give a national basis to the solar greenhouse concept developed by Bill and Susan Yanda and the Solar Sustenance Team.

The Team had been inundated by requests to run individual greenhouse workshops across the country, but was unable to meet the fast growing demand. The Solar Sustenance Team developed a program to train workshop leaders in areas throughout the United States. Twenty groups of three to four people each with skills in design, construction, gardening and community organization came to New Mexico to participate in two 3½ day seminars to learn the basics of solar greenhouse workshops. Participant teams learned how to design, build and operate a solar greenhouse and how to operate a hands-on greenhouse construction workshop where people could participate on a local level.

Using the skills acquired and the materials provided during the training session, participants returned to their communities fully equipped to organize and lead their own solar greenhouse construction workshops. As supportive follow-up, two members from the Solar Sustenance Team attended each group's first construction workshop to insure the success of the project.

As noted by Bill and Susan Yanda in the *Solar Greenhouse Outreach Program Final Report*, prepared for the United States Department of Agriculture Rural Development Services on pages 25 and 26, "the interest in solar greenhouses will grow faster than any other area of solar development...because of rising fuel and food prices." Not only did the response to the Community Solar Workshop Training bear this out, but the program went a long way toward dispelling the myth that greenhouses will only work in the Sun Belt. The solar greenhouse is an effective, low-cost heat and food producer in various climates. The greenhouses the participants from this project built from coast to coast will prove this fact. The project also showed that the community workshop format is a valuable educational tool in many different cultural and socio-economic settings and was easily adapted by trained groups in twenty locations throughout the United States.

The goals of this project were:

- To train twenty teams, each from a different region, to organize and run workshops to build inexpensive, practical solar greenhouses.
- To help create working solar greenhouse experts in the field available to respond to their community's needs.
- To establish a national model program for solar greenhouse construction workshops.
- To determine whether the "barn-raising" style used in the greenhouse construction workshops could be taught in the format of a 3½ day seminar with a follow-up workshop.
- To determine whether the audio-visual exhibit and printed materials used in the seminar were effective.

ORGANIZATION OF THE PROJECT

The Solar Sustenance Team began to solicit applications for the program in September, 1978. An application form was designed to help select individuals and groups with appropriate skills, interests and track records. Applicants were required to commit themselves to financing and conducting their own solar greenhouse workshop following the training. We sought a balanced group of men and women from various climates with various skills.

We were required by the New Mexico Department of Energy and Minerals to give priority to pilot state applicants. In order to complete the project, including the follow-up workshops, in the 1978-79 building season, participants from colder climates were generally assigned to the first seminar, held in September, and those from warmer climates were assigned to the October seminar. The following states were accepted, received our training packet and attended the seminars:

SEPTEMBER
Colorado
Illinois
Massachusetts
Michigan
Minnesota
Montana
Oregon
Rhode Island
Washington
Wisconsin
Wyoming

OCTOBER
Arizona
Arkansas
California
Louisiana
Missouri
Oklahoma
Pennsylvania
Tennessee
Utah

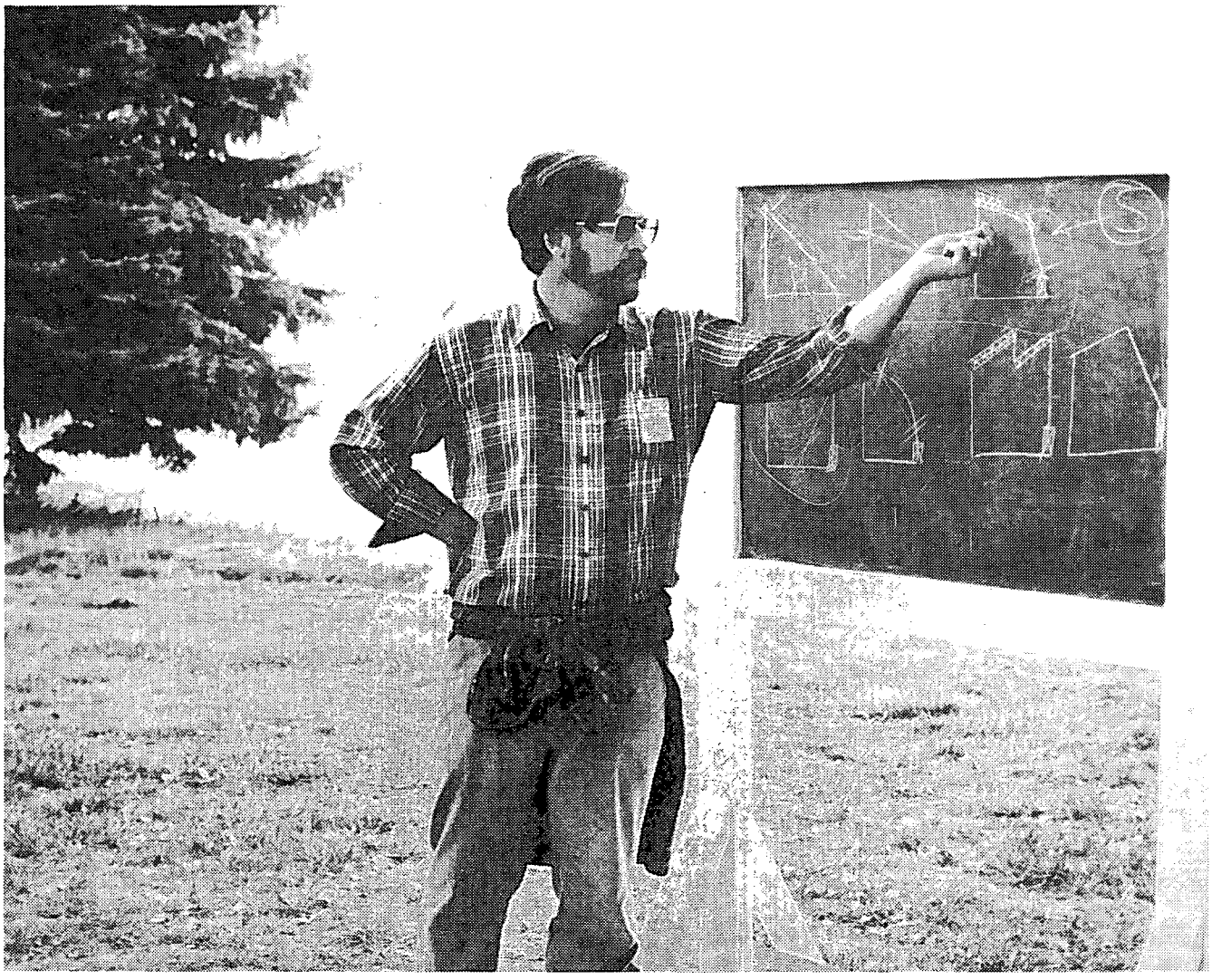
Five other groups applied, but were not accepted. A few groups came to Ghost Ranch as observers. They made no commitment to hold a greenhouse workshop, nor did the Team make a follow-up commitment to these groups. Observers attended the seminars and received an abridged version of the training materials. These groups were from the following states:

SEPTEMBER
Wisconsin

OCTOBER
Connecticut
Massachusetts
Texas
Nevada

THE GHOST RANCH SEMINARS

The Solar Sustenance Team has found that participants in greenhouse workshops learn better from a number of educational approaches. Some participants respond best to the written word, others to demonstrations, still others to audio-visual aids. We planned our seminar to include a whole spectrum of educational tools. Each group received a training packet including a 16mm movie, written materials, slide and tape presentations, books and pamphlets. Sessions were led by different team members and guest speakers, all of whom used widely varying approaches and styles.



Bill Yanda, Solar Sustenance Team Director, leading a session in greenhouse design.

We wanted the "team" approach to be visible. We hoped each group of three or four people would coalesce into a working group, and we tried to encourage this by showing that the Solar Sustenance Team worked well by combining different talents, skills and styles toward a common purpose.

The Solar Sustenance Team arranged sessions and materials to clearly illustrate these important concepts:

a) A variety of teaching tools is effective in a workshop.

b) A team of three or four people who share their different skills and interests can handle the myriad of tasks required of workshop leaders better than a more homogeneous group of experts. This multi-disciplinary approach to workshops helps paticipants and leaders alike teach and learn from one another.

SEMINAR MATERIALS AND AGENDA

Each team attending the seminars was given a multi-media instructional package. The following excerpt is the description of the instructional package prepared for the participants:

INSTRUCTIONAL PACKAGE

This instructional package includes a complete guide covering the principles, organization, coordination, and implementation of a "hands-on" solar workshop.

The components of the package give examples of various solar workshops, show how to handle specific problem-solving situations, basic design, and teach about materials, their cost and performances. The package covers publicity and news coverage techniques.

The following is a description of each component of the instructional package:

1. Film: *Build Your Own Greenhouse—Solar Style* produced by Danamar Productions; Bill and Susan Yanda, Associate Producers. This film takes the viewer through an actual workshop sequence and highlights the important points of greenhouse design and construction. Used as an introduction, the film sets the stage for more specific information.

2. Books: The Food and Heat Producing Solar Greenhouse by Rick Fisher and Bill Yanda. An Attached Solar Greenhouse by W.F. and Susan Yanda, in English and Spanish. These books, written after years of solar greenhouse experience, are basic reference materials. They provide specific details about construction, materials cost, performance and operation needed to build and run a successful greenhouse.

3. Workshop Leaders' Packet: This "How to Run a Workshop" packet covers the steps necessary to run a successful three to four day community hands-on workshop. It includes design information, construction drawings, materials list, checklist for organizers, follow up information and a bibliography.

4. Workshop Participants' Packet: This packet provides simple but comprehensive graphics for participants. It enables a workshop volunteer to leave the site after a two or three day building session with information in hand that can easily be applied to his or her own situation.

5. Slides and Cassettes: Slide shows with cassettes that cover basic solar principles and their design applications. Different greenhouses will be shown followed by specific planting cycles and greenhouse operation.

6. Promotional Packet: Publicity, news, radio and television coverage are vital parts of the workshop sequence. It is important for word to get out in order for the community to become involved. Examples and suggestions for different kinds of coverage are presented.

7. Documentation and Monitoring: Examples of record keeping techniques, including monitoring and instrumentation, equipment needed and summary sheets are presented in this packet.

