The

ENERGY CENTER

at the

UNIVERSITY OF CALIFORNIA, SAN DIEGO (UCSD)

INITIATION OF THE ENERGY CENTER

Although informal proposals to develop interdisciplinary energy-related programs on the UCSD campus were made by S. S. Penner during the late sixties, the conception and development of the present activities began during the fall of 1973 with strong support from Chancellor W. D. McElroy and Vice Chancellor Paul D. Saltman. The following statement is abstracted from an October 1973 draft proposal for establishment of the UCSD Energy Center:

> "The purpose of a UCSD Energy Center is to strengthen interdisciplinary programs of research and teaching, as well as to provide graduate and post-doctoral students with added research opportunities, facilities and assistance.
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> The establishment of a UCSD Energy Center will serve important educational, research, and public-service functions which are not satisfactorily met by the existing departments or other organized research units at UCSD. An opportunity exists in the San Diego area to solve fundamental problems deriving from the interrelated physical, biological, economic, political, and social consequences of man's need for energy. The importance of energy problems arises from factors which include: i) the key role of energy supply in the functioning and growth of industrial society, ii) the finite supply of fossil-fuel resources, iii) the environmental side effects of energy production and use (air, water and thermal pollution), iv) risks associated with nuclear-energy production (radioactive release, diversion of fissionable material for military use), v) the danger that planning in the energy area, which has a controlling effect on many other areas of planning, will be ruled by considerations which are too narrow or biased to reflect the public interest."

S. S. Penner, Professor of Engineering Physics in the Department of Applied Mechanics and Engineering Sciences, was asked to assume overall responsibility for coordination and development of the UCSD Energy Center plan. The Associates of the Energy Center and their energy-related research interests are listed in the Appendix to this document.

Involvement in studies has followed the principle that faculty participation is only effective when it is accomplished in accord with individual preferences, competence and availability, depending on the subject matter under investigation.

Following required approvals by campus and statewide administrators, the UCSD Energy Center was officially established as an Organized Research Unit on the UCSD campus during June 1974. S. S. Penner was appointed the first Director of the Center.

SUPPORT FOR PROGRAM INITIATION

The development of the UCSD Energy Center was greatly aided by a program-initiation grant which was received from the Gulf Oil Foundation during 1973. Several graduate fellowships were established by grants received from the High Temperature Reactor Associates and the San Diego Gas and Electric Company. In addition, limited support was received from University sources.

ENERGY-RELATED COURSES

Early emphasis of Energy Center efforts was placed on course developments.

Since the beginning of the 1974-75 academic year, the following courses are being offered on a regular basis:

AMES 34: A Freshman-level course dealing with Energy: Demands, Resources, Technology and Policy. This is a survey course on energy stressing the following topics: the manner in which our energy demands are defined at the local, regional, national and international levels; the total (currently used and potential) resources available for satisfying energy demands; highlights of technological challenges concerning new energy production and utilization techniques; energy policy, with emphasis on potential environmental and economic impacts.

FS 119A: An interdisciplinary, upper-division course on Energy: Demands, Resources, Technology and Policy. Past and estimated future energy demands. Renewable and non-renewable energy resources. Economic impact of energy use. Environmental impact of energy use. Energy conservation in manufacturing, transportation, home use. Energy policy.

FS 119B: An interdisciplinary, upper-division course on Energy: Non-Nuclear Energy Technologies. Oil recovery from tar sands and oil shale. Coal production, gasification, liquefaction. The hydrogen economy. Energy storage systems. Techniques for direct energy conversion. Solar-energy utilization. Energy from

windmills. Tidal-and-wave-energy utilization. Hydroelectric power generation. Hydrothermal energy. Geothermal energy from hot rocks. Electrical power production, transmission and distribution.

FS 119C: An interdisciplinary, upper-division course on Energy: Nuclear Energy Technologies and Energy Policies. A brief survey of energy demands and resources. Available nuclear energy: physical background, thermal dynamics, atomic and nuclear physics; fission and fusion processes: physics of fission reactions, engineering aspects, safety and environmental effect of fusion; scaling laws and start-up criteria; laser fusion; magnetic confinement; equilibrium instability; energy policies.

