September 30, 2005

Karlene Fine, Executive Director
North Dakota Industrial Commission
State Capitol
600 East Boulevard Ave, Dept 405
Bismarck, ND 58505-0840
ATTN: Lignite Research Program

Dear Ms. Fine:

The University of North Dakota's Chemical Engineering Department is pleased to present their proposal entitled "Power Systems Engineering Education And Research Program" for consideration for funding from the Lignite Research Program. The Program's mission is to provide a well-trained work force to the electric power community cognizant of the issues facing the energy industry today and in future generations. It is our mission to provide this trained work force by engaging students in research and education that is focused on the needs of the electric power community. The realization of this vision will be fulfilled through education and research activities conducted through a partnership between the power generation community, School of Engineering and Mines, Energy & Environmental Research Center and state and government agencies.

The total cost of this program is $150,000 per year. The project team is actively seeking $105,000/yr from local utilities. The remaining $45,000/yr for the project is being requested from the NDIC. We are asking for a three year commitment to the project.

Please feel to contact me at 701-777-3852 or at mikemann@mail.und.nodak.edu.

Sincerely

Michael D. Mann
Associate Professor
Chemical Engineering

Barry Milavetz
Associate Vice President for Research
Research, Development & Compliance

POWER SYSTEMS ENGINEERING EDUCATION AND RESEARCH PROGRAM (PSEERP)

Principal Investigator: Michael D. Mann

The University of North Dakota
Department of Chemical Engineering
P.O. Box 7101
Grand Forks, ND 58202-7101

Date of application: September 30, 2005

Amount Requested: $45,000/yr
Duration: 3 yr

POWER SYSTEMS ENGINEERING ED.UCATION AND RESEARCH PROGRAM (PSEERP)

Abstract

The electric power industry has been undergoing a transformation from a regulated monopoly to a deregulated industry. In addition, social pressures related to global warming, sustainable energy development, renewable energy portfolios, and environmental responsibility is increasing. The vision of this program is a regional community able to meet the future energy demands with economic efficiency and minimal environmental impact. To realize this vision, it will be necessary to develop resources in conjunction with the electric power community (utility and process industry). The heart of these resources is personnel with training and experience in the generation, transmission, and distribution of power through sustainable technologies. We propose to realize our vision by providing the following to the electric power community:

- Personnel with good critical thinking skills and training in sustainable energy development,
- A professional development track for current employees on latest technological developments, and
- Leading edge research on issues critical to meeting future energy needs.

To realize this vision, it is the Program's mission to provide a well-trained work force cognizant of the issues facing the energy industry today and in future generations. It is our mission to provide this trained work force by engaging students in research and education that is focused on the needs of the electric power community. The realization of this vision will be fulfilled through education and research activities conducted through a partnership between the power generation community, School of Engineering and Mines, Energy & Environmental Research Center and state and government agencies.

POWER SYSTEMS ENGINEERING EDUCATION AND RESEARCH PROGRAM (PSEERP)

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POWER SYSTEMS ENGINEERING EDUCATION AND RESEARCH PROGRAM (PSEERP)

PROJECT SUMMARY

The power industry, including generation, distribution and transmission, has been undergoing a transformation from a regulated monopoly to a deregulated industry. In addition, social pressures related to global warming, sustainable energy development, renewable energy portfolios, and environmental responsibility is increasing. Although the UND School of Engineering and Mines (SEM) currently provides a good engineering foundation and the Energy & Environmental Research Center (EERC) offer students an opportunity for hands-on training, the utility of our graduates can be improved with a broader emphasis on all aspects of sustainable energy, where sustainable energy includes clean coal technologies, emerging renewable technologies, and the infrastructure needed to make them technically and economically viable.

It is the vision of this program to develop resources in conjunction with the electric power community (utility and process industry) that will be able to meet the future energy demands with economic efficiency and minimal environmental impact. The heart of these resources is personnel with training and experience in the generation, distribution and transmission of power through sustainable technologies. A variety of activities, focused on both undergraduate and graduate students, with a heavy emphasis on experiential learning will be used to provide personnel with good critical thinking skills and training in sustainable energy development. Through our established distance degree program we will be able to establish a professional development track for current employees on latest technological developments, including continuing education requirements set by the professional engineering license board. The personnel development goals will be accomplished through the conduct of leading edge

research on issues critical to meeting future energy needs.

