GEORGIA INSTITUTE OF TECHNOLOGY
OFFICE OF CONTRACT ADMINISTRATION
SPONSORED PROJECT INITIATION

No action
ASL
OAH

Date: 10/7/78

Project Title: A Post Secondary Solar Energy Curriculum

Project No: A-2244

Project Director: ~~Mr. J. M. Akridge~~ J.N. Harris

Sponsor: State Board of Education of the State of Georgia

Agreement Period: From 9/15/78 Until 9/14/79 (Project Period)

Type Agreement: Agreement, dtd. 9/14/78

Amount: $35,000
1,846 GIT (E- 832-003)
$36,846 Total

Reports Required: Interim Reports; Final Report.

Sponsor Contact Person (s):

Technical Matters

Director, Research Coordinating Unit
Program Development Support
Office of Vocational Education
Room 333, State Office Building
Georgia Department of Education
Atlanta, GA 30334

Contractual Matters
(thru OCA)

Cal Adamson
Associate State Superintendent of Schools
Office of Administrative Services
Georgia Department of Education
State Office Building
Atlanta, GA 30334
Mr. John J. Milkowski

Defense Priority Rating: n/a

Assigned to: ASL/SEMTD (School/Laboratory)

COPIES TO:

Project Director
Division Chief (EES)
School/Laboratory Director
Dean/Director—EES
Accounting Office
Procurement Office
Security Coordinator (OCA)
Reports Coordinator (OCA)

Library, Technical Reports Section
EES Information Office
EES Reports & Procedures
Project File (OCA)
Project Code (GTRI)
Other

GEORGIA INSTITUTE OF TECHNOLOGY
OFFICE OF CONTRACT ADMINISTRATION

SPONSORED PROJECT TERMINATION

Date: December 7, 1979

Project Title: A Post Secondary Solar Energy Curriculum

Project No: A-2244

Project Director: Mr. Joe N. Harris

Sponsor: State Board of Education of the State of Georgia

Effective Termination Date: 9/14/79

Reporting Period ~~Clearance of Accounting Charges~~: 10/31/79

Grant/Contract Closeout Actions Remaining:

X Final Invoice ~~and Clearance of Accounting Charges~~

_ Final Fiscal Report

_ Final Report of Inventions

_ Govt. Property Inventory & Related Certificate

_ Classified Material Certificate

_ Other _____

TERMINATED

Assigned to: CMSL/MSD (~~School~~/Laboratory)

COPIES TO:

Project Director
Division Chief (EES)
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Dean/Director–EES
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Procurement Office
Security Coordinator (OCA)
Reports Coordinator (OCA) ✓

Library, Technical Reports Section
EES Information Office
Project File (OCA)
Project Code (GTRI)
Other _____

CA–4 (1/79)

A-2244

ENGINEERING EXPERIMENT STATION
GEORGIA INSTITUTE OF TECHNOLOGY • ATLANTA, GEORGIA 30332

January 4, 1979

Director, Research Coordinating Unit
Program Development Support
Office of Vocational Education
Room 333, State Office Building
Atlanta, Georgia 30334

Attention: Mr. Robert K. Mabry

Subject: "A Post-Secondary Solar Energy Curriculum," Interim Report No. 1, for the Period 15 September - 15 December 1978, Georgia Tech Research Project A-2244

Dear Mr. Mabry:

The objectives of the project "A Post-Secondary Solar Energy Curriculum" are to develop, field test, and demonstrate a 300-hour, self-paced solar energy curriculum to be offered by post secondary vocational institutions as an optional component after completion of an existing state-approved heating and air conditioning program or to be utilized in a continuing education format by practitioners in the field. Progress through December 15, 1978, is covered in this letter report.

Work on the project began at a later date than was anticipated due to delay in award of the contract, and due to the unexpected unavailability of the proposed principal investigator. For these reasons, progress toward the completion of Tasks I and II did not begin until 1 November. The following activities have, however, been carried out:

- Draft of a general job description for the residential solar energy technician.
- Draft of a task listing for the job. This listing is expected to provide the framework for the sequencing of the unit sheets, since the task is the unit on which these are built.
- Draft of the format for development of the task unit sheets, through use of the task detailing sheet suggested by Robert Mager.

- Draft of an annotated bibliography of solar energy materials suitable as references in the couse to be created.
- Collection of relevant references and materials from related courses.
- Visit to the Training Division at Lennox Corporation, and attainment of their cooperation and permission for use of their solar energy curriculum materials during the course development.
- Meeting with the Project Monitor.

In the next three months it is anticipated that the draft curriculum will be brought close to readiness for field testing. This will be done with the advice of a committee of instructors in the heating and air conditioning field. This Advisory Committee will have the opportunity to review all project materials for clarity of expression, appropriateness for the target group of students, and for practicality in the existing (or potential) classroom situation.

Respectfully submitted,

J. N. Harris
Project Director

jw

A-2244

ENGINEERING EXPERIMENT STATION
GEORGIA INSTITUTE OF TECHNOLOGY • ATLANTA, GEORGIA 30332

April 3, 1979

Director, Research Coordinating Unit
Program Development Support
Office of Vocational Education
Room 333, State Office Building
Atlanta, GA 30334

Attention: Mr. Robert K. Mabry

Subject: "A Post-Secondary Solar Energy Curriculum," Interim Report No. 2, for the Period 15 December 1978 - 14 March 1979, Georgia Institute of Technology Research Project A-2244.

Dear Mr. Mabry:

This interim letter report covers progress on the program, "A Post-Secondary Solar Energy Curriculum," from December 15, 1978 to March 14, 1979.

Due to the delays in receiving the contract and the personnel changes, work did not begin until November 1, 1978. To overcome this late start, Dr. Joanne Green was added to the project staff to devote full-time to the program until 15 April 1979 to meet the project milestone for Tasks I and II. Ms. Burks and Mr. Harris devoted an average of 10 and 30 percent time, respectively.

As a result of the 14 December project review meeting, three Heating, Ventilating, Air Conditioning (HVAC) instructors from Metropolitan Atlanta technical schools were asked to serve as an advisory committee to the project staff and to review curriculum materials as they are developed.

A project review meeting and a working session with the advisory committee was held at the Atlanta Area Vocational Technical School on January 19, 1979. A request for revision of the milestone forecast to extend the time for completion of Task II to April 15 was approved. The project staff was provided specifications and instruction on developing curriculum materials and the final report.

The project staff discussed with the advisory committee the HVAC curricula as taught in each of their respective schools to obtain an understanding of background course requirements to be included as optional units in the solar curriculum. A job description for the solar energy technician, a curriculum

task listing, and detailing of three of these tasks were presented to the advisory committee for review and comment. A potential text book and other materials were also reviewed for appropriateness of reading level.

A suggestion that solar installers and contractors be contacted for input to the task listings resulted in development of a survey questionnaire (Attachment A) sent to twenty solar installers and contractors. Five were returned. Answers to the questionnaire indicated the following:

1. Three respondents indicated a basic understanding of solar energy should be the most important task for the curriculum. The other two felt installation skill was the most important.

2. Three respondents expressed a desire to hire personnel with solar system design skills.

3. Four respondents indicated the greatest problem with present solar systems was control failures.

Based on suggestions of the advisory committee, answers from the questionnaire, and experience gained in writing units the task listing has been revised as indicated in Attachment B. This listing does not include goals and performance objectives stated in final form since it has been found necessary to make modifications to these as each individual unit is developed.

