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U. S.-BASED SHORT COURSES IN RENEWABLE ENERGY TECHNOLOGIES: A SELECTIVE GUIDE FOR DEVELOPING COUNTRY PARTICIPANTS

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PREFACE

This handbook is a collective effort by the staff of Associates in Rural Development, Inc. (ARD). Ed Harvey undertook much of the preliminary contract work and drafted the sections on hydroelectric power systems and biomass direct combustion systems. Rick McGowan prepared the wind, photovoltaic, passive solar design and active solar sections. He also verified much of the information collected on the other technologies presented here. John Ashworth served as the project manager and was responsible for the sections dealing with biomass densification and gasification. Sally Ballin was responsible for the design and preparation of the report. She was assisted in these tasks by Margaretha Wilcke.

The authors would like to thank the many technology specialists who assisted in the selection process, as well as the dozens of individuals who kindly provided detailed information about the courses and programs they manage or offer. Without their cooperation, assembling the information that follows would have been a more difficult process.

Anyone who would like assistance in designing, organizing and implementing a training program which uses these resources may contact Associates in Rural Development, Inc.

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INTRODUCTION

The following report is designed to be a desk guide for planners, energy officers and training staff in USAID missions throughout the world. It is meant to be highly selective, presenting a few organizations in each technology that have significant experience in providing short, focused courses. By short course, we mean programs of instruction that are one- to 10-weeks long, although some particularly well-designed programs of shorter duration have been included.

As an additional resource, we have included descriptive material on a number of brief, one- to three-day seminars. Care has been taken to screen out seminars aimed strictly at U. S. situations or conditions. For example, there are a large number of seminars currently being offered on financing strategies (limited partnerships, leaseback arrangements, etc.) for wind and small-scale hydroelectric installations in the U. S. However, as these are based on U. S. tax law, particularly on income tax and investment tax credits, they have not been included in the seminar section.

Lastly, short descriptions have been presented on educational institutions that provide specialized programs in renewable energy technologies. In some cases, these are programs aimed at training skilled technicians; while in others, they are an integral part of an undergraduate or graduate engineering or architecture program.

The reader should note that short courses normally have a high focus in terms of subject matter, approach and target audience. Courses in installation and troubleshooting will take a different approach and require totally different skills from courses in system design. Therefore, a major effort has been made to clearly indicate prerequisites for candidates, as well as the overall course orientation. These should be carefully reviewed prior to selecting courses for counterpart staff.

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To insure accuracy of the information presented, detailed questionnaires were sent to more than 60 individuals, training institutions and universities. Information was subsequently verified by follow-up telephone interviews. Graduates of programs or noted experts in each technology were consulted on the quality of the courses offered. From the responses, institutions were selected that offer the best available mix of appropriate subject matter, experience in short-course presentation and sensitivity to the problems of developing countries. Institutions were given the opportunity to review and revise their listings in this directory prior to publication.

The short sections on each technology area that follow are not exhaustive. For example, less than one percent of the solar installer courses available in the U.S. have been listed. Other courses of equal quality have not been included due to space limitation and to the subjective judgment of the authors as to the applicability of training to developing-country energy specialists.

The authors welcome suggestions for other training courses that should be included in subsequent editions of this guide. All such suggestions will be carefully evaluated, using the same process and criteria used during the initial selection process. Comments from individuals having direct experience with the courses and programs offered by an organization are particularly solicited.

Section I

Biomass Technologies

INTRODUCTION

Biomass gasification is the process of converting solid biomass into a gas, generally called "producer gas." In most instances, the gas is produced by the thermal decomposition of wood chips or blocks in a heated reactor chamber having a restricted air flow. The gas produced is normally a low-BTU variety (100 to 200 BTUs per cubic foot), although it can be upgraded by using oxygen rather than air as a feed gas. The resulting producer gas is either used directly as a boiler fuel, as a chemical feedstock or as a fuel for an internal combustion engine.

Biomass gasification activity in the United States at present is a mixture of product marketing, system development and basic research. In the first instance, designs developed in Europe during World War II have been revived and are being marketed as devices to produce boiler fuel, process heat and electricity. Development work has been restricted primarily to improvements in the gas-cleaning system and to automation of the input of feedstock to the gasifier unit. Most of the product marketing has been aimed at the wood products industry and allied firms with access to large quantities of wood wastes and a substantial demand for process heat and power.

In addition, considerable work has been done on designing and developing second generation gasifier systems, often smaller in size than the earlier European models. These units are aimed at markets for stand-alone power generation, using wood chips or similar feedstocks.

Thirdly, a substantial amount of basic research is being done to understand the actual chemical processes within the gasification chambers toward designing improved third generation units with more complete conversion of feedstocks into gas, and smaller, less costly cleaning systems.

As is the case with biomass combustion, training in gasification is sharply divided between system design/engineering and system operation. In the first instance, biomass gasification training normally takes place as part of a chemical or mechanical engineering program.

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INTRODUCTION
(continued)

Heat transfer and thermal decomposition of biomass feedstocks are considered integral parts of the training process, usually undertaken as part of a two-year master's or four-year doctoral program in engineering. In the case of system operation, instruction focuses on how to make a certain set of equipment work well and how to keep it operating through periodic maintenance and operation procedures. It is system-specific and generally provided as part of an equipment sale or installation.

The research team was unable to uncover any regularly scheduled biomass gasification short courses. A number of gasifier manufacturers or importers contacted for this report indicated a willingness to conduct a tailored training program for developing country engineers or scientists. However, none currently offer courses except as part of a sale or installation. Similarly, several universities and research institutions (specifically, the Georgia Institute of Technology, the University of Missouri at Rolla and the Solar Energy Research Institute in Colorado) indicated that they previously proposed setting up just such a course, but were unable to find the sponsorship required to hold the first session.

Given the capital cost of an operating gasifier and the current scarcity of commercial installations, it is apparent that U. S.-based training courses will have to be held by those manufacturers, universities or research institutes with active gasifier testing and development programs. Leading institutions are indicated under the university and research programs that follow.

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COURSE SUMMARY

Organization	Course or Program	Schedule	Page
University of California/Davis	Gasification studies and research	university quarter	I-4
University of Missouri/Rolla	Gasification studies and research	university semester	I-4

DEGREE PROGRAMS

University of California at Davis

Graduate degree programs are offered by the Department of Agricultural Engineering, in which biomass gasification and heat/power generation from derived producer gas are emphasized. Degrees offered are M.S., M.E., Ph.D. and D.E. and are administered by the College of Engineering. UC/Davis has been working on the design and performance of gasifiers and gasifier-engine systems since 1975. Gas producer sizes range from 35 to 10,000 KJ per hour. Spark and compression ignition engines from five to 180 hp, fueled with producer gas, have been studied. The research team is led by Professor J. R. Goss. Dr. Goss and his graduate students have worked extensively on the problem of gasification systems for developing-country applications and have performed research and development work for the U.S. Agency for International Development and other federal and state agencies as well as corporations.

Contact: Professor J. R. Goss
Department of Agricultural Engineering
University of California
Davis, CA 95616

Phone: (916) 752-1421

University of Missouri at Rolla (UMR)

UMR has been actively researching gasification, pyrolysis, wood waste processing and associated fields for the past eight years. Research team is led by Professor Virgil J. Flanigan, Department of Mechanical Engineering. Both M.S. and Ph.D. degrees in mechanical engineering are offered, although most graduate studies associated with gasification research have been done at the M.S. level. UMR teaching/research/consulting program on thermochemical conversion of biomass is united under the title of GROW (Gasification Research on Wood). Participation in GROW provides access to a number of local commercial facilities, including: five gasifiers (up to 200 tons per day), large charcoal kiln operations, a charcoal briquetting plant, a wood-fired power plant and a large charcoal furnace.

continued

DEGREE PROGRAMS
(continued)

UMR staff have provided technical assistance to gasification programs in the Philippines and the biomass program in India. The UMR staff have proposed offering a 12-month training program in biomass engineering for developing-country participants, but have not yet implemented it.

Contact: Dr. Virgil J. Flanigan
University of Missouri at Rolla
School of Engineering
Rolla, MO 65401

Phone: (314) 341-4572
Telex: 364412 INTR #390

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INTRODUCTION

Biomass direct combustion is a generic term covering a variety of processes in which organic matter is burned, generally in the presence of excess air, to produce heat or to drive turbines to produce electricity and/or shaft power. In the context of this guide, it is used to cover a range of end-use applications and biomass feedstocks. These vary from small, portable, metal cook stoves to wood-fired, central, electrical-generating facilities.

Biomass combustion systems vary greatly in their complexity, capital cost, operation and maintenance requirements and feedstock requirements. For ease of analysis by USAID personnel, a representative sample of training institutions has been selected for each of three categories of biomass direct combustion systems: small-scale/domestic applications; agricultural facilities waste byproducts; and wood-fired or wood waste-fired boilers. The latter category includes both process heat production and electrical generation via steam boilers.

This three-part division is paralleled closely by a specialization in the U. S.-based organizations offering training in biomass combustion. In the first instance, small-scale/domestic applications, small, nonprofit/appropriate technology organizations offer courses in the design and fabrication of low-cost cook stoves for developing country applications. While U. S.-based, these programs are oriented almost exclusively to developing country needs, as there is little demand in the United States for low-cost biomass combustion systems for cooking alone.

In the case of agricultural process applications, training is customarily offered by equipment manufacturing or engineering firms, usually in conjunction with a specific installation. Major emphasis is on upgrading a waste byproduct (sugar bagasse, rice hulls, etc.) into a high-quality fuel, which is then burned to produce process heat, shaft power and/or electricity. These are usually custom engineering projects, provided either by manufacturers of the equipment or agricultural processing engineering firms.

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INTRODUCTION
(continued)

Lastly, training in wood- or wood waste-fired boilers is normally tailored to a specific, planned installation. If the system is to be a retrofit or a replacement installation in an existing factory, the training emphasis is on operation, maintenance and fuel handling. If the biomass combustion system is to be part of a new plant or electric power plant, then training may also include close collaboration with plant/utility engineers on design considerations and plant layout as well. In large installations (50 MW and above), the training may become an integral part of the entire design and construction process, and may differ little from that of a comparably sized coal-fired installation.

COURSE SUMMARY

Organization	Course or Program	Schedule	Page
Approvecho Institute	Improved Cookstoves for Use in Developing Countries	1-month Intensive, on demand 6-month Internship, beginning Jan. and July, annually	I-9
Boiler Efficiency Institute	Boiler Efficiency	2- to 4-day workshops, frequently offered	I-11
Auburn University	studies and research	university semester	I-13
Louisiana State University	studies and research	university semester	I-13

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SHORT COURSE

Biomass Direct Combustion

Sponsor: Aprovecho Institute, Cottage Grove, Oregon

Description

The focus of Aprovecho is on finding solutions to the world firewood crisis. Aprovecho sponsors training programs and research in the design and construction of improved cookstoves for use in developing countries, experimentation with alternative solid fuels, and methods of improved charcoal production.

Training includes: a one-month intensive course in woodstove technology; or a six-month internship program.

Both courses award a Certificate of Proficiency to successful participants.

Aprovecho also arranges specially-tailored training programs for groups or individuals.

RET installations on-site include: a large assortment of experimental wood- and charcoal-burning cookstoves, charcoal kilns, active and passive solar systems for water and space heating, and a range of agricultural season extenders.

Background

The one-month intensive training program has been offered for the past four years both in the U. S. and abroad. There have been several hundred graduates. The six-month internship program has been in existence one year (two cycles) and has graduated approximately 12 participants.

Availability

The one-month course can be arranged on fairly short notice. Fees depend on the size of the training group. The six-month program is offered semi-annually in January and July. Fee is $1,000.

continued

SHORT COURSE
(Aprovecho continued)

Prerequisites

Some knowledge of English required, as most training programs conducted in English. Participants should be capable of self-directed learning and intend to work in developing countries after training.

Key Instructors

Rob Larson, background in ceramics; experience in Latin America; proficient Spanish.

Ianto Evans, background in architecture and ecology; stovework since 1976; experience in Africa, Latin America and Asia; fluent Spanish, proficient French.

Margaret Thomas, background in anthropology; experience in Africa; fluent Spanish, Sesotho.

Laurie Childers, background in ceramics training; experience in East Africa; some Swahili.

Accommodations

Accommodations available at Aprovecho at $300 per month.

Key Contact

Rob Larson, Training Coordinator: (503) 942-9434

Aprovecho Research Center
80574 Hazelton Road
Cottage Grove, OR 97424

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SHORT COURSE

Boiler Efficiency

Sponsor: The Boiler Efficiency Institute, Auburn, Alabama

Description

The Institute offers two- to four-day training seminars/ workshops in improved boiler efficiency for boiler systems fired by virtually any type of feedstock (i.e., wood, peat, coal, gas, oil, etc.).

Training consists of lectures/seminars, field trips and hands-on practice in such topics as: types of burning equipment (availability and function), economics of efficiency increase, low-excess combustion, equipment maintenance and cleaning, and equipment testing.

Participants range from technicians to engineers from commercial, industrial and institutional organizations. Workshops are held at various sites in the U. S. that offer the particicular facilities necessary for training. Training has also been conducted abroad.

Background

The Institute has conducted these workshops for over 10 years, with an average of over 40 workshops per year. The sessions average 75 - 100 participants.

Availability

Workshops are scheduled at least six months in advance. A list of the specific types of workshop to be given (e.g., oriented toward wood- or gas-fired boilers) can be obtained by writing to the Institute and describing the training interest.

The cost of the two-day workshop is $285.00 per participant. Fee includes two luncheons, six refreshment breaks, and instructional materials (including two texts).

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SHORT COURSE
(Boiler Efficiency Institute continued)

Prerequisites

Active present involvement with boiler systems.

Key Instructors

Dr. Glendon Maples, Ph.D. in mechanical engineering, currently professor at Auburn University.

Dr. Dupree Maples, Ph.D. in mechanical engineering, currently professor at Louisiana State University.

Dr. David Dyer, Ph.D. in mechanical engineering, currently professor at Auburn University.

Accommodations

Reduced room rates are arranged for workshop participants. Contact the Institute for recommended accommodations.

Key Contact

Dr. Glendon Maples: (205) 887-3372

The Boiler Efficiency Institute
P. O. Box 2255
Auburn, AL 36830

DEGREE PROGRAMS

Auburn University

Auburn University is well known for its work in the direct combustion of biomass. B.S., M.S., and Ph.D. degrees in mechanical engineering are offered. Programs combine intensive in-class training with research (theory applied to an experimental situation), and use is made of superb research facilities. The Auburn Woodburning Laboratory is a full-scale research facility providing experimental capability in all aspects of biomass energy conversion and related thermal sciences.

Students from outside the U. S. may enroll for a single semester as "special" students.

Contact: Dr. Glendon Maples
Department of Mechanical Engineering
Auburn University
Auburn, AL 36849

Phone: (205) 826-4575

Louisiana State University

Louisiana State University is well known for its work in the direct combustion of biomass. B.S., M.S., and Ph.D. degree programs are offered with emphasis on biomass direct combustion. Research facilities include boiler units rated at five million BTUs heat release. Special areas of research include biomass waste fuel combustion (bagasse, woodchips, "hog" fuels) and combined fuel combustion.

Students from outside the U. S. may enroll for a single semester as "special" students.