In addition, at least one course per year is being offered at the advanced graduate level on selected energy technologies (e.g., geothermal energy, solar energy, fusion power, etc.). Faculty members from several departments have been regular participants in these interdisciplinary offerings. The course material that has been used in AMES 34, FS 119A, 119B and 119C is described in the following publications:

Energy, Volume I: Demands, Resources, Impact, Technology, and Policy, 373 pages, by S. S. Penner and L. Icerman, Addison-Wesley Publishing Company, Reading, Mass., 1974;

Energy, Volume II: Non-Nuclear Energy Technologies, 673 pages, by S. S. Penner and L. Icerman, Addison-Wesley Publishing Company, Reading, Mass., 1975;

Energy, Volume III: Nuclear Energy and Energy Policies, 713 pages, by S. S. Penner, K. A. Brueckner, R. J. Cerbone, A. Hochstim, J. P. Howe, L. Icerman, M. Z. Nagel, W. B. Thompson, and B. J. West, Addison-Wesley Publishing Company, Reading, Mass., 1976.

Some related interdisciplinary courses at UCSD, most of which antedate establishment of the UCSD Energy Center, deal with such topics as Technology, Ecology, Morality; Quantitative Aspects of Social and Environmental Problems; Transportation: A Technology in Its Societal Setting; Society and the Sea; Management of the Air Environment; Chemistry and the Air Environment; etc.

ENERGY-RELATED RESEARCH

It is proper to note that essentially all research in the physical, engineering, biological, and social sciences is energy-related. In this sense, all of the investigations performed by all of the many distinguished UCSD faculty members under their own grants and contracts are important in furthering the objectives of the Energy Center. The following examples of these studies will serve to indicate the scope of activities with readily identifiable bearing on important current issues:

Geothermal resource development for use in the San Diego region.

Environmental effects of large nuclear farms; coastal and off-shore siting of nuclear reactors.

Predictive air-quality model for land use, transportation and energy planning; physico-chemical models of regional air pollution; short-term statistical predictions; air-basin time-response studies.

Measurements of rate constants for elementary reaction steps in natural-gas combustion.

Development of superconducting materials for use at higher temperatures.

Hydrogen storage in rare-earth metals.

Fundamental combustion and fire-control studies; the effect of turbulence on combustion processes.

Development of *in situ* procedures for the recovery of fossil fuels.

The use of biological systems for the direct production of hydrogen on exposure of water to solar radiation.

Development of new insulating materials for energy conservation.

Petrochemicals and energy use.

Geophysical aspects of energy utilization.

The UCSD Energy Center does not accept or process applications for graduate students. All inquiries concerning admission to graduate work must be submitted directly to the responsible UCSD departments.

SPECIAL ACTIVITIES

In accord with the principle that public-service functions constitute an important focus for faculty effort, very many of the UCSD faculty members serve on the advisory boards of national, statewide and regional governmental

agencies. Examples of these activities are the following: National Science Board; advisory committees of the Energy Research and Development Administration and of the congressional Office of Technology Assessment; State of California committees dealing with energy and resources; the Quality of Life Board of the City of San Diego; the EPRI advisory committee.

Sponsored studies have included workshops dealing with such topics as in situ recovery of shale oil, the social impact of energy use, and resource estimates for copper. Among the scientific journals edited by UCSD faculty members is the new International Journal on Energy, a Pergamon Press publication.

The UCSD campus serves as a regional focus for professional seminars, special lectures, and symposia dealing with important public issues such as energy. Examples of these activities during the 1974-75 academic year were a Third College Symposium on Solar Energy: Future Prospects and Present Reality and a Conference on Limits to Non-Growth sponsored by the UCSD Program in Science, Technology and Public Affairs.

