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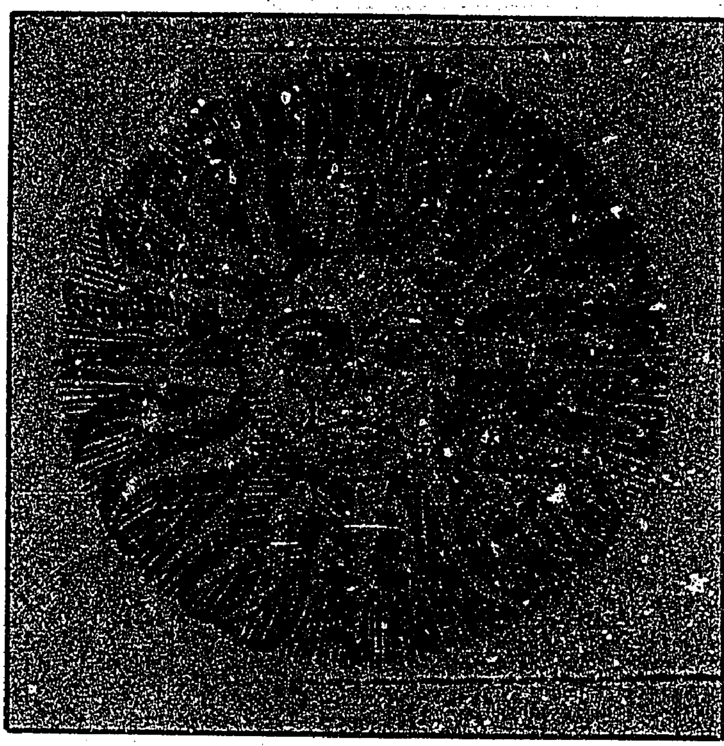
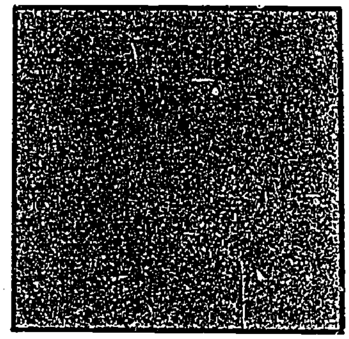
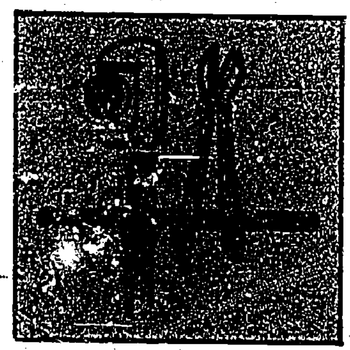
ABSTRACT

Planning, operation, and evaluation outcomes are reported for a project undertaken by the League for Innovation in the Community College to train vocational faculty in the installation of solar energy systems. After introductory material examining the need for a cadre of trained installation instructors at community colleges, the report describes Phase I of the project, which consisted of three, three-day workshops and one, five-day workshop conducted in various locations for faculty from over 40 institutions. This examination of Phase I details: the planning activities of the committee charged with workshop development; criteria for participant selection; the topics covered and the materials used during the workshops; and a revised workshop agenda developed by an evaluative task force. The report then summarizes topics covered at three additional workshops conducted during Phase II, which were modified on the basis of experiences gained during Phase I. This is followed by an outline of the topics and learning objectives of a prototype five-day installation workshop, based on the recommendations of a final task force review. The report concludes with: (1) findings of a mailed survey conducted to identify the solar energy activities of project participants since attending the workshops; and (2) summary recommendations stressing the need to provide instruction relevant to installers, rather than to technicians or engineers. (JP)

INSTALLATION OF SOLAR ENERGY SYSTEMS







TRAINING COMMUNITY COLLEGE FACULTY

CONDUCTED BY

THE LEAGUE FOR INNOVATION IN THE COMMUNITY COLLEGE

Funded by
The Department of Energy
Contract # EM-78-C-01-4223

R E P O R T

TRAINING COMMUNITY COLLEGE FACULTY IN THE TECHNIQUES AND SKILLS REQUIRED FOR SOLAR ENERGY SYSTEM INSTALLATION

A Pilot Project Directed by
The League for Innovation in the Community College

Funded by the Department of Energy,
Solar Technology Transfer Division
(EM-78-C-01-4223)

Report Submitted by:

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League Project Director

May 1980

Los Angeles, California

INTRODUCTION

On June 1, 1978, the League for Innovation in the Community College entered into a contract (E#M-89-C-01-4223) with the Solar Technology Transfer Division of the Department of Energy to conduct a pilot training program in solar energy installation. The overall purpose of the project was to train a specified number of community college, vocational/technical faculty in the techniques and skills required to install solar energy systems. This report chronicles the planning that led to the contract, the development and conduct of the training workshops, and the outcomes. It also includes an overall evaluation of the project and recommendations for the future.

BACKGROUND

The ten-year-old League for Innovation in the Community College, a national consortium of 17 districts that includes 54 public community colleges enrolling more than 840,000 students, concluded that the nation's two-year colleges could make a significant contribution to the country's efforts to conserve energy and to use alternative energy sources. Early in 1976, the League initiated a dialogue among its members on the role community colleges could play in the development and utilization of one important energy alternative - solar.

Through this dialogue, the League and its members were able to identify those issues in solar energy which directly affected the role of community colleges. They may be summarized as follows:

1. The limited number of community college faculty members who have the knowledge and skills to train or retrain students in the installation of solar energy systems.
2. The lack of a concerted national effort to provide opportunities for community college faculty members to gain the knowledge and the skills required for installing solar energy systems.
3. The fact that although solar energy technology has made rapid strides in the past decade, there is still a need to develop more sophisticated yet low-cost devices.
4. The dilemma of delaying the training until research is completed or moving ahead with training at a calculated risk that research will be completed in time to coincide with the need for trained installers.
5. The need for qualified trainers despite the state of the art in solar energy system installation.

In addressing these issues, the League was able to draw on the experiences of its member colleges. For example, the Dallas County Community College District identified its North Lake College as a center for training in solar energy. Coast Community College District in Costa Mesa, California, installed solar panels on a number of buildings. Kern Community College District in Bakersfield, California, is working with the Joint Apprenticeship Councils to initiate training in installation of solar energy systems. The Los Angeles Community College District has established a committee to consider solar energy for its nine-college system. Other colleges have focused on the consumer in order to create an awareness of the potential of solar energy; programs in this area have been conducted at Moraine Valley Community College in Illinois, De Anza College in Northern California, and Santa Fe Community College in Florida.

Capitalizing on these experiences and responding to the colleges' concern for meeting national and local manpower needs, the League identified the following factors relating to the training of solar energy systems installers at the community college level:

1. Community colleges offer a variety of vocational/technical programs which can be modified or adapted to provide initial training of solar energy systems installers. These programs include, but are not limited to, heating, ventilation, air conditioning and refrigeration; pipefitting and plumbing; sheetmetal; electrical trades; construction technology; and architectural and drafting technology.
2. Because of its extensive vocational/technical offerings, the community college is committed to providing short-term in-service programs for individuals currently employed in skill and technical occupations. Utilizing existing close working relationships with management and labor, the community colleges have the capability to reach a variety of people who could receive training in the installation of solar energy systems.
3. In order to meet the needs related to the installation of solar energy systems, a knowledge and skills base must be established for faculty members in community colleges. This should then result in a trained cadre of resource personnel.

The factors were substantiated by the vocational-technical/community college working group convened by the Department of Energy in Philadelphia on March 17-18, 1978. This group recommended that:

> The Department of Energy (should) give priority to training programs that capitalize on existing specialties, e.g., roofers, plumbers, HVAC, sheet metal workers, etc. Whereas continuing education programs (in-service), including adult supplementary training and upgrading of existing skills and knowledges, may be offered primarily by post-secondary institutions, and whereas preparatory (or pre-service)

> solar education and training programs may be offered by both secondary (high school) and post-secondary institutions (community and junior colleges, technical institutes, etc.) to students planning to enter this field of employment...

In preparation for a League venture into the solar installer area, four faculty members from League colleges attended the Colorado State University four-week summer course for instructors on the principles and practice for design, installation and operation of solar heating and cooling systems. The four representatives were: Bill Abernathy, Technology, Orange Coast College; Bob Tuttle, Welding and Sheetmetal, Bakersfield College; Clark Most, Science, Delta College; and Jerry Schuitman, Mathematics, Delta College.

CONDUCT OF THE TRAINING PROJECT

Planning

Although preliminary project plans and guidelines had been set forth in the contract proposal, detailed planning for the conduct of the pilot began on March 1, 1978. Planning was supervised by Robert J. Leo, Associate Executive Director of the League and energy project director, in conjunction with the project's coordinating committee. Members of this committee were: lead workshop instructors Bill Abernathy, heating/ventilation/air-conditioning (Orange Coast College, California); Bob Tuttle, welding (Bakersfield College, California); and Clark Most, chemistry (Delta College, Michigan). These members were selected because of their expertise in solar energy installation. Also serving on the coordinating committee were Seymour Lampert, professor of mechanical engineering, University of Southern California; and Mildred Bulpitt, assistant to the chancellor, Maricopa Community Colleges in Arizona, and an expert on continuing education programs.

Specific plans were to be determined in line with the three objectives of the project:

1. Train community college vocational/technical faculty members from a minimum of nine League districts in the Western United States in the techniques and skills relating to the installation of solar energy systems.
2. Explore the utilization of television as an instructional mode for training of installers of solar energy systems.
3. Establish a network for the nine districts in order to share information relating to solar energy systems.

On June 1-2, 1978, the coordinating committee and project director Leo met in Bakersfield to determine final plans for the project including participant selection criteria, workshop format and content, and workshop schedules. These planning decisions are summarized as follows:

Criteria for selection of participants: The committee developed guidelines for selection of participants in line with the philosophical framework established by the League and the specifications of the DOE contract, i.e., the primary group for training had to be vocational/technical faculty members working in programs where the likelihood of the installation of solar energy systems was greatest. The teaching specialty of the individual and the interest and commitment of the institutions were primary considerations. It was agreed that community college faculty members would be selected from the following vocational/technical areas: heating, ventilation, air-conditioning and refrigeration; sheetmetal and welding; pipefitting and plumbing; electrical trades; construction technology (commercial and residential); architectural and drafting technology; and related trade/technical areas. It was also agreed that participants must have an interest in training installers in their respective institutions and geographical areas and that the institutions must have a commitment to pre-service and in-service training for installers.