The second meeting was held with the advisory committee at the DeKalb Area Technical School on March 13, 1979. At this meeting two "model" modules on Collectors and Storage Units were reviewed for appropriateness, level of interest and clarity of format. The advisory committee felt some of the learning activities (projects) were too elementary for the age level and interest of Vocational Technical students. These activities will be revised.

As a result of a meeting on 27 February, questions were answered regarding specifications for the curriculum, particularly with regard to audio visuals to accompany learning units. As a result of this meeting, plans are to provide audio visuals with approximately 30 percent of the learning units. These audio visuals will be a mix of locally developed slides, slides in the public domain which are of a quality to be reproduced and commercially avialable slides recommended for purchase only if they are to be available at resonable cost for a period of three years and if a royalty free right for local reproduction can be obtained for any audio visual material which cannot be obtained for a period of five years.

During this report period, numerous sources of commercial and public domain literature have been obtained from a wide number of sources. Thirty-five

millimeter slides have also been examined from a number of commercial and public domain sources. (Attachment C.) Slides are being produced at Georgia Tech and other slides in the public domain are being used to augment learning units. Some commercial slides, particularly in the area of installation, are to be recommended at the April 17, 1979 meeting at the Marietta Area Technical School. It is anticipated that the majority of manuscript material will be completed and submitted to the Department of Education at this time. However, there may be a delay in providing all of the locally produced 35 millimeter slides. There has been difficulty in keeping a full time draftsperson working on the slide layouts and these could be delayed past April 17, 1979.

Respectfully submitted,

Joe N. Harris
Project Director

sb

Enclosures

5. What safety precautions are important when installing solar systems?

6. Right now, if you could hire a trained solar technician, would you hire someone primarily for: (Check One)

   Sales
   System Design
   Installation
   Service

7. Do you have suggestions for materials or activities which you've found helpful in training your employees to work in the solar field?

ATTACHMENT B

TASK LISTING FOR SOLAR SYSTEM INSTALLERS:
A CURRICULUM UNIT WILL BE DEVELOPED FOR EACH TASK

Explain the importance of solar energy, and principles of solar radiation.
Describe and identify solar system components, and explain principles of solar heating and cooling system operation.
Recommend solar collectors.
Recommend and locate storage units.
Recommend and locate sensors, controls, and other regulators of energy flow.
Describe modes of solar system operation.
Recommend a domestic hot water system, either alone or with a space heating system.
Calculate building heat load.
Explain concepts related to sizing of collectors, storage units, heat exchangers.
Perform a life cycle cost analysis of a solar system.
Recommend passive solar measures.
Recommend non-solar energy conservation measures.
Site collectors.
Install collectors.
Install collector loop.
Install load side loops.
Install controls and wiring.
Build pebble storage unit.
Start up system.
Check modes of operation and associated controls.
Balance fluid flow.
Perform maintenance operations.
Perform steps for trouble-shooting and correcting system problems.

ATTACHMENT C

WRITTEN MATERIALS

1. Information on solar property tax credits in Georgia - from State Department of Revenue.

2. Information on solar system control devices - from Heliotrope General, Spring Valley, Calif. and from Honeywell, Atlanta, Georgia.

3. Solar Heating: Theory, Equipment and Systems Design (training notes) - from Sennergetics, Northridge, Calif.

4. Information on other solar system design and installation courses - from a. Arthur C. Meyers, Navarro College, Corsicana, Texas.

   b. T. J. O'Leary, Blue Hills Regional Technical Institute, Canton, Mass.

   c. New England Fuel Institute, Watertown, Mass.

5. Consumer information on solar systems, including domestic hot water system installation guidelines - from Mass. Dept. of Consumer Affairs.

6. Master's theses on task detailing of the jobs of solar technician and mechanic - from William Hunt, Southwest Energy Management, Inc., San Diego, Calif.

7. Outline of new Lennox Training Course - "Residential Solar Application Outline I (SA)."

8. Introduction to Solar Heating and Cooling Design and Sizing - from G.P.O.

9. The Solar Decision Book by R. H. Montgomery and J. Budnick, published by Dow-Corning, Midland, Mich.

10. Solar Energy Handbook 1979 - published by Popular Sciences.

11. Fundamentals of Solar Heating - from G.P.O.

12. SOLCOST Space Heating and Solar Hot Water Handbooks - from G.P.O.

13. Selling the Solar Home - from G.P.O.

14. Buying Solar - from G.P.O.

15. Information about solar systems and other resources - from National Solar Heating and Cooling Information Center.

16. Information on phase change storage units - from Valmont Industries, Inc., Valley, Neb.

17. Building the Solar Home - from G.P.O.

35 mm Slides

1. Slides from Solar-Ed., Co., Woodbridge, Conn. - for previewing.
2. Slides from Solar Engineering Magazine - for previewing.
3. Slides from Solar Energy Research Institute.
4. Slides from Independent Living, Atlanta, Georgia.

A-2244

GTEES ENGINEERING EXPERIMENT STATION
GEORGIA INSTITUTE OF TECHNOLOGY • ATLANTA, GEORGIA 30332

July 9, 1979

Director Research Coordinating Unit
Program Development Support
Office of Vocational Education
Room 333, State Office Building
Atlanta, GA 30334

Attention: Mr. Robert K. Mabry

Subject: "A Post-Secondary Solar Energy Curriculum," Interim Report No. 3, for the Period March 15 - June 14, 1979, Georgia Institute of Technology Research Project A-2244.

Dear Mr. Mabry:

During this report period the majority of the competency-based modules were completed and distributed to four schools for field testing and evaluation. The four schools receiving the modules were: (1) Albany Area Technical School, (2) Atlanta Area Vocational-Technical School, (3) Dekalb Area Vocational-Technical School, and (4) Marietta-Cobb Area Vocational-Technical School. As of the date of this report, none of the questionnaires sent to the schools with each module have been returned.

Five modules (units) remain to be reproduced and sent to the schools. Short titles for these units are: (1) "Inside Plumbing Loops," (2)"Wiring and Controls," (3) "System Start-Up," (4) "Maintenance," and (5) "Trouble-Shooting." The delay in completing these units is primarily due to the contract budget being essentially expended. This shortage of funds has required the professional personnel to work on these units outside the regular working day to prevent additional charges against the contract. It is anticipated that the final five units will be mailed by July 13, 1979.

All art work and original slides have been completed, except for six individual masters. These must be re-shot because of light reflections on the backgrounds. It is anticipated that all slides will be available for reproduction by the State Department of Education after July 11, 1979.

Three textbooks were recommended and advance copies purchased by the State Department of Education for use by the four schools conducting the field testing.

The modules, as presently constructed, will require technical training aids to complete the Job Sheets. The training aids to be recommended are from Lennox and are as follows:

Technical Training Aid	Cost Per Unit
Lennox EB-5 Solar Schematic Trainer	$ 845
Lennox RT-5 Solar Cycle Trainer	845
Lennox ST-17 Solar Heat Service Trainer	1,695
Lennox AP-4 Solar System Trainer Kit	2,795
Lennox SHW-2 Solar Domestic Hot Water System	1,675
TOTAL:	$7,855

Tasks remaining to be completed on this program are:

(1) Complete and mail the five remaining modules to the schools.

(2) Make necessary revisions to the modules after field testing and receipt of all comments.

(3) Plan workshop for August 8 and 9.