In addition, participants received the following books and pamphlets as part of the instructional package:

PAMPHLETS

- Duties and Responsibilities
- Design Exercise—Christ in the Desert Monastery
- Solar Greenhouse Structural Considerations—Helion, Inc.
- Plant Growth Considerations for Solar Greenhouses—Helion, Inc.
- Solar Greenhouse Thermal Processes—Helion, Inc.
- Per Curiam (Legal Brief)
- Zoning, Codes and Permits—The Habitat Center
- Habitat Center Limitation of Liability Form

BOOKS

- *The Food and Heat Producing Solar Greenhouse—Design, Construction, Operation,* Rick Fisher and Bill Yanda
- *Vocational Region 10 Solar Greenhouse,* Environment Energy Education Project, Maine Audubon Society
- *The Survival Greenhouse—An Eco-System Approach to Home-Food Production,* James DeKorne
- *A Solar Greenhouse Guide for the Northwest,* Ecotope Group, Seattle, Washington
- *The Solar Greenhouse Book* edited by James C. McCullaugh

These materials were the foundation of the seminar curriculum and were constant reference points for all discussions.

The seminars which were built around these materials were organized to present first an overview of the solar greenhouse workshop concept and process; next, fundamental principles of solar energy use; then application of those principles to solar greenhouse design and construction; and finally the less quantifiable, but nonetheless crucial problems of workshop organization and greenhouse gardening and management. The following is an outline of the agenda:

DAY 1
- AM Design and Concepts
- PM Construction Materials

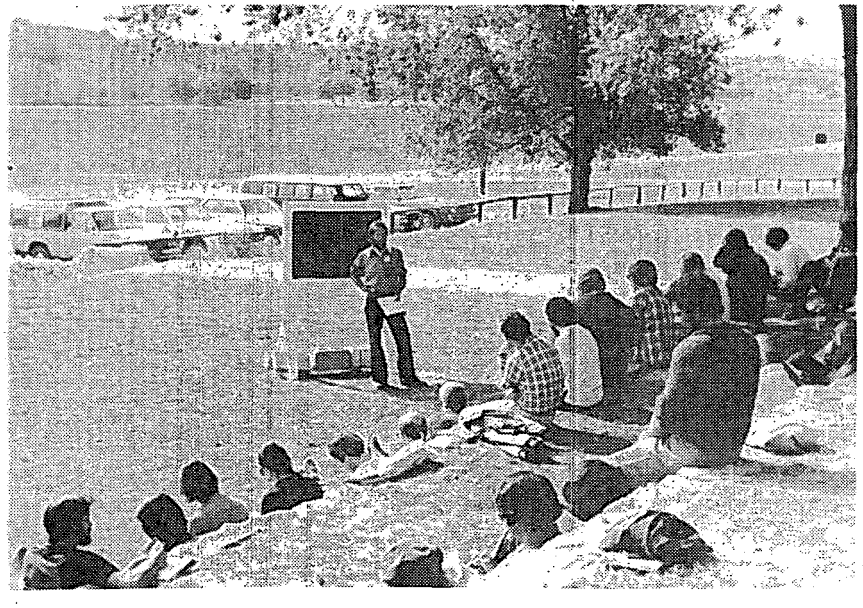
DAY 2
- AM Community Mobilization
  Workshop Organization and Media
  Legal Barriers
- PM Greenhouse Gardening

DAY 3
- AM Monitoring, Follow-up
- PM Tour of Four Solar Greenhouses

Two evenings during each seminar were left open for presentations by those groups who attended the seminars. This gave us all a chance to share information and learn from one another. The members of the Solar Sustenance Team were amazed at the quantity and quality of community solar work the participants were engaged in across the country.

One of the best suggestions made by September participants was to divide the construction and gardening sessions into skill levels. At the same time novices could begin with basics and the more experienced could delve into more intricate problems. We did this in October and found it worthwhile. However, we did not follow the suggestion of some September participants that we run concurrent sessions in different subject areas. The Team felt it was important that all participants be exposed to all areas of the curriculum, especially those outside their particular expertise. Rather than encourage specialization and compartmentalization of skills, the Solar Sustenance Team wanted experts in each field to be acquainted with and able to work in all aspects of greenhouse workshops.

The October session also incorporated the desire for additional, smaller sessions on specific topics such as: ventilation and cooling, structural design problems, special problems with building materials and solar energy law.



Engineer, Greg Shenstone, and seminar participants at Ghost Ranch.

The Solar Sustenance Team tried, simply, to expose participants to as much useful information on solar greenhouses and solar greenhouse workshops as possible in the short 3½ days available for each seminar. The Team provided a basic reference library on passive solar energy, construction, solar greenhouses and gardening for use by participants. We enlisted the help of some of the most knowledgeable and able people in the field: commercial solar greenhouse operator Joan Loitz charmed everyone with her Traveling Bug Show; engineer Greg Shenstone covered structural design problems; Jack Park of Helion, Inc., and Lynn Nelson of the Habitat Center, both leaders in solar work in California, prepared valuable materials for the instructional package; Robert Nicolais, architect, did the graphics and schematics for the package; Jim DeKorne, author of *The Survival Greenhouse*, gave a slide presentation on greenhouse hydroponics and a tour of his own operations. A finely detailed scale model solar greenhouse illustrating a number of design and construction options was built by Austin Cannon of Ojo

Caliente, New Mexico, author of the *Solar Self Help Book*. The Sundwellings Demonstration Center at Ghost Ranch, with its four prototype solar adobe houses, including two solar greenhouses, was a fertile environment for our seminars. Finally, a tour of four owner and workshop built greenhouses gave participants a practical understanding of solar greenhouse design and construction.

THE GREENHOUSE WORKSHOPS

What is a solar greenhouse community workshop? The Solar Sustenance Team has conducted over seventy five workshops in the last five years, and each has been different. They have been in different climates; with different ages, races and classes of people; in cities, suburbs, and rural areas. The twenty greenhouses in this project were probably the most varied of any of the earlier projects but they underlined the basic qualities of a workshop better than any sampling to date.

A greenhouse workshop is a gathering together of community residents to learn about and actually build a useful solar application. A workshop is much like an old fashioned barn-raising. Everybody comes out to help his or her neighbor, works, enjoys, makes new friends and celebrates. A workshop dispels the myth that solar energy is complicated, expensive and something for only the engineer or architect. People learn and see basic solar design and construction principles in action. Greenhouses are a meeting place for organizers, builders, gardeners, designers, engineers, teachers, scientists and homeowners.

Even kids enjoy the workshops.

Twenty one workshops in twenty states sprang from the Ghost Ranch seminars. Each, though different from the rest, was successful. The common accomplishment was that people came out to the workshops and built, going home with the knowledge and confidence that they could make something with their hands to help heat and feed themselves and their families.

Each team participating in the Ghost Ranch seminars went home with a challenge—to organize the financial, material and human resources necessary to run a solar greenhouse construction workshop. All but three teams have done so by April 1, 1979. One team was hampered by code restrictions; one team was delayed due to severe winter weather; one team disbanded before conducting a workshop.

Each team generally followed the organizational format suggested by the Solar Sustenance Team. The construction of the greenhouse was preceded by a public informational session. These took the form of lectures, discussions, problem solving sessions, movie and slide shows. In all cases, the basic principles behind solar energy and its specific application to the solar greenhouse design were discussed.

Two days later a greenhouse was 75-95% finished. In the process people learned to work together and to learn from one another. Workshop leaders lived through the surprising number of difficulties and frustrations involved in orchestrating between ten to thirty people building a relatively small, simple structure. Carpenters learned to teach skills they usually coveted, organizers learned to hammer and nail, women enjoyed new roles on the construction site, and the group as a whole learned to solve problems as they came up. The workshop leaders report that through feedback from the workshop participants, everyone who came left with a sense of belonging to a group and a process, of having accomplished something together.

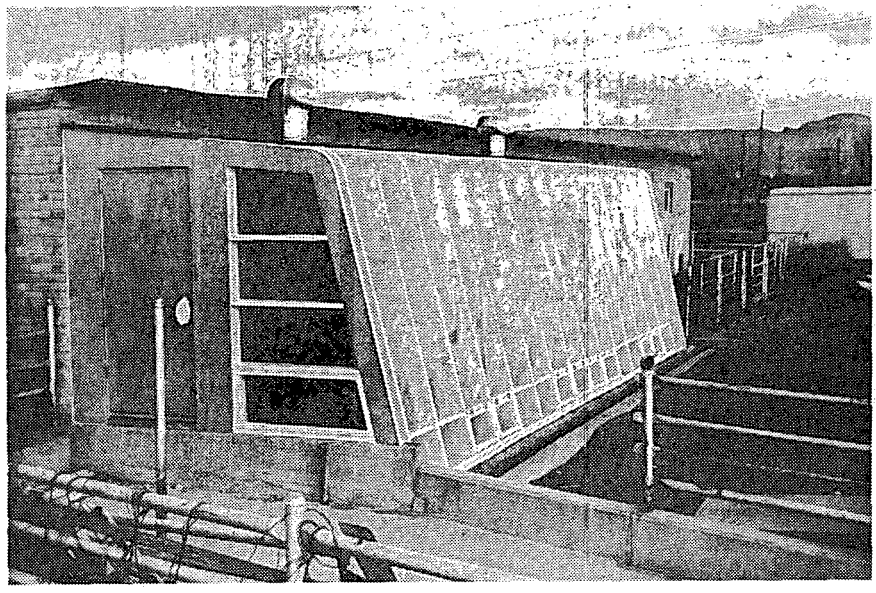
Many of those people went home to design and build their own greenhouses. Many organizing groups went on to conduct more greenhouse workshops. In some cases the community then had an effective, experienced grass roots organization to depend on for organizational skills for various projects.