Workshop format and content: The coordinating committee agreed that there should be three, three-day workshops for approximately 60 faculty members and one five-day intensive workshop for approximately 18 faculty members. Because of the anticipated varying backgrounds and experiences of the participants, the committee members established the following minimal outcomes for the participants:

1. Participants will have received instruction on basic system theory, sizing, and installation methods.
2. Participants will have a better understanding of what knowledge is required to successfully design, size, and install solar heating and cooling systems in residential buildings.
3. Participants will have received printed lists containing sources for obtaining more information on solar systems and addresses for solar periodical literature and other training resources.

The committee decided the format for the workshops would involve a combination of lecture-discussion and hands-on activities.

Workshop schedule: The following schedule and site locations were established for the four workshops:

September 25-27	Coast Community College District Costa Mesa, California
October 9-11	Maricopa Community Colleges Phoenix, Arizona
October 16-18	Kern Community College District Bakersfield, California
November 27 - December 1	Kern Community College District (five-day intensive)

Selecting the Participants

Utilizing the established procedures of the League, the project staff invited each institution to submit nominees for the three-day workshops. A preliminary matching of 30 institutions interested in participating to workshop sites was established in order to control travel expenditures and accommodate geographical interests in installation. Nominees were reviewed by the staff (lead instructors) and 56 were invited to attend. (See Appendix 1.)

Conducting the Workshops

The three-day workshops (see Appendix 2) were held as scheduled in each of the three sites. A total of 56 faculty members representing 30 community colleges in four states - Oregon, California, Texas, and Arizona - participated. California, with 31 attendees, had the largest participation. This may be due to two factors: 1) the greater number of League colleges in California; and 2) the fact that two of the three workshops were held in California. Fourteen participants were from Arizona, seven from Texas, and three from Oregon. (Clark Most from Delta College in Michigan also attended one of the three-day workshops.) Eighteen participants were from heating/ventilation/air-conditioning; ten from the general trades; seven from construction; five from engineering; and five from electronics.

The agendas for the three workshops centered on three general areas:

1. General information - Lectures and discussions focused on the sun and history of solar technology, systems, economic codes, tax incentives and laws.
2. Systems Components - Lectures, discussions, media presentations and "hands-on" activities focused on areas of new and retrofit considerations.

3. Training Resources - Lectures, discussions, a variety of slide-tape presentations, simulators, books, pamphlets, and packets of resource materials were used. (Appendix 3.)

A mobile laboratory, which had been designed and assembled for the project by coordinating committee members Abernathy and Tuttle, was set up at each workshop. It was designed to allow trainees to develop their understanding of the solar cycle and its integration into auxiliary heating systems. The lab had six stations:

> The Lennox RT-5 Solar Cycle Trainer
> Station No. 1 permits the instructor to isolate the flow patterns and discuss what is happening. While following the Lennox Manual, trainees can operate the trainer and observe the different cycles as called for by mode selection. The trainer switches are designed to program various conditions into the trainer, i.e., sun or no sun, warm or hot storage, outdoor temperature conditions, open or closed solar coil limit and domestic hot water.
>
> The EB-5 Solar Schematic Trainer
> Station No. 2 demonstrated the electrical control sequence for each cycle.
>
> The Omnidata Solar Energy Technology Simulation
> Station No. 3 simulated the solar cycle and space heating with domestic hot water. Readouts are presented for all functions of energy gathering and storage cost of auxiliary fuel and other important training functions. The electrical schematic is functional, and can be tested for faults that are programmed into the system by the instructor. A readout on parts used and repair time is useful for evaluation of the student in a classroom problem. The special volt ohm meter reads simulated voltages, and will not be damaged if a student inadvertently uses the incorrect scale, but will notify the user of a malfunction. This equipment was very useful in a sequence of training before the student is comfortable working with live equipment and high voltage.

The ST-17 Solar Heat Service Trainer
Station No. 4 used commercially available valves, switching relays and thermostat and control panel. The advanced student can work out programmed control problems on this equipment working with live voltage under normal conditions. The student's knowledge acquired on previous stations will allow him to work safely and at less cost to damaged test equipment and control parts.

The AP-3
Station No. 5 is a complete hydronic solar system using one collector. The student will charge the system, prime the pump and operate the complete system in a normal sequence of space heating.

Station No. 6 is a complete air system using an air collector or collectors to heat a pebble storage bed. The SAM Air Handling equipment and its control system is used to show a normal full-scale system. The only modification was to slow the blower down for a normal air flow through one or two air collectors. Collectors used were Solaron and an on-site constructed collector designed to work on new construction or retrofit situations. The on-site collector was designed by Abernathy, and the commercially available air system was built by Tuttle for the trainer laboratory. Equipment can be energized by the sun or the sun can be simulated by a bank of heat lamps to activate the learning devices on cloudy days or in the interior of the trailer. As the trainee works the many functions of a solar system in the trailer lab, he is guided by operation manuals at every station. Schematic diagrams are posted throughout the trailer to guide the student in operation or installation. All wiring diagrams are furnished with the equipment, and wiring on the actual equipment is color coded for good training practice. When a trainee has completely mastered the simulations and actual equipment in the trailer, he is ready for the installation and service of solar systems integrated with auxiliary systems in both residential and small commercial installations.*

Each participant was given a packet of materials that included the following:

SOLAR HEATING AND COOLING OF RESIDENTIAL BUILDINGS, DESIGN OF SYSTEMS, Solar Energy Applications Laboratory, Colorado State University for the U.S. Department of Commerce, Superintendent of Documents. Government Printing Office, Washington, D.C. 20402, Stock No. 003-011-00084-4.

SOLAR HEATING AND COOLING OF RESIDENTIAL BUILDINGS, SIZING, INSTALLATION AND OPERATION OF SYSTEMS, Solar Energy Applications Laboratory, Colorado State University for the U.S. Department of Commerce, Superintendent of Documents, Government Printing Office, Washington, D.C. 20402, Stock No. 003-011-00085-2.

FUNDAMENTALS OF SOLAR HEATING, Sheet Metal and Air Conditioning Contractors Association, Vienna, Virginia, January, 1978.

COURSE OBJECTIVES, provided by Solar Installation Workshop Instructors.

DUCT SIZING AND HEAT LOAD CALCULATION, handout, B. J. Abernathy, Orange Coast College, Costa Mesa, California.

GLOSSARY OF TERMS, provided by Solar Installation Workshop Instructors.

SOLAR ENERGY, a status report, DOE/ET-0062, U.S. Department of Energy, June, 1978, a program of SMACNA, Sheet Metal and Air Conditioning Contractor's National Association, Inc., 1977, 8224 Old Courthouse Road, Tysons Corner, Vienna, Virginia 22180.

Additional materials were supplied by the National Solar Heating and Cooling Information Center, the U.S. Department of Energy and the state energy offices in California and Arizona.

Speakers during the three-day workshops were drawn from the public and private sectors. They included, among others, Gregory Stutzman, Arizona Solar Energy Commission; Howard Kraye, Conserdyne, Inc.; Paul Bevens, Familian Pipe and Supply; Seymour Lampert, Professor; John Yellott, Professor, Arizona State University; and Anna Fay Friedlander, editor, Solar Engineering.

Five-day Intensive Workshop

Seventeen faculty members from ten colleges attended the five-day intensive training workshop at Bakersfield College in Bakersfield, California. The workshop focused on 1) basic knowledge and skills in solar installation and 2) the teaching of solar installation.

Knowledge and skills: The components of air and hydronic systems were treated in depth. Common installation problems were identified and solutions discussed. Sizing and heat loads were probed and the participants were introduced to SOLCOST. Further, the participants were able to explore the state of the solar industry: its past, its present, and its future. The mobile laboratory was used extensively. Speakers included Greg Stutzman, Arizona Solar Energy Commission; Byron Winn, Professor, Colorado State University; Anna Fay Friedlander, editor, Solar Engineering magazine; Debra Langford, Department of Energy, and Robert Tuttle and William Abernathy, instructors.

Teaching installation: The participants actively engaged in creating objectives and test items and developing teaching approaches. Two manufacturers, Lennox and Omnidata, presented their training approaches. Speakers and group leaders included Stuart and Rita Johnson on instructional methodology. Further, the participants, working in small groups, discussed the problem of developing an approach for initiating and integrating programs in solar energy at their respective institutions.

EVALUATION

A comprehensive evaluation approach was utilized for this project and included the following elements:

1. For participant evaluation, two instruments were devised for the three, three-day workshops and one instrument was devised for the five-day workshop. The evaluation of the workshop was completed in two parts. First, the participants evaluated the content of the workshop according to its "usefulness" on a descending scale of 5 ("useful") to 1 ("not useful"). Second, the participants evaluated the workshop in terms of four standard components: subject matter, speakers, facilities and format, using a range of "excellent" to "very poor." The latter evaluation form included two additional items: overall assessment and recommendations for continuing workshops of this kind. (See appendix for evaluative instruments.)
2. A post-workshop session of selected participants and lead workshop faculty was held.

Three-day Workshops

Evaluation of the three-day workshops was completed in two parts. First, the participants evaluated the content according to its usefulness; and second, the participants evaluated the workshop in terms of the four standard components of subject matter, speakers, facilities, and program format. Some highlights of evaluation results included:

- Texts and materials were rated highest in all workshops.
- 100% of the participants rated the discussion of collectors as useful.
- The mobile classroom was rated as useful by 88% of the participants.
- The discussion of legal and code implications received high ratings in all workshops, and ranked fourth in terms of importance.
- Heat-load calculations was rated lowest of the eleven evaluation categories.
- The four major workshop components were rated generally as excellent and good; in rank order they were: conference facilities, subject matter, program format, and program speakers.

Differences were evident among the three workshops in specific content categories. For example, "sizing" was rated last in one workshop and yet received a rank of 4 in another workshop. Again, "storage" was ranked third in one workshop, and 7 and 6 in the two other workshops. The category "films" was ranked 3 and 4 in two workshops and yet received an overall 9 rank in a third workshop. (Appendix 4) These differences could be accounted for in the following ways:

1. The presentation of the content category by a specified speaker
2. The placement of the category in the overall workshop design; and/or
3. The content of the presentation.

