

ANNUAL REPORT

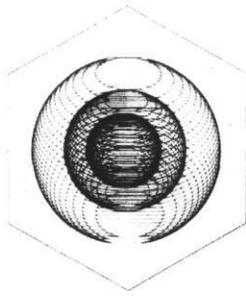
ENERGY SYSTEMS GROUP

DEPARTMENT OF MECHANICAL ENGINEERING

TEXAS A&M UNIVERSITY

COLLEGE STATION, TEXAS

March 1986



ENERGY SYSTEMS LABORATORY

Department of Mechanical Engineering
Texas Engineering Experiment Station
Texas A&M University

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STATEMENT FROM THE DIRECTOR

The Energy Systems Group at Texas A&M University is pleased to be able to report on its activities and status as it enters a new year. We have gone through an exciting period of unparalleled growth involving both The Group and Texas A&M University. We are now in an excellent position to further develop and serve students, Texas Industry, and the citizens of the State of Texas. We are excited and happy about our prospects.

This is the first time we have formally used the name Energy Systems Group. Having operated for a number of years as the Energy Management Group, energy management and conservation educational research is still our major thrust. Energy Systems is a broader term and we want it to include energy management as well as other energy areas. It is indicative of our expanding role in Texas and the Gulf Southwest.

The following pages will describe to you and formal industrial relationship, research facilities, outreach programs, academic programs, our personnel, and our future plans. Our goal is to provide this country with professionals who will be able to tackle some of its pressing energy needs. We do this in many ways, varying from dissemination of information to development of technology, and this report will provide more information about our activities.

If we may be of direct service to you or your organization please do not hesitate to contact us. We are thankful for opportunities to serve.

Sincerely,

Dan Turner, P.E.
Director, Energy Systems Group
Mechanical Engineering Department
College Station, TX 77843
409-845-1292

ENERGY SYSTEMS GROUP FACULTY

The Energy Systems Group is composed of faculty members at Texas A&M University in the Department of Mechanical Engineering. All have shared interests in the area of energy conversion or energy systems. The faculty and their interests is listed below, and it has remained essentially unchanged since its beginning in August of 1982.

Dr. N.K. Anand
(HVAC system modeling heat transfer)
(409) 845-3923

Dr. Jerry Caton, P.E.
(cogeneration, Combustion)
(409) 845-4705

Dr. Warren M. Heffington, P.E.
(industrial, energy management, alternate
fuels, combustion)
(409) 845-5019

Dr. Dennis L. O'Neal, P.E.
(residential and commercial HVAC equipment,
energy forecasting)
(409) 845-8039

Dr. Siram Somasundaram, P.E.
(HVAC equipment, turbomachinery
fluid mechanics)
(409) 845-0170

Dr. Dan Turner, P.E.
(energy conservation, energy systems,
solar energy)
(409) 845-5244

INDUSTRIAL RELATIONS

The Energy Systems Group was organized as a group of Mechanical Engineering faculty with common interests in August of 1982. Known in the beginning as the Energy Research Committee, and then the Energy Management Group, the first year was spent in planning and consolidating individual programs. During that year, the group quickly realized the need for a group of industrial representatives to provide advice about academic programs, outreach and research effort.

About one year later, in September of 1983, the Advisory Board was formed. In October of 1983, it had its first meeting. The board formally meets two times per year with the Energy Systems Group to review research, the academic program and the annual Building Energy Symposium.

The Advisory Board has been an excellent source of advice and industrial input about the director of the programs of the Energy Systems Group. They have also assisted in giving seminars at Texas A&M University, hosting field trips for students and teaching short courses. Some of the graduates of the Energy Management Program have also found employment with the firms of some of the Advisory Board. The arrangement has directly benefited Texas industry with graduates knowledgeable about energy conservation and with technology information transfer.

ENERGY SYSTEMS ADVISORY BOARD

We are very grateful to the members of our Advisory Board and present members and their affiliations are listed below.

Mr. Warren Andrews
Texas Instruments, Inc.

Mr. James McClure
Estes-McClure and
Associates, Inc.

Mr. Dick Cawley
Lennox Industries

Mr. Joe Spears
Planergy, Inc.

Mr. Louis E. Chaump
The Trane Company

Mr. Ronald Stallings
Carrier Co.

Mr. Harry Englehardt
Dow Chemical Company

Mr. Leo Stambaugh
Dallas Power & Light

Mr. Richard L. Good
Union Carbide

Mr. Malcolm Verdict
Public Utility Comm.