HIGHLIGHTS OF THE TWENTY PROJECT GREENHOUSES

REGIONAL INNOVATIONS

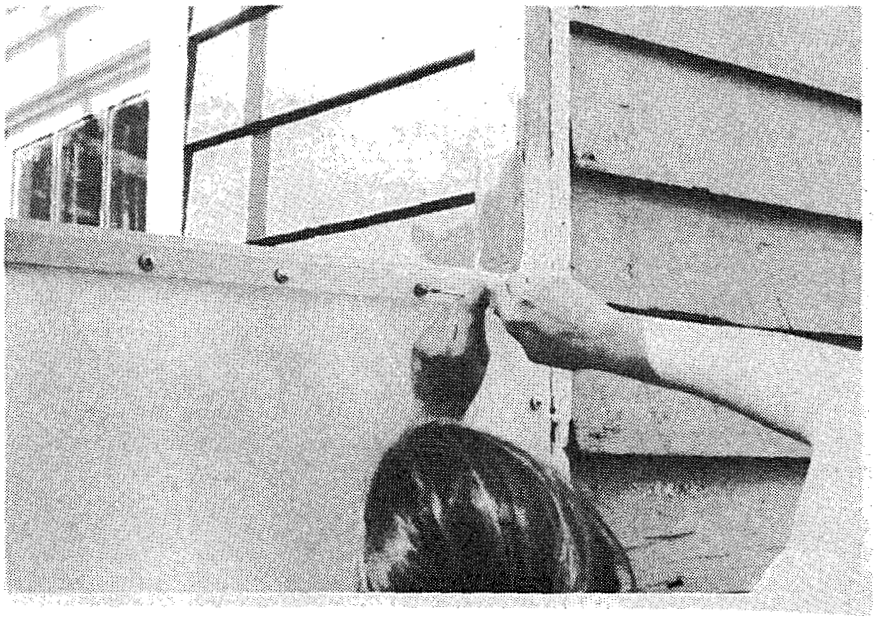
- Truss Systems

  Each of the twenty greenhouses built in this project varied with the climate and the whim and fancy of the team designing it. The design which required the most deviation from what has been standard workshop procedure was the truss system used by the Colorado, Rhode Island and Arkansas teams. Solar Sustenance Team workshops have always built the front face on the ground, then tilted it into place and secured it to the sill and wall plates. With the truss system, front face-to-rafter units are separately fabricated in a jig and individually attached to the building and the greenhouse foundation. It was the Solar Sustenance Team's impression that the truss system workshops did not flow as well at the beginning because there was no way to get most of the people involved in a common activity early in the first day. Fabricating the trusses is time-consuming work for a few people only, leaving everyone else standing around waiting. Once the trusses are up, more people can be involved and things go more smoothly and rapidly. A team less organized and skilled than the Colorado team runs the risk of losing the interest and participating of people early in the workshop. The ease of caulking and sealing, however, gives this system an advantage over the traditional design.



COLORADO TEAM

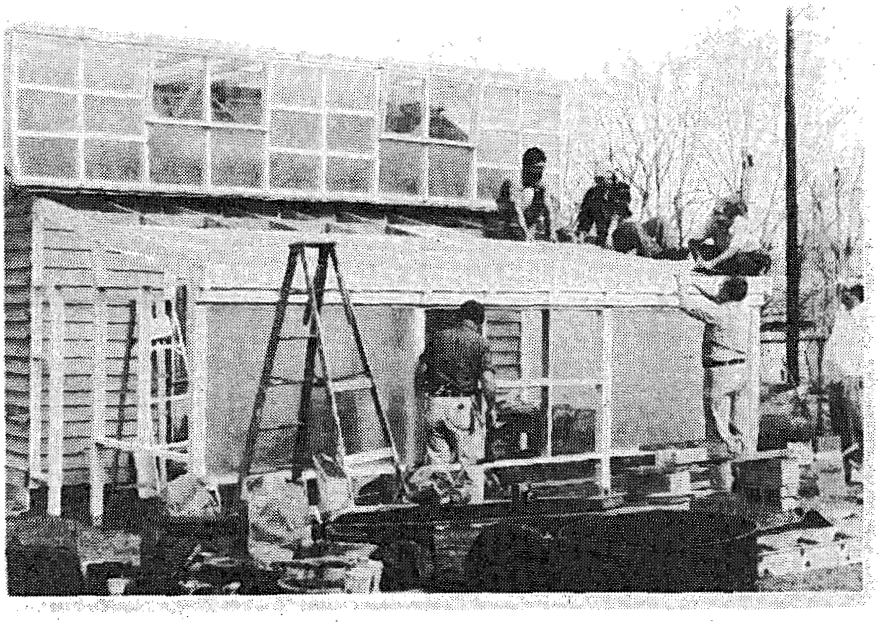
Example of the truss system used by the Colorado Team.



Removeable fiberglass panels used in the Louisiana greenhouse.

THE SWAMP GREENHOUSE

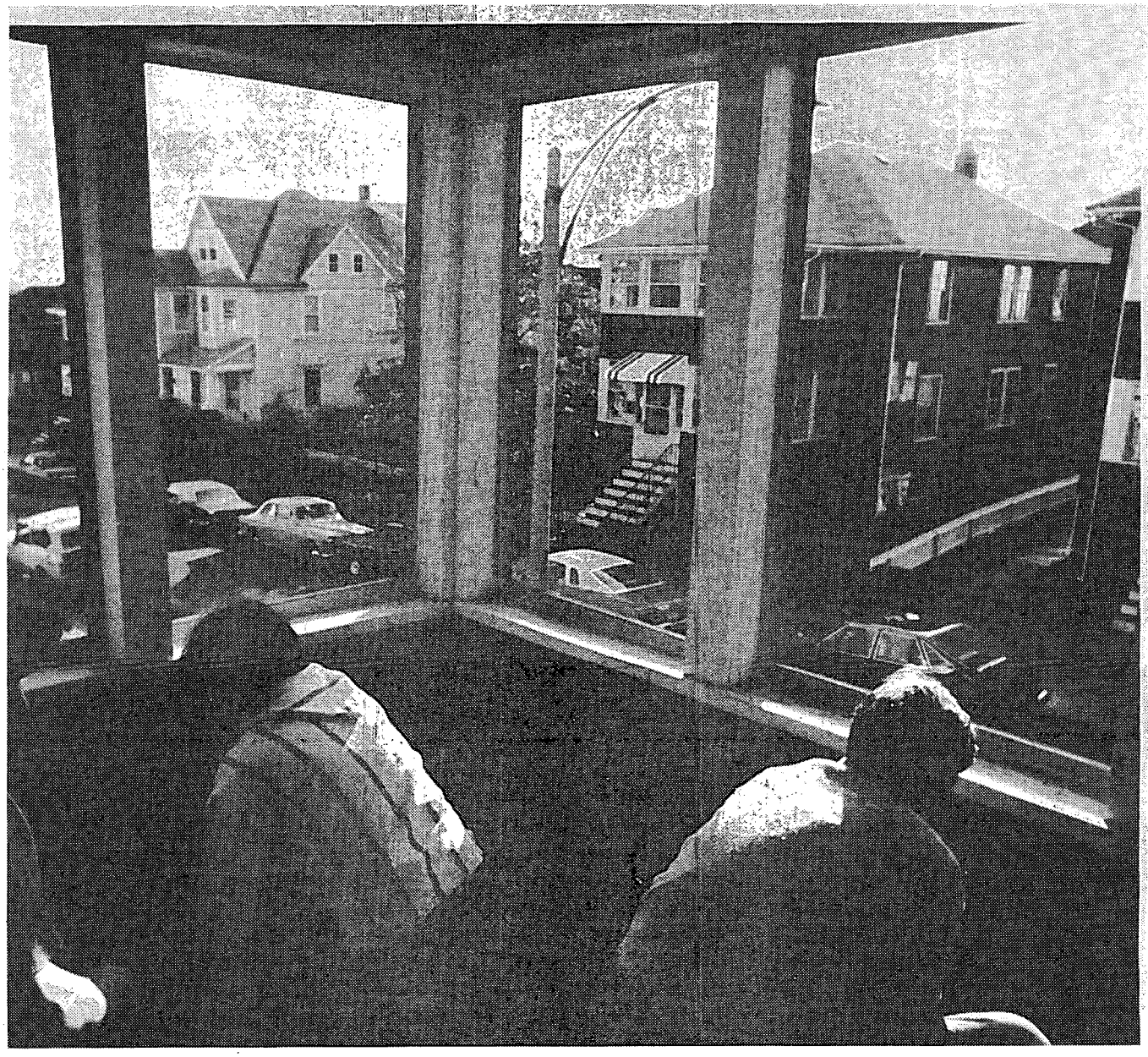
The hot, humid climate of southern Louisiana demanded very special consideration to prevent it from becoming a summer vegetable steamer. The greenhouse was designed with removeable panels on all sides for summer dismantling. No foundation was laid. Instead, treated posts were sunk into the ground to secure the greenhouse and act as framing members. Flap vents were built around the perimeter of the greenhouse below all the glazing. This allowed for good ventilation from the low south, east, and west parts of the greenhouse, through the house and out the dormer vents built into the house before the workshop. This dormer now houses two tanks to preheat hot water.



The Louisiana greenhouse showing the upper story dormers.