All participants were asked to agree or disagree with the following statement: "The League should continue to sponsor workshops of this kind." The outstanding response showed that no participants were neutral or disagreed with this statement. Most strongly agreed with this statement.

Five-day Workshop

Using an evaluation format similar to that used in the three-day workshops, the participants were asked to assess content areas in relation to their usefulness in training installers. Overwhelmingly (100% of the participants), the Lennox Training Program (LTP) was rated extremely useful, with many participants commenting on the need for more time with the representative. General materials on solar distributed at the workshop, content areas on the state of the industry and problems encountered, and installation codes were found to be very useful by the participants. Course outlines, which were shared by the participants, also received a very high rating. Interestingly, three areas relating to developing teaching aids and packages, constructing test items, and creating objectives were ranked lowest of all categories. (Appendix 5)

Follow-up Task Force

On July 24 and 25, 1979, a task force was convened to evaluate the overall project. Participants in the meeting included Robert Tuttle, one of the lead instructors in the project; and faculty members Bill Bolin, Northlake College; Keith Carrico, Maricopa Technical Community College; and Jim Lawson, Lane Community College. Based on their experiences, Task Force members proposed a revised general format for the three-day and five-day workshops and recommended that they be divided into six segments, each incorporating a minimum of four hours of instruction, as follows:

Segment I - History of Solar and Basic Systems

Segment II - Collectors and Storage

Segment III - Hydronics, Air Systems and Controls

Segment IV - Load Calculating, Sizing and Economics

Segment V - Consumer Problems, Legal and Code Implications

Segment VI - Instructional Methodology - Teaching Installers

The five-day workshop would build on the six segments providing in-depth treatment in order to establish a core of knowledge and skills for the participants.

The guidelines and curriculum to be field tested at the five-day workshop were as follows:

Workshop Guidelines:

1. A maximum of 30 participants should be involved in each workshop in order to insure hands-on activities and individual consultations.

2. Training hours should range from 40 to 60.

3. As a minimum, content for the workshops should include the following: active and passive systems; air and hydronics; collectors and storage; controls; heat load calculations; system elements; and instruction techniques and materials.

4. Instructional aids should be utilized to provide hands-on activities for participants; aids used should be basic to installation.

5. Peer instructors, faculty members currently working in community colleges and vocational/technical institutions, should be used as workshop instructors and resource personnel.

6. Representatives from the solar industry, governmental agencies (local, state, federal), and university researchers should be involved in the workshops.

7. Instructional materials (books, films, etc.) should be available for participants' evaluation and perusal. When possible, they should be made available on a no-fee basis.

8. On-site visits, to both residential and commercial sites with solar energy systems, should be part of the workshops.

9. Class assignments in reading and problem solving should be given and time allotted for questions, individual consultations, supplemental hands-on activities, individual projects, and group rap sessions.

WORKSHOP PURPOSE, CONTENT, AND OBJECTIVES*

Day 1: History of Solar Energy and Introduction to Basic Systems: Active and Passive

Purpose: Using visual aids, demonstrations, models, and short lectures, this segment will a) present a brief history of solar energy and technology; b) introduce the major components of basic active solar systesm; and c) introduce passive concepts and design.

At the conclusion of this segment, the faculty participants will have:

1. Increased their knowledge of the history of solar energy and technology.
2. Learned the difference between active and passive solar heating.
3. Learned the major components of solar heating and cooling systems in an introductory mannger.
4. Become familiar with factors affecting the availability of solar radiation at the earth's surface.
5. Become familiar with the concepts of direct gain, indirect gain and isolated gain in passive solar.
6. Attained general awareness of the difference between new construction and retrofitting.
7. Learned the advantages of passive and active systems working together.

* Critical to any training curriculum are the objectives which should be accomplished. The activities may vary, but the objectives remain constant.

Day 2: Collectors and Storage

Purpose: Using hands-on activities, specific exercises and lectures, this segment will present those principles which influence the design, operation, installation, and maintenance of solar collectors; and will describe the practical methods and basic guidelines for heat storage and sizing.

At the conclusion of this segment, the faculty participants will be able to:

1. Differentiate between beam and diffuse radiation.
2. Recognize the magnitude of solar energy available and the seasonal variations in solar insolation.
3. Locate sources of solar data.
4. Determine the amount of solar radiation available for a given period of time in a specific geographic location.
5. Identify the functions of individual components of a solar collector.
6. Compare the performance of various collectors.
7. Recognize the effects of system design changes.
8. Explain the factors contributing to solar collector durability.
9. Identify what materials are used in thermal storage mediums and why.
10. Size and locate the thermal storage unit.

Day 3: Hydronics, Air Systems, Controls

Purpose: Using demonstrations, simulators, and hands-on activities, this segment will present the components and functions of hydronic and air systems, and will describe the basic controls of air and hydronic systems including domestic hot water systems.

At the conclusion of this segment, the faculty participants will have:

1. Learned the details of component arrangements in hydronic and air heating solar systems.
2. Gained a better understanding of the performance characteristics of solar hydronic and air systems.

3. Learned the basic modes of operation for solar air, hydronic, and domestic hot water systems.
4. Learned to identify the various control devices used in solar heating systems.

Day 4: On-site Visits; Load Calculations, System Sizing and Economics

Purpose: In the morning, workshop participants will make site visits to residential and commercial locations where active solar energy systems have been installed and/or passive design has been incorporated. In the afternoon, the workshop will present the processes for calculating the design heat load, the average monthly heating load, and the average annual heating load; and will present processes used in selecting solar system components.

At the conclusion of this segment, the faculty participants will have:

1. Observed solar energy system installation in actual application at the visited sites.
2. Calculated the design heat load, average monthly heat load, and average annual heat load for given applications.
3. Determined annual fractional load supplied by solar. Determined the appropriate type, size, and number of collectors required, calculated the type and size of storage required, and selected additional hardware required.
4. Learned to conduct an economic analysis of solar and non-solar systems.
5. Learned how to determine annual cash flow for solar and non-solar systems.
6. Learned how to determine the economic feasibility of a solar system.
7. Developed an understanding of the integration of passive and active systems as an economical and efficient approach.

Day 5: Teaching Techniques and Theory Application

Purpose: Using exhibits and short lectures, this segment will present methods and materials which may be used in the instruction of solar energy system installation - active and passive. Participants will have time to assess the materials and to consult with various resource personnel.

At the conclusion of this segment, the faculty participants will have:

1. Learned the baseline skills needed by students in learning the installation of solar energy systems.
2. Evaluated available reading and audio-visual materials.
3. Become more aware of other resources in the teaching of solar energy system installation.

PHASE II

Phase II of the project to train community college faculty in the techniques and skills required for solar energy system installation consisted of two three-day workshops and one five-day workshop. Utilizing the experiences gained during Phase I of the project, the workshops were modified to meet the needs of the particular geographical area.

Workshop - Delta College, September 26-28, 1979

Twenty-eight participants from 23 community colleges in five states representing 14 different vocational/technical areas attended the first workshop of Phase II, hosted by Delta College, University Center, Michigan. The workshop focused on: passive systems; storage; economics; installation problems; heat load calculations; collectors; sizing; heat transfer; training simulators; on-site visits; controls; codes, incentives, costs; earth-sun relationships; and F chart. A number of individuals representing various segments of the solar industry were involved as resource personnel. They included Paul Moses, Dow Chemical; Bruce Shook, Dow Corning Corporation; Robert Hamos, Lennox Education Projects; Tony Gates, Jordan College;

Rich Wale, Michigan Energy Administration; and Byron Winn, Colorado State University. Jim Lawson, Construction Technology, Lane Community College, and Keith Carrico, Heating/Ventilation/Air Conditioning, Maricopa Technical Community College, served as resource people for the League.

The participant evaluations indicated that passive systems and storage components of the workshop were ranked highest. (See Appendix 6 for more details.)

Workshop - Central Piedmont Community College, Charlotte, North Carolina

Twenty-one participants from seven states representing eight different occupational areas were in attendance. Typical of the three day workshops, the agenda included discussions on collectors and storage, air systems, hydronics, load calculations, consumer problems, laws and codes, and instructional methodologies. Presenters from various segments of the solar industry included Dan Knee, Exxon Corporation; Cal Lassiter, Heat Transfer Sales; Dick Gibbons, P.C. Godfrey, Inc.; Louis Abernethy, P.E. Ferebee-Walters and Associates; and Ben Albright, North Carolina Department of Public Instruction. Resource personnel for the League were Keith Carrico, Maricopa Technical Community College, and Bob Tuttle, Bakersfield College.

Evaluation results from the workshop indicated that consumer problems, collectors and storage were found to be extremely useful by 100% of the participants. The overall evaluation of the workshop was excellent (See Appendix 7 for more details.)

Five-day Workshop - Central Piedmont Community College

The five-day workshop held at Central Piedmont Community College was attended by 22 community college faculty members from 11 states representing nine specialty occupational areas. The proposed training guidelines and curriculum were utilized as a framework for format and content. However, modifications were made to accommodate the presenters from various segments of the solar industry. (See appendix 8 for agenda.) The presenters included: Anna Fay Friedlander, editor of Solar Engineering, whose presentation on the state of the solar industry set the stage for the workshop; Greg Stutzman, Arizona Solar Energy Commission, who discussed installation problems and standards and certification; Timothy Gates, Jordan College, who focused on controls; Bob Hamos, Lennox Education Products, and Scott Brown, Omnidata, who demonstrated teaching simulators; and Bill Fisher, the National Solar Heating and Cooling Information Center, who discussed passive principles and design. Resource faculty members for the League included Bob Tuttle, Bakersfield College; Keith Carrico, Maricopa Technical Community College; Bill Abernathy, Orange Coast College; Bill Bolin, North Lake College; and Jim Lawson, Lane Community College.

As an integral part of the workshop, instructional resources and media were used to expand the content as well as to give faculty participants the opportunity to evaluate them in terms of their usefulness in training installers. The resources included videotapes, slide/tape presentations, self-paced (print) packages, films, and simulators. (See Appendix 9 for results of evaluation.)

At the conclusion of the workshop, each participant completed an evaluation form. Using a five-point scale (5-excellent; 4-above average; 3-average; 2-below average; and 1-poor), the participants rated the content of presentations, the relevance and usefulness of the topics presented, and the overall success of the workshop. Content received a 4.6 rating; relevance and usefulness a 4.5; and the overall workshop was rated 4.66. (See Appendix 10 for complete results.)