Contact: Dr. Dupree Maples
Department of Mechanical Engineering
Louisiana State University
Baton Rouge, LA 70803

Phone: (504) 388-5792

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INTRODUCTION

Biomass densification is the process of upgrading biomass waste products into easily handled, high BTU-content fuels. It generally involves drying, grinding and then pressing or shaping the ground feedstock into blocks, cubes or pellets.

Training activities in biomass densification available in the United States today are normally offered as part of a product sale. Training is either given to individuals in an organization that has purchased a wood pellet-fired boiler system or to operating personnel from an agricultural processing plant that has just installed a waste product utilization system. In either case, the training is restricted to the set of hardware just installed or purchased. It does not normally sample the range of densification options available, nor does it provide analytic tools for sizing and designing a biomass densification system.

Biomass densification is a fledgling commercial business in the United States. It serves two separate and distinct markets: fossil fuel boiler retrofits, and heat and electricity production by the agricultural processing industry. In the first instance, sawdust and other byproducts of wood processing are manufactured into pellets or blocks using extrusion equipment adapted from the animal feed industry. The resulting pellets are a commercial energy product, sold in direct competition with other boiler fuels--coal, residual fuel oil and natural gas. Because they are uniform in size, moisture and energy content, pellets are ideal for automated retrofits to boilers previously fired by fossil fuels. And because the energy density of pellets is high (the BTU per pound is equivalent to bituminous coal), they are economical to transport to boilers from a centralized processing plant. Currently, there are 12 to 15 centralized pellet manufacturing plants in the United States and Canada.

Pellets are often sold in conjunction with a packaged fuel storage, handling and combustion system, which is easily attached to an existing fossil fuel boiler. Training consists chiefly of brief introductory sessions, offered by wood pellet package boiler firms for boiler operators in the feeding, cleaning and maintenance of the new heating systems.

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INTRODUCTION
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In the agricultural processing industry, the focus is on converting a waste byproduct (rice hulls, pecan shells, sugar bagasse, etc.) into an energy source, generally by drying, compressing or compacting, and burning the by-product at the plant site to produce industrial process heat and/or electricity. This is normally a custom engineering task, with a system designed specifically for each plant. A number of engineering firms specialize in this work, undertaking the entire job of system design, procurement and installation on a turnkey basis. Training consists of instruction to the local plant engineering staff on operating the installed hardware and maintaining system output in the face of any variations in the size, moisture content and quality of the feedstock.

One prototype short course is given in the section that follows as an example of how commercial pellet vendors and custom engineering firms could be used to provide training to developing country participants in biomass densification. This proposed course is a combination of visits to existing installations, such as those normally made by vendors to demonstrate the working of their units to potential customers, and instruction on operation and maintenance, such as is normally given to plant operators after a sale or after the completion of a custom installation.

COURSE SUMMARY

Organization	Course or Program	Schedule	Page
New England Soli-Fuels	Biomass Pellets and Pellet-Fired Energy Systems: Design Procurement, Installation and Operation	1- to 4-week workshops, on demand	I-17

PROPOSED SHORT COURSE

Design, Procurement and Supply of Biomass Pellet Boiler Systems

and

Biomass Pellets and Pellet-Fired Energy Systems: Design, Procurement, Installation and Operation

Sponsor: New England Soli-Fuels, Ltd., South Burlington, Vermont

Description

Proposed course consists of a tour of a pellet-fabrication plant, visits to biomass pellet-fired boiler installations throughout the northeastern United States, and detailed instruction on the operation and maintenance of wood pellet-fired boilers, storage facilities and automated pellet stokers.

Training sessions will be custom designed for each organization or customer. Emphasis is on operation of the system, routine maintenance requirements, troubleshooting, etc. Every effort is made to have participants visit a number of installations with end-use applications for the pellets similar to the needs of their home countries (space heating, industrial process heat, standalone power generation, etc.). Information on sizing and system design will also be available, providing that the participants have detailed information on their local installations, energy needs and available densified biomass supplies.

Background

New England Soli-Fuels, Ltd. is a distributor of biomass pellets, produced from wood (densified) or municipal/industrial waste (not densified), and a distributor of pellet-burning equipment. Currently, it distributes biomass pellets produced by Bio-Shell in a Canadian plant, although previously it sold pellets produced in Maine. The firm has been designing and installing biomass-pellet handling and combustion systems for six years.

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PROPOSED SHORT COURSE
(Soli-Fuels continued)

Primary emphasis has been on retrofitting pellet-handling and storage and handling systems to older boiler units which previously burned coal or #2, #4 and #6 coil. Experience ranges from residential to commercial and industrial systems up to 600,000 pounds of steam per hour, burning biomass on the grate or in suspension.

Availability

Course will be one to four weeks long, depending on the interests of participants, and will be given on request. Fee will be negotiated on a case-by-case basis, depending on the travel requirements of the firm's staff, the number of site visits, etc.

Prerequisites

Course is designed for individual/corporate engineers and design engineers representing organizations interested in using wood pellets or other densified biomass to substitute for current fossil fuels or to provide boiler fuel for new installations. Understanding of boiler operation and fuel handling practices helpful but not essential. Course will be tailored to the level of technical background of participants. English is the language of instruction, although French language capability is available at Canadian pellet plant and at various Canadian installations.

Key Instructor

Bud Bailey, president of New England Soli-Fuels, will handle training, with assistance from their in-house personnel and operators of various installations to be visited and from the plant staff of Bio-Shell, Canada.

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PROPOSED SHORT COURSE
(Soli-Fuels continued)

Accommodations

Housing is available at any number of hotels/motels in Burlington and South Burlington. It is suggested that arrangements be made at least three weeks in advance, particularly during summer and fall months. A full list of possibilities is available from the Lake Champlain Chamber of Commerce, (802) 863-3489, or arrangements can be made through New England Soli-Fuels, Ltd.

Key Contact

Bud Bailey: (802) 862-9228

New England Soli-Fuels, Ltd.
41 Baldwin Avenue
South Burlington, VT 05401

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COURSE SUMMARY

Organization	Course or Program	Schedule	Page
Institute for Gas Technology	annual conference on Energy from Biomass and Wastes	5-days, once a year	I-21
Georgia Institute of Technology	research facility		I-23
Solar Energy Research Institute	research facility		I-23

SHORT COURSE

Energy from Biomass and Wastes

Sponsor: Institute for Gas Technology (IGT), Chicago, Illinois

Description

Five-day conference, presented at Walt Disney World, Buena Vista, Florida, consisting of presentation of papers and reports on research and commercialization in progress in the U.S. and overseas. About 65 papers are presented.

Topics covered include: current developments in biomass research and biomass procurement and distribution; biomass combustion (ranging from wood to municipal solid wastes); biomass economics/energetics; thermal gasification; biomass liquefaction; production of alcohol fuels; chemicals from biomass; and current major funded research programs.

There is also an optional tour each year. In 1985, it will include pavillions at Walt Disney World's EPCOT Center and deal with energy from biomass and wastes.

Background

The biomass symposium has been offered annually since 1976. It is designed for the research and business community, to enable decision-makers to keep abreast of current trends and significant projects. A number of other symposia and short courses are offered, mostly oriented toward fossil fuel utilization, transportation and research. A yearly symposium on non-fossil fuels for transportation is also offered.

Availability

Program is five days long and held annually. Fee is $630 for IGT members and $740 for non-members. Full-time students may register for a fee of $150. Fees include a copy of the papers presented and a subsequent copy of the proceedings.

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SHORT COURSE
(IGT continued)

Prerequisites

Program is oriented toward professionals in engineering, utility and energy firms, forest products industries and academic research communities. There are no education prerequisites and all presentations are in English.

Accommodations

Housing provided separately and may be reserved through IGT. It is suggested that reservations be made two to four weeks in advance.

Key Contacts

Dr. Donald L. Klass, Conference Chairman: (312) 567-3784

Institute of Gas Technology
3424 South State Street
Chicago, IL 60616

Telex: 25-6189

RESEARCH FACILITIES

Georgia Institute of Technology

Georgia Tech Research Institute (GTRI) at Georgia Tech has been working on wood combustion, gasification and pyrolysis since the late 1970s. In keeping with the extension role of the Institute, the Mechanical Systems Division has worked with private industry to provide feasibility studies and detailed engineering assistance for the substitution of wood for oil and natural gas as boiler fuels. Currently, there is a 1.5 million BTU per hour gasifier located at GTRI. Tours of commercial installations throughout the Southeast (up to 300 MMBtu/hr. including boilers and gasifiers) have been conducted previously by Georgia Tech for visitors from Africa, South America and the South Pacific, and included not only gasification facilities but combustion and feedstock handling as well.

Contact: William S. Bullpitt
Technology Applications Laboratory
Georgia Institute of Technology
Georgia Tech Research Institute
Atlanta, GA 30332

Phone: (404) 894-3475

Solar Energy Research Institute (SERI)

SERI, operated by the Midwest Research Institute for the U.S. Department of Energy (DOE), is a laboratory for research and development of all fields of solar and renewable energy. Personnel of the Thermochemical and Electrochemical Research Branch (Thomas A. Milne, branch chief) are now setting up a Gasification and Pyrolysis Facility in a new Field Test Laboratory Building (FTLB). The high-bay engineering laboratory contains an experimental gasifier test bed for testing gasifiers; a transparent, gold insulated quartz gasifier for studying gasifier operation; a one-ton per day entrained flow, ablative pyrolysis gasifier for producing olefins, aromatics and other valuable pyrolysis products; and a unique mass spectrometer sampling system for real time direct

continued

RESEARCH FACILITIES
(SERI continued)

observation of the molecular processes of biomass pyrolysis gasification and combustion.

The staff have conducted both basic and applied research on gasification and pyrolysis reactions. SERI is involved developing commercial-scale oxygen gasifiers. SERI offers research facilities for evaluating gasifiers and provides some training in gasifier measurement and experimental procedures.

Contact: Dr. Thomas Reed
Solar Energy Research Institute
Thermochemical and Electrochemical Branch
1617 Cole Boulevard
Golden, CO 80401

Phone: (303) 231-1000

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OTHER RESOURCES

Please refer to Index:

Jordan Energy Institute

Mississippi County Community College

Red Wing Energy Education Center

University of Wisconsin

Section II

Wind Energy Systems

INTRODUCTION

Wind energy conversion systems (WECS) fall into two main categories: electrical generation or mechanical output--normally, reciprocating motion for water pumping. Electrical generators can then be used either to feed power into the electrical grid or to serve an on-site purpose, such as residential electrical consumption, telecommunications or running electrical water pumps.

Courses tend to stress one or the other of these categories. The Wind Baron course in windmill water pumping, for instance, deals almost exclusively with mechanical energy conversion. The Helion course addresses mainly electrical generation. The New Mexico State University course covers both. In general, university-level courses in wind energy conversion focus on electronics, aerodynamics and fluid mechanics.

Since extensive research and development efforts have gone into the design of commercially available machines, it is unlikely that developing country governments would wish to duplicate these efforts. Hence, course offerings listed here are based not on actual machine or component design, such as DC to AC inverters, but rather on selecting the right machine for the application and correctly matching components to provide maximum output for each site's wind conditions. Some simply designed wind machines can be constructed locally (see New Alchemy Institute), but most require close tolerance metal machining, which is not always possible in developing countries.

The range of training offered is somewhat limited. Until recent legislation made it economically feasible to build large-capacity wind farms in the U. S., few electrical generators were used other than for remote-site telecommunications. On the other hand, windmill pumpers have traditionally been seen as a simple technology for which one simply called a local supplier and stated one's needs. Since most sites have less than ideal wind regimes, careful attention in either situation must be paid to machine and component selection to justify rising costs. This is the issue to which the courses listed address themselves.

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COURSE SUMMARY

Organization	Course or Program	Schedule	Page
Helion, Inc.	Wind Energy: Resource Evaluation, Measurement and System Design	1- to 10-day classes and seminars on demand	II-3
New Mexico State University	Windmill Course: Water and Electrical	2 weeks each April and October	II-5
Wind Baron Corp.	Wind-Powered Water-Pumping Systems	3 days to 2 weeks, on demand	II-8
University of Massachusetts	Wind Energy specialization	university semester or 1-week seminar, on demand	II-10

SHORT COURSE

Wind Energy: Resource Evaluation, Measurement, and System Design

Sponsor: Helion, Inc., Brownsville, California

Description

Course is concerned principally with wind electric generating turbines, although mechanical water pumpers are briefly discussed. A variety of types of wind energy installations are visited on field trips. Course format is approximately 60 percent lecture and 40 percent field experience.

Curriculum includes: wind energy measurement techniques and data analysis; site selection and analysis, including engineering, environmental and communication considerations; sizing of wind energy equipment with respect to site and application, including preparation of specifications for the equipment; and performance monitoring instrumentation. Theory relevant to design is given as background. Courses are designed around trainee background and experience rather than offering fixed content.

Background

Helion has been offering training courses in wind energy applications since 1976. One of the instructors is author of The Wind Energy Book, a widely used resource in this field. About 50 trainees have attended the course so far, many of whom were from developing countries. Number of participants varies from four to 12.

Availability

Courses are scheduled on demand rather than on a regular basis. Length varies from one- to two-day seminars to five- to ten-day classes, depending on trainee request. Fee for a typical one-week class is $3,500 divided by number of participants. Course arrangements must be made well in advance of desired training period.

continued

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SHORT COURSE
(Helion continued)

Prerequisites

Courses have been directed toward both the technician and the person with an engineering level of technical background. Basic requirements are a high school education and mechanical skills in equipment operation and field construction. All presentations are in English.

Key Instructors

Jack Park, B.S. in aeronautical engineering; author; 10 year's experience in wind energy systems; has taught courses in solar and wind energy theory and applications at three universities, as well as short courses in the United States and Africa.

Billy Owens, B.A.; seven year's experience in wind energy and electronics; has taught courses on wind energy siting and measurement techniques.

Accommodations

Trainees are responsibile for making own housing arrangements. Housing is available nearby at reasonable rates. Contact instructors for further information.

Key Contact

Billy Owens, Vice President: (916) 675-2478

Helion, Inc.
Box 445
Brownsville, CA 95910

Telex: 172133 HQSAC/HELION

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SHORT COURSE

Windmill Course
(Water and Electrical)

Sponsor: Continuing Education, College of Human and Community Resources, New Mexico State University (NMSU), Las Cruces

Description

Course addresses the system sizing, background theory, installation, operation and maintenance of water pumping windmills. It is designed for the rural community where windmills are still in existence, but where qualified technicians are practically nonexistent. Half the time is spent in the classroom and half in hands-on windmill experience.

The curriculum consists of history of wind power, types of windmills, windmill theory, windmill technology, water production and distribution, various methods of pumping wells, selection of proper size mill, selection of cylinder and rods, packer heads, screens, storage tanks, overhaul of older mills, maintenance, erection of tower, installation of new mills, electrical wind generator, DC and AC systems, selection, installation, repair and maintenance, battery banks, rectifier, synchronous inverters, distribution systems, auxiliary equipment and towers. There are eight different windmills located on site.

A certificate as Certified Windmill Technician is given to each trainee who successfully completes the course.

Background

Course has been offered twice a year for the last eight years. Between 12 and 20 trainees participate per course. Of these, about 20 percent are from developing countries.

Course is particularly well recommended by past trainees for its hands-on experience and depth of coverage.

continued

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SHORT COURSE
(NMSU continued)

Availability

Course is two weeks long, eight hours a day and held twice a year in April and October. Class size is limited to insure reasonable student/teacher ratio, so it is advisable to register a month in advance. A $100 deposit must accompany registration form. Total cost of course is $235 per student. Applications are accepted up to the start of the course on a space-available basis. Reference materials are included in cost of course.