(4) Conduct workshop at Dekalb Community College on August 8 and 9.

(5) Supply all master materials to State Board of Education.

(6) Write Final Report.

Mr. William Penland of the Dekalb Area Vocational-Technical School has agreed to assist in planning the workshop, and will meet with the Project Staff at Georgia Tech on July 11, 1979.

Final planning is to be completed on July 18, 1979. A letter has been prepared asking Dr. Barry Mellinger at Dekalb Community College to host the workshop at his school.

Respectfully submitted,

Joe N. Harris
Project Director

JNH:sb

A-2244

FINAL REPORT

PROJECT A-2244

A POST SECONDARY SOLAR ENERGY CURRICULUM

By

Joe N. Harris

October 1979

Performed for

GEORGIA DEPARTMENT OF EDUCATION
Atlanta, Georgia 30334

GEORGIA INSTITUTE OF TECHNOLOGY
Engineering Experiment Station
Atlanta, Georgia 30332

FINAL REPORT

PROJECT NO. A-2244

A POST-SECONDARY SOLAR ENERGY CURRICULUM

Joe N. Harris	Project Director
Esther Lee Davenport	Research Scientist II
Joanne Green	Research Scientist II

GEORGIA INSTITUTE OF TECHNOLOGY
Engineering Experiment Station
Atlanta, Georgia 30332

October 1979

Performed for

GEORGIA DEPARTMENT OF EDUCATION
Program Development Division
Office of Vocational Education
Atlanta, Georgia 30334

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FOREWORD

This final report documents the planning and operating procedures used in developing a solar energy curriculum to be used in post-secondary vocational-technical schools as an adjunct to the existing Heating, Ventilating and Air-Conditioning Programs.

This curriculum development program was conducted by the Georgia Institute of Technology, Engineering Experiment Station for the Program Development Division, Office of Vocational Education, Georgia Department of Education. The work was conducted under the technical direction of Mr. Robert K. Mabry of the Georgia Department of Education.

The project staff wishes to acknowledge the efforts of the advisory committee and the assistance of the vocational-technical schools that they represented. These advisory committee members were: Mr. W. D. Penland, DeKalb Area Vocational-Technical School; Mr. H. E. Ragan, Atlanta Area Vocational-Technical School; and Mr. C. N. Roper, Marietta-Cobb Area Vocational-Technical School.

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CHAPTER I

PLANNING

A. Objectives of the Project

The increasing cost of conventional energy sources for domestic heating and cooling will make the use of solar energy an attractive alternative. Up until the present time the high cost of domestic solar equipment and installation costs, coupled with the low cost of electricity and natural gas, have kept the installation of solar heating and cooling systems in Georgia to a minimum. Also, there has been some adverse publicity about non-working and inefficient solar systems caused by poor design and/or installation.[1] This has undoubtedly caused some knowledgeable buyers to delay purchase of solar systems that they might otherwise have already installed.

During the one-year life of this program, the world price for oil has increased more than fifty per cent and the U. S. Government has taken steps to deregulate the price of natural gas. Due to the skyrocketing prices of fossil fuels and electricity, the demand for domestic solar heating is expected to increase rapidly. This will open up many new jobs for trained solar installers and maintenance personnel. The Georgia Department of Education recognized the need for a training program to teach heating, ventilating and air-conditioning (HVAC) personnel: (1) the fundamentals of heating with solar energy, (2) the techniques for installing "state-of-the-art" commercial equipment, and (3) the techniques for maintaining the equipment after installation.

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[1] Christine N. Sullivan, "Installation--A Key to a Successful Solar Program," Solar Age, September 1977, pp. 21-22.

The general objective of this program was to develop and field test a 300-hour, self-paced solar energy curriculum to be offered by post-secondary vocational institutions as an optional component after completion of an existing state-approved heating and air-conditioning program. Specific objectives were:

1. Prepare a job description and a list of tasks to be performed by job incumbents.
2. Determine the sequence in which the required tasks should be learned.
3. Develop learning activities designed to develop competency in each task.
4. Provide all instructional materials, including audio-visual aids necessary to implement learning activities.
5. Provide teacher materials to include: operational and management instructions, student projects, instructor-check information and student evaluation and self-check materials.
6. Recommend a list of commercially available hardware and training aids for use with the curriculum to include source and estimated costs.
7. Conduct a formative evaluation of the curriculum by field testing with a small sample of the intended user group.
8. Revise the draft curriculum in light of the results of the evaluation.
9. Provide a two-day workshop to familiarize the teachers with the operation of the curriculum and create an enthusiastic attitude for its use.

B. Strategies

1. Staffing the Project

The initial proposal for this program was prepared by Ms. E. L. (Burks) Davenport and Mr. A. T. Sales. The Principal Investigator named in the proposal

was Mr. J. M. Akridge, but, due to other committments, he was unable to serve in this capacity. Mr. J. N. Harris assumed direction of the program on 1 November 1978 and was officially designated Project Director on 16 January 1979.

Although the project was funded for one year, beginning 15 September 1978, work was not actually begun until 1 November 1978 when Ms. E. L. Davenport and Mr. J. N. Harris began part-time work on the program. Dr. Joanne Green was added to the staff on 5 January and worked full time on the program through 30 April 1979 to provide the level of effort stipulated and to overcome the late start caused by delays in funding and personnel assignments. Dr. Green continued to work on the program on a part-time basis from May through September 14, 1979. The art work for visual aids on this program was done by Mr. Claude Lattimore working under the direction of Ms. Martha Clayton.

In additional to the primary staff, technical input on solar energy applications was provided by Mr. J. M. Akridge, Mr. C. A. Murphy, Mr. N. E. Poulos, and Mr. A. T. Sales of the Solar Energy and Materials Technology Division of the Engineering Experiment Station, Georgia Institute of Technology.

2. Appointment and Use of an Advisory Committee

Mr. Robert K. Mabry, program monitor, from the Research Coordinating Unit of the Georgia Department of Education, asked members of the HVAC faculty from three Area Vocational-Technical Schools to serve as an Advisory Committee to the Project Staff. Members of the Advisory Committee and the Schools represented were: Mr. W. D. Penland, DeKalb Area Vocational-Technical School; Mr. H. E. Ragan, Atlanta Area Vocational-Technical School; Mr. C. N. Roper, Marietta-Cobb Area Vocational-Technical School.

3. Coordination

a. Program Monitor

Monthly or bi-monthly meetings were held with the program monitor and the Advisory Committee as required. These meetings were used to update the program monitor on progress toward completion of milestones (objectives) of the program. Written quarterly progress reports were also provided to the program monitor.

b. Advisory Committee

Three formal meetings were held with the committee. In addition, there were numerous telephone conversations between individual committee members and the project staff for coordination between meetings. The advisory committee was asked to provide guidance to the project staff on student capabilities and needs. In addition, the committee provided immediate input on the relevance of teaching materials as they were developed. This input reduced the requirement for rewriting after field testing. The committee was specifically asked to comment on the teaching materials as to:

(1) Clarity of expression

(2) Appropriateness for student needs

(3) Practicality for use in the existing (or potential) classroom situation.

The committee also provided many practical suggestions not covered in the areas above.

c. First Advisory Committee Meeting

The first meeting was held at the Atlanta Area Vocational-Technical School on 19 January 1979. Topics discussed with the advisory committee were:

(1) The differences in the HVAC curriculum as taught in the three schools represented

(2) The capabilities of the vocational-technical student as to reading and mathematical skills

(3) The solar residential technician job description

(4) The overall task listing for the curriculum

(5) Task details for three of the tasks

(6) Potential texts for the solar curriculum.