TASK FORCE REVIEW

On January 13-15, 1980, an ad hoc task force met to review the results of the workshops and make recommendations for future workshops. The members of the task force were:

Ed Byrne, instructor, New Hampshire Vocational Technical College

Keith Carrico, instructor, Maricopa Technical Community College

Jim Lawson, instructor, Lane Community College

Richard O'Donnell, Executive Director, Northern New England Center for Appropriate Technology

Bob Tuttle, instructor, Bakersfield College

John Xerri, instructor, Henry Ford Community College

Based on the evaluation of the trainers, participants and consultants compiled during the two phases of the pilot project, the task force recommended that the five-day workshop format serve as a main vehicle for the initial training of community college faculty, and that the guidelines with minor modifications serve as a framework for content and format of the workshop.

It is recognized that training faculty in a five-day workshop requires in-depth treatment of the skills and techniques related to teaching the installation of solar energy systems. Critical to teaching is an understanding of a core of knowledge which will serve as a foundation for the further acquisition of skills and information in installation. Within the restrictions of a five-day block of time, the results of the pilot project have indicated that the core knowledge can be divided into eight interrelated modules:

I Energy: Solar Technology

II Load Calculations

III System Components

IV Systems

V Design and Sizing

VI Installation Procedures

VII Instruction, Curriculum and Teaching Resources

VIII State of the Industry, Ethics, Incentives, Public and Private Resources

Also, the task force recommended that:

1. Pre-workshop materials should be sent to participants in order to prep them on some of the items to be covered.
2. The set of objectives developed for each component in the workshop should be sent to each presenter and an indication should be made that the presenter must meet the objectives.
3. The simulators should be used in all workshops at specific times.
4. Questionnaires should be sent out prior to the workshop in order to identify the skill levels of the individual participants.
5. A certificate of completion should be developed to be given to the participants at the end of the five-day workshop.
6. Speakers with handouts should pre-package the materials with a cover sheet noting what is included in the package.
7. All activities should be structured especially those dealing with the simulators (a guide should be developed).

Based on the task force recommendations, a revised training curriculum was developed by the project director and disseminated to the task force for modifications. The proposed training curriculum which follows is based on a five-day session with a minimum of 40 and a maximum of 60 training hours.

The number of hours assigned to each component will be dependent upon the prior experience of the participants. Suggested hours appear after each component, e.g., System Components (11 hours). Further, the sequence of topics can be modified to accommodate participants, presenters and space availability.

Proposed Training Curriculum
Five-day Session - (Minimum 40 hours)

I. Energy

A. General Overview

The participants will be able to:

1. Understand the workshop format, content, and expectations.

B. Energy Overview

The participants will be able to:

1. Identify the general sources of energy and the role that solar energy will play as an alternate source.

2. Understand the history of solar technology.

II. Load Calculations (4 hours)

A. Energy Efficient Buildings

The participants will be able to:

1. Identify the elements of construction in energy-efficient buildings.

2. Understand the procedures involved in calculating the energy efficiency of buildings (new and retrofitted).

3. Calculate the average monthly and annual heat load requirements of a given solar application.

4. Calculate the size, type, and number of selected solar collectors and determined storage needed for domestic hot water and pool installations.

B. Domestic Hot Water

The participants will be able to:

1. Explain the procedures used to calculate mixing of hot and cold water; find hot water temperature and demand requirements; heat losses; efficiency; cost.

2. Define cold water, hot water, mixed systems, BTU, specific heat, and be able to convert volume of water to weight of water.

3. Identify advantages and disadvantages of single and dual storage.

C. Pools

The participants will be able to:

1. Determine the amount of heat loss occurring from a swimming pool.

2. Determine the amount of heat loss from a swimming pool by convection, evaporation and nocturnal radiation.

3. Use various means to reduce the heat losses from swimming pools.

III. System Components (11 hours)

A. Basic System - Mechanical/Electrical

The participants will be able to:

1. Recognize the features which distinguish active and passive solar heating systems.

2. Identify the principal characteristics of air and liquid heating systems.

3. Identify and describe the basic function of key components of a basic solar heating system.

4. Recognize advantages and disadvantages of different designs of components and systems.

B. Collectors

The participants will be able to:

1. Identify and describe the functions of the individual components of a solar collector.

2. Describe the difference between flat plate and concentrating solar collectors.

3. Understand solar energy absorption as related to solar collectors.

4. Explain how energy is lost from a solar collector and how to reduce these energy losses.

5. Explain the materials available for glazings.

6. Describe the materials and design considerations for constructing and mounting.

7. Discuss the efficiency, performance, capacity of collectors.

C. Storage

The participants will be able to:

1. Explain how water is used in the storing of solar energy; how volume weight and specific heat content are used in determining storage needs and capabilities for hydronic and/or air solar systems.

2. Describe how rocks (pebbles) are used for storing collected solar energy, by determining the volume needed and explain various considerations.

3. Understand how phase change materials function and the use of these materials as they pertain to the solar industry today.

D. Hardware

The participants will be able to:

1. Identify the mechanical and electrical components needed in a solar energy system.

2. Explain the function and differentiate among components.

3. Identify potential problems and troubleshoot the components.

IV. Systems (7 hours)

A. Solar Domestic Hot Water

The participants will be able to:

1. Describe the different types of solar hot water heating systems.

2. Explain the different methods used to provide freeze protection.

3. Calculate the average volume of hot water required for a typical family given family size.

4. Calculate the heat requirement in BTU/day to provide calculated volume of water given inlet water temperature and desired storage temperature.

5. Calculate the required collector area given desired percent of annual load, size of family, geographical location, temperature of cold water main, desired temperature of hot water, and sizing chart.

6. Draw schematics of a drain down, drain back, and a dual fluid system.

7. Explain why and when the control system on a dual fluid solar domestic hot water heating system will start and stop circulation of the collector loop fluid.

B. Pool

1. Active Systems

   The participants will be able to:

   a. Describe various types of active pool heating systems and be able to identify the components and their position in the system, as well as their purpose and function.

   b. Explain the basic theory of passive pool heating, as well as the pros and cons of the materials and their uses that are currently available to the public.

C. System Heating - Active and Hybrid (Hydronic & Air)

The participants will be able to:

1. Describe the operation of the heating systems.

2. Recognize the different heating modes.

3. Discuss the use of an auxiliary energy source.

4. Identify the components in a hybrid system.

D. Passive Solar

The participants will be able to:

1. Describe the three basic concepts of passive solar: direct gain, indirect gain, and isolated gain.

2. Explain the two basic elements of passive solar: south-facing glass and thermal mass.

3. Discuss types and relative quantity of required thermal mass.

4. Describe similarities and differences involved in various passive approaches: trombe wall, water wall, attached greenhouse, roof ponds.

5. Explain the advantages and disadvantages of passive solar.

6. Explain considerations to be made before building.

7. Discuss sizing: south-facing glass, water wall, greenhouse, roof ponds, thermal mass.

V. Design and Sizing (8-10 hours)

A. Design

The participants will be able to:

1. Identify the advantages of active and passive systems working together.

2. Identify a back-up system that will provide an economical total of heating requirements.

3. Define and understand the importance of angles, orientation and insolation.

4. Identify various analysis methods/computer programs which will assist them in design of systems.

5. Explain mechanical and electrical design recommendations in relation to the components and the total system.

B. Sizing

The participants will be able to:

1. Determine the proper amount of area needed to collect solar energy using specified formulas (e.g., ASHRAE).

2. Identify various analysis methods/computer programs which have been developed to assist them in sizing of systems.

3. Determine the required total area of a particular solar swimming pool collector array to adequately heat a swimming pool.

4. Express the necessary requirements in hydronic pipe and component sizing.

VI. Installation Procedures (6-8 hours)

A. The participants will be able to troubleshoot:

1. Mechanical systems (understand all the basic components and their functions in the system, possible problems and some solutions to these problems).

2. Electrical systems (know the basic electrical components and their functions in a solar water or air system and the problems which may occur).

B. The participants will be able to:

1. Identify the elements of retrofitting existing buildings.

2. Formulate the procedures needed in retrofitting.

3. Identify the relationship between active and passive elements of retrofitting.

VII. Instruction, Curriculum, Resources (3 hours)

A. The participants will be able to:

1. Identify a variety of instructional techniques and methodologies employed in teaching solar installation.

2. Identify sources of materials and approaches used in initiating solar installer programs.

VIII. Related Issues and Developments (4 hours)

A. The participants will be able to:

1. Discuss current and future trends in the solar industry.

2. Discuss the role of governmental installation incentives.

3. Discuss current certification movements in installation.

4. Understand the institutional and personal commitments and planning related to the training of installers.

PARTICIPANT FOLLOW-UP

In March, 1980 a short questionnaire was sent to the participants in the pilot project. The questionnaire was designed to identify the types of activities undertaken by the participants at their home institutions since attending the solar workshops. Survey forms were sent to 104 participants from the three-day and five-day workshops. Sixty-five (62%) returned their survey forms by the deadline.

The results of the survey were as follows:

1. Credit courses in solar energy were offered by 66% (42) of the respondents.
2. Non-credit (community services/continuing education) courses in solar energy were offered by 35% (22) of the respondents.
3. Solar installers training programs offered since the completion of the solar workshops were offered by 38% (20) of the participants.
4. Special solar energy workshops, courses, programs offered by participants for a variety of target groups included:

Group	No. of Activities
Heating, Ventilation, Air Conditioning Contractors	
Plumbing Contractors	5
Architects	14
Homeowners	21

Group	No. of Activities
Building Contractors	12
Building Inspectors	6
Other	16

In the "Other" category, such diverse groups as construction trade apprentices, general public, and physical science majors were included.

5. Ninety percent of the respondents indicated that they have introduced solar energy content into existing courses.

6. The major obstacles encountered by participants in attempting to establish solar energy installer courses/programs were as follows:

Obstacles	Number
Lack of administrative support	10
Lack of financing	32
Lack of equipment	33

Other problems encountered by the respondents were faculty indifference, lack of resource material, lack of community support.

7. Respondents were asked to indicate their involvement in solar energy in a variety of areas. The results indicated that 14 serve on community or governmental solar energy advisory committees; 23 have served or are serving as solar energy consultants; 24 indicated that they make presentations to community groups; seven indicate that they teach solar energy classes outside their institution; eight indicate that they "team teach" courses in solar energy; 15 indicate that they have contacted their regional solar center for assistance; and 34 indicate that they read <u>Solar Age</u> or <u>Solar Engineering</u> magazines.