Prerequisites

Course does not assume any academic or technical background, although familiarity with common hand tools is required. It is aimed at those who will be physically working with water pumping windmills, both installation and maintenance. Instruction is ordinarily given in English, but is available in Spanish and German as well.

Key Instructors

Principal instructor is Dr. M. I. Rasmussen of the Agricultural Engineering Department at NMSU. He has had 15 years of teaching experience in mechanical wind pumping systems, including four years experience in Latin America. He speaks English, Spanish, German and Danish.

Accommodations

Trainees are expected to make their own arrangement for room and board. Both are available nearby. Rooms are available at reasonable rates to trainees at the Coachlight Inn, Route 2, Box 495, Las Cruces, NM 88001, Phone: (505) 526-3301; or Super 8 Motel, 245 La Posada Lane, Las Cruces, NM 88001, Phone: (505) 523-8695. Meals are available on a free choice basis at campus facilities. No housing is available on campus.

continued

SHORT COURSE
(NMSU continued)

Key Contact

Dr. Leon A. Wagley: (505) 646-4511

New Mexico State University
Box 3501
Las Cruces, NM 88003

SHORT COURSE

Wind-Powered Water Pumping Systems

Sponsor: Wind Baron Corporation, Phoenix, Arizona

Description

Course addresses both technical design, installation and manufacturing of wind-powered water pumping windmills. Included in the curriculum are: manufacturing processes/techniques, instrumentation and data collection for windmill performance testing, rating standards, system sizing and performance, hands-on installation training, foundations and towers, and comparisons of various manufacturers' machines.

Certificates of Completion are offered to trainees who successfully complete the course. Credit may be available through Arizona State University in the future.

Background

Courses have been taught for one and a half years, with 40 trainees having completed training. Classes are limited to 15 participants. About 80 percent of these have been from developing countries.

Availability

Courses vary in length from three days to two weeks, depending on the needs of the trainees. There is no set schedule. Classes are held as demand dictates, usually biannually. Structured internships are considered on a monthly basis. Most classes are available at no cost to participants. Application deadlines are three days prior to start of each course.

continued

SHORT COURSE
(Wind Baron continued)

Prerequisites

There is no scholastic background requirement, although trainees must have a good command of English, some mechanical ability and a willingness to participate in the hands-on portion of the training seminar. Course is directed to those who are or will be actually involved in sizing and installing windmill systems.

Key Instructors

Richard Sutz, President; holds degrees in engineering, business and finance; has worked extensively with design, development and testing of wind-powered water-pumpers; speaks English, French and German.

Brian Foose, Operations Manager; has 11 years' experience in marketing, engineering and manufacturing; has conducted manufacturing seminars for four years at Wind Baron.

Pat Grace, instructor in tower and footing designs; has mechanical engineering degree.

John Taylor, Field Service Manager; instructor in assembly and safety procedures; has over five years of windmill installation and maintenance experience.

Accommodations

Trainees must make their own reservations at any of the many nearby motels. Suggestions for rooms and restaurants are available through the Wind Baron support staff.

Key Contact

Brian Foose, Operations Manager: (606) 269-6900

Wind Baron Corporation
3702 West Lower Buckeye Road
Phoenix, AZ 85009

Telex: 6835005 INTELEX

DEGREE PROGRAM

Wind Energy

Sponsor: University of Massachusetts, Amherst

Description

The Mechanical Engineering Department of the University of Massachusetts offers a specialization in wind energy as part of its undergraduate and graduate programs. Courses are offered in resource measurement, system sizing, design and analysis, testing and monitoring, modelling and economic analysis of wind-energy systems, designed for both electricity generation and mechanical output. Degrees offered are B.S., M.S. and Ph.D.

Availability

Courses are offered on a semester basis. AID-sponsored participants may register under "special student" status for a single semester of coursework. The Mechanical Engineering Department also organizes shorter, intensive seminars (from three days to one week long) that give an overview of wind energy systems. These can be scheduled to fit the needs of any interested organization. Cost is dependent on the number of participants and duration of the session.

Instructors

John McGowan, Ph.D. in mechanical engineering; experience in West Africa.

James Manwell, Ph.D. in mechanical engineering; speaks Spanish.

Robert Kirchoff, Ph.D. in mechanical engineering.

Duane E. Cromack, Ph.D. in mechanical engineering.

continued

DEGREE PROGRAM
(U. Mass continued)

Key Contacts

Dr. John McGowan or Dr. James Manwell: (413) 545-2505

Mechanical Engineering Department
University of Massachusetts
Amherst, MA 01003

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OTHER RESOURCES

Please refer to Index:

Cabrillo Junior College

Jordan Energy Institute

Mississippi County Community College

New Alchemy Institute

Red Wing Energy Education Center

Yavapai College

Section III

Small-Scale

Hydroelectric Systems

INTRODUCTION

Hydropower has been used to produce electricity in the United States for over 50 years, mainly by large-scale facilities. Reliance on hydropower declined, however, between the late 1950s and early 1970s, owing to low-cost petroleum products and the consequent development of large, oil-fired electricity generating plants. Many small-scale hydroelectric and shaft power installations, particularly in the northeastern United States, were abandoned as a result. It was not until the "energy crisis" of the early 1970s that hydroelectric facilities appeared economical once again, and a surge of interest in restoring small-scale hydroelectric facilities began.

Civil engineering departments of several large universities have offered formal courses in technical areas related to the design, construction and management of large hydro facilities for some time. Training specific to small-scale hydropower engineering had its genesis in the mid-1970s, and many short courses have been offered by universities, equipment manufacturers and engineering firms since that time. The number of these courses, however, has dropped in the last few years as demand and enrollment declined.

Some universities have incorporated courses specific to small-scale hydro development into their civil engineering curriculum, such as hydrology, hydraulic engineering, hydraulic structures, fluid mechanics, and water resources engineering, for example. The second part of this section lists universities that are particularly well-known for these courses. The first part describes courses currently offered that address different types of training needs in small-scale hydro development, such as technician-oriented, hands-on training; management training in planning, feasibility and design of facilities; and training in the application of computer simulations for hydropower planning and management.

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COURSE SUMMARY

Organization	Course or Program	Schedule	Page
Denver Research Institute	Small-Scale Hydropower Development	5 weeks a year, May 20 to June 21, 1985	III-4
Denver Research Institute	Development, Management and Engineering	15 weeks a year, May 27 to Sept. 6, 1985	III-4
Hydrocomp, Inc.	Hydrologic Simulation	5 days, twice a year: March 25-29 and Sept. 16-20, 1985	III-7
Hydrocomp, Inc.	Hydrologic Estimates for Hydropower	3 days, twice a year: April 3-5 and Sept. 25-27, 1985	III-7
University of Minnesota, St. Anthony Falls Hydraulic Lab	Development: Planning, Feasibility and Design	5 days each July	III-10
Massachusetts Institute of Technology, Ralph M. Parsons Lab	Water Resources and Environmental Engineering studies	university semester	III-13
University of Colorado	Water Resources Engineering studies	university semester	III-13
University of California/Davis	Water Resources Engineering studies	university quarter	III-14
University of Minnesota, St. Anthony Falls Hydraulic Lab	Hydropower Engineering and research	university quarter	III-14
Washington State University	Hydraulic Engineering studies and research	university semester	III-15

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COURSE SUMMARY

Organization	Course or Program	Schedule	Page
University of Idaho	Hydropower Engineering studies and research	university semester	III-15
University of Idaho	Hydropower Engineering Video courses	on demand	III-16
Colorado State University	Hydropower Engineering studies	university semester	III-17

SHORT COURSE

Small-Scale Hydropower Development (five weeks)

and

Small-Scale Hydropower Development, Management, and Engineering (15 weeks)

Sponsor: Denver Research Institute (DRI), Office of International Programs, Denver, Colorado

Description

Office of International Programs offers two small-scale hydro courses, one of five weeks, the other of 15 weeks. Both are heavily field oriented and include practical, hands-on experience at existing facilities, facilities under construction, and planned sites with rated unit capacity ranging from 12 kW to 5 MW.

Five-week course topics are: introduction to small hydro engineering; rationale for hydro project development; management approach to small hydropower project identification and planning; introduction to small hydro economics and financial analysis dealing with and compensating for risk and uncertainty; resource development; reconnaissance and feasibility studies; project design; project engineering and construction services; project operations and maintenance; project financing; conducting engineering and construction services with international firms; and several manufacturers and suppliers presentations.

Fifteen-week course topics are: economic and financial analysis/financing small hydro development (3 weeks); topography, rheology and hydrology (1 week); technical feasibility studies and reconnaissance (2 weeks); small hydro project engineering and design (3 weeks); facility operation and maintenance (3 weeks); construction management/working with domestic and international contractors (1 week); rural development and electrification (1 week); and information resources (1 week).

A Certificate of Completion is awarded to participants at the end of both courses, and Continuing Education Units (CEUs) are awarded for the 15-week course.

continued

SHORT COURSE
(DRI continued)

DRI can arrange structured internships for studies in small-scale hydropower development and can assist participants in gaining access to regional hydro sites for inspection tours.

Background

The Denver Research Institute, University of Denver, is engaged in research in the areas of engineering, science, applied economics and the humanities for government and industry. DRI was established in 1974. Its list of government and industrial clients numbers over 200 and includes organizations from all over the world. DRI's international programs provide training, technical assistance, and cooperative research aimed at the resolution of problems and the development of local capabilities to provide similar services in their own countries. Both courses have been offered for the past two years and have averaged 10 participants per session, all of whom have been from developing countries.

Availability

Both courses are offered annually. 1985 session of the five-week course is: May 20 to June 21; of the 15-week course: May 27 to September 6. Tuition for the short course is $3,425, including materials; and for the long course, $7,500, including materials. Applicants should be registered, accepted and, if possible, paid for by one month before start of course.

Prerequisites

Courses are aimed at developing country engineers and managers. English language fluency and current involvement in hydro projects are required. University degree is desirable, but experience in pratical applications is acceptable.

continued

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SHORT COURSE
(DRI continued)

Key Instructors

All training staff have extensive experience in developing countries. For each session, the faculty is assembled from a number of engineering companies, equipment manufacturers, consulting firms active in hydro contracts, university testing labs, public utilities and other organizations.

In previous years, instruction has been provided by: Stravos Nicolaou - PRC/ECI; John Williams, Gordon Little and Nelson Jacobs - Tudor Engineering; Bill Harris - North American Hydro; Graham Taylor - Colorado Energy Research Institute; Jack Fritz - NAS; Warner Wayne, Ed Tondu, Gene Chick and Ken Lawrence - Stone and Webster Engineering; John Lyle - Colorado Public Service Co.; Maury Albertson - Colorado State University; Norman Crawford - Hydrocomp; James Cudney, Bart Jackson, Ed Gaither and Miko Smith - NRECA; Jim Fish, Peter Cordukes - World Bank; Ed Moore - Harza Engineering; Paul Carr - Axel Johnson Corp.; George Sabol - Tipton and Kalmbach; and Ed Fullerton - Simons, Li and Associates. Others joining the staff for the first time at each session are representatives of turbine and generator manufacturers.

Accommodations

Dormitory-style housing is available at the University of Denver for $35 a day, room and board. Hotel arrangements are available starting at $40 a day.

Key Contact

James W. D. Frasche, Management Scientist: (303) 763-2185

Denver Research Institute
Office of International Programs
University Park
Denver, CO 80208

Telex: 9109310586 UDRESEARCH OVR
Cables: DRISEARCH

SHORT COURSE

Hydrologic Simulation

and

Hydrologic Estimates for Hydropower

Sponsor: Hydrocomp, Inc., Mountain View, California

Description

Courses train participants in computer applications of continuous hydrologic simulation to water resource management, including hydropower project design and operation forecast and optimization.

The five-day "Hydrologic Simulation" course helps planners use computer models to understand the hydrologic regime and the continous behavior of a watershed as land use, power production, irrigation diversion, or groundwater usage is changed. It is designed for people who wish to use simulation techniques for hydrologic analysis or environmental studies.

This workshop includes descriptions of hydrologic simulation programming (HSP) model algorithms, calibration of continuous models, data requirements, data management and applications of models to specific water resource planning problems. Participants operate an HSP model on the in-house HP 3000 computer.

The three-day "Hydrologic Estimates for Hydropower" workshop is designed for professionals who design or manage hydropower projects. It will be helpful to those who make hydrologic estimates, or who need to understand the merits or limitations of hydrologic methods.

This workshop considers two main topics: the development of hydrologic information for constructions of new hydro facilities, and the role of hydrology in operating existing hydro facilities effectively. Methods to develop hydrologic estimates for ungaged streams and calculations for existing projects such as spillway requirements and flood inundation studies are introduced.

continued

SHORT COURSE
(Hydrocomp continued)

Evaluation of the effects of power production on fisheries and technical methods for establishing in-stream flow requirements are reviewed. Since demands on water resources for irrigation, fisheries, municipal and industrial water, navigation and recreation are all increasing, methods of finding optimal operation of hydro facilities in this changing environment are discussed.

Background

Hydrocomp has sponsored workshops in hydrologic simulation and estimation since 1970. Current workshops were developed in cooperation with the U. S. Environmental Protection Agency (EPA) in 1979. Approximately 5 - 10 percent of participants come from developing countries. Workshops have been implemented in North and South America, Europe and Asia.

Availability

Both courses offered biannually. Hydrologic Simulation will be offered from March 25 - 29 and from September 16 - 20, 1985. Fee is $595, and attendance is limited to first 15 respondents. Hydrologic Estimates for Hydropower will be offered from April 3 - 5 and from September 25 - 27, 1985. Fee is $295, and first 30 respondents are admitted.

Prerequisites

No prerequisites, although some familiarity with computer simulation models and the general problems and methods of hydropower development is helpful.

Key Instructors

Norman H. Crawford, Ph. D., hydraulic engineering; specialties--applications of computer simulation of hydrologic resources in regional environmental planning and hydropower development.

continued

SHORT COURSE
(Hydrocomp continued)

Allen Bradley, M.S., civil engineering; specialty--water resources hydrology.

C. D. D. Howard, M.S., civil engineering; specialty--hydro resource optimization.

Accommodations

A list of hotels and motels located near Hydrocomp is available on request. Bus transportation is available from the airport.

Key Contact

Dr. Norman H. Crawford: (415) 948-3919

Hydrocomp, Inc.
201 San Antonio Circle, Suite 280
Mountain View, CA 94040

SHORT COURSE

Small-Scale Hydropower Development: Planning, Feasibility, and Design

Sponsor: The University of Minnesota, St. Anthony Falls Hydraulic Laboratory (SAFHL), Minneapolis

Description

Course consists of in-class lectures accompanied by detailed notes. Tours of existing hydropower facilities in Minnesota and Wisconsin and the St. Anthony Falls Hydraulic Lab supplement lectures at the end of each daily session.

Topics covered in lectures include: hydropower hydraulics, hydrological and operational analysis, introduction to small-scale hydropower, case studies in hydrologic and hydraulic analysis, hydromechanics of turbines, low-head hydroelectric fundamentals, cavitation and turbine research, generators, electrical equipment and control systems, economic development of efficient hydroelectric systems, estimating civil works construction costs, case studies in facility design, environmental impacts of small-scale facilities, economic and financial analysis, hydropower development: an entrepreneur's perspective, hydropower licensing procedures, and institutional aspects of hydropower development.