APPENDIX

ENERGY CENTER ASSOCIATES AND ENERGY-RELATED RESEARCH

Associate	Energy-Related Research Interests
J. R. Arnold, Professor of Chemistry:	energy policy
G. Arrhenius, Professor of Oceanography:	shale-oil recovery, energy from the oceans;
T. Barnett, Academic Administrator, NORPAX:	climatic impacts of escalating energy use;
K. A. Brueckner, Professor of Physics:	laser-induced fusion reactions;
J. Clinton, Lecturer, AMES:	solar-energy applications;
R. D. Emmerson, Assistant Professor of Economics:	cost minimization, regional planning;
C. H. Gibson, Associate Professor of Engineering Physics and Oceanography:	climatic impact of energy use;
E. Goldberg, Professor, Geological Research Division:	environmental impact assessments;
M. Goodman, Professor of Chemistry:	synthetic fuels, petrochemicals;
A. Gordon, Adjunct Professor of Engineering Chemistry:	air pollution and environmental impact assessments;
A. Hochstim, Visiting Professor of Engineering Physics:	fusion reactors;
J. P. Howe, Adjunct Professor of Nuclear Engineering:	fission and breeder reactors;
J. D. Isaacs, Professor of Oceanography:	wave energy, salinity power, OTEC;
N. O. Kaplan, Professor of Chemistry:	photosynthetic production of H_2;
W. Kohn, Professor of Physics:	photovoltaics;
G. Krishnamoorthy, Associate Professor of Civil Engineering, California State University at San Diego:	energy conservation, structural designs;
S. Lakoff, Professor and Chairman, Political Science:	societal impacts of energy-use curtailments;
L. Liebermann, Professor of Physics:	photovoltaics;
P. A. Libby, Professor of Fluid Mechanics:	heat transfer and secondary cycles;
R. H. Lovberg, Professor of Physics:	magnetic confinement and fusion reactors, MHD;

Associate	Energy-Related Research Insterests
J. H. Malmberg, Professor of Physics:	fusion reactors, MHD;
B. T. Matthias, Professor of Physics:	superconductivity and superconducting power lines;
W. D. McElroy, Chancellor and Professor of Biology:	biomass production;
H. W. Meldner, Assistant Adjunct Professor of Physics:	laser fusion and thermonuclear neutron capture;
W. H. Munk, Professor of Geophysics:	ocean-atmosphere interactions and the impact of energy use on climate change;
W. Nachbar, Professor of Applied Mechanics:	nuclear-reactor sitings;
J. Namias, Research Meteorologist:	climatic impact of escalating energy use;
D. B. Olfe, Professor of Engineering Physics:	thermal plumes, climate changes;
H. Oesterreicher, Assistant Professor of Chemistry:	energy storage;
S. S. Penner, Professor of Engineering Physics:	energy conservation, energy technologies, climatic impact of escalating energy use;
W. Ramm, Assistant Professor of Economics:	economic efficiency of energy use;
R. R. Revelle, Professor of Political Science and Director Emeritus, Scripps Institution of Oceanography:	energy use in food production;
R. E. Roberson, Professor of Engineering Sciences:	transportation systems and energy use;
M. Rotenberg, Professor of Applied Physics:	demographic studies, social systems;
P. D. Saltman, Vice Chancellor for Academic Affairs and Academic Personnel and Professor of Biology:	biomass production;
A. Sebald, Assistant Professor of Engineering Sciences:	energy conservation, utility-systems optimization;
R. Schmalensee, Assistant Professor of Economics:	fuel supplies and costing;
W. R. Schmitt, Associate Specialist in Oceanography:	wave energy, salinity power;
A. M. Schneider, Professor of Engineering Sciences:	energy conservation, electric-load forecasting;
S. Schultz, Professor of Physics:	solar-energy applications, photovoltaics;

Associate	Energy-Related Research Interests
K. E. Shuler, Professor of Chemistry:	sensitivity analysis for complex systems, chemical kinetics;
H. Suhl, Professor of Physics:	photovoltaics, catalysis;
K. G. P. Sulzmann, Research Engineer:	energy technologies, energy conservation;
W. B. Thompson, Professor of Physics:	magnetic confinement and fusion reactors;
T. G. Traylor, Professor of Chemistry:	petrochemicals;
C. W. Van Atta, Professor of Engineering Physics and Oceanography:	climatic impact assessments, ocean engineering;
W. Vernon, Associate Professor of Physics:	solar-energy applications;
F. A. Williams, Professor of Aerospace Engineering:	combustion research;
K. R. Wilson, Associate Professor of Chemistry:	environmental-impact assessments;
H. F. York, Professor of Physics:	geopolitical aspects of energy use.