8. In order to gauge the respondents' perception of the solar energy system installation activity in their locale, the respondents were asked to indicate on a scale ranging from "extremely high" to "low" the amount of activity. The results were: one checked "very high"; six indicated "high"; 16 "somewhat high"; and 41 "low."
9. The respondents were asked to rate the solar energy workshop in terms of the knowledge gained and used. Twenty-seven indicated that the workshop was "extremely helpful"; 16 "very helpful"; ten "helpful"; and eight "somewhat helpful."
10. Fifty-three of the respondents indicated they would be interested in attending other workshops on solar energy.

Conclusions and Recommendations

The development of a curriculum to train community college/vocational-technical faculty to teach the installation of solar energy systems provides important opportunities to test a variety of approaches and techniques. Throughout the pilot project, there emerged a need to balance the curriculum between theory and application. Prior to the implementation of the project, it was noted that individuals attending the workshop would have varying backgrounds in solar ranging from none to extensive. Certainly, it would have been simpler to group faculty members by occupational areas; however, simplicity is not always the best when dealing with community colleges with varying constituencies, faculty and programs. Realistically, the advocacy of solar energy in the community college will come from a variety of occupational areas. Further, a "mix" of faculty members fosters the cross-fertilization of ideas, suggestions and skills.

The critical underlying assumption for training vocational-technical/community college faculty members is that the institution - by virtue of its comprehensive nature - can be the vehicle for meeting the energy needs of the community. The community college is adaptable and can respond quickly to a felt need, i.e., the commercialization of solar energy. Further, faculty members in vocational-technical programs who are adept in certain specialty areas do not necessarily have an engineering background. Their primary focus is "hands-on" experiences to prepare individuals to enter the work force immediately upon completion of the training. Thus, the training curriculum must be designed to train faculty members to teach installers, not technicians; installers, not engineers. The installer seeking engineering proficiency should turn to the university for additional training.

The installation of solar energy systems involves a variety of existing skills evident in a number of occupational areas and then melded together to insure that quality installation occurs and the consumer is protected. To provide that kind of training, it is imperative that faculty be exposed to a balanced program of air and hydronics, active and passive, theory and application. Further, participants need an understanding of the solar industry and governmental agencies, especially their roles in the development of codes, standards and certification. The efforts of industry and government will surely affect classroom content and techniques.

The results of the pilot project indicated that there is a continuing interest in teaching solar energy installers in the two-year postsecondary institution, and that the training of faculty members in these institutions is a needed first step. It is evident that short-term concentrated group training is an efficient and effective approach for two major reasons. First, currently employed faculty members cannot be released from existing teaching responsibilities for a long period of time. Second, the workshop format which combines faculty members from a variety of disciplines provides an excellent vehicle for dialogue and sharing of information and skills.

The training of faculty in a concentrated period of time also allows the participants the opportunity to collect materials and information which then provide them with beginning resources for establishing solar installer training courses. The use of peer instructors proved to be a vital part of the training workshops in that it provided an identity link for the participants. Peer instructors who have previously encountered institutional problems in their efforts to establish courses provide valuable information. Further, peer instructors can also assist the participants with course syllabi, resource materials and instructional approaches that work. They can also warn of instructional approaches that don't work and indicate instructional aids and equipment necessary to initiate a solar installer program.

As indicated earlier, the training is a needed first step; however, the faculty member returning to the home institution is likely to encounter additional problems which need to be addressed. These include, but are not limited to: 1) the complex institutional and state processes and procedures necessary for restructuring existing courses and programs and establishing new courses/programs; 2) identifying useful resources (texts, media, instructional aids, equipment, etc.) that are necessary to establish training programs and purchasing said equipment; 3) continuing his/her own education in the developments in solar energy; 4) working with uninformed or uninterested colleagues; 5) establishing linkages with business, industry and governmental agencies; and 6) evaluating their own knowledge and programs.

In terms of the participants' teaching of content and the utilization of effective methodology, the pilot project results indicate that there needs to be a clearer distinction between an "installer" and a "technician." Such a distinction would assist faculty members in identifying the types of courses and training that are necessary. Coupled with this distinction is the involvement of the faculty member in establishing codes, specifications and certification. Too often, the activities of industry and governmental agencies do not involve working faculty members.

Overall, the project has facilitated the commercialization of solar energy through training community college faculty members. The basic curriculum developed through this pilot project will probably need further refinement and modification as new developments in the solar energy research emerge. However, there now exists a trained cadre of resource personnel throughout the country who will be able to respond to the needs of industry and, when necessary, make appropriate changes in their programs. If a greater need develops for more skilled tradesmen, the community college faculty, trained in this program, will have the knowledge and skill base necessary to provide solar installer training for their students. Thus, from the point of view of training, the League's program will not only fulfill present educational needs in solar, it will also establish a posture of readiness if expansion is required in solar energy training.

APPENDIX 1

PARTICIPANTS' GEOGRAPHICAL DISTRIBUTION
THREE-DAY WORKSHOPS

STATE	COLLEGE	DISTRICT		NUMBER
Arizona	Glendale	Maricopa		2
	Maricopa Technical	"		4
	Mesa	"		2
	Phoenix	"		2
	Scottsdale	"		1
	Pima	"		1
	Northland Pioneer	"		1
	Yavapai	"		1
			Subtotal	14
California	Orange Coast	Coast		7
	Bakersfield	Kern		3
	Cerro Coso College	"		1
	Porterville	"		2
	De Anza	Foothill-De Anza		1
	Foothill	"		1
	Feather River	Peralta		1
	Laney	"		3
	Merritt	"		1
	Vista	"		1
	Trade-Technical	Los Angeles		3
	Harbor	"		1
	Valley	"		2
	American River	Los Rios		1
	Cosumnes	"		1
	Sacramento City	"		2
			Subtotal	31
Oregon	Lane			3
			Subtotal	3
Texas	Cedar Valley	Dallas		1
	North Lake	"		3
	Eastfield	"		2
	Richland	"		1
			Subtotal	7
Michigan	Delta			1
			Subtotal	1
			TOTAL	56

Appendix 1 continued)

SUMMARY

Twenty-eight colleges from 12 districts in five Western States sent participants to the three-day workshops.

INSTRUCTIONAL SPECIALTIES OF PARTICIPANTS

Heating/Ventilation/Air Conditioning		13
Construction Technology		7
Electronics		5
Engineering Technology		5
General Trades		10
Architecture Technology		3
Environmental Design		3
Technical Math/Physics		5
Sciences		5
	TOTAL	56

APPENDIX 2

SAMPLE WORKSHOP AGENDA

BAKERSFIELD COLLEGE

FINLINSON CONFERENCE CENTER

OCTOBER 16 - 18, 1978

Day 1

8:30 a.m. - 10:15 a.m.	Introduction
	The Sun
	History of Solar Technology
	Economics
	System Elements
10:15 a.m. - 11:00 a.m.	Coffee Break
11:00 a.m. - 12:00 noon	Collectors
12:00 noon - 1:30 p.m.	Lunch and SMACNA Film
1:30 p.m. - 2:30 p.m.	Collectors
2:30 p.m. - 3:30 p.m.	Storage
3:30 p.m. - 4:00 p.m.	Break
4:00 p.m. - 5:00 p.m.	New/Retrofitting - Considerations
Evening	Exhibits - Demonstrations

Day 2

8:30 a.m. - 12:00 noon	Control Logic - Air, Hydronic and Hot Water
12:00 noon - 1:30 p.m.	Lunch and Film
1:30 p.m. - 2:30 p.m.	Orientation to and Use of Mobile Classroom
2:30 p.m. - 5:00 p.m.	"Hands-on" Mobile Classroom

Appendix 2 continued)

Day 3

8:30 a.m. - 9:30 a.m.	Heat Load Calculations
9:30 a.m. - 10:30 a.m.	System Sizing Methods
10:30 a.m. - 11:00 a.m.	Break
11:00 a.m. - 12:00 noon	The Law and Solar Code Responsibilities
12:00 noon - 1:00 p.m.	Lunch
1:00 p.m. - 2:00 p.m.	System Economics
2:00 p.m. - 3:00 p.m.	Consumer Problems
3:00 p.m. - 4:00 p.m.	Teaching Solar System Installation
4:00 p.m. - 4:30 p.m.	Evaluation

APPENDIX 3

Bibliography of Selected Print Materials Used in the Project

COURSE OBJECTIVES, provided by Solar Installation Workshop Instructors.

DUCT SIZING AND HEAT LOAD CALCULATION, handout, B.J. Abernathy, Orange Coast College, Costa Mesa, CA

ENERGY CONSERVATION DESIGN MANUAL FOR NEW RESIDENTIAL BUILDINGS, HEAT LOSS THROUGH THE BUILDING ENVELOPE, State of California Energy Resources Conservation and Development Commission, Conservation Division, February, 1978.

Fundamentals of Solar Heating, HCP/M4038-01, U.S. Department of Commerce National Technical Information Service, January, 1978. Prepared by U.S. Department of Energy, under contract No. EG-77-C-01-4038.

FUNDAMENTALS OF SOLAR HEATING, Sheet Metal and Air Conditioning Contractors National Association, Vienna, VA, January, 1978.

GLOSSARY OF TERMS, Provided by Solar Installation Workshop Instructors.

Installation Standards for One- and Two-family Dwellings and Multifamily Housing including Solar, a program of SMACNA, Sheet Metal and Air Conditioning Contractors National Association, Inc., 1977, 8224 Old Courthouse Road, Tysons Corner, Vienna, Virginia 22180.

RT-5 SOLAR CYCLE TRAINER OR EB-5 SOLAR SCHEMATIC TRAINER, Instructor's Manual, Lennox Industries, Inc.

SOLAR AIR MOVER, Customer Service Manual, Solar Control Corporation, December, 1977.

Solar Energy, a status report, DOE/ET-0062, U.S. Department of Energy, June, 1978, a program of SMACNA, Sheet Metal and Air Conditioning Contractors National Association, inc., 1977, 8224 Old Courthouse Road, Tysons Corner, Vienna, Virginia 22180.

SOLAR HEATING AND COOLING OF RESIDENTIAL BUILDINGS, DESIGN OF SYSTEMS, Solar Energy Applications Laboratory, Colorado State University for the U.S. Department of Commerce, Superintendent of Documents, Government Printing Office, Washington, D.C. 20402, Stock No. 003-p11-00084-4.