The committee found the proposed texts to be at an acceptable reading level for Vo-Tech students. Additional recommendations from the committee were:

(1) That solar installers/contractors be requested to react to the task listings.

(2) That proposed modules be designed to allow student flexibility in determining individual objectives

(3) Identify intermediate exit points that would qualify a student for different tasks (e.g., installer or maintenance specialist).

d. Second Advisory Committee Meeting

The second meeting with the advisory committee was held at the DeKalb Area Technical School on 13 March 1979. Two curriculum modules which had been mailed previously to committee members were discussed in terms of appropriateness, level of difficulty, level of interest, clarity of instructions and clarity of format. The advisory committee responses also included recommendations on packaging the curriculum.

e. Third Advisory Committee Meeting

This meeting was held at the Marietta-Cobb Area Vocational-Technical School on 17 April 1979. Several curriculum units were discussed in detail. Some of the commercial slides to be used with the units were shown to the committee. Committee members were asked to assist by field testing these units and

to field test additional modules as they were completed. Preliminary plans for the workshop to be held in August were discussed with the committee and the program monitor.

CHAPTER II

OPERATIONS IN CURRICULUM DEVELOPMENT

A. Solar Technical Information

The initial proposal for this work was based on the two training courses developed by Colorado State University (CSU).[2,3] After extensive study of these two documents, they were deemed unsuitable for use as the basis for a self-paced post-secondary solar curriculum because the reading level and mathematics involved were considered too difficult for Vocational-Technical School students. An extensive literature search was conducted to examine: books, periodicals, and Federal and State reports to find the documents best-suited for developing self-paced course materials and for use as textbooks. A solar bibliography is included in Appendix A.

Two periodicals, "Solar Engineering" and "Solar Age," provided extensive references to other materials and provided excellent articles on installation and equipment. Particular attention was paid to U. S. Government and state government materials in the "public domain" that could be used without paying copyright fees. Some public domain materials was incorporated directly into the learning units. The only copyrighted materials used were audio-visual slides with copying rights purchased from the holder. A few slide sets could not be purchased for copying. However, their suppliers provided written assurance of their availability, and of duplication privileges should the slides be-

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[2] Solar Heating and Cooling of Buildings--Sizing, Installation and Operation of Systems, Solar Energy Applications Laboratory, Colorado State University, prepared for U.S. Dept. of Commerce, October 1977, U.S. GPO Stock No. 003-001-00084-4.

[3] Solar Heating and Cooling of Residential Buildings--Design of Systems, Solar Energy Applications Laboratory, Colorado State University, prepared for U.S. Dept. of Commerce, October 1978, GPO Stock No. 003-001-00085-2.

come unavailable. These have been recommended to the State Board of Education for purchase by individual schools. From the publications examined three were selected for recommendation to the Georgia Department of Education as textbooks for the post-secondary solar energy curriculum. The first is a U. S. Government Publication[4] with all material in public domain which covers the fundamentals of solar heating. This publication was originally designed as a correspondent course and the level of reading is well-suited for a Vo-Tech student. Since it is available from the Government Printing Office, it has a low purchase price ($3.50) which would allow each student to purchase his own copy. The second recommended text is published by Lennox Industries[5] and is used by Lennox in education courses for solar installers and maintenance personnel. This is the most detailed, complete manual found describing installation and operation of specific solar domestic heating equipment. This book describes and pictures Lennox equipment, but since Lennox equipment is fairly representative of solar lines in general, the techniques of installation described are applicable to other manufacturers' systems as well. The purchase price of $13.95 may, in some cases, limit the students' purchase. Individual schools may choose to provide several check-out copies in their learning centers. The third text is for the learning unit on passive solar design and is published by the American Institute of Architects[6] at a price of $10.00 per copy. Since this text will only be used with one unit, two or three copies in each learning center should be sufficient.

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[4] Fundamentals of Solar Heating (Correspondence Course), Sheet Metal and Air Conditioning Contractors National Association, prepared for U.S. Department of Energy under Contract #G-77-C-01-4038, January 1978, USGPO Stock No. 061-000-00043-7.

[5] Solar Job-Related Training, Education Department, Lennox Industries, Inc., Dallas, TX, 1979.

[6] A Survey of Passive Solar Design, American Institute of Architects.

B. Self-Paced Development Materials

The job description, course task listings and the individual learning units were developed using the principles outlined by Mager[7] and by following the guidelines of the Georgia Department of Education Manual on developing individualized instruction.[8]

1. Job Description

The solar residential technician job description was written, reviewed by the advisory committee and revised to the form shown in Appendix B.

2. Task Listings and Detailings

An initial task listing was compiled based on the format suggested by Mager. This listing was reviewed by the advisory committee and, at their suggestion, was sent to twenty solar installer/contractors along with the questionnaire in Appendix C.

The advisory committee and the contractors' suggestions, along with written information about a variety of solar systems, helped shape the final task listing. (Appendix D).

3. Self-Paced Modules

Writing of the self-paced modules was divided between the principal staff members. Dr. Joanne Green wrote the majority of the units on basic understanding and design and some of the units on installation. Ms. Davenport prepared the units dealing with actual installation practice, maintenance and trouble-shooting. Upon completion of a unit, the writer and the other staff members reviewed the unit for content, clarity, grammar and spelling prior to final typing.

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[7] Robert F. Mager, Developing Vocational Instruction, Fearon Publishers, Palo Alto, CA, 1972.

[8] Installing and Operating an Individualized Instructional Program, Developed-Furnished by State of Georgia, Educational Department Vocational Media Center, June 1978.

4. Audio-Visual Materials

Approximately eighty of the 35-millimeter slides used in the audio-visual presentations were original designs prepared by Mr. Claude Lattimore at the Georgia Institute of Technology. The remaining slides necessary for the complete presentation were obtained from several sources. A number of slides came from the files of a local solar contractor,[9] who granted the state copying privileges. Rights to copy some slides were purchased with the basic set from a local source.[10] The rights to reproduce two other commericially available slide sets could not be obtained. These slide sets will have to be purchased by the Georgia Department of Education or the participating schools.[11,12]

C. Field Testing and Evaluation

As units were completed, they were sent to the advisory committee members for review. The committee member as an instructor worked through these units with selected HVAC students at each school. In addition to the advisory committee members, units were field tested at the Albany Area Vocational-Technical School by Mr. Joe Dollar and selected students.

The major difficulties with the field testing were: (1) inability to supply the instructors with the complete audio-visual package and (2) the bulk of the units reached the instructors late in the spring quarter so they had limited time in which to work with students. The original 35-millimeter slides prepared at Georgia Tech and those slides for which rights to reproduce were

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[9] Independent Living Incorporated, Atlanta, GA.

[10] Georgia Solar Coalition.

[11] New Mexico Solar Association, "Passive Solar Energy Slides," $60.00 for six sets of slides.

[12] Solar-Ed Corporation, Woodbridge, CT, slide sets $49.95.

obtained could not be duplicated in time to be used in the field testing. The audio-visual scripts were provided to give the instructors an overview of the material covered in the audio-visual presentations. The questionnaire, included as Appendix E, was supplied with each unit. No negative comments were received on any of the self-paced teaching materials, although several suggestions regarding organizational clarity were made.