A certificate of course completion awarded to each participant. Course has been approved for 2.5 Continuing Education Units (CEUs).

Background

SAFHL was established as an educational and research institution of the University of Minnesota over 40 years ago. It has sponsored this course each July for the last four years, averaging between 50 and 100 participants per session. Approximately two percent of these are from countries outside North America.

continued

SHORT COURSE
(SAFHL continued)

Availability

Course is five days; held annually in July. Fee is $650, which includes lecture notes and transportation for site visits. Fee also includes four luncheons, a reception and refreshment breaks.

Course application form and fee must be received no later than two weeks before start of session.

Prerequisites

Course is oriented toward engineers and planners from consulting engineering firms, equipment manufacturers, contractors, government agency and industry employees who are involved in planning, feasibility, design or retrofit of small-scale hydropower facilities. There are no educational prerequisites. All presentations are in English.

Key Instructors

Dr. Roger E. A. Arndt, Director and Professor, SAFHL - specialties: cavitation, aero-hydroacoustics, hydropower.

Dr. C. Edward Bowers, Professor, SAFHL - specialties: hydrology, hydraulic engineering.

Dr. John S. Gulliver, SAFHL - specialties: hydropower, air-water dynamics, turbulent diffusion.

Dr. Charles C. S. Song, SAFHL - specialties: hydraulic transients, fluvial mechanics.

Accommodations

Housing is reserved at Best Western University Inn, 2600 University Avenue, S. E., within walking distance of classroom. Suggestion is that reservations be made at least two weeks in advance by calling (612) 379-2313 and mentioning participation in the "Small-Scale Hydropower Course."

continued

SHORT COURSE
(SAFHL continued)

Key Contacts

John S. Vollum, Program Director: (612) 373-3157
Cheryl Jones, Program Associate: (612) 373-3173

Small-Scale Hydropower Short Course
Department of Conferences
223 Nolte Center
315 Pillsbury Drive, S. E.
Minneapolis, MN 55455

DEGREE PROGRAMS

Massachusetts Institute of Technology (MIT)
Ralph M. Parsons Laboratory

Bachelor's, master's, doctoral and engineering degrees are offered by MIT through its Department of Civil Engineering, Division of Water Resources and Environmental Engineering and the Ralph M. Parsons Lab. Courses and research opportunities are offered in the areas of hydropower development, hydrology, hydrodynamics, coastal and oceanographic engineering, solar ponds, cooling systems, ocean wave energy extraction, ocean thermal energy conversion and hydraulic modelling on a semester basis, beginning in September and February.

Contact: Rafael L. Bras: (617) 253-2117
Ralph M. Parsons Lab
Massachusetts Institute of Technology
77 Massachusetts Avenue
Cambridge, MA 02139

University of Colorado

As part of a water resources engineering graduate program, the Department of Civil Engineering offers a specific course in hydropower engineering during the Spring semester of every other academic year. Course covers the following topics as they relate to hydropower development: hydrology, flow analysis, plant layout, operation studies, types of power facilities, hydraulic design, power estimates, costing and regulations. Semester lasts approximately 4½ months. Next course offered in 1985. Non-resident tuition is $850. The department recommends that students attending on a "special student" basis also take advantage of related courses offered during the Spring semester including: open channel hydraulics and water law.

Contact: Ernest Flack: (303) 492-7111)
Department of Civil, Environmental
and Architectural Engineering
Campus Box 428
University of Colorado
Boulder, CO 80309

continued

DEGREE PROGRAMS
(continued)

University of California

Courses offered by the Department of Civil Engineering lead to graduate degrees in water resources engineering and include the following topics: hydrology, hydraulics, dynamic systems and controls, energy systems, fluid mechanics and power and machinery. Courses are offered on a 10-week quarter basis, and "special student" status is available. Registration deadline is April 15 of each year for the following Fall quarter.

Contact: Dr. Karl M. Romstad: (916) 752-1755
Department of Civil Engineering
University of California
Davis, CA 95616

University of Minnesota

The Department of Civil Engineering and the St. Anthony Falls Hydraulic Lab offer courses and research opportunities in many aspects of hydropower engineering, and include: hydraulic machinery (pumps and turbines), introduction to hydropower, fluid mechanics, hydraulic structures, dimensional analysis, hydrology and environmental hydraulics and water quality. Graduate research in these areas is aided by the St. Anthony Falls facilities. Master's and doctoral degrees are awarded in civil engineering or in the specialized area of fluid mechanics.

Contact: Heinz G. Stefan, Graduate Program: (612) 373-2782
St. Anthony Falls Hydraulic Laboratory
University of Minnesota
Mississippi River at Third Avenue, S. E.
Minneapolis, MN 55414

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DEGREE PROGRAMS
(continued)

Washington State University

The Hydraulic Engineering Section of the Department of Civil and Environmental Engineering offers a two-year M.S. program. Courses and research opportunities exist in the administrative framework of the department to provide training in several areas of hydropower development: hydrology and water resources planning; soils, rock mechanics and foundations; structural engineering and construction planning, hydraulic engineering design, streamflow mechanics and hydromachinery; economic analysis of development and maintenance; and environmental assessments. Specific areas of interest can be applied to rockfill and earthen dams, concrete dams and combinations--either high- or low-head--conventionally required components of hydropower engineering.

Instituted during the 1980-81 academic year, the program uses the variety of hydro sites in the immediate area on the Columbia and Snake River systems as case studies. Another campus resource is the Albrook Hydraulic Laboratory. Washington State has a cooperative relationship with the University of Idaho, eight miles away, which allows students at both institutions to attend courses at either. USAID has sponsored two graduates of this degree program.

Contact: Dr. Alan F. Babb: (509) 335-4546
R. L. Albrook Hydraulics Laboratory
Washington State University
Pullman, WA 99164

University of Idaho

Several courses related to hydropower are part of the master's and doctoral programs. They include two hydraulic design courses, emphasizing design and functioning of pumps and turbines; two courses in hydrology; a water resources systems course, emphasizing systems analysis techniques; and a water resources planning course, emphasizing planning methodologies associated

continued

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DEGREE PROGRAMS
(continued)

with hydropower development. Integral to these are field trips to a variety of hydro sites (from micro- to large-scale) in the immediate area.

The university has a cooperative relationship with Washington State University, eight miles away, which permits students at both institutions to attend engineering courses at either. USAID has sponsored graduate students at Idaho.

Contact: Dr. James H. Milligan, Chairman: (208) 885-6782
Department of Civil Engineering
University of Idaho
Moscow, ID 83843

Besides graduate courses, Idaho's Video Outreach Program has a series of videotaped lectures in hydropower planning. Instructor Dr. Calvin C. Warnick, Professor Emeritus of Civil Engineering, has over 36 years of teaching experience in the area of hydropower. Most recently, he taught a series of short courses at the university. Videotapes are available on the following subjects: fundamentals of hydropower planning, hydrology for hydropower, selection of units, turbine setting selection, water passage sizing, economic analysis, speed and pressure control, electrical considerations and environmental feasibility. The textbook used in conjunction with taped lectures is Hydropower Engineering, by C. C. Warnick in collaboration with Howard A. Mayo, Lee H. Sheldon and James L. Carson. Tapes are available for either purchase or rental through the University of Idaho Video Outreach Program.

Contact: ITV/Video Outreach
University of Idaho
Moscow, ID 83843

Phone: (208) 855-6373

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DEGREE PROGRAMS
(continued)

Colorado State University

The Department of Civil Engineering has been a leading center of studies related to hydropower engineering for many years. Courses offered include: flood distribution, hydrographs, water and power optimization, hydraulic structures, hydrology and water resources. Field visits to several kinds of hydro facilities in the area are part of the program.

Contact: Maurice Albertson: (303) 491-5753
Department of Civil Engineering
Colorado State University
Fort Collins, CO 80523

OTHER RESOURCES

Please refer to Index:

Farallones International

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Section IV

Photovoltaic Systems

INTRODUCTION

As the cost-effectiveness of photovoltaic energy systems has improved, interest in them has grown, not only in remote-site telecommunications applications, but in far wider uses. This has led to a number of short training programs addressing various aspects of PV applications.

While the manufacture of PV cells is a very sophisticated process, the design of PV systems involves only careful matching of various components to achieve a reasonably efficient operating system. Given certain rules of thumb, the choices are not difficult.

Common PV applications include telecommunications, water pumping, village lighting systems and cold chain vaccine refrigeration for remote clinics. In the U. S., residential electrical needs are being met by PVs in a few demonstration projects, but these are far from cost effective at this time.

PV training normally includes a brief discussion of the electronics of the photovoltaic effect, and then concentrates on matching system components and local microclimate to effectively and economically meet the required load. This is true of semester courses and two-day seminars alike.

As in other sections of this guide, categories of training cover technician-level semester courses, short seminars, and a list of universities where engineering-level courses are available. As PVs have been viewed as an exotic and expensive energy source until quite recently, university-level courses are few. PVs are generally treated as one aspect of a course on direct energy conversion devices, rather than as a topic unto themselves. Because PV pumping is a very new field, although research is ongoing, academic courses focused on this topic specifically are not yet available.

COURSE SUMMARY

Organization	Course or Program	Schedule	Page
ARCO Solar Training Dept.	Basic Photovoltaic Technology	1 week, 5 times a year or 3 weeks, once a year	IV-3
Louis Rosenblum, Ph.D.	Photovoltaic Technology	5 days, on demand	IV-5
Colorado Mountain College	Vocational training in Photovoltaics	3 weeks in July or August, on demand	IV-7
Florida Solar Energy Center	Photovoltaics Applications seminar	2 days, frequently offered	IV-9
New Mexico Solar Energy Institute	Photovoltaics short courses	2- to 5-days workshops, frequently offered	IV-9
Home Energy Workshop	PV System Design, Installation and Operation	2 days, frequently offered	IV-9
Blue Sky Water Supply	PV Water Pumping	1 week, on demand	IV-10
Solarwest Electric	PV Cell Manufacturing, System Design and Applications	1 week, twice a year	IV 10
New England Solar Energy Association	PV Applications	2- to 5-day workshops, frequently offered	IV-10
Cleveland State University	Photovoltaics specialization	university quarter	IV-12

SHORT COURSE

Basic Photovoltaic Technology

Sponsor: ARCO Solar Training Department, Chatsworth, California

Description

Photovoltaic system design and component specification are thoroughly covered in this well-recommended course, which addresses each of the many types of PV applications, and are offered as one- or three-week courses.

Details vary between the two; however, both curricula include: history of PVs, theoretical concepts, manufacturing, basic electricity, array wiring, batteries, system sizing for both AC and DC systems, water delivery systems, inverters, controllers, hands-on practice with installation and performance evaluation, safety considerations. The three-week course emphasizes intensive hands-on work and includes additional field site visits.

Background

ARCO Solar has been conducting training courses in PV applications, in conjunction with its manufacturing and marketing efforts, since 1981. About 1,500 trainees have attended courses, which have been given in 36 other countries, principally developing nations.

Availability

Basic course is one week and offered five times a year. The intensive, three-week course is offered annually and is intended for trainees working with large ARCO Solar projects. In many cases, courses are offered at no cost, upon recommendation of trainees by ARCO regional offices. Prospective trainees should contact ARCO regional office six weeks before start of course to request enrollment. 1985 schedule is January 21, March 17, May 19, September 22 and October 20 for one-week course; intensive course is tentatively scheduled for late March.

continued

SHORT COURSE
(ARCO continued)

Prerequisites

English language ability is essential. No specific level of technical education is required; however, completion of a self-taught, pre-course, "Basic PV Technology," using video-taped and written material, is a prerequisite for course participation.

Key Instructors

Mark Mrohs, B.S. in physics; Manager of Training; has eight years in PV research and manufacturing; speaks French.

Gary Zahnstecher, has 15 years in electrical engineering with three years specifically in PV; speaks Spanish.

Harlan Chapman, B.S. in engineering; has 20 years in construction engineering, include four in working with PVs.

Peter McKenzie, has six years in PV engineering and installation; extensive overseas experience.

Robert Muhn, B.S. in engineering; has five years in PV engineering and marketing; speaks Portuguese and Spanish.

Accommodations

Trainees must make their own housing arrangements. Suggested accommodations include: Country Squire, 7631 Topanga Canyon Road, Canoga Park, CA; Holiday Inn, 21101 Ventura Boulevard, and Vagabond Hotel, 20157 Ventura Boulevard, Woodland Hills, CA.

Key Contact

Mark Mrohs, Manager of Training: (818) 700-7687

ARCO Solar Training Department
9351 Deering Avenue
P. O. Box 2105
Chatsworth, CA 91313

SHORT COURSE

Photovoltaic Technology

Sponsor: Louis Rosenblum, Ph.D., Cleveland, Ohio

Description

Course provides participants with detailed information on the practical aspects of PV systems, an overview of various PV applications and operating experience for PV systems, and the tools needed for preliminary system design, cost estimation and trade-off analysis.

Major items covered include: system sizing, choice of batteries, regulators and system controls, design factors, instrumentation, load matching, and procurement procedures.

Course consists of classroom lectures, site visits and laboratory sessions. A major textbook, written specifically for this course by Dr. Rosenblum, is provided.

Background

Dr. Rosenblum worked for the National Aeronautics and Space Administration (NASA) for nearly 30 years, both as a scientist and administrator. He was the chief of the Direct Energy Conversion Division (later, the Solar and Electro-Chemistry Division) of the NASA-Lewis Research Center from 1969 to his retirement in 1981. Dr. Rosenblum has worked on and overseen research on technology development for space and terrestrial applications of PV cells. In 1983, under USAID auspices, he presented the PV Technology course in Ecuador, Guyana, Kenya and Zimbabwe. In 1984, the course was presented in Gabon under U.S. DOE auspices. Participants at these four-day courses were national energy planners, university scientists, utility managers and representatives of the private sector.

continued

SHORT COURSE
(Rosenblum continued)

Availability

To date, Dr. Rosenblum has presented this course only overseas. However, a U.S.-based course is tentatively planned in cooperation with Cleveland State University. It will consist of four days of classroom sessions and one day of lab presentations and site visits. The fee will depend on the number of participants.

Prerequisites

Course is designed for people with technical and scientific background, but does not require previous experience with PV systems. All presentations are in English.

Key Instructor

Louis Rosenblum, Ph.D. in organic chemistry

Key Contact

Louis Rosenblum, Program Director: (216) 234-3755

7696 Alan Parkway
Cleveland, OH 44130

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SHORT COURSE

Vocational Training in Photovoltaics

Sponsor: Colorado Mountain College (CMC), Glenwood Springs, Colorado

Description

This three-week certificate program provides a mix of classroom and hands-on skills training in PV. The classroom portion includes basics of solar electricity, PV system components and how to design and specify equipment for small-scale residential solar electric systems. Commercially available technology, which is practical and cost effective, is stressed.

Hands-on PV training follows classroom training and includes the complete installation of an operational PV system. PV installations may typically service AC and DC loads, including lighting, communications, home appliances, power tools and water pumping. Proper installation procedures, tools, materials and safety are stressed.

Background

CMC has developed this course over three years and has offered it as a portion of its regular eleven-month Solar Retrofit Training program.

Availability

The program may be offered as an intensive three-week course in July or August, upon request by a particular organization. Cost is dependent on the number of participants.