SOLAR HEATING AND COOLING OF RESIDENTIAL BUILDINGS, SIZING, INSTALLATION AND OPERATION OF SYSTEMS, Solar Energy Applications Laboratory, Colorado State University for the U.S. Department of Commerce, Superintendent of Documents, Government Printing Office, Washington, D.C. 20402, Stock No. 003-011-00085-2.

APPENDIX 4

RESULTS
CUMULATIVE PARTICIPANTS EVALUATION

THREE-DAY WORKSHOPS
CONTENT AREAS IN RANK ORDER BY USEFULNESS

	1	Texts & Materials
	2	Collectors
	3	Legal & Code Implications
	4	Mobile Classroom (Aids)
	5	New & Retrofitting Considerations
(Tie)	6	Films
(Tie)	6	Storage
(Tie)	7	Sizing
(Tie)	7	System Economics
	8	Control Logic
	9	Heat Load Calculations

APPENDIX 5

Five-day Workshop

Phase I

Bakersfield, California

The participants were given a list of ten major topics covered in the five-day workshop. They were asked to rate the topics using the following rating system: 5 - Extremely Useful; 4 - Very Useful; 3 - Useful; 2 - Minimum Usefulness; 1 - Not Useful. All participants (17) completed the evaluation.

Topics are listed in rank order by points and percentages.

Responses - 17
Maximum Points - 85

	Topic	Points	%
1.	Lennox Training Program	85	100
2.	Materials on Solar	79	93
3.	Installation Problems	67	79
4.	Sizing	63	74
5.	Course Outlines	61	72
6.	State of Industry	60	71
7.	Environmental Control Systems (Omnidata)	58	68
8.	Developing Teaching Aids and Packages (Tie)	46	54
8.	Constructing Test Items (Tie)	46	54
9.	Creating Objectives	40	47

APPENDIX 6

SOLAR ENERGY SYSTEMS INSTALLATION
Workshop Agenda
Delta College, September 26, 27, 28, 1979

Day 1

7:30-8:30	Breakfast, Conference Room A, B, C
8:30-9:15	Welcome; Why Solar Energy - Jerry Schuitman, Delta College
9:15-10:15	Collectors - Dr. Clark Most, Jr., Delta College
10:15-10:45	Coffee
10:45-11:45	Storage, Dr. Paul Moses, Dow Chemical Company
11:45-1:00	Lunch
1:00-2:30	Heat Transfer Media and Exchangers; The Total System - Bruce Shook, Dow Corning Corporation
2:30-3:00	Coffee
3:00-3:30	Introduction to Controls - Dr. Clark Most, Jr., Delta College
3:30-5:00	Introduction to Training Modules - Bob Hamos or Bill Schaeffer, Lennox Education Products
5:00-7:00	Dinner
7:00-9:00	Modules Workshop

Day 2

7:30-8:15	Breakfast
8:15-10:00	Relays, Thermostats, Control Logic - Tony Gates, Jordan College
10:00-10:30	Coffee
10:30-11:30	Typical Solar Energy Installation and Consumer Problems, Retrofitting - Dr. Thomas Slykehouse, Jordan College
11:30-12:00	Demonstration and Discussion of ST-17 Trainer - Bob Hamos or Bill Schaeffer, Lennox Education Products
12:00-1:15	Lunch for Group 1, Training Modules for Group 2
1:15-2:30	Lunch for Group 2, Training Modules for Group 1
2:30-3:30	Earth-Sun Relationships, - David Williams, Delta College, Geographer
3:30-4:00	Coffee
4:00-5:00	Building Codes, Tax Incentives, Legal Implications and Sun Rights, Energy Costs - Rich Whale, Michigan Energy Administration
5:00-8:00	Tour of Midland Solar Systems
8:00	Dinner at Adam's Rib, Midland

Day 3

7:30-8:15	Breakfast
8:15-9:15	Heat Load Calculations - Jerry Schuitman, Delta College
9:15-10:30	Sizing Methods - Dr. Byron Wynn, Colorado State University
10:30-11:00	Coffee
11:00-12:00	F-Chart - Dr. Byron Wynn, Colorado State University
12:00-1:00	Lunch
1:00-2:00	Passive Solar Heating - Ralph McGivern, Delta College, Architect
2:00-3:00	Solar System Economics, Dr. Byron Wynn, Colorado State University
3:00	Evaluation

SOLAR ENERGY SYSTEMS INSTALLATION
September 26, 27, 28, 1979
Objectives of Workshop Segments

Welcome; Why Solar Energy?
Objectives: To acquaint participants with the overall purpose of the program and the methods for carrying out the same.

To outline the need for solar energy uses.

Collectors
Objectives: To identify the components of solar collectors and describe their functions; to relate them to collector efficiency.

Storage
Objectives: To describe practical systems of storing solar heat and to make comparisons among them.

Heat Transfer Media and Exchangers; The Total System
Objectives: To describe various heat transfer media and heat exchangers along with their functions, efficiencies, and comparative advantages.

To describe installed active solar systems, the relationship among components thereof, their operation and maintenance requirements.

Introduction to Controls
Objectives: To explain the basic function of controls in a solar system.

Introduction to Training Modules
Objectives: To describe the Lennox modules, their functions and uses as training devices.

Training Modules Workshop I
Objectives: To provide "hands on" experience in working with the Lennox modules.

Relays, Thermostats, Control Logic
Objectives: To describe the components and functions of control devices.

To acquaint the participants with the basic electronics necessary to basically understand control systems.

To describe control logic for various solar heating systems.

Typical Solar Energy Installation and Consumer Problems; Retrofitting
Objectives: To describe architectural and other problems related to installing active solar systems in new and old structures.

Demonstration and Discussion of ST-17 Trainer
Objectives: To describe the Lennox ST-17 trainer, its function and uses in training solar installers.

Appendix 6 continued)

Solar Energy Workshop Objectives

Training Modules Workshop II

Objectives: To provide "hands on" experience in working with the ST-17 and Omnidata trainers.

Earth-Sun Relationships

Objectives: To describe the physical relationships between the sun and earth and the factors which affect availability of solar radiation at the earth's surface.

Building Codes, Tax Incentives, Legal Implications and Energy Costs

Objectives: To describe advantages and problems associated with legal and government related solar energy implications; to discuss energy costs on such bases.

Tour of Midland Solar Systems

Objectives: To give participants a first hand examination of installed solar devices.

Heat Load Calculations

Objectives: To explain the necessity and process of calculating design heat loads.

Sizing Methods

Objectives: To explain the calculations required to size solar heating systems.

F-Chart

Objectives: To describe the use of F-chart in sizing.

Passive Solar Heating

Objectives: To describe passive solar heating architectural requirements for the same, and advantages thereof.

Solar System Economics

Objectives: To describe appropriate cost methods of economic analysis to compare solar and non-solar systems.

SOLAR WORKSHOP: DELTA COLLEGE

LIST OF SPEAKERS AND/OR CONSULTANTS

Dr. Paul Moses, Dow Chemical

Mr. Bruce Shook, Dow Corning Corporation

Mr. Bob Hamos, Lennox Education Products

Mr. Tony Gates, Jordan College

Dr. Tom Slakhouse, Jordan College

Mr. Rich Whale, Michigan Energy Administration

Dr. Byron Wynn, Colorado State University

Mr. Ralph McGivern, Delta College

Mr. David Williams, Delta College

Dr. Clark Most, Jr., Delta College

Mr. Jerry Schuitman, Delta College

Mr. Jim Lawson, Lane Community College

Mr. Keith Carrico, Maricopa Technical Community College

9/4/79

THE LEAGUE FOR INNOVATION
IN THE COMMUNITY COLLEGE
1100 Glendon Avenue Westwood Center, Suite 925
Los Angeles, California 90024 (213) 479-3941

SOLAR ENERGY SYSTEMS INSTALLATION

WORKSHOP EVALUATION

DELTA COLLEGE, SEPTEMBER 26-28, 1979

(DOE Project # EM 78-C-01-4223)

The participants' evaluation of this workshop was completed by rating the content of the workshop according to its "usefulness" (descending scale, 5 Extremely Useful to 1 Not Useful). Also requested from participants were general comments on the workshop and the workshop presenters.

Twenty-seven participants responded to the evaluation questionnaire. The maximum number of points which any item could receive was 135 (27 participants times the 5 highest rating). The items were then placed in rank order. A summary of the participants' comments and reactions to the workshop follows the rank ordering.

WORKSHOP EVALUATION

DELTA COLLEGE

Items are listed in rank order by points and percentages.

Responses - 27

Maximum Points - 135

1. Passive: 121 points; 59% rated this category as extremely useful, 30% very useful, 11% useful
2. Storage: 107 points; 30% rated this category as extremely useful, 48% very useful, 19% useful.
3. Tour: 107 points; 37% rated the tour as extremely useful, 41% very useful, 11% useful.
4. Lennox Modules: 103 points; 19% rated the modules as extremely useful, 48% very useful, 30% as useful.
5. Economics: 103 points; 15% rated this category as extremely useful, 56% very useful, 26% useful.
6. Installation Problems: 102 points; 19% rated this area as extremely useful, 48% very useful, 26% useful.
7. Heat Load Calculations: 99 points; 26% rated this category as extremely useful, 41% as very useful, 11% as useful.
8. Collectors: 99 points; 19% rated this area as extremely useful, 40% very useful, 33% useful.
9. Sizing: 98 points; 11% rated this category as extremely useful, 56% very useful, 19% useful.
10. Heat transfer: 95 points; 15% rated this category as extremely useful, 44% very useful, 33% useful.

11. Controls: 87 points; 11% rated this category as extremely useful, 37% very useful, 30% useful.

12. Codes, Incentives, Costs: 79 points; 7% rated this area as extremely useful, 22% very useful, 44% useful.

13. Earth Sun Relationships: 72 points, 4% rated this area as extremely useful; 17% very useful; 30% as useful; 37% as somewhat useful; and 11% as not useful.

14. F Chart: 67 points; 7% rated this area as extremely useful, 30% very useful, 22% useful.

Summary:

As was the case with the other Solar Systems Workshops held by the League for Innovation, both the Passive and Storage components of the workshop were ranked high. Sizing and Codes, Incentives and Costs ranked somewhat lower in this workshop due to the nature of the participants.