UPPER STORY GREENHOUSE

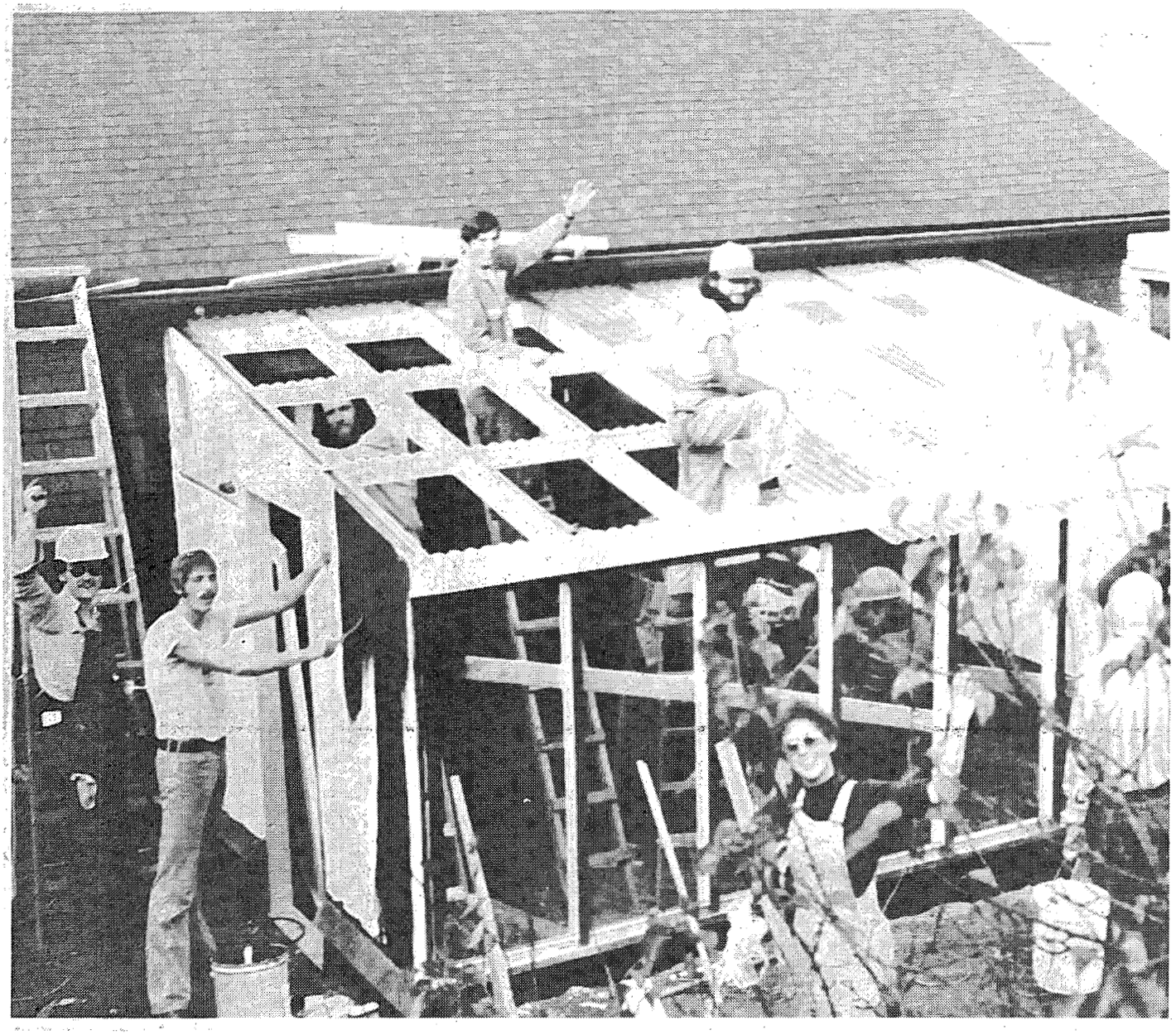
The Massachusetts team remodeled a second story balcony of a triple decker for their greenhouse. Such a design is particularly applicable to urban settings although it may create structural problems if the porch or decking cannot take the weight of the greenhouse and the storage it will demand. The problem was solved by installing a 4" x 8" beam across the spanners underneath the floor. A second Massachusetts group that attended as observers took the idea even further. They built a rooftop greenhouse in downtown Boston during their workshop.



Residential second story greenhouse in Massachusetts

PACIFIC NORTHWEST GREENHOUSE

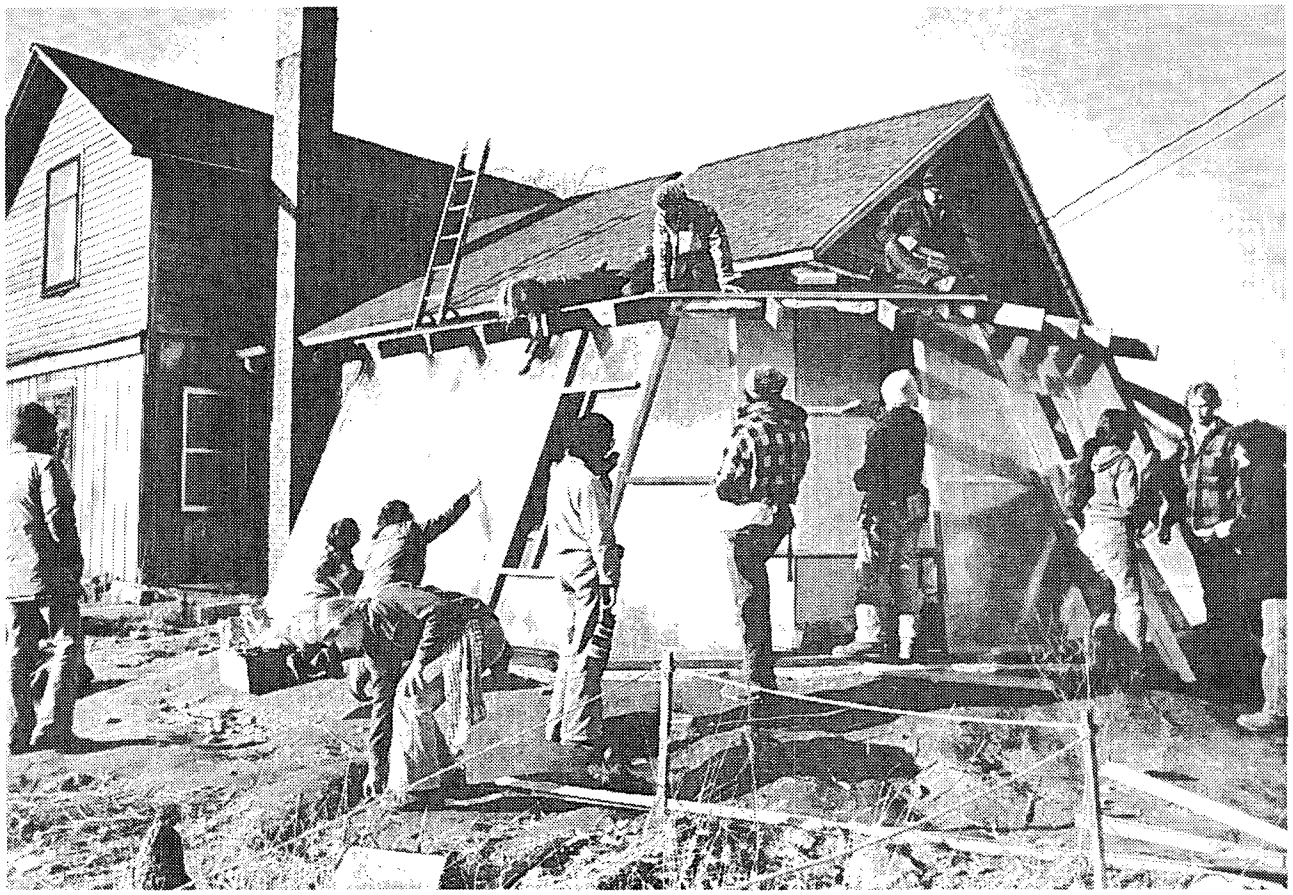
Many Pacific Northwest greenhouse builders have determined that their mild climate and diffuse skies do not demand a second layer of glazing. The Washington group built with one layer of glass to cut costs and allow for more complete solar transmission. Because of the diffuse nature of their solar radiation, this group also designed a totally clear roof. Usually the roof is split about half and half with an opaque section up against the existing building for summer shading.



An example of a clear-roofed greenhouse in the Northwest.

GREENHOUSES FOR EXTREME NORTHERN WINTERS

For precisely the opposite reasons both the Michigan and the Minnesota teams designed their greenhouse roofs to be totally opaque. Winters are long, very cold and cloudy. Insolation is low and heat loss is high. With a generous tilt on the front face (between 60-70^{O}) plenty of sun enters the greenhouse during the spring and fall, the opaque roof shades against overheating in the summer and protects against large heat losses during the winter.



MICHIGAN TEAM

The 3-faceted Michigan greenhouse.

The Michigan greenhouse must be noted for its three-faceted, sloping faced greenhouse built on the foundations of a pit greenhouse. Although ambitious for a first workshop, the team was well organized, worked well with the owners and participants and construction went very smoothly.

RECYCLED GREENHOUSE

The California greenhouse stands as a true example of the low-cost greenhouse. Every single item used in their workshop was recycled and on the site beforehand. Participants cleaned and sorted lumber and barrels, repaired damaged fiberglass for glazing and almost finished their greenhouse in two days. Working with unmatched materials can be difficult at best, especially for novices. An experienced carpenter on the site made construction go smoothly.

Everyone is a part of the workshop.

WISCONSIN TEAM

THE CHARACTERS THAT SHOW UP

Workshops always attract interesting people. Some groups limited their attendance for specific reasons. The Arkansas group built with only agency people because this first workshop was seen as a training ground for employees who would go on to organize future workshops. Louisiana on the other hand, attracted quite a variety of people including a famous Cajun singer, an architectural professor and his students and an offshore oil worker. The architecture students were especially gratified to be able to put design to the saw and hammer. The blending of design and construction skills at the non-expert level is a constant goal of the Solar Sustenance Team. Often the carpenter knows how to build, but hasn't been exposed to solar principles. The engineer knows all about solar design theory but hits his thumb more often than the nail. These two learn from each other in a relaxed, enjoyable atmosphere.

Many workshops attracted a number of women, some skilled, some unskilled. Especially evident in the Wisconsin workshop, skilled women seemed to enjoy being carpentry teachers and novice women learned they could hammer and saw just as well as novice men. Children came to many workshops and were almost always active throughout the building sequence. Many of them commented how much they had learned and how pleasant it was to work easily with adults.

PORTLAND SUN

3334 Southwest First
Portland, Oregon 97201

Sunspace Workshops

The State Journal
Monday, November 20, 1978, Lansing, Michigan

Metro | Michigan News State Government

Missouri Botanical Garden

Courses
Workshops
Tours

Winter-Spring 1979

Sun and food go together

By TRUDY WESTFALL
Staff Writer

Despite a weekend's worth of grey skies and numbing temperatures, a group of enthusiastic builders spent their time thinking "sunny" thoughts.

Participating in the first solar greenhouse workshop in the greater Lansing area, some 35 to 40 persons helped build one onto the Perry home of Eileen [illegible] sell and Terry [illegible]

A solar greenhouse differs from a conventional one because it is designed and built to add heat to the home in winter and maintain temperatures in the greenhouse above freezing without using petro-chemical heat. Sided with fiberglass and windows and using five gallon boxes, cans [illegible] water as "[illegible] house.

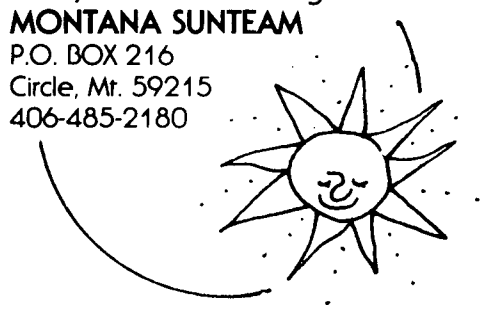
Lake View Citizen

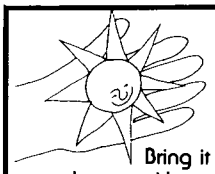
Community Interests

Solar Greenhouse

The Jane Addams Center has started a Neighborhood Solar Greenhouse Project. They are looking for a "ground level" site (i.e. home, church, etc.) on which to build an attached solar greenhouse (Un invernadera conectado de energia solar). An attached solar greenhouse differs from a conventional one in that it is designed to add heat to the home in the winter and also provide an all year around garden for fresh salads, flowers and herbs. Southern exposure is required, and no large obstructions should block the winter sun. A wood frame home would be ideal. A brick home with a wood porch addition is acceptable. Materials and labor will be provided. The owner will be asked to manage (e.g. record temperature,

Many hands make light work.
MONTANA SUNTEAM
P.O. BOX 216
Circle, Mt. 59215
406-485-2180





Bring it home with an "attached"* solar greenhouse

The answer to rising food and energy costs.