Prerequisites

High school graduation or equivalent. All instruction is in English.

continued

SHORT COURSE
(continued)

Key Instructors

Steve McCarney, M.Ed., 10 years' renewable energy experience in contracting and energy analysis.

Ken Olsen, M.A., 10 years' renewable energy experience in contracting, community work and training.

John Weiss, building, 10 years' renewable energy experience.

Accommodations

Dormitory-style accommodations are available for $9 per night. Apartments are also available near the campus at rates of $100 per week for one bedroom or $150 per week for two bedrooms.

Key Contact

Steve McCarney: (303) 945-7481

Solar Retrofit Program
Colorado Mountain College
Spring Valley Campus
3000 114 Road
Glenwood Springs, CO 81601

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SEMINARS

Florida Solar Energy Center

Two-day seminars in practical photovoltaics applications are offered frequently throughout the years. In addition, special one-day sessions are available. FSEC is the site of the Southeast Residential Experiment Station of the U.S. Department of Energy (DOE).

Contact: Ken Sheinkopf
Florida Solar Energy Center
300 State Road 401
Cape Canaveral, FL 32920

Phone: (305) 783-0300

New Mexico Solar Energy Institute

NMSEI offers short courses in PV, including residential systems, water pumping and basic background theory. New Mexico State University (NMSU) in Las Cruces, NM, is also the site of the Southwest Residential Experiment Station for PV residences. Regularly scheduled courses as well as special sessions are available.

Contact: Michael Hensley, Project Manager
Information and Education
New Mexico Solar Energy Institute
Box 3 SOL
Las Cruces, NM 88003

Home Energy Workshop

H.E.W. offers workshops in PV system design, emphasizing the practical aspects of PV operation and installation. Regular scheduled course in the U.S. (two days) and special training programs of up to a month in duration are available. Experience in conducting PV training programs overseas. Of more than 300 graduates, 30 percent have been from developing countries.

continued

SEMINARS
(H.E.W. continued)

Contact: Jim Welch
1558 Riverside Avenue
Fort Collins, CO 80524

Phone: (303) 482-9507

Blue Sky Water Supply

Blue Sky offers a short course in PV water pumping using progressive cavity pumps. Many of these systems have been installed in Africa as well as in the United States. Available on arrangement with Blue Sky.

Contact: Ron Shaw
P. O. Box 21359
Billings, MT 59104

Phone: (404) 259-0654

Solarwest Electric

Solarwest gives a course twice a year on PV cell manufacturing, system design and applications.

Contact: Bonnie Sue Workman
232 Anacapa Street
Santa Barbara, CA 93101

Phone: (805) 963-9667

The New England Solar Energy Association

NESEA has sponsored a number of workshops on PV applications with some very experienced applications personnel. Installation, operation and maintenance are stressed rather than theory.

continued

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SEMINARS
(NESEA continued)

Contact: New England Solar Energy Society
P. O. Box 541
Brattleboro, VT 05301

Phone: (802) 254-2386

DEGREE PROGRAM

Photovoltaics

Sponsor: Department of Electrical Engineering, Cleveland State University, Ohio

Description

The Department of Electrical Engineering offers a Masters in Electrical Engineering (M.S.E.E.) with a specialization in photovoltaics, for students with backgrounds in engineering, mathematics and related areas. Included in the program are courses in semiconductor device theory, solar cell theory, PV system design, power electronics, faulted power systems and power systems control. Courses are planned in socioeconomic aspects of PV and advanced cell concepts.

The Electrical Engineering Department has four faculty members actively involved with funded research in PV devices and systems and maintains an Energy Research Center and a Photovoltaic Systems Laboratory. Research at the university has included fundamental studies of PV materials, device research on the solar cell, and all aspects of small, medium and large PV power systems, either stand-alone or utility-connected. Proximity to the NASA-Lewis Research Center, a leading research center in solar cell technology, provides students excellent research and internship possibilities. Several area industries, including SOHIO and Gould, have entered into PV research and development and serve as resources.

Background

The Electrical Engineering Department has been active in PV research and development for the last 10 years. The Solar Cell Theory I course was first offered in 1978, and the PV Systems I course was first offered in 1981. Solar Cell Theory II and PV Systems II were first offered during the winter quarter, 1984. In the past five years, the department has awarded 10 students M.S.E.E. degrees with a specialization in photovoltaics. At present, there are eight students in the program, four of them from outside the U.S.

continued

DEGREE PROGRAM
(continued)

Availability

Cleveland State University operates on the quarter system. Students may enroll at the beginning of any quarter. Out-of-state tuition is approximately $1400 a year, with on-campus room and board estimated at $2100 a year, plus $500 for books and supplies, approximately. In certain cases, students not wishing to pursue a degree can take one or two courses under special student status.

Prerequisites

Graduation from an accredited college or university and an appropriate academic background are required. All instruction is in English.

Key Instructors

Manju Ghalla-Goradia, Associate Professor; experienced in fabrication and testing of silicon solar cells.

Chandra P. Goradia, Professor; experienced in fabrication and testing of silicon solar cells; teaching and research experience in theoretical modelling of single crystal silicon and gallium arsenide solar cells and amorphous silicon solar cells.

Peter P. Groumpos, Associate Professor; teaching and research experience in systems analysis, controls and optimization techniques for PV systems; has conducted research in modelling, analyzing and simulating village stand-alone PV systems.

Eugene A. Klingshirn, Professor; teaching and research experience in power electronics, electrical machines and power systems.

F. Eugenio Billaseca, Assistant Professor; teaching and research experience in classical and modern theory of electric power and control systems.

continued

DEGREE PROGRAM
(continued)

Key Contacts

Dr. Peter P. Groumpos or Dr. Chandra Goradia: (216) 687-2592

Electrical Engineering Department, SH-305
Cleveland State University
Cleveland, OH 44115

OTHER RESOURCES

Please refer to Index:

Cabrillo Junior College

Colorado Mountain College

Colorado Technical College

Jordan Energy Institute

Mississippi County Community College

Pennsylvania State University,
Fayette Campus

Section V

Low-Temperature Active

Solar Thermal Systems

INTRODUCTION

Because of the relative simplicity of the technology and the comparatively short payback time for many installations, hundreds of training centers have sprung up throughout the United States for solar domestic hot water heating (DHW). Very few, however, have been developed for active solar space heating, a system of greater complexity. Most courses focus on a simple introduction to solar geometry, heat transfer and basic plumbing techniques required for system installation. Longer courses generally cover the same material but in greater detail.

Courses listed in this section are divided into two main categories. The first category consists of technical training institutions--frequently vocational training schools or community colleges offering courses in solar energy applications from a technician's point of view. Classes cover both theoretical background and extensive hands-on experience in system installation. Normally, a high school equivalency and command of English are the only requirements for enrollment. Facility with common tools is assumed.

The second category consists of a number of resources which offer two- to three-day seminars in some specific aspect of solar technology. One might be solar DHW heating; another, energy-conserving residential design. Courses are generally accompanied by reference materials to help students gain enough competence to select and install a simple DHW system.

A short list of academic degree programs and institutions offering courses in solar engineering is also included in this section. The list is by no means exhaustive, but does list institutions having the best known and reputable programs. Recent changes in the levels of federal and state support of these programs has created uncertainty, so it is important to make inquiries directly to the institutions to determine current course offerings.

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COURSE SUMMARY

Organization	Course or Program	Schedule	Page
New England Fuel Institute Technical Training Center	Solar Heating: Installation & Maintenance	4-week day course or 20-week night course, 3 - 7 times a year	V-4
Solar Energy Applications Lab, Colorado State University	Solar Heating and Cooling of Residential Buildings	1 week, on demand	V-6
New Mexico Solar Energy Institute	Various Alternative Energy Technology workshops	1- to 3-day workshops, frequently offered	V-8
New England Solar Energy Association	Various Solar Energy Technology workshops	1- to 3-day workshops, frequently offered	V-8
Home Energy Workshop	Solar Water Heating	2 days each month	V-9
Urban Solar Energy Association	DWH Systems and Solar Space Heating	2- to 5-day seminars, on demand	V-9
University of Wisconsin, Extension	Various Solar Energy Technology seminars	2- to 5-days seminars, offered frequently	V-10
Ozark Sun	Various Alternative Energy Technology seminars	2- to 5-day seminars, on demand	V-10
Mid-Atlantic Solar Energy Association	Various Solar Energy workshops	2-day workshops, offered frequently	V-11
Florida Solar Energy Center	Solar Design and Installation	4-day workshop, 4 times a year	V-11
Cabrillo Junior College	Solar Energy Technology degree program	2 years, beginning annually in Sept.	V-12

continued

COURSE SUMMARY
(continued)

Organization	Course or Program	Schedule	Page
Colorado Mountain College	Solar Retrofit degree program	11 months, beginning each Sept.	V-14
Colorado Technical College	Solar Engineering Technology degree program	2- or 4-year programs, university quarter system	V-16
Mississippi County Community College	Solar Energy Technology degree program	2 years, beginning each Sept. and Jan.	V-19
Pennsylvania State University	Solar Energy Technology degree program	1 year, beginning annually in Aug. and Jan.	V-21
Yavapai College	Solar Technician certificate	1 year, university semester	V-23
Yavapai College	Solar Building Technology degree	2 years, university semester	V-23

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SHORT COURSE

Solar Heating, Installation and Maintenance

Sponsor: New England Fuel Institute Technical Training Center (NEFITTC), Watertown, Massachusetts

Description

Course consists of a four-week hands-on vocational training course for solar heating technicians. It provides the basic working theory and practical training required for installing and servicing active solar heating systems and components.

Curriculum includes: types of systems, air and water as heat transfer media, heat loss calculations and energy conservation strategies, plumbing and electrical fundamentals, controls, hybrid (solar/oil) systems, contracting and business issues, economic analysis. Course is 60 percent lab work and 40 percent lecture format.

A Solar Heating Technician Certificate is awarded to successful trainees.

Background

NEFITTC has operated under license from the Massachusetts Department of Education since 1971. Approximately 2,000 trainees have completed the course, of which three percent were from developing countries. Class size averages about 17 trainees.

Availability

Courses are 160 hours each. Day course is four weeks of five eight-hour days, tuition $700. Night course is 20 weeks of two four-hour sessions per week, tuition $754. Seven day-courses and three night-courses were given in 1984. Tuition costs include all materials and books.

continued

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SHORT COURSE
(NEFITTC continued)

Prerequisites

Registrants should have high school equivalency and be fluent in English. No prior technical ability required other than facility with common hand tools.

Key Instructors

Bernard Smith, Director of Operations.

Charles Thomas, Director of NEFITTC.

Both have taught thousands of students in cooperation with the U. S. Army and Air Force, and the Department of Energy, as well as technicians from Egypt, Kuwait, Chile, Argentina and other countries.

Accommodations

Easily arranged in nearby motels. Inquire of program coordinator.

Key Contacts

John Carey, Director of Education, or
Dolores Levenson, Registrar: (617) 924-1000

New England Fuel Institute
Technical Training Center
10 Summer Street
Box 888
Watertown, MA 02172

Telex: NEFI-WTN 922-401

SHORT COURSE

Solar Heating and Cooling of Residential Buildings

Sponsor: Solar Energy Applications Laboratory (SEAL) at Colorado State University, Fort Collins

Description

Two parallel week-long courses are offered covering identical topics--one addressed to building contractors and the other to engineers or others with a similar technical background. Two excellent manuals have been developed for the courses.

Curriculum covers: solar radiation; collectors; heating and cooling load analysis; system sizing and methods for estimating performance; components of liquid and air based systems; space heating; design procedures; economic considerations; installation, operation and maintenance procedures; fundamentals of active solar cooling.

Five completely instrumented solar heated and cooled buildings are on-site for class visits.

A Certificate of Completion is offered to each participant.

Background

SEAL was established in 1974 as one of the principal research sites in solar energy applications in the U. S. One of its many projects was the development of a solar course accessible to both contractors and engineers. The course has been offered more than 20 times with over 550 graduates. It was used as the principal training for community college and teacher training in 36 states. Class size ranges from 10 - 30. Visiting faculty from over 10 countries have participated in the program.

Availability

Courses are available on demand for groups of 10 or more. Fee is about $400 for each trainee for a five-day course. Arrangements must be made with the instructors well in advance.

continued

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SHORT COURSE
(SEAL continued)

Prerequisites

Courses can be addressed either to those familiar with the building trades or those with an engineering or technical background. This should be discussed when making course arrangements. All presentations are in English.

Key Instructors

S. Karaki, Ph.D. in civil engineering; Director of SEAL; 10 years' experience in research in the applications of solar energy; professor of civil engineering at Colorado State University.

G. O. G. Löf, Ph.D. in civil engineering; 40 years' experience in solar energy research; professor of civil engineering at Colorado State University.

W. E. Duff, Ph.D. in mechanical engineering; eight years' experience in solar research; professor of mechanical engineering at Colorado State University.

C. B. Winn, Ph.D. in mechanical engineering; 10 years' experience in solar research; professor or mechanical engineering at Colorado State University.

Key Contact

S. Karaki, Director: (303) 491-8617

Solar Energy Applications Laboratory
Colorado State University
Fort Collins, CO 80523

SEMINARS

New Mexico Solar Energy Institute

NMSEI offers numerous courses relating to alternative energy technologies of one to three days in length. These include passive and active solar DHW, passive and active space heating, photovoltaics, geothermal use, water pumping and electrical generation with wind energy. Cost ranges from $35 to $325; room and board is available for $44 a day. Materials range from $25 to $200, depending on type of course. NMSEI has six years' experience and taught over 2,500 trainees, three percent of whom have been from developing countries. These are technician-level courses.

Contact: Michael Hensley, Project Manager
Information and Education
New Mexico Solar Energy Institute
Box 3 SOL
Las Cruces, NM 88003

Phone: (505) 646-1846

The New England Solar Energy Association

NESEA offers one- to three-day seminars in passive solar design, energy-efficient housing construction, solar water heating, photovoltaics applications and commercial applications of solar energy. Usual cost is $100 a day per trainee. Specially tailored instruction is available if arranged in advance. NESEA has been conducting seminars and professional conferences for seven years covering nearly every aspect of solar application.

Contact: Alex Wilson
New England Solar Energy Association
P. O. Box 541
Brattleboro, VT 05301

Phone: (802) 254-2386

continued

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SEMINARS
(continued)

Home Energy Workshop

Two-day course in solar water heating, covering active, batch and thermosyphon systems, is offered monthly. Construction is emphasized. Certificates of Completion awarded. $250 per trainee. Apply three weeks in advance. Twenty percent discount offered to groups of four or more. Course has been conducted both in U.S. and abroad. Of 700 graduates, four percent have been from developing countries. This is a technician-level course.

Contact: Jim Welch
Home Energy Workshop
1558 Riverside Avenue
Fort Collins, CO 80524

Phone: (303) 482-9507

Urban Solar Energy Association

Seminars are offered on a continuing basis in low-cost solar space heating retrofits, and low-cost solar domestic hot water heating systems. Offered as demand dictates at $10 to $25 per student. Custom seminars are also available. These are technician-level seminars and have been offered since 1980.