Participant comments ranged from "A well-presented seminar - very well organized and the facilities and meals have been top quality" to "Would have been better to have increased the length of time for each speaker, allowing more time for questions, etc."

For the most part, participant comments complimented the workshop and presenters highly. A major area of concern was the amount of time - there should be more of it.

APPENDIX 7

SOLAR ENERGY SYSTEMS INSTALLER PROGRAM:
TRAINING COMMUNITY COLLEGE FACULTY

Central Piedmont Community College
Charlotte, North Carolina
October 29-30-31, 1979

WORKSHOP AGENDA

October 28 (Sunday)		
8:00-9:30 p.m.	Early Birds' Reception	Sheraton Center
October 29 (Monday)	Blue Ridge Room - Sheraton Center	
8:15-8:30 a.m.	Welcome and Introduction of Staff	Mr. Bill Whitman
8:30-9:15 a.m.	Utilization of Solar Energy	Mr. Dan Knee Exxon Company USA Charlotte, NC
9:15-9:30 a.m.	Break	
9:30-12:00 noon	Collectors and Storage	Mr. Bob Tuttle Bakersfield College Bakersfield, California
12:00-1:15 p.m.	Lunch - Blue Ridge Room	
1:15-2:30 p.m.	Air Systems	Mr. Keith Carrico Maricopa Technical Community College Phoenix, Arizona
2:30-2:45 p.m.	Break	
2:45-4:00 p.m.	Hydronics - Moving Water	Mr. Cal Lassiter Heat Transfer Sales Charlotte, NC
4:00-5:00 p.m.	Controls	Mr. Dick Givens P. C. Godfrey, Inc. Charlotte, NC
7:00-9:00 p.m.	Dinner - Slug's Choice Bus pick-up at Sheraton: 7:00 p.m.	
October 30 (Tuesday)	Pease Conference Room Bus leaves for CPCC at 8:00 a.m.	Central Piedmont Community College
8:15-10:00 a.m.	Load Calculations - System Sizing and Economics	Mr. Keith Carrico
10:00-10:15 a.m.	Break	
10:15-12:00 noon	Load Calculations - Systems Sizing and Economics	Mr. Keith Carrico
12:00-1:15 p.m.	Lunch - CPCC Citizens Center Dining Room	
1:15-5:00 p.m.	Field Trips: Charlotte Memorial Hospital and a Residence - Passive System	Mr. Louis Abernethy, P.E. Ferebee-Walters & Assoc. Charlotte, NC
6:00 p.m.	Dinner - The Marker - Sheraton Center	
7:45-10:00 p.m.	Demonstrations, Visual Aid Training and Tutoring Bus leaves for CPCC at 7:45 p.m., returning to Sheraton Center at 10:00 p.m.	CPCC Citizens Center
October 31 (Wednesday)	Pease Conference Room Bus leaves for CPCC at 8:00 a.m.	Central Piedmont Community College
8:15-9:30 a.m.	Consumer Problems	Mr. Louis Abernethy
9:30-10:00 a.m.	Laws and Codes	Mr. Louis Abernethy
10:00-10:15 a.m.	Break	
10:15-12:00 noon	Demonstrations - CPCC Citizens Center	Equipment Suppliers & Company Representatives
12:00-1:15 p.m.	Lunch - on your own	
1:15-3:00 p.m.	Instructional Methodology and Teaching Installers	Mr. Ben Albright North Carolina Department of Public Instruction Raleigh, NC
	Evaluation	
3:00 p.m.	Bus returns to Sheraton Center	
	End of Workshop	

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SOLAR ENERGY SYSTEMS INSTALLATION:
TRAINING COMMUNITY COLLEGE FACULTY

WORKSHOP: October 29-31, 1979

Central Piedmont Community College

Participant Evaluation

(DOE Project # EM-78-C-01-4223)

The participants' evaluation of the workshop focused on the content according to its usefulness (descending scale, 5 Extremely Useful to 1 Not Useful). The project director asked the participants to mail in their evaluation forms and hence the response rate was lower than in previous workshops (16 out of a total of 21 participants). The responses were tabulated and then placed in rank order. The maximum number of points which an item could receive was 95 (16 responses x 5 Extremely Useful).

Robert J. Leo
Robert J. Leo
Associate Executive Director
December 6, 1979

EVALUATION RESULTS
(Rank Order)

1.	Consumer Problems	16 responses	100% (16) found it useful; 87.5% (14) found it very useful
2.	Collectors & Storage	16 "	100% (16) found it useful; 75% (12) found it very useful
3.	Air Systems (tie)	16 "	93.8% (15) found it useful; 62.5% (10) found it very useful
4.	Instructional Methodology (tie)	16 "	93.8% (15) found it useful; 62.5% (10) found it very useful
5.	Demonstrations/Visual Aids	15 "	93% (14) found it useful; 53.33% (8) found it very useful
6.	Field Trip	14 "	92.8% (13) found it useful; 64% (9) found it very useful
7.	Utilization of Solar Energy	16 "	87.5% (14) found this section useful; 56.2% (9) found it very useful
8.	Load Calculations & System Sizing	16 "	81.25% (13) found it useful; 62.5% (10) found it very useful
9.	Hydronics	16 "	81.25% (13) found it useful; 50% (8) found it very useful
10.	Laws & Codes	16 "	81.25% (13) found it useful; 37.5% (6) found it very useful
11.	Controls	16 "	68.8% (11) found it useful; 56% (9) found it very useful

COMMENTS:

The discussion of Consumer Problems and Collectors and Storage were rated very high by the participants. This is consistent with the evaluations in the other workshops. Air Systems was rated high, while Hydronics was rated low, and this may have been a direct result of the types of presentations that were given.

APPENDIX 8

SOLAR ENERGY SYSTEMS INSTALLER PROGRAM: TRAINING COMMUNITY COLLEGE FACULTY

CENTRAL PIEDMONT COMMUNITY COLLEGE - CHARLOTTE, NC

NOVEMBER 26 - 30, 1979

WORKSHOP AGENDA

November 25 (Sunday) 8:00 - 9:30 pm	Early Birds' Reception	Sheraton Center
November 26 (Monday)	Pease Conference Room Bus leaves for CPCC at 8:00 am	Central Piedmont Community College
8:15 am	Welcome	Bill Whitman Central Piedmont Community College Charlotte, North Carolina
8:30 am	Overview of Workshop	Dr. Robert Leo Staff Member League for Innovation
9:00 am	State of the Solar Industry	Anna Fay Friedlander Editor, Solar Engineering
10:30 am	Break	
11:00 am	Basic Active Systems (a review)	Bill Bolin North Lake College Irving, Texas
12:00 noon	Lunch (on your own)	
1:00 pm	Collectors and Storage	Bob Tuttle Bakersfield College Bakersfield, California Keith Carrico Maricopa Technical Community College Phoenix, Arizona
2:45 pm	Break	
3:00 pm	Collectors and Storage (continued)	Bob Tuttle and Keith Carrico
4:30 pm	Omnidata Training Program Bus leaves for Sheraton at 5:30 pm	Jack Straub and Scott Brown Omnidata Cherry Hill, New Jersey
6:00 pm	Omnidata Reception	Sheraton Center
	Dinner (on your own)	
November 27 (Tuesday)	Continental Breakfast Bus leaves for CPCC at 7:45 am	Pease Conference Room
8:15 am	Collectors and Storage	Bob Tuttle and Keith Carrico
9:30 am	"Full Circle" and "History of Solar Technology"	
10:15 am	Break	
10:30 am	Retrofitting and Air Systems	Bill Abernathy Orange Coast College Costa Mesa, California
12:00 noon	Lunch	Citizens Center Dining Room
1:00 pm	"Day Star" (film)	
	Orange Coast College Programs	Bill Abernathy
2:15 pm	Break	
2:30 pm	Installation Problems - AND - Standards and Certification	Greg Stutzman ASERC Phoenix, Arizona
5:00 pm	Bus returns to Sheraton	
6:00 pm	Lennox Reception	Sheraton Center
7:30 - 9:15 pm	Dinner Bus pick up at Sheraton 7:30 pm	Benedictine's Restaurant

November 28 (Wednesday)		Continental Breakfast Bus leaves for CPCC at 7:45 am	Pease Conference Room
	8:30 am	Controls	Timothy Gates Jordan College Cedar Springs, Michigan
	10:15 am	Break	
	10:30 am	Controls continues	Timothy Gates
	12:00 noon	Lunch (on your own)	
	1:00 pm	Lennox Training Program	Bob Hamos Lennox Educational Products Dallas, Texas
	2:15 pm	Break	
	3:00 pm	Lennox Training Program continues	Bob Hamos
	5:00 pm	Bus returns to Sheraton	
		Dinner (on your own)	
November 29 (Thursday)		Continental Breakfast Bus leaves for CPCC at 7:45 am	Pease Conference Room
	8:00 am	Passive Principles and Design	Bill Fisher National Solar Heating and Cooling Information Center Philadelphia, Pennsylvania
	10:30 am	Break	
	11:00 am	Construction Technology Program Programs in Solar	Jim Lawson Lane Community College Eugene, Oregon
	12:00 noon	Lunch	Citizens Center
	1:00-5:00 pm	Site Visits - Field Trip	
		Bus leaves for CPCC at 6:15 pm	
	6:30 pm	Working Dinner	Citizens Center
	7:00 pm	Troubleshooting - Electrical Problems	
	9:00 pm	Bus returns to Sheraton	
November 30 (Friday)		Continental Breakfast Bus leaves for CPCC at 7:45 am	Pease Conference Room
	8:30 am	Lehigh County Community College	Robert Walker Director of Energy Education Lehigh County Community College Schnecksville, Pennsylvania
	9:00 am	Teaching the Introductory Solar Course	Bob Tuttle
	9:30 am	Teaching Troubleshooting and Maintenance	Keith Carrico
	10:20 am	Break	
	10:40 am	North Lake College Program	Bill Bolin
	11:15 am	Getting Started (Panel Discussion)	Resource Personnel
	12:15 pm	Lunch (on your own)	
	1:15 pm	Where do we go from here?	Bob Leo
	3:00 pm	End Workshop	
		Bus returns to Sheraton Center	

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SOLAR ENERGY SYSTEMS INSTALLATION:
TRAINING COMMUNITY COLLEGE FACULTY

WORKSHOP: November 26-30, 1979

Evaluation Results

Instructional Resources

During the five-day workshop participants were introduced to a variety of instructional resources. The participants evaluated each resource item in terms of their perception of its usefulness in training installers. A descending scale with 5 as Extremely Useful and 1 as Not Useful was used. Thus, the maximum amount of points a single item could receive was 95 (19 responses x 5 points). One item had only 16 responses with a potential maximum of 80. The form was returned to the project director on the last day of the workshop (November 30). Below are listed the resources as well as the number of responses received and a brief discussion of the results.