Free heat from the sun.

Simple to build (you can do it!)

longer growing season (Imagine fresh vegetables in March or November)

Inexpensive solar retrofit (Approx $1220 for a 8×20 Ft. Structure)

*to the south side of your home

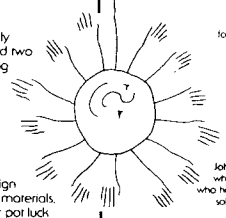
Many Hands make Light Work!

Come to a Solar Greenhouse Raising

Happening on the south side of homes all over Montana (and adjacent states) between April and October.

Participants spend only $30, one evening and two fun-filled days learning greenhouse skills by actually building one onto someone's home.

The hosts provide a sunny location, design fee, site preparation, materials, tools and a place for pot luck lunches.
In just one weekend, you'll watch your greenhouse take form!



The Montana Sunteam is a group of Montanans skilled in solar greenhouse design and building. They have been trained by Bill Yanda's Solar Sustenance Team.

We are committed to making solar energy available to Montanans

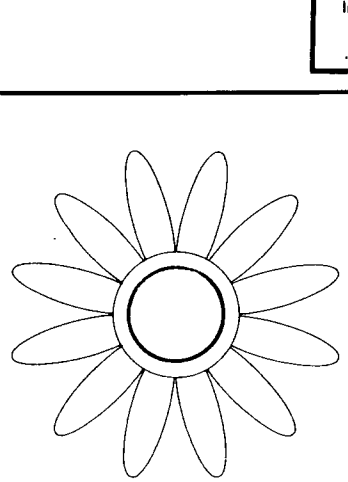
Ann Wilsnack was formerly with California's Office of Appropriate Technology and has participated in several solar greenhouse workshops

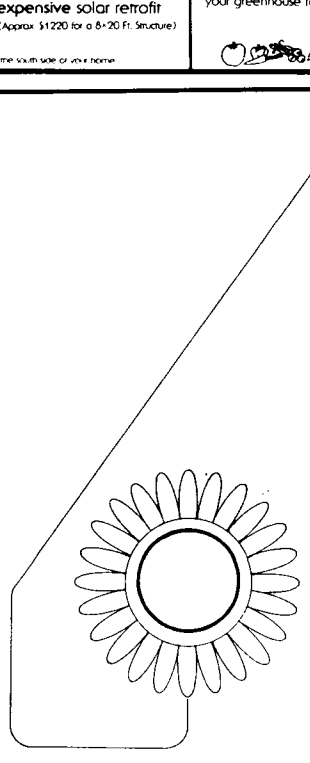
Kenny Flemming is an experienced builder and solar designer

John Brown is an organic wheat farmer from Circle who has utilized a 640 sq. ft solar greenhouse for the last two winters.

Bud Barta, greenhouse builder and designer, is one of our consultants and has led workshops for the New Western Energy Show.

John Krigger, another consultant, is a solar designer, carpenter and building consultant.





A SOLAR GREENHOUSE

FOR MESA COLLEGE
GRAND JUNCTION, COLORADO
1978

A carpenter participant in Washington.

THE CLIENTS THAT RECEIVE THE GREENHOUSES

Rather than describe the idiosyncracies of each greenhouse owner, it seems appropriate to do some categorizing. Greenhouses built onto buildings run by groups or institutions potentially have more problems than those placed on individual residences. But group greenhouses can open new educational applications. For example, the Arizona team built with a handicapped group on one of their homes. Gardening was viewed as therapy for the clients.

The problems may occur throughout the workshops, i.e. a) during planning before the greenhouse is built, b) during the construction workshop, and c) after the greenhouse is completed and is ready to be planted.

Often it may be more difficult for a group to come to the decisions necessary to plan a workshop than for a household. Who will publicize the event? What is the commitment of the group? What, if any, are the financial obligations of the group? Who pays for last minute purchases during the building? Who is responsible for each phase?

Managing the institutional greenhouse may be even more difficult. Who waters? Who sows? Who harvests? There are a few examples of large community greenhouses run by and for groups in the country. Successful ones, like the one run by one of the Wyoming team members in Cheyenne, has a single person in charge of final decisions and planting schedules.

WHO PAYS FOR IT?

The Oregon, Wyoming, Montana and Washington groups charged participants to come to the evening session and build the greenhouse. People paid $15 to $30 for the weekend's activities. Some states turned people away, others noted resentment from participants for having to pay. This method of running private workshops has been done by Lynn Nelson and the Habitat Center in California for years and seems to work well. This points to a potential commercial market for running workshops. Usually, money for materials comes from self-help groups, government programs or donations.

HOW DO YOU FIND OUT ABOUT WORKSHOPS AND GET INFORMATION ONCE YOU ARRIVE?

The most extensive publicity was done by the Michigan and Oklahoma groups. They used media very effectively. The Michigan group submitted Public Service Announcements of varying lengths to several radio stations. The evening session attracted almost 100 people and two newspaper articles and two television reports were done during the workshop itself. Numerous newspaper articles appeared afterwards. Oklahoma attracted 115 people to their evening session and were covered on both workshop days by local TV news.

Both Colorado and Michigan reprinted the schematic information given to them in their Ghost Ranch training package. Colorado included specific designs for their greenhouse and pages of notes from the Ghost Ranch seminar, all attractively bound and printed. The Michigan team added written descriptions to each of the Solar Sustenance Team schematics that they reprinted and handed out during the evening session.

Timing of the workshop proved to be as important as publicizing it well. The Wyoming group found all too late that scheduling their evening session on the first day of deer season was an unfortunate mistake. Their attendance was only thirty when they had expected many more.

SOME PROBLEMS AND WEAKNESSES OF THE WORKSHOP

The following problem areas were noted through follow up conversations and the evaluation questionaire sent to participants.

THE EVENING SESSIONS

The single most outstanding weakness of all of the workshops was the evening session. With a few exceptions they were either too long and complicated, difficult to follow, not very entertaining or in a few cases, even dotted with misinformation. Public speaking, lack of intimacy with the information and first time stage fright seemed to be contributing factors. After four or five workshops were completed, the Solar Sustenance Team, aware of these problems, sent out a letter with a suggested outline for evening session activities. Any future training programs would include an example of an evening public session during the seminar.

SITE SELECTION

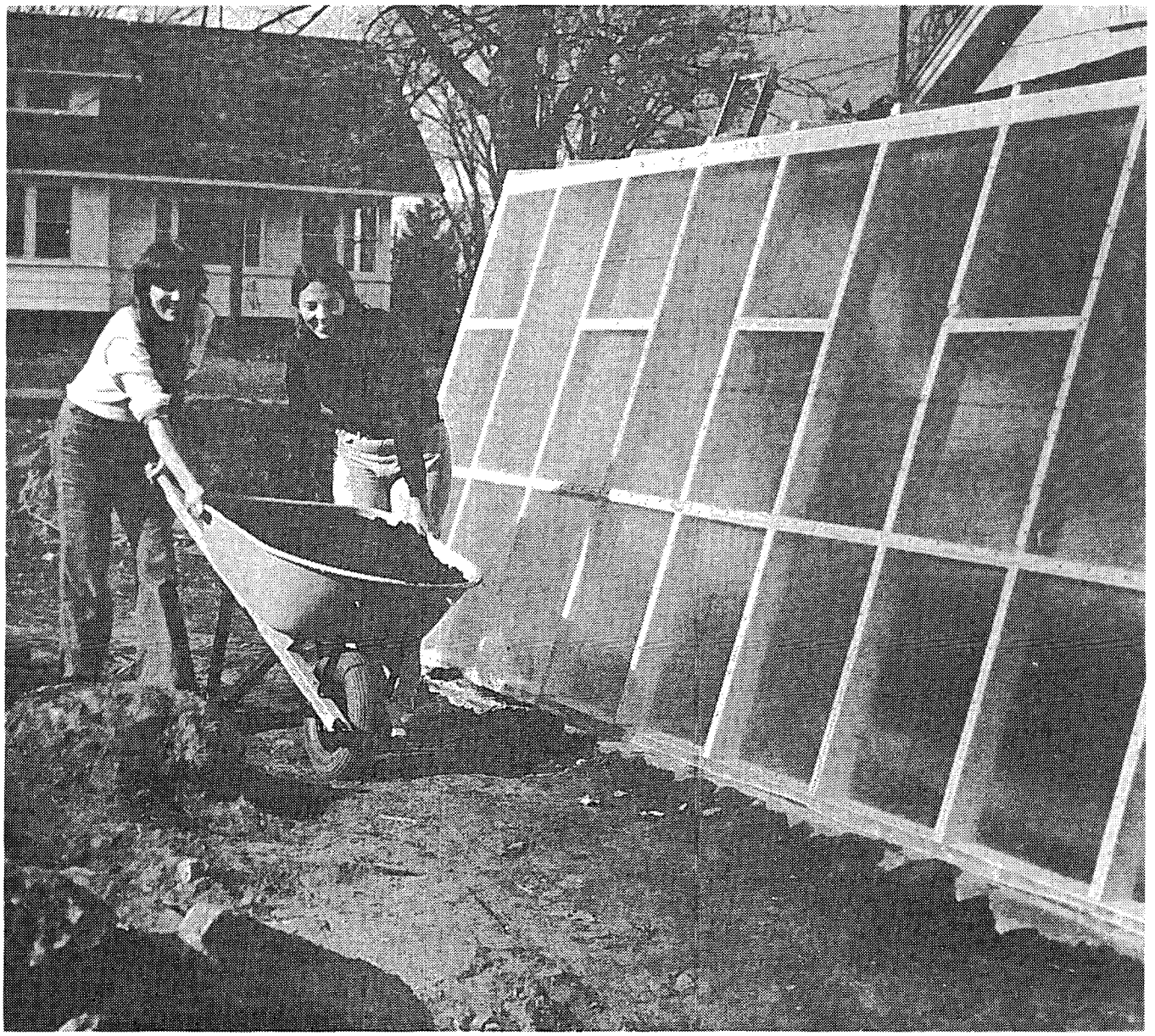
The Illinois group had the longest site selection saga in the history of greenhouse workshops. Because of the intricacies of the Chicago building code, the group was forced to view seventeen sites before they found a proper one, lost their funding a few days later and were snowed under within a week. The Minnesota group had to drastically alter the size of their greenhouse on a community center building and eliminate the important planned feature of venting between the greenhouse and the main building because of code restrictions. This group reports they are still in the process of seeking a variance in order to complete the greenhouse as originally designed. Pennsylvania was also hampered by code restrictions. HEW regulations for institutions made it impossible to build on their original site, a nursing home. Because of the stringency of urban codes, the Solar Sustenance Team will need to be even more prepared for further work in city areas. The Pennsylvania group has already organized a meeting in February in Philadelphia with national HEW officials. They are eager to work on methods to adapt passive solar designs to institutions.