Mr. Kenneth C. Jones
Shell Oil Company

Mr. Jerry Vogt
Lone Star Gas Company

Mr. Bill LaGrange
Consultant

Mr. J.C. Lanier
Alcoa

ENERGY SYSTEMS GROUP

RESEARCH

The primary mission of the research conducted by the Energy Systems Group is improving the efficiency of energy use. Currently, the research focuses on improving energy efficiency in heating and air conditioning equipment, improving thermal efficiency of buildings, implementation of cogeneration systems, and improving the capability of electric utilities to predict energy growth in their service areas. The major research facility operated by the Energy Management Group is the Energy Systems Laboratory. At the close of 1985, the Energy Systems Group had five funded research projects valued at approximately \$250,000. These included:

Attic Simulation and Associated Heat Transfer Study, funded by the Texas A&M Center for Energy and Mineral Resources. The heat transfer that occurs in residential attics is being studied by co-principal investigators, Drs. Turner and O'Neal. An attic simulator was built to provide a controlled environment to do the heat transfer studies. Several insulation systems (fiberglass, cellulose and reflective) were used to evaluate the impact of radiation heat transfer within the attic. A model of the heat transfer processes was also developed.

Texas State Agency Energy Study - Phase III, funded by the Public Utility Commission of Texas. Drs. Turner, O'Neal and Somasundaram are involved in this project. Annual expenditures for energy use in Texas State Agencies in 1984 was over two hundred million dollars. This study has four major tasks. First, the Energy Systems Laboratory is the data collection center for monthly energy data from each of the major state agencies. The second task is to evaluate the feasibility of applying cogeneration in selected state agencies and institutions. The third major task includes developing energy efficiency standards for all new buildings constructed for the state. For the fourth task, individual buildings will be monitored to determine the effectiveness of implementing energy conserving retrofits on the buildings.

Development of Residential and Commercial Energy End-Use Models For the City of Austin Electric Utility Department, funded by the City of Austin Electric Utility. The Principal Investigator is Dr. O'Neal. With the increasing cost of building new generating capacity, electric utilities are seeking more sophisticated methods of forecasting future energy use and demand. The purpose of this project is to develop end-use (air-conditioning, space heating, etc.) based forecasting models for both the residential and commercial energy using sectors for the City of Austin Utility. The models will allow the utility to estimate the impact of many conservation programs on the future energy use.

A Study on Frost Growth and its Effect on Heat Transfer in Finned Tube Heat Exchangers, sponsored by the Texas A&M Center for Energy and Mineral Resources. The principal investigator on this project is Dr. D.L. O'Neal. Frost can have an adverse impact on the energy use and capacity of heat pumps operating in the heating mode at outdoor temperatures between 20 and 40 F. The objective of this project is to experimentally characterize the frost formation process and its effect on heat transfer in heat exchangers. An experimental facility is being constructed to allow for precise control of temperature and humidity of air entering a heat exchanger. An analytical model of the frost formation process will also be developed.

An Analysis of Efficiency Improvements in Heat Pumps, funded by Lawrence Berkeley Laboratory (U.S. Department of Energy). Air-to-air heat pump technology has improved dramatically over the past ten years. A computer model is used with "off-the-shelf" component (heat exchangers, compressors, etc.) descriptions to investigate the practical limits to efficiency improvements that are possible on air-to-air heat pumps. This work is done with the cooperation of several large heat pump manufacturers, and under the direction of the principal investigator, Dr. O'Neal.

These projects are indicative of the research expertise processed by the Energy Systems Group at Texas A&M University. In a way, these are only beginnings because we hope to further develop research in air moving equipment, thermal storage, air conditioning research, thermal performance of buildings, and energy use in state agencies.

We anticipate that a very useful asset in accomplishing these developments will be the Energy System Laboratory, a responsibility acquired by the Energy Systems Group in the Spring of 1984.

ENERGY SYSTEMS LABORATORY

The Energy Systems Laboratory (ESL) is located at the Texas A&M University Research Annex in Bryan, Texas. Before 1984, the ESL was known as both the Fan Test Laboratory and the Engineering Test Laboratory. The ESL began operation in 1939 and was primarily involved with testing and measurements on air moving equipment. It is the official testing laboratory for the Home Ventilating Institute (HVI) and is the only fully independent Air Moving Committee of America (AMCA) certified test laboratory. It has operated for more than 40 years as an independent laboratory certifying fans, blowers, evaporative coolers and similar equipment.

The laboratory has facilities to do testing and research on fans with capacities up to 48000 CFM at zero static pressure. These facilities include two smaller nozzle air flow chambers and one large pitot static facility. The laboratory also has facilities for measuring performance of ceiling fans. The facility allows for multiple placement of fans as well as a ceiling whose height can be varied between 8 and 20 ft. There is no university in the United States with comparable air measurement facilities.

The laboratory also has a 6000 cubic foot reverberant room for making noise measurements on small air moving equipment such as might be found on oven hoods or bathroom exhaust fans.

The Energy Systems Group has been busy expanding the laboratory capabilities since acquiring control of the laboratory facility in the Spring of 1984. A new addition to the facilities at the ESL is two psychrometric rooms. These rooms provide a controlled temperature and humidity environment in which to evaluate the performance of heat pumps, furnaces, and air conditioners. The rooms can accommodate air conditioners of capacities up to 10 tons. Approximately \$60,000 in equipment was donated by private industry for use in the psychrometric rooms.

The ESL also has a solar simulator, attic heat transfer simulator, a heat exchanger test loop, and two small houses.