D. In-Service Teacher Training Workshop

An in-service teacher training workshop was held at the DeKalb Area Vocational-Technical School on August 8-9, 1979. The purposes of the workshop were:

1. To inform the HVAC instructors of the coming importance of solar energy for residential applications and the requirement for trained solar technicians.
2. To increase the instructor's enthusiasm for teaching the curriculum.
3. To "preview" sample modules so that instructors would have knowledge of course construction and content.
4. To obtain instructor input on potential problems in implementing the solar curriculum.
5. To provide contact with Georgia Department of Education personnel for answers to problems surfaced by the workshop.

Materials provided at the workshop, less sample modules, are included as Appendix F.

The feed-back forms in Appendix F have been marked to indicate the percentage of responses to the questions asked. Feed-back forms were turned in by 27 of the attendees for the first day and by 45 attendees on the second day. Over-

all, 67 per cent of the attendees felt the workshop program to be interesting or very interesting. The workshop had some motivating value since 27 per cent of the respondees checked answer #5 to question #2 on wanting to use the new solar heating curriculum ("Has really made me want to get going."). Sixty-eight per cent felt the workshop was very helpful or provided all the information needed to implement the course, but 13 per cent felt that they received too little practical help. Seventy-two per cent felt that they had received good or excellent use of their in-service training time. Sixty-one per cent indicated that they definitely planned to implement the curriculum during the 1979-80 school year with one-half indicating a Fall quarter 1979 staring date.

In the project staff's opinion, one of the best features of the workshop was the instructor input to potential problems in implementing the curriculum. Assignment sheets from the small group discussions were reviewed and the most prevalent answers were summarized on the questionnaire in Appendix F.

CHAPTER III

DISCUSSION

The initial objectives as stated in the proposal were met and the master solar curriculum materials delivered as required by the contract. One of the major difficulties occurred in meeting the milestone requirements to complete units in time for field testing. This was partially due to the late start on the contract and partially to the requirement for commercial materials (text books and slides) to accompany the modular units for field testing.

Although literature abounds on solar energy, care was necessary in selecting material to be used. Some of the available literature on installation techniques, particularly in periodicals, indicates practices which would not meet many local building, plumbing and electrical codes.

The time and funds available limited the curriculum to primary emphasis on active systems and, in particular, liquid storage and heat transfer systems. The project staff believes these to be the most practical types of systems for the State of Georgia at the present time. However, to give the student a broad background in the applications of solar energy, information has been included in the curriculum on active air systems and on passive solar heating and cooling techniques.

The curriculum as presented to the Georgia Department of Education represents the best state-of-the-art design and installation techniques used by current manufacturers of solar equipment. The entire field of solar residential heating and cooling is expected to expand rapidly. In so doing, new design and installation techniques will be developed. Therefore, it is important that the Georgia Department of Education periodically update the curriculum materials.

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APPENDIX A

SOLAR BIBLIOGRAPHY

1. Anderson, B., Solar Energy: Fundamentals in Building Design, McGraw-Hill Book Company, New York (1977)

Describes methods for achieving maximum energy-conserving designs. Suggests methods for evaluating construction methods, materials and equipment. Gives simple techniques of using solar energy for heating and cooling, including many unusual methods of incorporating the collection of solar heat into the building itself.

2. Anderson, B., and Riordan, M., The Solar Home Book: Heating, Cooling and Designing with the Sun, Cheshire Books, Church Hill, Harrisville, NH 03450 (1976)

Fundamentals of solar energy, solar heating and cooling systems for the average home, flat plate collectors, heat storage methods, integrated solar designs.

3. Beckman, W. A., Klein, S. A. and Duffie, J. A., Solar Heating Design by the F-Chart Method

Describes the common types of solar heating systems which can be designed by the F-Chart Method. Covers: thermal performance of flat-plate solar collectors, effects of collector orientation estimates of monthly space and domestic water heating loads, determination of optimum economic design.

4. Behrman, D., Solar Energy, the Awakening Science, Little, Brown & Company, (1976)

Broad review of historical and present uses of solar energy for general reading only. Not suitable as a text.

5. Braden, S., Graphic Standards of Solar Energy, CBI Publishing Company, Boston, MA (1977)

Design reference guide for solar heating and solar house design construction.

6. Cheremisinoff, P. N. and Regino, T. C., Principles and Applications of Solar Energy, Ann Arbor Science Publishers, Inc., Ann Arbor, MI

An overview of solar energy technology in an easy to read form. Good for basic background information but not as a working text.

7. Corcoleates, G., et. al., National Solar Energy Education Directory, SERI SP-42-141, January 1979, Solar Energy Research Institute, Golden CO 80401

Directory of Post Secondary Educational Institutions offering solar education courses.

8. Coulson, K. L., Solar and Terrestrial Radiation: Methods and Measurements, Academic Press, New York (1975)

Describes methods and measurements of solar radiation but is too advanced for VOED classes.

9. Daniels, F., Direct Use of the Sun's Energy, Yale University Press (1964)

A very basic text on use of solar energy, illustrated with many working models.

10. Duffie, V. A. and Beckman, W. A., Solar Energy Thermal Processes, John Wiley and Son, New York (1974)

Considers thermal processes in which solar radiation is absorbed by a surface and converted to heat. Treats in detail process and systems models, reviews heat transfer calculations and radiation measurement.

11. Edwards, D. K., Solar Collector Design, The Franklin Institute Press, Philadelphia (1977)

Describes design and use of solar collectors including heat loss control, heat collection, and design optimization.

12. Hill, J. E. and Richtmyer, T. E., Retrofitting a Residence for Solar Heating and Cooling: The Design and Construction of the System, NBS Technical Note 892, November (1975)

Describes a 4-bedroom 1200 ft^2 house originally equipped with a conventional gas furnace and central electric air-conditioning in a forced air distribution system on which controlled lab tests were conducted. The report deals with the design construction of a solar retrofit system consisting of 485 ft, 2-inch double-glazed flat plate collector, 1500 gal. of water storage and a 3-ton LiBr absorption air cooling unit.

13. Keaton, L., Edington, E., and Stephey, M., Understanding Solar Energy Systems, Wisconsin Vocational Studies Center, University of Wisconsin, Madison, 1978

A basic solar energy instructional module for post-high school and adult education.

14. Kreider, J. F. and Kreith, F., Solar Heating and Cooling: Engineering Practical Design and Economics, McGraw Hill Book Company, New York (1975)

Designed as a how-to-do-it handbook, not a highly theoretical treatise. The book focuses on these areas: Introductory information on solar and conventional energy use concepts and requirements, fundamental principles of heat transfer and the nature of solar radiation, practical and efficient methods of collecting solar energy, detailed quantitative descriptions of the practical systems for heating or cooling by means of solar energy--with analysis of their economics.

15. Kusuda, T. and Ishii, K., Hourly Solar Radiation Data for Vertical and Horizontal Surfaces on Average Days in the United States and Canada, NBS BSS-96 (1977)

Hourly solar radiation data for walls and roofs under "average" solar conditions were computed in order to be able to make estimates of the effect that incident solar radiation has on a building and for its heating and air conditioning system over a heating and/or cooling season. Data are compiled for 80 locations in the U. S. and Canada.

16. Meinel, A. B. and Meinel, M. P., Applied Solar Energy: An Introduction, Addison-Wesley Publishing Company, Reading, MA (1976)

Covers the history and theory of solar energy availability, devotes only one chapter to current applications. Designed for senior, undergraduate and graduate courses in solar energy.