Contact: Barbara Brandt
Urban Solar Energy Association
1 Summer Street
Somerville, MA 02143

Phone: (617) 628-8399

continued

SEMINARS
(continued)

University of Wisconsin - Extension,
Department of Engineering and Applied Science

A range of seminars, from two days to a week in duration, varying widely from year to year, are offered by the University of Wisconsin - Extension. Relevant topics in 1984 include solar domestic hot water system, energy management techniques, battery and pump selection for PV pumping applications, among other. In the past, seminars have dealt with passive solar building design, microhydro, biomass conversion and wind energy conversion systems. Single course costs range from $25 to $600. Certificates of Completion are awarded and continuing education credit is given in all instances. Renewable energy courses have been offered for over eight years, with more than 1,600 trainees attending. Many instructors have overseas experience.

Contact: Donald R. Schramm or Dr. Charles Dorgan
Energy Technology Center
University of Wisconsin
Extension Engineering
432 North Lake Street
Madison, WI 53706

Phone: (608) 262-2061 or (800) 262-6243

Ozark Sun

Ozark offers two-day to one-week seminars in solar water heating, cold frame and greenhouse design and construction, methane digesters, hydraulic rams for water pumping and agricultural waste management. A two-day seminar for 10 trainees on-site costs $800, including meals. Instructors have participated in training for Peace Corps and VISTA volunteers, as well as many private trainees, totaling over 800 people during the last four years.

Contact: Ron Hughes
906 South Main Street
Mt. Home, AR 72653

Phone: (501) 425-9353

continued

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SEMINARS
(continued)

The Mid-Atlantic Solar Energy Association

Workshops are sponsored in commercial and industrial applications of solar energy, passive solar design for builders and homeowners, solar space heating retrofitting and other topics. More than 2,000 trainees have attended. Professional conferences are sponsored as well. Workshops are generally two days long and cost around $150 per trainee.

Contact: Nancy Weissman, Executive Director
or Irisita Azary, Program Developer
Mid-Atlantic Solar Energy Association
2233 Gray's Ferry Avenue
Philadelphia, PA 19146

Phone: (215) 545-2150

The Florida Solar Energy Center

FSEC offers a four-day workshop on "Solar Design and Installation" three or four times a year. The course covers the essentials of solar installation, troubleshooting and operation procedures for domestic hot water systems. It is designed for both practicing and prospective DHW system installers. The cost of the course is $220 for one participant, $185 for each additional participant from the same organization.

Contact: Ken Sheinkopf, Program Director
Florida Solar Energy Center
300 State Road 401
Cape Canaveral, FL 32920

Phone: (305) 783-0300

DEGREE PROGRAM

Solar Energy Technology

Sponsor: Cabrillo Junior College, Aptos, California

Description

Program is designed to prepare participants for careers as designers, builders, installers and marketers in the field of solar energy. Participants learn the principles of solar energy and their applications to passive, active and hybrid space and water heating systems. They also study residential design concepts, including retrofit techniques, and are given an introduction to photovoltaics, wind energy and agricultural applications.

Courses include: fundamentals of solar energy; residential energy conservation; active solar systems; passive solar systems; photovoltaics; wind energy; applications of solar energy in agriculture; commercial energy management; microcomputer applications in energy; solar building design; solar home remodeling; solar fabrication projects; solar energy--community education; solar field studies.

This is a two-year program and offers an Associate of Science Degree in Solar Technology and/or a Certificate of Proficiency.

Background

Cabrillo has offered the program since 1976, and averages between 30 and 40 graduates per year.

Availability

Program begins annually in September. Tuition is approximately $3,500, depending on specific course of studies chosen by each participant. Tuition does not include room and board.

continued

DEGREE PROGRAM
(Cabrillo continued)

Prerequisites

High school graduation or equivalent, acceptance to Cabrillo. Courses in English.

Key Instructors

Douglas Brown, Ph. D., physics, special electronics, PV.

David Burton, Life Vocational Teaching Credential, specialities--solar thermal and energy conservation.

Richard Merrill, M. A., biology, specialties--biological energy organic waste systems, solar greenhouse design, horticulture.

Carl Stancil, M. S. E. E., specialties--linear circuit design, I. R. radiometry, PV, occupational electronic technology, solar electronics.

Robert Stayton, M. S., physics, specialties--passive solar design, wind energy systems, insulation data analysis, solar thermal.

Accommodations

Cabrillo has no dormitory facilities. Participants from outside the local area are encouraged to make use of the housing placement service in the Office of Student Services.

Key Contact

Dave Burton: (408) 425-6235

Solar Energy Technology Department
Cabrillo Junior College
6500 Soquel Drive
Aptos, CA 95003

DEGREE PROGRAM

Solar Retrofit

Sponsor: Colorado Mountain College (CMC), Glenwood Springs

Description

Curriculum provides a mixture of academic and hands-on skills training. Building trades skills and solar/energy conservation retrofit projects are integrated with community workshops and course offerings. Passive, active and hybrid solar designs are studied, fabricated and installed, including greenhouse/sunspaces, photovoltaic systems, weatherization options, movable insulation, Trombe walls, domestic hot water, rock storage systems, and daytime heaters. Program lasts eleven months. Six weeks are devoted to presentation and application of construction skills. For the next five and a half months, participants develop a variety of skills applicable to jobs in the solar industry. During the final three months the participants refine skills in their chosen areas. Upon successful program completion, participants receive an Occupation Proficiency Degree.

Renewable energy technology installations on-site include: PV systems, solar domestic water heaters, solar air space heaters, solar greenhouses, Lorena stoves, movable insulation and conservation retrofits.

Background

CMC has offered this course for three years and has averaged 30 trainees per year. All trainees have been from the U. S.

Availability

The eleven-month program is offered once a year in September, ending in August. Early registration is advised. Tuition is $5,040 per program, not including room and board. In addition, books and tools cost $400.

continued

DEGREE PROGRAM
(CMC continued)

Prerequisites

High school graduation or equal. All instruction is in English.

Key Instructors

Steve McCarney, M. Ed., 10 years' renewable energy experience in contracting, energy analysis and vocational training.

Ken Olsen, M.E.P., 10 years' renewable energy experience in contracting, community education and vocational training.

John Weiss, builder, 10 years' renewable energy experience in construction contracting and vocational education.

Accommodations

Dormitory-style accommodations are available. Fee is approximately $3,400 per program for room and board. Private housing is available adjacent to the campus. Information about private housing is available through the housing office.

Key Contact

Steve McCarney: (303) 945-7481

Solar Retrofit Program
Colorado Mountain College
Spring Valley Campus
3000 114 Road
Glenwood Springs, CO 81601

DEGREE PROGRAM

Solar Engineering Technology

Sponsor: Colorado Technical College, Colorado Springs

Description

This is one of two technician-level programs in the United States accredited by the Accreditation Board of Engineering Technology (ABET). It awards a two-year Associate of Science degree (A.S.) or a four-year B.S. degree. It combines classroom instruction with hands-on practice in system installation and maintenance.

The A.S. curriculum requires: introduction to engineering and energy; solar design I and II (heat loss, basic heating, ventilating and air conditioning, F-charts, engineering economics); solar science I (sun angles, calculations of radiation); fluid mechanics; solar systems specifications (sizing); passive solar design; applied solar skills (installation); instrumentation (theory and use); seminar/independent project; DC and AC fundamentals; engineering graphics; architectural drafting; programming in BASIC; algebra; trigonometry; calculus I; physics I and II; and business management I.

The B.S. degree calls for all of the A.S. requirements plus continued study during the third and fourth years in the following areas: thermodynamics; advanced passive design; statics and strengths of materials; principles of heating, ventilating and air conditioning design; solar science II; photovoltaics; heat transfer systems; passive solar architecture and construction; bachelor's seminar/independent project; programming in FORTRAN; chemistry; calculus II; differential equations; statistics; and business and personnel management.

RET installations available for use by students on campus include: solar-assisted heat pump, large array of solar collectors, liquid flat plate collector, air-type flat plate collector (with rock heat storage system) and a planned PV system.

continued

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DEGREE PROGRAM
(Colorado Tech continued)

Background

The bachelor's program graduated its first class in 1979. There are about 15 graduates annually from the B.S. program; about 25 from the A.S. program.

Availability

Courses are offered on a quarterly basis. Students may join the program at the beginning of any quarter. Normally, students take four quarters of instruction per year and may register prior to any quarter. Cost is $950 per quarter. Materials costs are estimated at $100 per quarter. Fees do not cover room and board.

Prerequisites

High school education or equivalent is required. All instruction is in English.

Key Instructors

Jack Wallick, M.S. in environmental engineering; is department chairman, specializes in engineering, fluid mechanics and passive design.

Don Mueller, M.S. in physics; specializes in physics, fluid mechanics; teaches advanced solar courses.

Lowell King, Ph.D. in chemistry; specializes in chemistry, physics and computer science.

Patricia Hopkins, B. Architecture; specializes in drafting.

Daryl Prigmore, M.S. in mechanical engineering; specializes in physics, thermodynamics and instrumentation.

Accommodations

Colorado Tech is not a residential college, so students must make their own arrangements for room and board.

continued

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DEGREE PROGRAM
(Colorado Tech continued)

Key Contact

Jack Wallick, Department Chairman: (303) 593-0200

Solar Engineering Technology
Colorado Technical College
655 Elkton Drive
Colorado Springs, CO 80907

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DEGREE PROGRAM

Solar Technology

Sponsor: Mississippi County Community College, Blytheville, Arkansas

Description

This two-year program offers an Associate of Applied Science (A.A.S.) degree. The first year of the program consists of a general introduction to mathematics, physics, chemistry, etc. The second year covers the following areas: solar thermal systems; photovoltaic power systems; wind power systems; alcohol power systems; biomass power systems; and commercial, industrial and residential energy auditing. Emphasis is on theory, sizing, installation and maintenance of various energy systems.

On-site renewable energy technology installations include: a large thermal power system with an absorption cooling system, an alcohol fermentation and distillation facility, solar thermal domestic hot water systems, planned wind power and biomass systems, and mini- and microcomputers.

Background

The program was first offered in 1976. There have been seven cycles of the program, with 18 A.A.S. degrees awarded. So far, no participants have come from developing countries.

Availability

The program is offered on a semester basis, beginning in September and January. Early registration is suggested. Fee for the program is $5,400, which does not include room and board. Materials are estimated to cost $50.

Prerequisites

High school diploma or equivalent. Experience with small hand tools recommended. Classes are conducted in English.

continued

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DEGREE PROGRAM
(Mississippi continued)

Prerequisites

High school diploma or equivalent. Experience with small hand tools recommended. Classes are conducted in English.

Key Instructors

Dr. Earl Stedman, Ph.D. in chemistry, speaks French, Spanish and German; 20 years' experience in renewable energy technologies.

O. Grant, M.S. in physical science, 18 years' experience in renewable energy technologies.

Accommodations

Dormitory room and board available at $4,320 for the two-year program and $2,160 for the one-year program.

Key Contact

Dr. Earl Stedman: (501) 762-1020

Mississippi County Community College
P. O. Drawer 1109
Blytheville, AR 72315

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DEGREE PROGRAM

Solar Technology

Sponsor: Pennsylvania State University, Fayette Campus, Uniontown

Description

This program is one of two technician-level courses in the United States that is accredited by the Accreditation Board of Engineering Technology (ABET). It consists of two years of 15-week semesters each and awards an associate in engineering technology degree. The program combines classroom and practicum training, covering solar heating and cooling technologies, electronic controls, domestic hot water systems, air/liquid active systems, passive systems, greenhouse design and operation, computer simulation and design, photovoltaics introduction and introduction to the thermal sciences. sciences.

There are several active solar systems installed on campus in addition to greenhouses, a PV system and computer facilities.

Background

The Fayette Campus has been offering this program since 1979 and graduated between 30 and 40 students per year.

Availability

Students may begin studies in either the Fall or Spring semester; classes start in August and January, respectively. Early registration is recommended. Tuition is $4,644, with an additional $200 estimated for materials. Room and board is not included.

Prerequisites

High school education or equivalent is required. Technical experience is helpful but not mandatory. All courses are taught in English.

continued

DEGREE PROGRAM
(Penn State continued)

Key Instructors

David Meredith, M.S. in mechanical engineering, has 10 years' experience in energy- and environment-related work.

Other staff are drawn from the faculty of the mechanical, electrical and physical engineering departments of the university.

Accommodations

Off-campus housing is available to students at an estimated cost of $3,000 per program.

Key Contact

David Meredith,
Program Chairman for Solar Technology: (412) 437-2801

Pennsylvania State University
Fayette Campus
P. O. Box 519
Uniontown, PA 15401

DEGREE PROGRAM

Solar Technician Certificate

and

Solar Building Technology Degree

Sponsor: Yavapai College, Prescott, Arizona

Description

Both programs combine classroom and hands-on training to prepare participants for sizing, installation and maintenance of active, passive and hybrid solar energy systems.

Solar Technician Certificate program is one year long and offered on a semester basis. The curriculum includes: solar technology I and II, industrial graphics, construction graphics, technical math, solar theory, uniform solar code and solar design.

Solar Building Technology Degree program is for two years, consisting of four semesters. Course includes: construction technology I, II, III and IV, construction graphics I and II, solar technology I and II, industrial graphics, technical math I and II, solar theory, solar design, uniform solar code and construction wiring.

Facilities on site include solar space- and water-heating systems.

A Certificate of Completion is awarded to students who successfully complete the certificate program. The degree program offers an Associate of Arts degree.

Background

Yavapai has sponsored these two programs since 1980. There have been no graduates from developing countries.

continued

DEGREE PROGRAM
(Yavapai continued)

Availability

Participants may join either program at the beginning of any semester. Semesters start in September and January. Early registration is suggested. Tuition for the certificate program is about $3,300; for the degree program, about $6,600. Fees vary depending on course selection of each participant.

Prerequisites

High school education or equivalent and fluent English.

Key Instructors

Dr. Lyle Minkler, P.E.; 10 years' solar energy teaching experience.

Mr. Sheldon Gilson, licensed contractor; two years' solar technology teaching experience.

Mr. Don Sieh, licensed contractor; two years' solar technology teaching experience.

Accommodations

Dormitory housing is available for $950 per semester, including all meals, plus a deposit of $80.

Key Contact

Dr. Lyle Minkler: (602) 445-5264

Yavapai College
1100 East Sheldon
Prescott, AZ 86301

OTHER RESOURCES

Please refer to Index:

Farallones International

Jordan Energy Institute

New Alchemy Institute

Red Wing Energy Education Center

Section VI

Passive Solar Heating & Cooling

Building Design

INTRODUCTION

With the recent realization that a modicum of careful design could significantly alter the energy needs of buildings, for both heating and cooling loads, planners are turning to passive solar design techniques and achieving a high rate of return. In residential, commercial and industrial buildings, passive design principles are being used by builders, architects and engineers to reduce reliance on auxiliary sources of energy and energy costs in general.

Two basic approaches to incorporating passive design principles are being used and can be applied at different levels of sophistication. The more simple, accessible approach is to modify present residential designs. The more complex relies on computer simulation of heat gain or loss models--a method used widely in the United States, but accessible only to those with technical backgrounds.

The courses listed in this section address both levels of complexity. Technician- and homeowner-level courses of varying length are aimed at selection of building materials, simple design techniques and hands-on construction practices. Seminars in advanced passive design are aimed at specific issues in the design process, ranging from types of glazing materials to economic analysis. University-level courses focus on various types of computer correlations and simulation models, as well as on research into unconventional approaches to the design process. Advanced courses are directed mainly toward architects and engineers.

Passive solar cooling has only recently received serious attention from energy researchers, which is unfortunate, as much of the world's population lives in tropical climates where cooling needs are paramount. One cooling course is listed here, and the subject is included as an adjunct to some of the heating courses in the technical-level section.