Framing up the front face of a solar greenhouse.

GROUP DYNAMICS

The members of some groups had difficulties working with each other and the faces in some of the groups have changed since the September and October seminars. Only one workshop did not go at all because of lack of team cooporation. However, most groups were able to work out their problems as they went along. One group reported in their evaluation:

> "We benefited greatly from the wide range of experience and expertise offered by the Solar Sustenance Team. We believe that the capabilities of each of our members improved our own workshop and post workshop involvement with the project."



WISCONSIN TEAM

mixing gardening soil at the Wisconsin workshop

THE WEATHER

The project was surprisingly lucky with the weather. Two workshops were rained out but completed within a few weeks. Snow has kept Illinois from building until March and Utah until late April or early May.

BUILDING AS PART OF THE SEMINAR

15 groups felt that an actual building session during the seminar would do much to aid the teams' presentations. "This way," commented one group, "the various principles of design, construction and workshop administration might be made more real prior to the subsequent team workshop."

EVALUATION OF THE PROJECT

In reviewing the goals set out by the project, the Solar Sustenance Team has found the program to be very successful in all of the five areas listed in the introduction of this report. The success of this project hinged on two important things: the capabilities and potentials of the groups that were trained and the skill with which those groups were taught and guided through their first construction workshop. Accomplishment by all involved in the program has far reaching implications for future work in many fields and by evaluating this project and making recommendations for future programs, the Solar Sustenance Team hopes to foster continued quality work in the solar field.

- Train Twenty Teams

  Twenty groups were trained from twenty different regions. Four workshops have not yet happened. Two of those are planned in March and one in April or May of 1979. Two of the observer states have run successful workshops. This compares favorably to our requirement that fifteen (75%) of the greenhouses be built during workshops and planted by March 31, 1979.

- Put Experts In The Field

  With the exception of one team that has disbanded without running a workshop, the Solar Sustenance Team would judge all remaining teams as well as two of the observer teams to be experts in the field.

- Create National Model Program

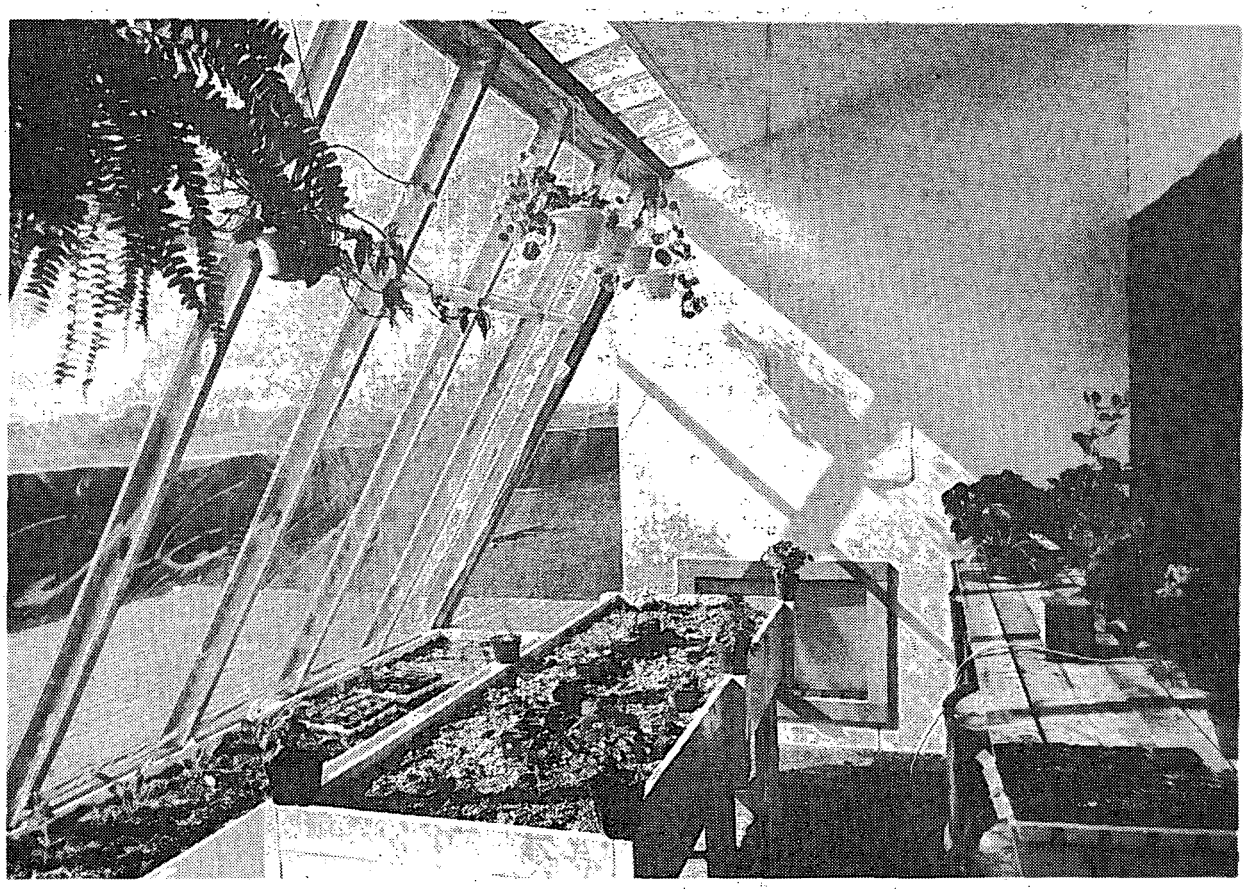
  The Solar Sustenance Team has established a model program for national implementation of construction workshops in low-tech solar applications. The Team would recommend a five day seminar including a building project. Rather than follow-up travel by the Team members to the trained groups' first workshops, a two day follow-up six months or one year later might prove more valuable. This would ensure that gardening procedures and record keeping would be taught and continued with the greenhouse owners.

- Teaching Barn Raising Style

  Judging from the workshops that the groups ran and the Solar Sustenance Team attended, the barn raising technique can be taught in a three day seminar with a follow-up workshop. Although we focused on solar greenhouses and all the groups built greenhouses at their workshops, this model is very applicable to other solar retrofits and other projects. These might include trombe walls, hot water heaters, solar dryers and cookers, even passive additions.

- Evaluate Our Curriculum Materials

  23 groups felt that the audio-visual, exhibit and printed materials used in the seminars were effective.



A rooftop greenhouse in Cambridge, Massachusetts

IMPACT

- 157 greenhouses have been built or committed as a direct result of the project in the twenty participating states. This is an average of 7 spinoff greenhouses per workshop built during the winter season.
- 4745 people in twenty states have seen the slides and the movie and have been exposed to basic solar greenhouse principles.
- 20 grassroots organizations have coalesced as a result of the work of teams in various states.
- All of the 25 participating teams, including observers felt that the workshop format taught in this project was a viable educational tool and applicable to other solar energy applications.

"I would say that over 200 people have seen the slides and movies here—not counting the thousands who stopped by to watch the slides at the Energy Expo in Tulsa where we had them on continuous display." *OKLAHOMA*

"Portland Sun will also be giving slide shows, lectures, teaching a solar greenhouse class at a local community college, designing individual greenhouses for owner/builders. We're also working under a grant from Oregon's Department of Energy to put together materials on attached greenhouses including a manual on how to lead a workshop, a brief pamphlet on attached greenhouses and a variety of local resource lists." *OREGON*

"We are planning to run a series of workshops throughout the state this spring, summer and fall." *MASSACHUSETTS*

FEBRUARY 1979/$1.25

home

Canada's House and Garden Magazine

Art's Garden News

Gardening Potpourri with Art C. Drysdale

NEW MEXICO'S SOLAR SUSTENANCE TEAM

Solar Sustenance Team trains workshop teams in New Mexico. Canadian groups that are interested, contact *Home* Magazine.

alternative sources of energy 36

Feb./March 1979

SOLAR SUSTENANCE:
building solar greenhomes

by Donald Marier

The SOLAR SUSTENANCE Team organized by Bill Yanda is one of the most widely known solar greenhouse groups in the country. SOLAR SUSTENANCE has given workshops in over 30 states and has trained other organizations to do similar workshops. Their effectiveness is not by accident. A carefully planned format and well organized team has been the key to their success.