17. Patton, A. R., Solar Energy for Heating and Cooling of Buildings, Noyes Data Corporation, Park Ridge, NJ

Collected data based on international studies conducted by industrial and engineering firms or university research teams. Experimental equipment and structures are reviewed and detailed by actual case histories.

18. Watson, D., Designing and Building a Solar House: Your Place in the Sun, Gardenway Publishing, Charlotte, Vermont (1977)

Describes passive and active solar systems with examples, included listing of sources of solar heating equipment.

19. Jordan, R. C. and Liu, B. Y. Y., Applications of Solar Energy for Heating and Cooling of Buildings, ASHRAE GRP 170 (1977)

A complete design text including sections on solar history; legal, political, economic, social and ecological considerations; solar radiation measurement; clear day design value; availability of solar energy for flat-plate solar heat collectors; selective surfaces for solar collectors; solar energy storage predictions; solar collector performance; simulation of solar heating systems (computer programs); testing and rating of solar collectors; solar water heaters; surface heating systems; and solar cooling.

20. Rankins, W. H. and Wilson, P. A., The Solar Energy Notebook, Lorien House, Black Mountain, NC (1976)

A thorough do-it-yourself design book written at the high school level. Weak on installation methods.

21. Senn, J. C., Solar Heating, Theory, Equipment and Systems Design, Sennergetics, Northridge, CA 91324

Training notes for a course for designers, builders, engineers and installers of solar heating systems.

22. Thayer, S. B., Jacobs, P. B., and Weaver, N., Cost-Effective Ways to Improve the Fabrication and Installation of Solar Heating and Cooling Systems for Residences, Final Report, June 1, 1977 - September 30, 1978, Solar Energy Applications Laboratory, Colorado State University, prepared for U. S. Department of Energy, Contract EG-77-S-02-4520, October 1978

On-site observations of twelve installations focusing on mounting and manifolding of collectors.

23. Wright, D., Natural Solar Architecture: A Passive Primer, Van Nostrand Reinhold Co., New York (1978)

Passive design techniques to take advantage of solar heating. Written at the early high school level.

24. A Survey of Passive Solar Buildings, American Institute of Architects, (AIA), Washington, DC, 1978

25. An Economic Analysis of Solar Water and Space Heating, DOE-2322-1, November 1976, Energy Research and Development Administration

26. Basics of Solar Air Systems, Sheet Metal and Air Conditioning Contractors National Association, Tysons Corner, Vienna, VA 22180

27. Building the Solar Home, Research Solar Program No. 2, U. S. Department of Housing and Urban Development

28. Buying Solar, FEA/G-76/154, U. S. Government Printing Office.

29. Fundamentals of Solar Heating, prepared for U. S. Department of Energy, by Sheet Metal and Air Conditioning Contractors National Association, Contract EG-77-C-o1-4038, January 1978, HCP/M4038-01

Designed as a correspondence course for basic understanding, design, installation, maintenance and trouble-shooting of solar liquid and air residential heating systems.

30. Honeywell Solar Energy Handbook,(1975)

Short discussion (27 pages) on systems design and controls. Gives piping and wiring diagrams for different types of systems.

31. Introduction to Solar Heating and Cooling -- Design and Sizing, August 1978, DOE/CS0011

Introduces practical aspects of solar heating and cooling systems to HVAC contractors, architects, engineers and other interested individuals.

32. National Solar Heating and Cooling Demonstration Program, Project Experience Handbook, DOE CS-0045/D, September 1978

Cites problem areas with regard to different aspects of systems.

33. Retrofitting a Residence for Solar Heating and Cooling -- The Design and Cost of the System, NBS Technical Note 892, November 1975

34. Selling the Solar Home, Research Solar Program 1, Published by U. S. Department of Housing and Urban Development

Some early lessons learned in selling solar homes.

35. Solar Heating and Cooling Demonstration Program, U. S. Department of Housing and Urban Development, Summer 1977

Descriptive summary of HUD Cycle 3, Solar Residential Projects.

36. Solar Heating and Cooling of Buildings -- Sizing, Installation and Operation of Systems, Solar Energy Applications Laboratory, Colorado State University, prepared for U. S. Department of Commerce, October 1977, USGPO Stock No. 003-001-00084-4

A solar curriculum for basic understanding and design is not specific enough and is too complex for vocational education students.

37. Solar Heating and Cooling of Residential Buildings -- Design of Systems, Solar Energy Applications Laboratory, Colorado State University, prepared for U. S. Department of Commerce, October 1978, USGPO Stock No. 003-001-00085-2

Contains historical and design data for residential systems, but is too complex for easy understanding by vocational educational students.

38. Solar Heating Systems Design Manual, Training/Education Department, ITT Corporation, 1977

Average historical solar data and assumptions.

39. Solar Hot Water and Your Home, A National Solar Heating and Cooling Center Publication

Basic design and evaluation information on solar hot water systems.

40. Solar Industry Index

Published annually by the Solar Energy Industries Association, Washington, DC. An index of solar industry product and services companies.

41. Solar Job-Related Training (Phase I), Education Department, Lennox Industries, Inc., Dallas, TX 75420, 1979

A basic manual on understanding and installation of solar heating systems. Primarily directed at Lennox equipment, but written broadly enough to apply to all types of equipment.

42. Solar Water Heater Installation Guidelines, Executive Office of Consumer Affairs, Solar Action Office, Commonwealth of Massachusetts, November 1978

A general explanation of how to install a solar hot water system.

43. Time-Free Modular Competency Based Curriculum -- Solar Energy Theory and Applications, Produced in cooperation with the Division of Vocational Education, Alabama State Department of Education and U. S. Office of Education, Division of Man-Power Development and Training, Link Education Laboratory, Montgomery, AL 36111

44. Uniform Solar Energy Code, 1979 Edition, International Association of Plumbing and Mechanical Officials, Los Angeles, CA 90032

APPENDIX B

JOB DESCRIPTION

VOCATION: Solar Systems Technician (Residential)

The solar systems technician (residential) is a heating and air conditioning specialist who can select, size, install, and repair or maintain solar heating systems in new or existing residences. He can integrate passive measures into the design and installation of active solar systems. He is able to explain to consumers the general technical principles of operation and the economic value of residential solar heating applications.

He can accurately calculate heating loads for buildings. He can explain the operating principles both air and liquid solar systems, and can integrate solar systems into conventional systems. He must be able to schedule the installation of the solar system in new construction, as well as design retrofit procedures.

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APPENDIX C

QUESTIONNAIRE SENT TO SOLAR CONTRACTORS

1. Rank from greatest to least, in importance, the following skills for a solar technician: (1 = greatest; 4 = least).

   Understanding Principles of the Use of Solar Energy

   Designing Solar Systems

   Installing Systems

   Maintenance of Systems

2. For the people you employ to work on solar systems, what parts of the job are the hardest?

3. Can you describe an incident that illustrates one of these difficult parts of the job?

4. What are the most frequent problems you have heard of with the operation of installed solar systems?

5. What safety precautions are importnat when installing solar systems?

6. Right now, if you could hire a trained solar technician, would you hire someone primarily for: (Check one).

   Sales
   System Design
   Installation
   Service

7. Do you have suggestions for materials or activities which you have found helpful in training your employees to work in the solar field?