Because there are no other similar, independent research and test facilities in Texas or the Southwest, the ESL is in a position to provide unique services to companies, governmental agencies, utilities and other organizations in Texas and in much of the United States. In particular, the ESL is in a position to focus on problems specifically related to hot, humid climates.

ENERGY SYSTEMS LABORATORY CONSORTIUM

Acquisition and improvements of the Energy Systems Laboratory (ESL) have created a unique method for industries to become further involved in university programs. A consortium is being organized to provide direction and financing for the selected research programs to be performed at the ESL.

Member companies of the consortium make an annual contribution of \$10,000 as a grant to the ESL. Relevant research projects financed by the contributions and performed at the ESL are jointly decided by consortium members at an annual planning meeting.

Energy System Laboratory Consortium members have immediate access to the reports and results of the ESL research effort. This includes all non-proprietary research programs, even those not supported by consortium funds.

Also, consortium members have access to Texas A&M faculty members who work in the energy management area, and laboratory facilities are available on a contract basis, with consortium members given a higher priority. Consortium members also become familiar with graduate students working on consortium projects and have a distinct advantage in hiring qualified students.

OUTREACH:
BUILDING ENERGY SYMPOSIA

The Energy Systems Group has sponsored an Annual Building Energy Symposium since 1984. The symposium has had as sponsors the Texas Center for Energy and Mineral Resources, the Gas Research Institute, and the Texas Public Utility Commission. The first symposium, coordinated by Dr. Dan Turner, was held in August of 1984 in College Station and attracted over 230 attendees. The chairman of the Texas Railroad Commission, Mack Wallace was the keynote speaker and Ralph Lewis, formerly Vice President of Gulf Oil Company, was the luncheon speaker. There were twenty-four technical papers, four tutorial seminars and four discussion groups.

The second symposium, coordinated by Dr. Bill Murphy, was held in September of 1985, again in College Station. Approximately 275 people attended the meeting which was expanded to three days and included forty-eight papers, four tutorial seminars and three discussion groups. Dr. Arthur Rosenfield, program leader at Lawrence Berkeley Laboratory, was the first luncheon speaker and Dr. Albert Bartlett from the University of Colorado was the second luncheon speaker. In both symposia, exhibits of energy efficient HVAC and lighting equipment were on display.

The next symposia will be held on November 18 and 19, 1986 in Arlington, Texas.

SHORT COURSES

Five one-day short courses have been offered by the Energy Management Group since August 1983. The following table summarizes these activities:

<u>COURSE TITLE</u>	<u>DATE</u>	<u>INSTRUCTORS</u>	<u>PAYING PARTICIPANTS</u>
Building Load Analysis	8/26/83	Turner, O'Neal, Murphy	38
Efficient Boiler Combustion & Management	8/13/84	Turner, Caton	13
Cogeneration Systems	8/16/84	Caton, Good, Turner	19
Retrofitting Buildings for Energy Efficiency	9/23/85	McClure, Heffington <u>etal.</u>	27
Cogeneration Systems	9/23/85	Caton, Good, Turner	16

The short courses in 1984 and 1985 were all held in conjunction with the symposia. In addition, the Texas Engineering Extension Service held two workshops on the day following the 1985 symposium to provide further educational opportunities to the attendees.

In addition to the above activities, Drs. Caton and Turner were invited in 1984 and 1985 by the Texas Engineering Extension Service to co-teach a workshop on boilers and steam.

ACADEMIC PROGRAMS IN ENERGY SYSTEMS

The graduate energy management specialization in the Department of Mechanical Engineering at Texas A&M University is designed to graduate a professional who can solve advanced energy management problems of commerce and industry. The traditional M.S. and Ph.D. graduate degrees are available as well as two professional degree programs: the M.E. (Master of Engineering) and D.E. (Doctor of Engineering) degrees. Both the traditional and professional degree programs require a core of engineering and technical coursework. Those in the M.S. or Ph.D. programs also require a thesis. The professional programs also require a significant number of non-technical courses designed to enable the graduate to adapt better in a commercial or industrial environment. Technical courses available from other departments such as Construction Science or Environmental Design may be taken.

An internship in industry is required of both the M.E. and the D.E. student in energy management. During the internship period the student works under a supervisor (a practicing engineer), who assigns an appropriate project (or projects) focusing on aspects of energy management. Salaries for the internship period are negotiated between the student and the employer. The internship could also be handled on a contract or consulting basis if appropriate. The length of the internship period is one semester or one summer for the M.E. student, and one year for the D.E. student. Key graduate courses include Energy Systems (ME661), Energy Management in Industry (ME662), Energy Management in Commercial Buildings (ME664), Applications of Energy Management (ME 665), Power Plants (ME 603) and Intermediate Heat Transfer (ME 630). Other courses in the areas of finance, management accounting and economics are generally taken to broaden the students background in these important areas (especially for the M.E. and the D.E. degrees).

Through December of 1985, 1 D.E., 12 M.E., and 2 M.S. students have graduated in this program. At the present time, there are approximately 8 M.E., 3 M.S., 3 D.E., and 2 Ph.D. students in the program.