Mention greenhouses and many people think of Bill Yanda. The *Food and Heat Producing Solar Greenhouse* by Bill Yanda and Rick Fisher is now one of the best sellers of the alternative energy field, having sold over 50 thousand copies. The *Solar Sustenance* team which Bill leads has given 35 to 40 workshops in 30 states over the last three years, training other people in organized materials. By putting together a team, the group can combine skills in different areas to do an effective workshop. Bill Yanda acts as what he describes as, "the front man and thermal designer." Susan Yanda works on greenhousing and gardening. Leslie Davis works on greenhouse gardening and construction techniques particularly, with women who have not

"We have had 200+ requests for workshops or information on solar greenhouses." *MICHIGAN*

"The Missouri team is teaching a solar greenhouse class at the Missouri Botanical Gardens this spring." *MISSOURI*

"OCE has committed $80,000 to this project for the initial phase which will begin in April and continue through the 1979 building season. This program will result in the construction of about forty attached solar greenhouses on low-income residences, schools and other public buildings." *PENNSYLVANIA*

"At the Louisiana Community Action Agency state convention a plan will be finalized to do workshops in each CAP area of the state." *LOUISIANA*

"The CAP agency received money to do solar training for 25 people from the area so that when the course is complete there will be 25 competent people available for employment in solar in this part of the state. Part of their training will be to build 20 solar greenhouses around our 7 counties. They will have this done by the end of the summer." *WISCONSIN*

"As a direct result of our attending the Solar Sustenance Team workshop at Ghost Ranch, Pennsylvania has launched a major greenhouse building effort which we believe will have a significant impact in solving the energy and food crises faced by many of the low-income people which we serve. We are very pleased that the Department of Energy funded this program and that we participated." *PENNSYLVANIA.*

PARTICIPANT RESPONSES CHART

	Colorado	Illinois	Massachusetts	Michigan	Minnesota	Montana	Oregon	Rhode Island	Washington	Wisconsin	Wyoming	Arizona	Arkansas	California	Louisiana	Missouri	Oklahoma	Pennsylvania	Tennessee	Utah	OBSERVERS	Massachusetts	Nevada	Texas	Connecticut	Wisconsin
Group Organized & Ran Workshop by April 1, 1979	√		√	√	√	√	√	√	√	√	√	√	√	√	√	√	√					√			√	
If Not, Is One Planned For Spring, 1979?		√																√		√						√
Number Attending Evening Session	30	-	30	100	30	17	35	160	30	40	30	28		30	25	50	115	-		-						
Number Building During Workshop	30	-	18	25	20	25	35	12	30	12	20	20	11	20	18	11	25	-		-						
Number of G.H.* Built or Committed as Result of Seminar	8	6	6	1	1	4	6	5	14	22	17	1	5	2	8	4	3	40		3		1	1			3
Number of People Who Have Seen Movies & Slides	150	15	480	600	130	50	235	340	380	300	400	270	105	30	130	235	315	500		80		Did Not Receive A-V Materials				

*Note that these 157 greenhouses built or committed have been since October, 1978 during the winter season.

The average cost of these workshop greenhouses is $4.65 per square foot.

QUESTIONS, CONCLUSIONS AND RECOMMENDATIONS

The workshop format has proven to be an effective tool in several ways:

a) The workshop is an organizational tool. It can be used to stimulate the community cooperation vital to self-help groups, cooperatives, and neighborhood associations. A workshop can strengthen an existing group or be used to start an organization. 20 groups began as a result of this project's greenhouse workshops. The workshop puts people in touch with each other creating networks that can cross social, economic and occupational barriers.

b) The workshop teaches principles of solar energy and energy conservation. Energy extension service programs, solar energy associations, CAP weatherization crews, architecture, design and engineering programs can benefit from the workshop format. Instead of abstract principles, a building workshop puts ideas into a tangible, active form.

c) The workshop teaches construction skills. The homeowner who wants to build for him or herself makes good use of the workshop. "Site built" solar applications have been given lower priority in government programs than hardware incentives or custom built projects such as those sponsored by the HUD passive solar home architectural competitions. Yet the site built application of solar energy makes the best economic sense from low to middle income homeowners. The workshop reaches the neglected area between the more expensive demonstration unit and the manufacturers' incentives.
Local building groups that want to train construction workers to build greenhouses can use the workshop format to do so and thus explore a whole new market potential. Weatherization crews, vo-tech schools and building trades programs could use this approach to develop new skills in the solar field.

d) The workshop teaches self-sufficiency. It gives the builder, the designer and the greenhouse owner the ability to provide more of their own basic needs. In the face of mounting shortages of food, fuel and water, the solar greenhouse is not merely a conserver—it is a producer.

e) The workshop is a highly flexible educational tool. At the heart of the successful workshop we find a core of effective audio-visual materials which provide guidelines for the organizers and useful information for the workshop participants to take home. Yet, the format is flexible enough to allow local groups to adapt the workshop to their own styles, innovations, and climatic conditions. For examples note the greenhouses built in Colorado, Michigan, Washington, Minnesota, Louisiana and Massachusetts.

RECOMMENDATIONS

a) A program with adequate follow-up, thermal management and extensive gardening training needs to be designed. Record keeping for food production as well as thermal performance of greenhouses needs more emphasis. 15 participating teams from this project feel that it is important that we re-group next year to compare data and information. All groups are interested in further exploration of the potential food production of the solar greenhouse.

b) Building code and institutional regulations have become difficult, if not impossible barriers to overcome in some areas, especially in cities. Citizens need to be made aware of these rules to both understand them and effect any necessary changes. Urban groups are interested in re-grouping next fall to discuss this problem and the inroads they are making in their locales.

c) Because of the usefulness of the workshop format in teaching almost any kind of building project, and the workshop's ability to cross linguistic and cultural lines, the Team foresees many applications in Third World areas. Foreign groups, governments, Peace Corps and Vista volunteers could benefit from solar workshop training by using some of the technical and educational tools it offers to organize and build in their communities.

d) The effectiveness of the workshop technique lends itself easily to school and other group settings. Vo-tech, building trades, science, home economic departments, handicapped groups, prisons could use the workshop to their advantage. However, good follow-up and coordination within the sponsoring group is vital. Otherwise, the greenhouse is left untended and mismanaged.

e) The challenge for government is to encourage these types of programs while fostering work at the local level. Local input, local adaptations of training materials has made the program the success it is.

f) A project of this kind would produce faster spin-off greenhouses if funded in the late winter or early spring, to take advantage of good building weather for several months following the training.

g) The Solar Sustenance Team, based on feedback from participating teams, recommends that a model for a national program for greenhouse construction workshops be in a five day format which would include a 3 day seminar and a two day building workshop. The participating teams have also stressed, and the Solar Sustenance Team concurs, that a follow-up session, where everyone would regroup after nine months to a year to discuss problems and successes, is important.

APPENDIX

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ECONOMIC ANALYSIS OF THE FOOD PRODUCTION AND THERMAL PERFORMANCES OF A MODEL GREENHOUSE

Compiled by Bristol Stickney with the cooperation of the New Mexico Solar Energy Association and the Solar Sustenance Team.

In 1978, Charles Kolstadt presented a preliminary economic assessment of the heating value of the attached solar greenhouse. This assessment is summarized here and can be found in its entirety in the *Proceedings of the Second National Passive Solar Conference.* In this paper, a simple monthly heat balance calculation is performed on an attached solar greenhouse and the value of the residual heat available to the adjoining building is tallied in "real" 1976 dollars over the 20 year lifetime of the greenhouse. The cost of the greenhouse is spread over 20 years and the cost of operating the backup heating system for a well insulated 1500 square foot attached building is also computed. The results are presented in graphic form in which total annual cost is represented as a function of the size of the solar greenhouse. Only the heating value of the greenhouse is included in this analysis, although Kolstadt states, "Quite simply, inclusion of the value of produce (vegetables) makes this analysis essentially unnecessary."

Kolstadt's economic model is extremely simplified, and is based on two major assumptions: (a) a $30^{o}F$ temperature difference between the greenhouse interior and the outside temperatures; and (b) residual heat in the greenhouse can be used regardless of temperatures. The validity of these assumptions depends entirely on climate conditions at the site and the proper use of thermal storage to couple the available heat from the greenhouse to the home heating load. In general, it can be expected that assumption (a) will weight the results in favor of conventional energy sources and assumption (b) will weight the results in favor of solar. These two assumptions could, therefore, effectively cancel each other. Other assumptions used in this paper such as the price escalation rate of fuel, the heating load of the conceptual test building and others may not be accurate in an absolute sense, but outline a valid and reasonable basis for comparison. Since all results are based upon identical assumptions, the relative value of the results is good. The purposes of this study are served adequately by the model; further refinement could only improve the analysis, but not invalidate the results.

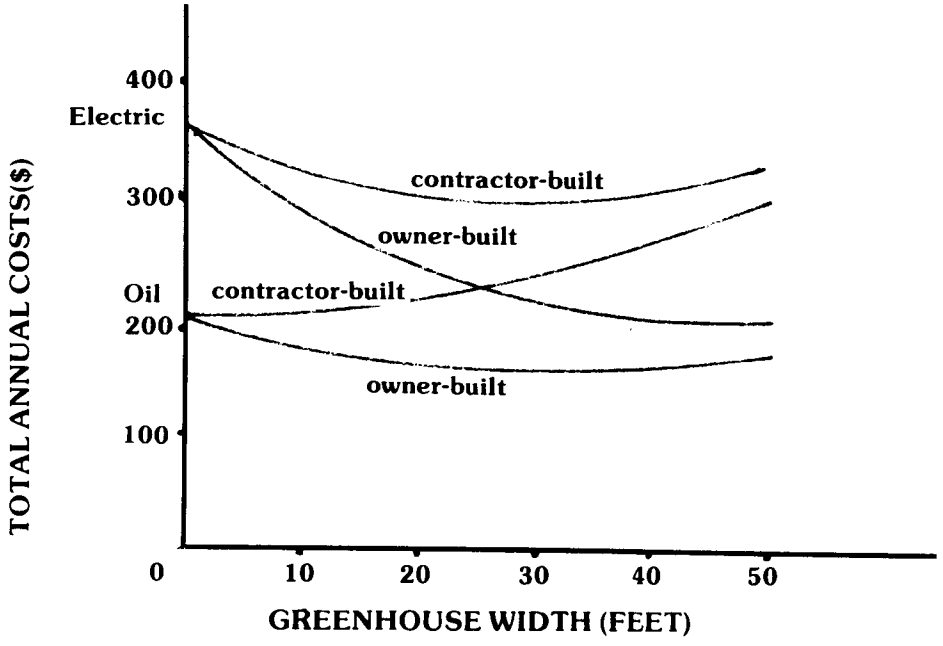
The results of this study, given in Figures 1, 2 and 3, are fairly easy to interpret. Total annual costs of heating with electricity and oil are compared to annual costs of various greenhouse sizes. Several significant trends are obvious. In every case shown, an owner built greenhouse (built without labor costs) will reduce annual fuel costs (in most cases this is a significant savings). In every other case shown, there is an optimum size greenhouse which delivers maximum savings. In most cases, the optimum size is between 240 - 360 square feet of floor area. In every case shown, the solar greenhouse is competitive with electrical backup heating. Keeping in mind that the savings from vegetable and plant production is not included in these results, it is fair to conclude that the solar greenhouse makes a significant contribution to the home heating load and could be the most economic alternative to many home heating applications in a variety of climates.