	# Responses	
Day Star - film (Exxon)	19	84 (88%) - 100% rated this film as useful (52% rated it extremely useful)
Full Circle - slide tape (Solar Engineering)	19	81 (85%) - 81% rated this slide tape as useful (52% rated it extremely useful)
Solar System Simulator (OMNIDATA)	19	69 (72%) - 89% rated the OMNIDATA Simulator as useful (29% as very useful and 21% as extremely useful)
Solar System Simulators (LENNOX)	16	66 (82.5%) - 100% rated the LENNOX Simulators as useful (37.5% as very useful and 30% as extremely useful)
History of Solar Technology - videotape (Solar Engineering)	19	63 (66%) - 89% rated this videotape as useful.
Film (SMACNA)	19	63 (66%) - 94% rated this film as useful.

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Appendix 9 continued)

COMMENTS:

1. Day Star

Film is excellent for the well-educated; however, for the lower and lower-middle socio-economic some other type of film needs to be developed for this type of person - these people would not react well to the type of people depicted - should contain more on older generation solar homeowners.

Good for intro, in solar layout.

Very good PR film.

Excellent - super. Good overview of additional natural energy system.

Most appropriate for under-30 audiences.

Very good.

Useful for public information and introductory information.

Good film; however, it has an element of non-positive approach to solar, e.g., "Change your life style," and "You've got to shiver a little, because it's good for you."

2. Full Circle

Very good - well done.

I like this slide set and would find it very useful for solar and also for heating & cooling.

Excellent for my purposes; can be used in both a solar and an architecture program.

Most interesting; can be used at any level of instruction. Introduction seems to be the best. It is a motivational item.

Very good all-round presentation. Thought stimulating.

Very informative and interesting.

Very good historical review of solar applications and would be an excellent orientation for all students.

Very good slides and audio presentation.

Thought-provoking; can be used for introductory motivation.

3. Solar System Simulator (OMNIDATA)

Too technical and expensive to justify for only 2-3 weeks of training. Trainer is for (in my opinion) post-technical institute engineering and design students. I could construct a live system with much less expense that would do most of the specifications of the Omnidata.

Would like to have one - but for this cost????

Because of cost it is of limited value for what is now basically a survey course.

The simulator is very flexible. The cost is higher than my budget.

This item can be a useful tool in teaching a diagnostic procedure.

General philosophy appears sound, but the true value could only be determined after hands-on experience and evaluation. Concept appears excellent; not sure how this system would relate to other systems available in the industry. Cost seems quite high.

(#5 and #6) Both are very good (but $?)

Expensive compared to other trainers.

4. Solar System Simulators (LENNOX)

Lennox is "extremely useful" but cost seems very high.

Good training detail and modules.

(#5 and #6) Both are very good (but $?)

Very, very good for public, homeowner, consumer education.

5. History of Solar Technology

Needs professional touch as well as removal of "personal" areas - better voice - do not need solar field expert to do history film.

This videotape would be very good at high school to cover the history of solar.

Coverage is spotty at best and the audio should be professionally narrated.

The History of Solar Technology is quite simple and interesting and would serve well as an introduction in a solar class.

Whenever a video presentation is produced, it does not fit well with slides. The slides would have been just as effective. On content, much of the material is redundant.

The (tape?) could be done better if done by a professional personage. Good use with high school students.

Good for introductory post-secondary education or high school instruction.

History of Solar Energy:

a. needs a professional voice
b. doesn't move well
c. good content
d. the time-dated ("until a week ago") should be reworked

Introductory type material, good public information.

6. Film (SMACNA)

I would use this film at HFCC and I know it would give a good insight to the solar program.

Very good introductory material, useful in a survey situation.

Very good. It helps to eliminate the idea that solar is not suited for the Midwest.

A very good view of one system and its impact on the market.

Good PR and background information. Good insight into system.

Again, some good basic ideas, but far too many commercial advertisements to really be a film that would merit any serious consideration.

Film makes statements that may no longer be true, e.g., "Mass production will reduce costs." All components are presently being mass-produced. Shows methods of installation that have caused problems such as using standard duct tape. In other words, the film may be outdated.

Very slanted to the trade.

APPENDIX 10

WORKSHOP EVALUATION SUMMARY

SOLAR ENERGY SYSTEMS INSTALLER PROGRAM:
TRAINING COMMUNITY COLLEGE FACULTY

CENTRAL PIEDMONT COMMUNITY COLLEGE - CHARLOTTE, NC
NOVEMBER 26 - 30, 1979

WORKSHOP EVALUATION

Please take a few minutes at the tend of the workshop to answer the questions below. The evaluation form can be left in the box marked "Evaluation Forms" on the resource table. Thank you for your time.

1. Do you presently offer a Solar Energy Program or courses at your College? 17 yes 6 no
2. If yes, do you teach any solar energy courses? 14 yes 3 no
3. If yes, please list the course titles below:

____

____

4. If yes, will the information presented at this workshop help you to strengthen any solar course or courses that you teach? 16 yes ____ no

5. If no, will the information presented at this workshop help you to design a solar energy course? 8 yes ____ no

6. If no, will the workshop materials distributed by instructors help you to design a solar energy course? 5 yes ____ no

7. How would you rate the workshop with regard to:

   a) Length: 22 just right ____ too short 2 too long

   b) Length of presentations: 25 just right ____ too short ____ too long

	Extremely Useful	Very Useful	Useful	Somewhat Useful	Not Useful
c) Content of Presentations:	5 (16)	4 (8)	3 (1)	2	1
d) Relevance and usefulness of topics presented:	5 (13)	4 (10)	3 (1)	2	1

8. Was the content of the presentations generally:
   22 balanced 1 too technical 2 not technical enough

9. Please state the strength(s) of the workshop. ____________________

____

____

Appendix 10 continued)

10. Please state the weakness(es) of the workshop. ____________________

____

____

11. If you had an opportunity to provide input into the planning of this workshop, what would you have done differently, if anything?

____

____

	Excellent	Above Average	Average	Below Average	Poor
12. Please rate the workshop overall:	5 (16) *	4 (8)	3	2	1

If you would like to make specific comments regarding individual presenters, topics, content, etc., please use this section of the form. All of your comments will be reviewed during the workshop evaluation process.

COMMENTS:

Rating Summary for the following questions:

7.c Content of Presentations: Total score = 115 x 25 = 4.6

7.d Relevance and Usefulness of Topics Presented: Total score = 108 x 24 = 4.5

12. Please rate the workshop overall: Total score = 116.5 x 25 = 4.66

* One participant scored question number 12 at 4.5.

APPENDIX 10

FIVE-DAY WORKSHOP
CHARLOTTE, N.C.

WORKSHOP EVALUATION SUMMARY: STRENGTHS

1. The agenda and varied opinions.
2. Very good workshop. The best one we have ever had.
3. Good presenters. Good topics.
4. I think it helped those who primarily have no current solar program. It also added knowledge to those who wish to expand existing programs.
5. The presenters were very well prepared. They had much material, all of it useful.
6. Motivation. Practical aspects of the "state of the art." Very helpful information. Introduction into the League's activities.
7. Informal, but productive atmosphere. The variety of designs, systems, and materials presented. Most presenters seemed to be genuinely interested in what they were doing. Great hospitality by CPCC.
8. The speakers were well-versed in their subject matter, and very willing to share ideas.
9. The interaction with other participants, the content, and the informality of the presentations.
10. The bringing together information, which has been there, but not known to us all.
11. Conducted by those who have "been there."
12. Very well-informed and interesting presenters.
13. This workshop has had a direct, and to-the-point, relationship with regard to the community college, with little, if any waste.
14. Very well-informed presenters, useful, valuable information in all areas.
15. The materials and references distributed, the chance to talk to other workshop participants with similar problems as I have, and the presenters sharing their experiences with us.
16. The masses of printed materials distributed to support the presentations.

17. The good rapport among all those involved in the program. Good communications and brainstorming to try to raise issues and solve problems.

18. The cohesive nature of the presentations, and the extraordinary enthusiasm of the speakers.

19. Excellent material handouts. I felt that Mr. Stutzman, Mr. Fisher and Ms. Friedlander lended a great deal of credibility to the workshop, being non-institutional presenters. All three presented factual, and valuable analysis of a view from the other side.

20. I think the workshop was strong in all points. But, pointing out problems, and the way a lot of systems are not working, was one of the strongest points.

21. The more concentrated coverage of the subject areas, and the interchange of information between participants.

22. The informal atmosphere. The opportunity for participants to respond (dialogue with the presenters).

23. Extremely useful. Very good for our solar courses + +.

24. Informative. It allowed instructors with like goals to get together. Good interaction and review of what has been done to date.

25. The hand-out materials were excellent.

WORKSHOP EVALUATION SUMMARY: WEAKNESSES

1. Tom Gates needed more time, and I would like to have heard more from Greg Stutzman.

2. There should be more covered on the architectural aspects (of solar).

3. The simulator set-up was somewhat weak. Due to the fact that most of the participants had already seen most simulators.

4. Although I enjoyed Tony Jordan's presentation, his presentation contained some theoretical ideas that are not workable.

5. Better site visits of (solar) installations, if possible.

6. Problems with audio/visual materials, and a lot of moving around to deliver same.

7. I could have used some actual training of solar equipment installation.

8. Need more detail on actual "hands-on" (activities).

Appendix 10, continued)

9. Some duplication of material (by presenters?).
10. The presentations, although well-presented and informative, did have areas of overlap of topic (content) areas.
11. Some programs (presentations) had to be eliminated for various reasons.
12. Not enough "hands-on" activity.
13. It was too basic for me.
14. Lack of actual installers to relate problems and give suggestions.
15. Some presenters tended to become too technical.
16. Some of the presentations got off track and did not seem to cover what needed to be covered.
17. Some presentations should have been more structured.
18. The half day to tour the (solar installation) sites.
19. Some presenters need to update their presentations and be more organized.

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