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APPENDIX D

FINAL TASK LISTING

PHASE A: Basic Understanding

Unit	Task
SA-1	Explain the value of solar energy and principles of solar radiation.
SA-2	Describe basic solar system components and their functions.

PHASE B: Design

Unit	Task
SB-1	Recommend non-solar energy conservation measures.
SB-2	Select passive solar approaches for new construction.
SB-3	Recommend collectors.
SB-4	Recommend and site the thermal storage unit.
SB-5	Recommend control devices.
SB-6	Recognize and describe modes of solar system operation.
SB-7	Calculate heat load for space or domestic hot water heating.
SB-8	Size solar system components.
SB-9	Perform a solar system economic analysis.
SB-10	Recommend a domestic hot water system.

PHASE C: Installation

Unit	Task
SC-1	Recommend correct thermal mass for direct gain system; fabricate and install modular wall units for passive solar
SC-2	Schedule solar installation
SC-3	Install a liquid storage tank

SC-4	Site and mount collectors
SC-5	Install liquid collectors and outside plumbing
SC-6	Install inside plumbing for collector load side loops
SC-7	Install controls and wiring
SC-8	Start up system

PHASE D: Maintenance

Unit	Task
SD-1	Maintain the solar system
SD-2	Troubleshoot solar system problems

APPENDIX E

SOLAR SYSTEMS: CURRICULUM EVALUATION

Unit Number: _____

Instructor or Student? (Circle one.)

If student, number of quarters completed in school: _____

Before taking this course, I considered myself to be: (Check one.)

_____ a. very knowledgeable of solar systems

_____ b. somewhat knowledgeable of solar systems

_____ c. not knowledgeable of solar systems

With regard to level of difficulty, I found the level of difficulty to be: (Check one.)

_____ a. very difficult

_____ b. difficult

_____ c. of appropriate difficulty

_____ d. easy

_____ e. very easy

With regard to the clarity of instructions for activities, I found the instuctions to be: (Check one.)

_____ a. very clear

_____ b. clear

_____ c. unclear

_____ d. very unclear

With regard to interest value, I found this unit to be: (Check one.)

_____ a. very interesting

_____ b. interesting

_____ c. okay

_____ d. boring

_____ e. very boring

List any activities that you felt were not valuable for accomplishing the objectives of the unit, as stated on the Unit Sheet. Indicate activities by name and number (for example, Assignment Sheet SB-5-5, or Information Sheet SA-2-3.).

Which activities did you find most useful?

List below any errors (conceptual, typographical, or others) you found in this unit. Be specific, so we can make corrections.

What changes would you make in this unit?

Other comments?

APPENDIX F

SOLAR HEATING SYSTEMS CURRICULUM

INTRODUCTORY WORKSHOP

August 8 - 9, 1979

DeKalb Area Vocational-Technical School

1. Agenda
2. List of Workshop Participants
3. List of Materials Necessary for Curriculum Implementation
4. Small Group Discussion Assignment Sheet
5. Feedback Form: First Day
6. Feedback Form: Overall Evaluation
7. List of Workshop Attendees

SOLAR SYSTEMS CURRICULUM WORKSHOP

AGENDA

August 8

9:00 AM	Introductory Remarks -- Mr. Robert Mabry, Coordinator, Vocational Evaluation, Program Development Division
9:30 AM	Employment Opportunities for Solar Installers -- Mr. Wayne Robertson, Solar Energy Specialist, Georgia Office of Energy
10:00 AM	Overview of Curriculum Design
10:30 AM	Morning Break
10:45 AM	Introduction to a Solar Curriculum Unit -- Unit SA-2: "Describe Basic Solar System Components and Their Functions"
12:00 Noon	Lunch
1:30 PM	Introduction to a Solar Curriculum Unit -- Unit SB-2: "Select Passive Solar Approaches for New Construction"
2:30 PM	Afternoon Break
2:45 PM	Issues Related to Solar Curriculum Implementation -- Small Group Discussions
3:45 PM	An Example of Passive Solar Design in Atlanta -- Mr. Terry Schneider, Architect
4:30 PM	Review of Day's Activities
4:45 PM	Return to Downtown Atlanta

SOLAR SYSTEMS CURRICULUM WORKSHOP (CONTINUED)

AGENDA

August 9

9:00 AM	Introductory Remarks
9:10 AM	Demonstration of Training Devices for Use with Solar Curriculum -- Mr. Bob Hamos, Manager, Lennox Educational Products
10:10 AM	Morning Break
10:25 AM	Further Discussion of Issues Related to Solar Curriculum Implementation -- Panel Discussion -- Mr. Robert Mabry, Coordinator, Vocational Evaluation, Program Development Division Mr. Charles Horton, Regional Coordinator for Post-Secondary Vocational Programs
11:15 AM	Lunch
12:15 PM	Return to Downtown Atlanta

WORKSHOP PARTICIPANTS

Mr. Robert Mabry	--Coordinator, Vocational Evaluation, Program Development Division, State Department of Education
Mr. Wayne Robertson	--Solar Energy Specialist, Georgia Office of Energy Resources
Mr. Terry Schneider	--Architect
Mr. Bob Hamos	--Manager, Lennox Educational Products
Mr. Charles Horton	--Regional Coordinator for Post-Secondary Vocational Programs, State Department of Education
Mr. Joe Harris	--Senior Research Engineer, Georgia Tech
Ms. Esther Lee Davenport	--Research Engineer, Georgia Tech
Dr. Joanne Green	--Research Scientist, Georgia Tech
Mr. Bill Penland	--Instructor, DeKalb Area Vocational-Technical School
Mr. Noel Roper	--Instructor, Marietta-Cobb Area Vocational-Technical School
Mr. Ed Ragen	--Instructor, Atlanta Area Vocational-Technical School

Solar Heating Systems: Curriculum Materials

The lists below provide some idea of the materials necessary to implement the solar heating systems curriculum. The exact extent of materials to be purchased will depend on the resources already available in a given school, on the instructor's discretion as to which activities and units are to be included in the course, and on budgetary limitations. Approximate materials costs are listed where available.

Required texts (for students and instructors)

Fundamentals of Solar Heating - available from the Government Printing office	$3.50
Lennox Job Related Training Handbook, Phase I Solar Volume I - published by Lennox Industries, Inc.	$13.95
A Survey of Passive Solar Design - available from the American Institute of Architects	$10.00

Lab equipment

A solar heating system, either space heating or domestic hot water. For schools without existing solar systems, it is recommended that the Lennox LSHW2 Domestic Hot Water System be purchased.	$1675
Lennox AP-4 Solar System Trainer Kit Lennox ST-17 Solar Heat Service Trainer	$1695.00

Schools will also need to purchase additional construction and lab materials for use in other activities. The cost of such materials will depend on student enrollments, on the extent to which materials such as lumber and hardware are already available in the school, and on the instructor's discretion as to whether all units and activities are included in the course.

Recommended texts for instructors

Solar Heating and Cooling of Residential Buildings: Design of Systems - available from the Government Printing Office	$15.00
The Solar Decision Book by Richard H. Montgomery with Jim Budnick, published by John Wiley and Sons.	$10.00
The Solar House Book by Barry Anderson	

Commercial Audiovisual Materials

New Mexico Solar Energy Association Passive Solar Energy Slides - Slides - $60 for 6 sets of slides

Flat plate collectors - available from Solar - Ed Corp., Woodbridge, Conn., $49.95

SOLAR HEATING CURRICULUM WORKSHOP

Feedback Form: First Day

Overall, how would you rate the Workshop so far with respect to:

1. ...keeping your interest in today's program? (Circle one.)