GREENHOUSE FOOD PRODUCTION

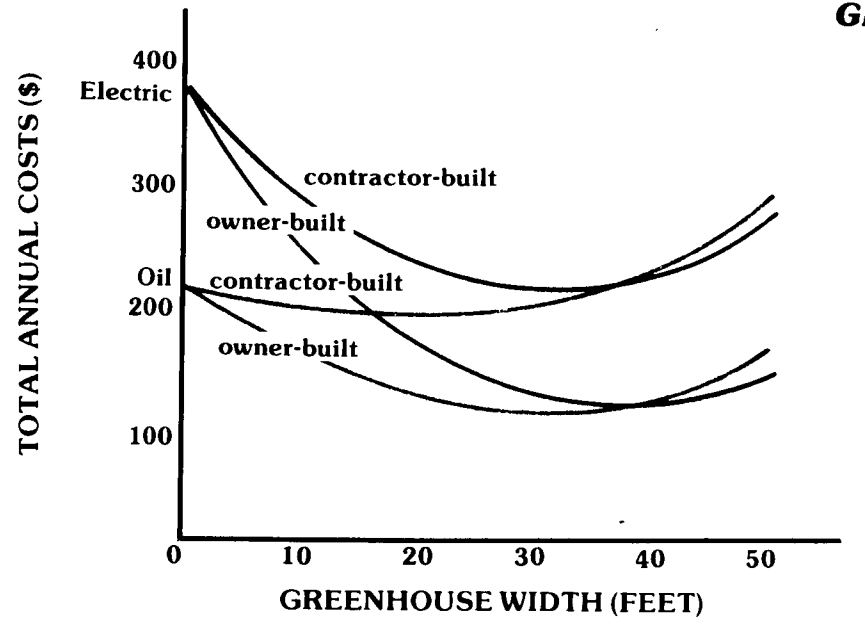
This chart is based on 1979 supermarket prices in Northern New Mexico. It is typical of one 160-200 square foot greenhouse annual production. The data are a compilation of 7 growers' experiences over a combined total of 23 years of attached solar greenhouse growing.

ANNUAL PRODUCTION OF A 160-200 FT^2 GREENHOUSE

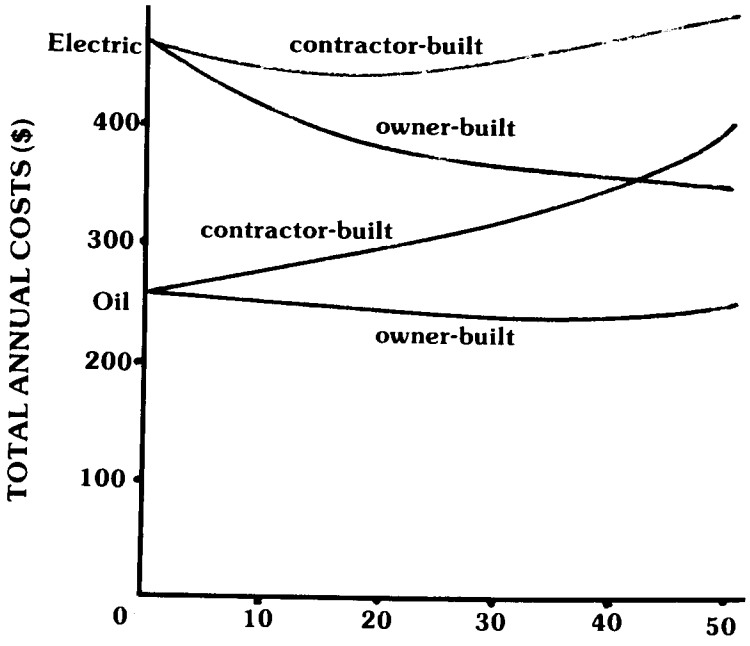
VEGETABLES	Beans	12 lbs.	@.69/lb.	$ 8.28
	Cabbage Family	75 lbs.	.29/lb.	21.75
	Carrots	6 lbs.	.25/lb.	1.50
	Cucumbers	12 lbs.	.33/lb.	3.96
	Eggplant	20 lbs.	.45/lb.	9.00
	Leafy Greens	125 lbs.	1.46/lb.	182.60
	Squash	12 lbs.	.39/lb.	4.68
	Onion Family	8 lbs.	.27/lb.	2.16
	Peas	8 lbs.	.69/lb.	5.52
	Peppers	20 lbs.	.50/lb.	10.00
	Radishes	5 lbs.	1.07/lb.	5.35
	Tomatoes	100 lbs.	.52/lb.	52.00
	Herbs	10 lbs.	1.00/lb.	10.00
				$316.80
	Seedlings for the outside garden 70 six packs @ .90/six pack			$63.10
	TOTAL VEGETABLE PRODUCTION:			$379.90
ORNAMENTALS	50 six packs @ .90/six pack (for garden)			45.00
	cut flowers @ 5.00/arrangement 2/mth			120.00
	house plants @ 2.00/plant 10/yr.			20.00
	TOTAL ORNAMENTAL PRODUCTION:			$185.00
	TOTAL PRODUCTION OF THE GREENHOUSE:			*$564.90*



1 ***ANNUAL HEATING COSTS GRAND JUNCTION, COLORADO***



2 ***ANNUAL HEATING COSTS RATON, NEW MEXICO***



3 ***ANNUAL HEATING COSTS GREAT FALLS, MONTANA***

In his paper "Passive Solar Systems...The Economic Advantages,"[1] Larry Sherwood develops a conceptual model to compare houses designed to be identical except for their heating source. Capital and operating costs are calculated in dollars for electric baseboard, a natural gas furnace, two active and three passive systems. He offers several methods of economic comparison. Let's see how the greenhouse system fares against the gas and electric alternatives.

Sherwood's model house is 1680 sq. ft. of well-insulated 2x6 frame construction in Santa Fe, New Mexico. Heat loss is calculated at 4.7BTU/sq.ft./degree day. Electric baseboard heaters and a gas furnace were installed in two separate houses. Each system was sized by the standard ASHRAE method for gas and electric. A 10x31 ft. greenhouse, designed to provide 90% of the standard house heating load, is added to a third house. The auxiliary backup is electric baseboard heaters.

In the following tables, dollar costs to build and operate each system are calculated. Initial or capital costs of building materials and labor were estimated using the *Building Estimator's Reference Book.*[2] Annual operating expenses were separated into energy and maintenance costs and were based on the then current (August 1978) electric and gas rates in Santa Fe. In Table I, Sherwood outlines the initial capital cost and the annual operating expenses for the three systems.

TABLE I

CAPITAL & OPEATING COSTS OF HOME HEATING SYSTEMS

	Capital Expense	Operating		Auxiliary & Maintenance Totals
		Auxiliary	Maintenance	
Electric Baseboard	$ 475	$ 608	$ 5	$613
Gas	1165	264	12	276
Greenhouse	3555	67	36	103

Electric baseboard heat is the cheapest to initially install but it has a very high operating cost. On the other hand, the greenhouse requires a substantial capital investment, but has a very low operating expense.

Sherwood points out that almost half of the greenhouse cost is for labor. An owner doing some or all of the work himself could realize a significant savings. Furthermore, using water drums instead of a masonry wall will reduce the cost of thermal storage in the greenhouse by over 80%. Even without such design or construction changes, Sherwood concludes that the low initial cost of the fossil fuel systems are more than offset by their high annual operating costs.

How one compares costs over a period of time determines the economy of one system over another. In Table II, Sherwood calculates the equivalent annual costs of the gas and electric systems. These figures take into account mortgage rates and maintenance on a twenty-year system. They also allow for escalation of fossil fuel costs above a given inflation rate. Furthermore, he includes an interest rate on the capital if, for example, it was put into a savings account instead of being invested in a solar greenhouse. For comparison, the current costs of gas and electric are also included.

[1] LARRY SHERWOOD, "Passive Solar Systems...The Economic Advantages," New Mexico Solar Energy Association, P.O. Box 2004, Santa Fe, NM 87501.

[2] McCLURG and SHOEMAKER, eds., *The Building Estimator's Reference Book*, Frank R. Walter Co., Chicago, 1973.

TABLE II EQUIVALENT ANNUAL COSTS

Solar vs. Electric

		$/Million BTU
Greenhouse		10.68
Electricity:	Current Cost	13.18
	Equivalent Annual Cost	26.05

Solar vs. Gas

Gas:	Current cost, furnace efficiency = 75%	4.06
Gas:	Current cost, furnace efficiency = 60%	4.88
Greenhouse		8.87
Gas:	Equivalent annual cost, efficiency = 75%	9.40
Gas:	Equivalent annual cost, efficiency =60%	11.36

Assumptions: Inflation rate = 6%.
Real inflation rate for electricity = 2%.
Real inflation rate for gas = 4%.
Opportunity cost of capital = 6%.
Mortgage rate = 9-3/4%.
Gas cost includes electricity required for furnace operation.

In analyzing the economic advantages of a greenhouse versus gas and electric, the greenhouse does well. Specifically, when compared with electric heat, the cost of the greenhouse is below the current cost of electricity. However, the contracted greenhouse cost is well above the current cost of gas and slightly below the equivalent annual costs.

The economics of the greenhouse application improve dramatically by changing three assumptions. They are:

1. include food savings
2. eliminate labor costs with an owner-built system
3. substitute the electric auxiliary with gas.
   Again, equivalent annual costs are assumed.

TABLE III EQUIVALENT ANNUAL COSTS

Greenhouse vs. Gas

		$/Year
Greenhouse:	No labor, include food	-284.50
Greenhouse:	Contracted labor, include food	-85.50
Gas:	Current cost	194.00
Greenhouse:	No labor	227.00
Greenhouse:	Contracted	426.00
Gas:	Equivalent annual cost, 75% efficiency	448.00

Assumptions: All Table II assumptions.
50% labor costs.
Gas auxiliary.
$1.65/sq. ft./year in vegetables.[3]

Table III makes it clear that attached solar greenhouses are outstanding investments for the home heating future. While a contracted greenhouse is marginally less than the equivalent annual cost of natural gas, the owner-builder will spend 50% less annually on home heating than his gas-sucking neighbor. The economics of the greenhouse system are even more attractive when food savings are included in the analysis. The contracted greenhouse will operate at a negative cost, or in other words, increase the owner's spendable income by over $85/year for the lifetime of the system. The numbers of the no labor, food included application are even more impressive. By Sherwood's model, this greenhouse will provide enough food and fuel savings over 20 years to afford the owner a $280/year increase in spendable income.

[3]Numbers taken by Solar Sustenance Team, "Solar Greenhouse Training Project," p. 28, April, 1979.
Total annual vegetable production ($379.80) minus annual cost of seeds, fertilizers, soil additives, etc. ($50) divided by square feet in greenhouse (200) equals vegetable production/sq. ft./year ($1.65).

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