COURSE SUMMARY

Organization	Course or Program	Schedule	Page
Cornerstones Energy Group	Passive Solar Design/ Construction	2 days - 6 weeks, 3 - 4 times a year	VI-3
Yestermorrow	Passive Solar Design	2 weeks, 5 or 6 times a year	VI-5
Florida Solar Energy Center	Principles of Low-Energy Building Design in Warm, Humid Climates	3 days, twice a year	VI-8
Arizona State University	Solar Architecture and Technology specialization	2 years, university semester system	VI-9
Massachusetts Institute of Technology	M.S. in architecture	2 years, university semester system	VI-11
University of Oregon	B.S. or M.S. in architecture or physics	2 or 4 years, university quarter system	VI-13

SHORT COURSE

Passive Solar Design/Construction

Sponsor: Cornerstones Energy Group, Brunswick, Maine

Description

A variety of two-day to six-week courses in building design, analysis and construction are offered.

Courses include: a two-day seminar on passive solar design and conservation strategies; one-week course on architectural design and drafting; two-week course on solar retrofit, solar siting and analysis; three-week course on energy efficient housebuilding; and six-week inclusive course which covers foundations and framing, solar energy engineering, electricity and plumbing, and carpentry. A one-week course in residential energy auditing is also offered, as are short seminars on solar hot water heating and photovoltaic installation for small residential systems. Class format is 50 percent lecture, 50 percent hands-on experience.

Department of Energy Auditors Certificate and/or college equivalent units available upon completion of relevant courses.

Background

Cornerstones has operated since 1976, teaching residential design and construction. There are usually three to four programs per year. Since 1976, there have been 3,000 graduates, less than one percent being from developing countries.

Availability

Fee for two-day seminar is $245, for three-week course $495. Materials are included in registrations costs. 10 percent group discounts are available.

continued

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SHORT COURSE
(Cornerstones continued)

Prerequisites

Courses offered in English only. In most cases, neither academic nor experiential background required, although evidence of basic skills is necessary for some advanced courses.

Key Instructors

James Young, industrial designer, certified energy auditor.

Dale McCormick, carpenter/school supervisor.

Patrick Foster, construction supervisor.

Steven Oransky, designer.

Accommodations

Available in town. Contact Cornerstones for additional information.

Key Contact

Peter Hollander, Vice President: (207) 729-6701

Cornerstones Energy Group, Inc.
54 Cumberland Street
Brunswick, ME 04011

SHORT COURSE

Passive Solar Design

Sponsor: Yestermorrow, Warren, Vermont

Description

Yestermorrow offers several two-week long courses in building design and construction. Integration of design and construction is accomplished by teaching construction methods, architectural approaches to design and interactive problem solving techniques. Emphasis is on energy and resource optimization.

The design section covers environmental analysis and siting, architectural programming, solar radiation, geometry and estimation, heat loss and building performance evaluation using hand and simple computer passive design techniques, structural consideration, basic design and drafting, image and model making, working drawings and cost estimation. Additional courses offered: building renovation, solar greenhouse design and construction, etc.

Hands-on learning of building techniques is emphasized. The staff teaches different construction techniques, using a variety of materials, to students from areas where American standard wood framing techniques don't apply. All students learn fundamentals of carpentry, electrical plumbing and site layout.

College credit can be arranged. A Certificate of Course Completion is given to successful trainees.

Background

The school's intent is to improve the quality of design and construction in energy-efficient home building. The curriculum is tailored to the time, money and material resources of each student. The integrated design/build approach has been taught for over five years. Twenty two-week courses have been taught. No trainees from developing countries have attended yet.

continued

SHORT COURSE
(Yestermorrow continued)

Availability

Two-week designer/builder courses are offered five or six times a year, from late spring to late summer. Cost is $400 per trainee. Materials are included, but certain tools must be purchased beforehand. Additional classes are available gratis after paying tuition for the initial course. Expanded professional course is six weeks long. This will be offered for the first time in 1984. One building renovation and professional course will be offered simultaneously.

Prerequisites

All courses are conducted in English. A familiarity with tools and willingness to engage in hands-on activity are required. Courses are addressed to those who will be building and designing residences. No academic prerequisites. Prospective students must be over 18 years old.

Key Instructors

John Connell, architect/builder, program director; five years' experience teaching design/construction classes.

David Sellers, architect/builder.

David Norris, architect/international consultant.

Ted Montgomery, solar architect

Accommodations

Available at training site. Double and triple rooms, no bedding provided. Three meals provided daily. Room and board costs $350 for duration of course.

continued

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SHORT COURSE
(Yestermorrow continued)

Key Contact

Lillian Brewster, School Manager: (802) 496-5545

Yestermorrow School
Box 76a
Warren, VT 05674

SEMINAR

Florida Solar Energy Center

FSEC offers a three-day seminar, entitled "Principles of Low-Energy Building Design in Warm, Humid Climates," twice annually. The course focuses on the fundamentals of energy-efficient building design, applied to areas with warm, humid climates. Presentations include: site layout/solar radiation data; shading techniques/fenestration design; natural ventilation; mass and insulation; dehumidification; mechanical systems; domestic water heating; fundamental concepts of photovoltaics; PV systems and building integration; and PV stand-alone and utility-interactive applications. Fee is $305 for one participant; $290 for each additional participant from the same organization.

Contact: Ken Sheinkopf, Program Director
Florida Solar Energy Center
300 State Road 401
Cape Canaveral, FL 32920

Phone: (305) 783-0300

DEGREE PROGRAM

Solar Design

Sponsor: Arizona State University (ASU), Tempe

Description

ASU School of Architecture offers a solar architecture and technology specialization which addresses both active and passive approaches to building energy science and design at the graduate level.

Three major two-semester sequences are offered: active systems--first semester focuses on collectors and storage, second semester on system components and configurations; passive systems--first semester addresses design approaches for small commercial and residential buildings using correlation-based design tools, second semester looks at large building design and use of mainframe computer simulation models; and architectural studio design--two sequential single semester courses. Numerous complementary courses are also offered. Students are required to do weekly experiments at the experimental solar lab and report on the thermal performance of both active and passive systems and components. Passively designed buildings in nearby communities are available for site visits.

M.Arch., M.E.P. and M.S. degrees are offered.

Background

ASU has been doing research in solar design since 1974, mostly on heating issues. (Passive cooling is not a separate course, but integrated into other courses, and there are several ongoing research projects in that area.) There are 10 to 15 graduates annually from the solar program, of which 20 to 50 percent are from abroad.

Prerequisites

High school equivalency is required for admission to the university. All graduate classes require the permission of the instructor or admission at the graduate level. All classes are conducted in English.

continued

DEGREE PROGRAM
(ASU continued)

Key Instructors

Benjamin T. Rogers, P. E., mechanical engineering; originator of "passive" as applied to solar heating and cooling; visiting professor; with Solar Research Group, Los Alamos.

Jeffrey Cook, M. Arch.; editor of the Passive Solar Journal; member of Board of Directors of the American Solar Energy Society; involved in solar research since 1974.

John Yellot, M. S., mechanical engineering; thirty years' research in solar field; internationally known authority in solar engineering.

Cornelius Van Wyk, M. Arch.; doctoral candidate from University of Michigan; particular interest is computer modeling of daylighting.

Hofu Wu, D. Arch., University of Michigan, thesis on the effects of microclimate on building energy performance.

Jim Scalise, M. Arch.; ten years' experience in solar work, former chairman of Architecture Department; practicing architect; particular interest is earth sheltered residences.

Accommodations

Dormitories are available. Contact the University Admissions Office at (602) 965-3251/

Key Contact

Jeffrey Cook: (602) 965-2764

Department of Architecture
Arizona State University
Tempe, AZ 85282

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DEGREE PROGRAM

M. S. in Architecture

Sponsor: Massachussetts Institute of Technology (MIT), Cambridge

Description

Courses in the two-year program through the Architecture Department cover many elements necessary in energy-efficient building design.

Courses offered include micro-climate design, uses of energy in building (explores energy use in buildings specially emphasizing conservation and thermal comfort), solar architecture (develops and applies principles and materials for the use of passive solar heating/cooling in buildings), design of systems and performance prediction, energy conscious design (uses commercial design program in studio format to examine design issues), uses of daylighting in buildings (explores and analyzes detail design methods, calculations and control strategies for efficient daylighting), and special problems in environmental controls (consists of individual or group supplementary work as extension of above topics).

Background

MIT has long been recognized as one of the centers of technical excellence in the United States. 30 students are admitted to the program each year. Energy conscious design courses have been offered for five years.

Availability

Tuition for the two-year program is $10,500 per year. Living expenses for nine months are approximately $5,000. Under certain circumstances, students not interested in pursuing a degree can take one course under special student status. For additional classes, enrollment in the program is required.

continued

DEGREE PROGRAM
(MIT continued)

Prerequisites

A first professional degree is required for admission to the program. For enrollment in a single course, permission of the instructor must be obtained. English is the medium of instruction.

Key Instructors

T. E. Johnson has over eight years' experience in research of advanced glazing materials and low-energy buildings; author of Solar Architecture: The Direct Gain Approach; has consulted widely in the field of energy and buildings, both in the U.S. and Europe.

H. J. Bryan is an international consultant in daylighting, environmental-controls and energy-use-in-buildings courses.

Key Contact

Professor T. E. Johnson: (617) 253-5965

School of Architecture and Planning
Department of Architecture
Room 3-439
Massachusetts Institute of Technology
77 Massachusetts Avenue
Cambridge, MA 02139

DEGREE PROGRAM

B. S. in Architecture or Physics

and

M. S. in Architecture or Physics

Sponsor: University of Oregon, Eugene

Description

The School of Architecture and Applied Arts' Department of Architecture offers an excellent selection of graduate and undergraduate courses in passive design principles and environmentally conscious architecture.

Classes available include: passive solar heating; passive cooling--one of the few courses available in the U. S. specifically on cooling issues; the physics of energy and the environment; the sun as a future energy source; and environmental control systems. Daylighting, solar radiation monitoring and waste water systems are also addressed. A solar monitoring station and several solar heating installations are included in the labwork.

The nearby Lane Community College has a technician-level energy training program.

Background

The Department has taught energy-conscious architectural design for ten years. Approximately 150 students graduate from the program each year. About 10 percent are foreign students.

Availability

Coursework is in 10-week term sequences. Three-month full program tuition for undergraduates is $1,353, for graduates $1,115. For the nine-month program, undergraduate tuition is $4,058, graduate tuition is $3,344. Minimum estimated room and board for nine months is $2,400.

continued

DEGREE PROGRAM
(University of Oregon continued)

Prerequisites

Fluency in English required. For entry into undergraduate program, completion of U. S. high school equivalency is necessary. Application procedures, particularly for graduate school, should be initiated nine months prior to the beginning of the program. Foreign students should contact the Foreign Student Office for additional information.

Key Instructors

John Reynolds, M. Arch. from MIT; 17 years' teaching and architecture practice; at Oregon since 1967; experience in monitoring passive cooling installations in Mexico (1981-82); some Spanish and Italian.

D. K. McDaniels, PH.D., physics, from University of Washington; at Oregon since 1963; research in atomic energy in France (1962); physics research in Sweden (1979); some French.

G. Z. Brown, M. Arch. from Yale; six years' teaching and architectural practice; at Oregon since 1977; architectural experience in Nigeria (1983-84).

Key Contacts

John S. Reynolds, Director: (503) 686-3631

Solar Energy Center
University of Oregon
Eugene, OR 97403

Alan Gubrud: (503) 747-4501

Lane Community College Energy Training Program
Lane Community College
Eugene, OR 97405

OTHER RESOURCES

Please refer to Index:

Colorado Mountain College

Cornerstones Energy Group

Farallones International

Florida Solar Energy Center

Jordan Energy Institute

Mid-Atlantic Solar Energy Association

New Alchemy Institute

New Mexico Solar Energy Institute

Pennsylvania State University,
Fayette Campus

Red Wing Energy Education Center

Urban Solar Energy Association

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Section VII

Geothermal Energy Systems

INTRODUCTION

Because of the new and complex nature of geothermal energy development, which is usually large-scale and capital-intensive, little is offered in short-course technical training. Rather, training is concentrated in civil, mechanical or geophysical engineering departments of universities having geothermal resources on or near campus.

An exception to this general rule is the program offered by the Geothermal Resources Council, a nonprofit, educational corporation that supports research, exploration, development and use of geothermal resources around the world. As a central information source, GRC is closely connected to both educational and commercial organizations working in this field, and they use these affiliations in the course of implementing workshops and seminars covering geothermal energy development.

Besides the GRC short course, a number of universities, well-known for their work in this field, offer programs in related areas that participants from developing countries may attend on a "special student" status, either for one semester or as full-time graduate students. In all cases, these universities have geothermal resources on campus.

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COURSE SUMMARY

Organization	Course or Program	Schedule	Page
Geothermal Resources Council	Various courses and/ or workshops	2- to 5-day seminars	VII-3
New Mexico State University	Resource studies and research	university semester	VII-5
University of Utah Research Center	Resource studies and research	university semester	VII-5
Oregon Institute of Technology	Resource studies and research	university semester	VII-5
Boise State University	Research and courses	university semester	VII-6

SHORT COURSE

Various Courses and/or Workshops in Geothermal Resources

Sponsor: Geothermal Resources Council (GRC)

Description

GRC offers courses or workshops in the following subjects: geothermal geology, geophysical prospecting, geothermal geochemistry, legal problems of geothermal resource development, environmental problems, economics, high-temperature drilling, small-scale power plants, and geothermal energy: an overview. Most of these subjects can be covered in two- to seven-day workshops. The GRC will arrange and convene other short seminars on specialized subjects upon request. Participants in these courses can be awarded a Certificate of Participation.

Background

GRC is a nonprofit educational corporation, a leading proponent of geothermal energy and a major center for information on this subject. It actively encourages research, exploration, development and use of geothermal resources. The Council has been offering courses in geothermal exploration and development for over 10 years. It has conducted functions jointly with the U. S. Department of Energy, the American Association of Petroleum Geologists, the American Bar Association, the Bonneville Power Authority and the states of California, Oregon and Idaho. Depending on the course, usually five to ten percent of participants come from developing countries.

GRC has no established training sites. It routinely develops and runs field trips to geothermal sites in the U. S., Canada and Mexico.

Availability

Courses and workshops sponsored by the Council are developed and offered when the demand reaches a significant level. Announcements are made in flyers and the Geothermal Resource Council Bulletin. For information about upcoming courses,

continued

SHORT COURSE
(GRC continued)

write GRC and ask to be put on their mailing list. Subscriptions to the Geothermal Resources Council Bulletin are available at $45.00 per year. Courses are usually announced two to three months in advance.

Given six months'time, the Council can develop a course in any of the areas listed above. Present emphasis is changing from exploration to power production. The fee is about $150.00 a day, which includes a study guide for the material to be covered. Room and board costs are not included in this fee.

Key Instructors

David N. Anderson, Executive Director, oversees the development and implementation of courses and workshops that GRC sponsors. Instructors are members of the geothermal industry and representatives of key educational institutions and government laboratories and agencies. Most instructors have more than eight years' experience in developing geothermal energy resources.

Prerequisites

These are specified in the flyer announcing each course. Some courses do not have prerequisites.

Accommodations

Housing can be arranged by GRC.