		PERCENT
1.	Very boring	0%
2.	Boring	5%
3.	OK	15%
4.	Interesting	55%
5.	Very Interesting	26%

2. ...making you want to use the new Solar Heating curriculum? (Circle one.)

		PERCENT
1.	A real turn-off	0%
2.	Somewhat a damper	4%
3.	OK	18%
4.	Adds to my interest	52%
5.	Has really made me want to get going	26%

3. ...helping with practical information on using the curriculum? (Circle one.)

		PERCENT
1.	Not nearly enough	4%
2.	Too little practical help	7%
3.	OK	22%
4.	Very helpful	56%
5.	All I need	11%

4. Before you came to the workshop this morning, did you plan to implement the Solar Heating course in the coming year? (Circle one.)

		PERCENT
1.	Definitely not	0%
2.	Probably not	8%
3.	Maybe	0%
4.	Probably	22%
5.	Certainly	70%

5. Why did you feel the way you did?

6. Do you have any comments or suggestions about making the most of the remaining half-day in the workshop?

7. Do you have any other more general comments or reactions?

SOLAR HEATING CURRICULUM WORKSHOP

Feedback Form: Overall Evaluation

Considering the whole workshop, how would you rate this experience, with respect to:

1. ...keeping up your interest in the program? (Circle one.)

	PERCENT
1. Very boring	0%
2. Boring	2%
3. OK	31%
4. Interesting	47%
5. Very interesting	20%

2. ...making you want to use the new Solar Heating curriculum? (Circle one.)

	PERCENT
1. A real turn-off	0%
2. Somewhat a damper	9%
3. OK	22%
4. Adds to my interest	42%
5. Has really made me want to get going	27%

3. ...helping with practical information on implementing this course? (Circle one.)

	PERCENT
1. Not nearly enough	0%
2. Too little practical help	13%
3. OK	19%
4. Very helpful	64%
5. All I need	4%

4. ...overall worth of the time spent? (Circle one.)

	PERCENT
1. Waste of my time	2%
2. Not very helpful	6%
3. OK	20%
4. Good use of in-service training time	46%
5. Excellent use of in-service training time	26%

5. Do you plan to implement this Solar Heating Curriculum sometime in the coming school year? (Circle one.)

		PERCENT
1.	Definitely not	0%
2.	Probably not	6%
3.	Maybe	11%
4.	Probably	22%
5.	Certainly	61%

6. Why did you answer question 5 the way you did?

7. If your answer to question 5 was "probably" or "certainly," what quarter would you prefer to begin offering the course? (Circle one.)

		PERCENT
1.	Fall	50%
2.	Winter	10%
3.	Spring	20%
4.	Summer	20%

8. Do you have any other comments or suggestions?

SOLAR HEATING CURRICULUM WORKSHOP

Small Group Discussion Assignment Sheet

Question 1:

What problems can you foresee in implementing the new solar heating curriculum? The items below will help you think about these.

a. Consider the list of required materials for the curriculum that is in your workshop packet. Do you foresee problems related to this list? List these.

1) Funding
2) How do individual schools obtain equipment?
3) Cost to students for textbooks

b. Considering what you know so far about how the curriculum is organized, do you foresee problems in using these self-paced materials? List these. (Only five responses to Question 6.)

1) One instructor felt the curriculum might be too complex for some students.
2) One instructor forsaw difficulty in teaching maintenance and repair due to lack of "real" equipment.
3) One instructor felt the curriculum would require too much of the instructor's time with each student.
4) Two instructors felt activity sequence sheets were confusing.

c. This curriculum is now viewed as an add-on to the existing HVAC curriculum, to be studied as an option by students who have completed all other work in HVAC. Is this point a good place for introduction of the solar heating training? What problems do you see with this aspect? List these.

1) Problems with VA unless course is integrated into existing into existing 24-month HVAC program or is listed as an extension of the 24-month program.
2) Getting students to take course, unless it is mandatory.

d. As you think about the Solar Heating curriculum, in general, are there other problems that you can foresee arising with it? List these.

1) One-year courses too short to implement solar curriculum.
2) Repeated installation of some equipment will destroy it.
3) Insufficient demand for solar trained personnel at present.

Question 2:

For each of the problems you listed in Question 1, write down at least one idea for a potential solution.

1) Provide sufficient funds for equipment
2) Provide a single manual (textbook) for the course
3) Construct training aides at individual schools
4) Provide phasing for different options in solar
5) Make "solar" mandatory as a fifth or ninth quarter
6) State and counties update codes to include "solar"
7) Construct model systems and even model houses
8) Standardize all HVAC programs state-wide

Question 3:

Participate with your group so as to come up with a master list of the most important problems related to implementing the Solar Heating curriculum and the most likely solutions available for these. Turn in this Assignment Sheet to the group leader at the end of the discussion.

Problems

1) Money and equipment
2) Teacher loads
3) Student motivation to take solar option
4) Difficulty in testing students, practical experience in installation and maintenance (teardown and set-up) not practical with single set of equipment
5) Varying curriculum requirements and keeping students in school longer than two years
6) Training of personnel already in industry

The most prevalent problems were discussed in group session with Mr. Robert K. Mabry and Mr. Charles Horton of the Georgia Department of Education.

SOLAR CURRICULUM WORKSHOP ATTENDEES

August 8 - 9, 1979

Name	School Represented
Jerry Plott	Brunswick Jr. College
John C. Hair Bill Montgomery Adrian G. Palmer, Sr.	Columbus Tech College
T. J. Keener	Pickens Tech
Dan Stelling Rembert Parker John B. Brownlee	Augusta Tech
Henry D. Owens Norman NeSmith	Thomas Tech
Frank Bankson Jack M. Dye	Coosa Valley Tech
Paul F. Swanson Warren H. Ray	Valdosta Vo-Tech
James D. Bussey	Griffin Tech
Loran D. Hogg Edwin L. Buckner	Walker Tech
Conrad Ryan	Rossville High School
Wayne Robertson	GA Office of Energy Resources
Gene Smith Carter Stanfield Hugh H. Helmly	Athens Area Tech
W. J. Webb C. Noel Roper	Marietta-Cobb Vo-Tech
Wesley Barnett Thomas L. Sanders	Savannah Area Vo-Tech
Peter J. Robichaud Henry Ragan Hydkial Williams Claude L. LaHale	Atlanta Area Tech

Name	School Represented
E. H. McDonald	Waycross Ware Tech
Jerry Bryant Willie E. Yates Joseph L. Dollar	Albany Area Vo-Tech
Joe C. Garrison Louis H. Warlick William D. Penland Tom Marney Tom L. Brawner Eulas S. Smith Glenn Keener	DeKalb Area Tech
Harry Dragon	South GA Tech & Vo School
Arthur T. Sales	GA Tech EES
Don O'Hearn	Houston Vocational Center Warner Robins, GA
Charley Adkesor Jack C. Bell	Macon Tech
Maurice W. Robert	Forest Park Sr. High
Gary L. Hodges	Swainsboro Tech
Jack L. Miller	CETA Adult Macon, GA
Sam Rhodes Lloyd Effaim	Lanier Tech
Eugene Lastinger Charles Johnston	Moultrie Tech
Louie Muse	Calhoun High School
Allen Owens	DeKalb OEC South