Key Contact

Mr. David Anderson
Geothermal Resources Council
P. O. Box 1350 (111 G Street)
Davis, CA 95617

Telephone: (916) 758-2360

UNIVERSITY PROGRAMS

New Mexico State University

A $1.5 million geothermal demonstration project went on-line in February 1982. During periods of peak winter demand, it provides 250 gallons per minute of 135°F water and 10 million BTUs per hour of space heat for several NMSU campus facilities.

Contact: Roy A. Cunniff, Project Engineer: (505) 522-9349
New Mexico State University
Campus Geothermal Demonstration Project
Las Cruces, NM 88033

University of Utah Research Institute

The Earth Science Laboratory has been conducting research and providing exploration and resource development studies in geophysics, geology, geochemistry, hyrdology and electronics engineering, related to geothermal energy development, for seven years.

Contact: Dr. Philip Michael Wright, Technical Vice President
Earth Science Laboratory
University of Utah Research Institute
391 Chipeta Way, Suite C
Salt Lake City, UT 84108

Oregon Institute of Technology

Oregon Tech uses its on-campus geothermal energy system for graduate training in geothermal resources exploration and development.

Contact: John Lund: (503) 882-6321
Oregon Institute of Technology
Department of Mechanical Engineering
Klamath Falls, OR 97601

continued

UNIVERSITY PROGRAMS
(continued)

Boise State University

Boise State uses geothermal systems in and around Boise as the basis for research and courses in geothermal geology, applied geophysics, geochemistry and geothermal reservoir hydrology.

Contact: Dr. Claude Spinosa, Department Chairman:
(208) 385-3660, or
Dr. Spencer Wood: (208) 385-3629
Boise State University
Department of Geology and Geophysics
Boise, ID 83625

Section VIII

Multiple-Technology

Training Programs

INTRODUCTION

A number of institutions offer courses or programs covering the gamut of renewable energy technologies. This section lists institutions which offer courses in individual technologies, but are so varied in depth and emphasis that they can be assigned to no single category.

All listings in this section are referenced at the end of preceding sections on individual technologies, as appropriate. Multiple offerings are not subdivided by entry-level requirements or length of course, as has been done in other sections. The variety of courses offered would make such divisions useless.

COURSE SUMMARY

Organization	Course or Program	Schedule	Page
Farallones International	Appropriate Technology and Community Development	10 weeks each Spring, Summer and Fall	VIII-3
New Alchemy Institute	Studies in Appropriate Technology	2-day workshops; 1 month - 1 year internships; semesters, Feb. to May, yearly	VIII-6
Jordan Energy Institute	Renewable Energy Technology degree program	2- and 4-year programs, beginning Jan. and Sept.	VIII-9
Red Wing Energy Education Center	Alternative Energy degree program	18 mos., late Aug. to May for 2 consecutive years	VIII-12
Washington Univ. at St. Louis	Technology for International Development	2- and 4-year programs, beginning Sept. and Jan.	VIII-14

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SHORT COURSE

Appropriate Technology and Community Development

Sponsor: Farallones International, Occidental, California

Description

Program emphasizes community development skills training within the context of appropriate technology, including: solar energy (design, construction, siting, sizing, shade mapping, PV, model building, and country-specific applications); wind energy applications; hydraulic ram application; micro-hydroelectric power generation; pedal/treadle power devices; fuel-conserving cookstoves; alternative waste/water management systems (alternative toilets, greywater recycling/recovery).

Special programming is available for groups and individuals. Workshops, courses and structured internships in these areas vary in length from one day to ten weeks. University credit for participants is available through World College West and Antioch University West (of Northern California).

Demonstration facilities on-site include: solar heating and cooling systems, fuel-conserving cookstoves, greywater recycling and alternative waste disposal systems, food- and heat-producing greenhouses; and experimental demonstrations of wind power generation, wind water pumping and micro-hydroelectric power generation. There are workshops for wood, metal and clay machinery, a complete clay and tile facility.

Background

Farallones was founded in 1974 as a nonprofit institute for participatory education and appropriate technology. It has been conducting workshops and training programs since that time, with approximately 25 percent of participants coming from developing countries.

Farallones has provided staff training for personnel from the following institutions: Research Center for Applied Science and Technology (RECAST) at Tribhuvan University, Nepal; the National Center for Appropriate Technology (NCAT), Dominican Republic; and the Appropriate Technology Development Institute, Papua New Guinea.

continued

SHORT COURSE
(Farallones continued)

Availability

Schedules vary with each program. Typically, the 10-week programs are scheduled in 3 sessions: Spring (beginning mid March); Summer (beginning mid June); and Fall (beginning mid Sept.) Registration deadlines are generally four weeks prior to the start of each session. Tuition fee for the 10-week course is $1,000, with a room and board fee of $500. Cost of materials varies with each course.

Prerequisites

These vary with each course. For courses with American/foreign culture mixed groups, communication skills in the English language are necessary.

Key Instructors

Judith Elliott, specialty: solar; speaks Spanish, Hebrew and Italian.

William Eschenbach, specialty: wind water pumping and power; speaks Spanish and French.

Laura Goldman, specialty: health and nutrition; speaks Spanish, French, Quechua, Pidgin.

Max Kroschel, specialty: waste/water management systems, speaks Spanish.

John Morgan, specialty: solar; speaks Amharic, French, Italian and Spanish.

Glen Price, specialty: community development; speaks Spanish, French and Indonesian.

Christopher Szecsey, specialty: community development; speaks Spanish.

Michael Wilburn, speciality: community development; speaks Spanish.

Peter Zweig, specialty: solar; speaks Spanish and French.

continued

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SHORT COURSE
(Farallones continued)

Accommodations

Program fee includes dormitory or camping, nutritionally balanced lunches and dinners, organically-grown vegetables, use of the kitchen, solar bath houses, sauna, and access to the library, woodshop, blacksmith shop, photocopier and telephones.

Key Contact

Mr. Glen Price, Director: (707) 874-2441
Farallones International
15290 Coleman Valley Road
Occidental, CA 95465

Telex: 499-5244

SHORT COURSE

Studies in Appropriate Technology

Sponsor: The New Alchemy Institute, East Falmouth, Massachusetts

Description

NAI offers three types of training opportunities in AT, emphasizing AT applications in agriculture, aquaculture, bioshelters, wind power, solar design and energy conservation.

Weekend courses in these areas are offered throughout the year. A list of courses and registration information are available from the Institute.

Internships are available through NAI for those interested in intensive, hands-on training in appropriate technology. Length of internship varies from one month to one year.

Semester in Biological Agriculture and AT opened its first session in February, 1984. This is a cooperative effort between the National Audubon Society Expedition Institute and NAI, consisting of courses, field work and an applied studies project, under the direction of an advisor, in one of the following areas of concentration: organic gardening, solar greenhouse gardening, solar aquaculture, energy-efficient design, ecological land-use planning, tree crops and permaculture, and computer monitoring/modeling. The Semester emphasizes integration of studies and use of renewable resources to develop sustainable ecological systems.

Credit is available to participants in the internship and semester programs.

Background

NAI, a small, nonprofit research and educational organization, was formed in 1969 to promote sustainable strategies for human support systems--food, energy, shelter--that are environmentally sound and ecologically efficient. It has sponsored about 40 interns a year since the beginning of its internship program in 1975.

continued

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SHORT COURSE
(NAI continued)

Weekend workshops have hosted about 100 participants a year. The semester program began in February, 1984, and has around 12 participants per program. Fewer than five percent of participants in NAI programs are from developing countries.

Availability

Information about weekend workshops is available by writing to NAI. Applicants interested in internships should write, indicating their background, goals, and the projects in which they would like to work. The semester program's session is scheduled from February to mid-May each year. Applications will be accepted until December 15 of the previous year. Early applications are encouraged. Fee for the semester is $3,040 for credit or $2,025 for noncredit, and includes materials. Room and board are not included in this fee.

Prerequisites

None required for weekend courses. Internships call for some background in the area to be studied and some practical field experience. Applicants to the Semester program should have background in basic biology and ecology plus familiarity with AT issues. All training is in English.

Key Instructors

Earle Barnhart, B.S., 11 years' experience in Caribbean, the Philippines and Costa Rica.

Ron Zweig, B.S., 12 years' experience, worked with FAO in China.

Bill McLarney, Ph.D., 12 years' experience, worked in Costa Rica.

continued

SHORT COURSE
(NAI continued)

Accommodations

NAI is not a residential facility. Housing is left largely up to the student, although NAI staff can help arrange for rooms in private homes. Housing costs, about $50 per week, are not included in this fee.

Students should plan on spending about $150 a month on food, which is not provided by NAI. However, garden produce is available to those who help in the gardens.

Key Contact

John Quinney, Research Director: (617) 563-2655/2219

The New Alchemy Institute
237 Hatchville Road
East Falmouth, MA 02536

DEGREE PROGRAM

A.A.S. and B.S. Degrees

Sponsor: Jordan Energy Institute, Jordan College, Comstock Park, Michigan

Description

Three degree programs are offered in renewable energy technologies. The Associates in Applied Science degree in renewable energy (A.A.S.) is a two-year program designed to provide students with both theoretical and practical knowledge of the design, operation and installation of alternative energy systems. Participants spend four college semesters studying subjects related to RETs, including: physical science, introduction to renewable energy (with lab), basic electricity (with lab), algebra, energy conservation, control systems, heating/ventilating/air conditioning, residential energy audits, construction materials, solar, wind, biomass, geophysical energy and systems design, energy management and power production/co-generation, installation and operation of small-scale power plants.

Two four-year programs are offered: Bachelor of Science degrees in renewable energy and renewable energy engineering technology. Both programs are designed to provide an in-depth understanding of RETs with very specific knowledge of the design, installation and maintenance of RET systems.

Objectives of the B.S. in renewable energy are to develop a strong technical understanding of conventional and renewable energy sources; to gain basic understanding of the ecological impact of governmental and industrial energy decisions, thus gaining a background within which technical decisions can be framed; and to develop laboratory and field experience in renewable energy applications.

Objectives of the B.S. in renewable energy engineering technology are similar; however, this degree requires more math and stresses energy management and resource recovery. It provides an internship for participants and offers a series of interdisciplinary seminars to examine technology from a humanities and social science perspective.

continued

DEGREE PROGRAM
(Jordan continued)

Curriculum is similar to that of A.A.S. program, but the last two years emphasize more specific, in-depth investigation of RETs of participant's choice.

Campus facilities include: solar greenhouses, PV arrays, wind electric systems, passive solar design, wood-fired boiler systems, a thermosyphon, domestic water heating systems, Trombe walls, a direct gain system, and a 1,000-square-foot space heating system.

Background

The Institute opened in 1974. The four-year degree programs began in 1978, with the first class of 15 graduating in 1981.

Availability

Programs are conducted on a semester basis, beginning in September and January. Cost is $1,250 per semester, excluding materials. Some courses also have lab fees of $20 to $35.

Prerequisites

High school graduation is required. Test scores from American College Testing Program (ACT) or Scholastic Aptitude Test (SAT) are recommended for admission, but not mandatory. All instruction is in English.

Key Instructors

Niels Andersen, B.F.T., Latin American Institute

Alison Heins, M.S., Cornell University; M.L.S., University of Iowa

Conrad Heins, Ph.D., University of Illinois

continued

DEGREE PROGRAM
(Jordan continued)

Tom Post, M.S.E., University of Michigan

Roger Stanley, M.A., Northern Michigan University

Accommodations

Jordan is not a residential facility, so participants must make their own housing arrangements.

Key Contact

Niels Andersen, Director: (616) 784-7595

Jordan Energy Institute
155 West Seven Miles Road
Comstock Park, MI 49321

DEGREE PROGRAM

Alternative Energy

Sponsor: Red Wing Energy Education Center, Minnesota

Description

This 18-month program offers a Proficiency Degree. It combines classroom and field experience in the areas of active solar, passive solar design, wind energy, energy from biomass, photovoltaics and other forms of alternative energy. Participants are introduced to theory associates with a particular technology, given hands-on instruction in system installation and maintenance by working with the energy systems on campus.

Campus resources include: five different wind electric generators, including an 18 kW installation; 10 different configurations of solar collectors; one PV system, with another planned for installation this year; a 30-gallon-per-day alcohol still; and several smaller experiments in methane and geothermal energy production.

Background

Programs began in 1978. Fewer than one percent of participants have come from developing countries.

Availability

Program runs from late August to the end of May for two consecutive years. Participants may begin studies in August of each year. Registration is accepted at any time during the year, prior to the August starting date. Cost of the program is $4,200, excluding materials, room and board. Materials costs are estimated at about $1,000 for the entire two-year program.

continued

DEGREE PROGRAM
(Red Wing continued)

Prerequisites

High school education or equivalent is required. Experience with high school algebra is especially recommended. All instruction is in English.

Key Instructors

Norm Hilleren, M.S. in physics and chemistry, instructs in these two areas.

Georgiana Allan, M.S., has been an architect with Criteria, Inc. for the past 10 years.

Rich Huelskamp, M.Ed., instructs in math and physics, owns a solar business, formerly worked for the Minnesota Energy Agency.

Bob Christianson, B.S., owned a plumbing and heating company.

Bill Walden, A.A., is a sheet metal/vocational instructor.

Dana Sills, specialist in electricity and electronics, was formerly with Control Data Corporation.

Other part-time instructors teach computer classes, small business management and technical writing, among other subjects.

Accommodations

There are no residential facilities at Red Wing, so students must make their own housing arrangements.

Key Contact

Ms. Pat Enz, Director: (612) 388-3594

Red Wing Energy Education Center
Highways 61 and 19 West
Red Wing, MN 55066

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DEGREE PROGRAM

Technology for International Development

Sponsor: Department of Technology and Human Affairs, Washington University at St. Louis, Missouri

Description

The objective of the program is to train participants in appropriate technologies applicable to economic situations prevalent in developing countries.

The program sponsors courses, projects and research in: alternative energy, modeling and simulation, strategic management, technology assessment, international development technology, energy policy, bioresources, energy conversion and conservation, environmental quality control, science and technology policy, and transfer of appropriate technology.

B.S., M.S, and Ph.D. degrees are offered.

Installations at the campus currently include a facility for manufacturing small wood and charcoal cookstoves, and the program intends to expand experimental capabilities in renewable energy technologies during the next year.

Background

The program has been in existence for 10 years. It graduates approximately five students per year at each degree level. Several graduates have been from developing countries.

Availability

The program is offered on a semester basis and participants may join at the beginning of any semester (September or January). Early registration is recommended. Tuition is $7,560 per year (two semesters) with an additional $400 per year estimated cost for materials. This does not include room and board.

continued

DEGREE PROGRAM
(Washington University continued)

Prerequisites

High school graduation or equivalent. For students from non-English speaking countries, TOEFL scores of at least 550 are required.

Key Instructors

Dr. Michael Brambley, assistant professor; specializing in energy technology/policy, energy conservation and economics, and alternative energy technologies.

Dr. Robert P. Morgan, professor; specializing in appropriate technology/policy.

Dr. Eugene B. Shultz, Jr., professor; specializing in appropriate technology, biomass, technology innovation and energy for rural development.

Accommodations

Dormitory accommodations available at $3,420 per year (two semesters)--includes room and board.

Key Contact

Dr. Robert P. Morgan, Director: (314) 889-5455

Center for Development Technology
Campus Box 1106
School of Engineering and Applied Science
Washington University at St. Louis
St. Louis, MO 63130

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