The Power Systems Engineering Education and Research Program (PSEERP) will rely on industrial members to identify critical needs of the power generation, distribution and transmission sector and provide direction for the Program's activities. Utilizing this input, the Program will develop a roadmap for the education of students and conducting fundamental and applied research. The Program's activities will rely heavily on the involvement of faculty and students in the School of Engineering and Mines (SEM). The Program will collaborate with the Energy & Environmental Research Center (EERC) to determine direction on the most critical fundamental research needs, provide input and instructors for new course development, and host selected research activities. Government agencies, such as the U.S. Department of Energy and the Environmental Protection Agency will be invited to join the Program, providing direction toward successfully implementing the U.S. Energy Policy.

This program will complement the Electric Power Plant Technology Program offered at Bismarck State College (BSC). The BSC is focused on training entry-level technicians and operations personnel for fossil-fuel generation. Our Program will prepare professionals, rather than technicians, and will explore all aspects of energy production. The Program will address top industry research needs, examine new, innovative technologies, and provide unbiased, peer-reviewed results while training the next generation of experts.

PROJECT DESCRIPTION

The following contains the prospectus that is currently being reviewed by the potential industrial collaborators for this project. Although formatted slightly different than the NDIC proposal requirements, it contains many of the required components. Those items specific to the NDIC requirements that are not included in this prospectus will be presented after the prospectus.

PROSPECTUS
POWER SYSTEMS ENGINEERING EDUCATION AND RESEARCH PROGRAM

VISION

The vision of this program is a regional electric power community able to meet the future energy demands with economic efficiency and minimal environmental impact. To realize this vision, it will be necessary to develop resources in conjunction with the electric power community (utility and process industry). The heart of these resources is personnel with training and experience in the generation of power through sustainable technologies. We propose to realize our vision by providing the following services to the electric power community:

- Personnel with good critical thinking skills and training in sustainable energy development,
- A professional development track for current employees on latest technological developments, and
- Leading edge research on issues critical to meeting future energy needs.

The realization of this vision will be fulfilled through education and research activities conducted through a partnership between the School of Engineering and Mines, Energy & Environmental Research Center, Industry, and government agencies.

The Power Systems Engineering Education and Research Program (PSEERP) will rely

on industrial members to identify critical needs of the power generation, transmission, and distribution sector and provide direction for the Program's activities. Utilizing this input, the Program will develop a roadmap for the education of students and conducting fundamental and applied research. The Program's activities will rely heavily on the involvement of faculty and students in the School of Engineering and Mines (SEM). The Program will collaborate with the Energy & Environmental Research Center (EERC) to determine direction on the most critical fundamental research needs, provide input and instructors for new course development, and host selected research activities. Government agencies, such as the U.S. Department of Energy and the Environmental Protection Agency will be invited to join the Program, providing direction toward successfully implementing the U.S. Energy Policy.

This program will complement the Electric Power Plant Technology Program offered at Bismarck State College (BSC). The BSC is focused on training entry-level technicians and operations personnel for fossil-fuel generation. Our Program will prepare professionals, rather than technicians, and will explore all aspects of energy production.

FOCUS

The Program will focus on educational and research and issues associated with sustainable power generation, transmission, and distribution from fossil, biomass, and agriculture-based fuels and renewable resources.

a) Educational: Our primary educational focus is to provide the electrical power industry a resource pool with specialized education and training in topics germane to problems currently facing the industry. Critical thinking skills will be reinforced using experiential learning, i.e. applied research, senior design projects, special topics courses, and industry directed graduate studies as a primary educational tool. Specifically, we will:

- Provide undergraduates with hands-on experience and classroom training in topics related to sustainable energy development.
- Immerse graduate students in research related to the needs of the power industry to provide personnel with the in-depth training required to solve current and future problems.
- Provide the opportunity for current power industry employees to advance their knowledge in subjects important to advancing their company's goals.

b) Research: We feel it is important to have a balanced, non-biased approach as we develop technical, environmental, and economic information for use by the power generators setting their future course. While the activities of the Program will be guided by the Industrial Advisory Committee, it is expected that the primary focus will include:

- Stationary power generation including increasing energy efficiency from existing and new systems, clean coal technologies, carbon sequestration, renewable energy systems, and hydrogen production.
- Transmission and distribution systems, including approaches to integrate distributed generation produced from renewable resources.
- Production of liquid and gaseous fuels (ethanol, biodiesel, hydrogen, methane for example) and specialty chemicals from biomass, fossil fuels and other resources, including infrastructure development.
- Environmental cleanup and protection of air, water, and soil, focusing on energy and industrial generated sources.

The focus will include issues important to both the electric utility and those process industries generating their own power.

MISSION/GOALS

As stated previously, the vision of this program is an electric power community able to meet the future energy demands with economic efficiency and minimal environmental impact, that is, through sustainable energy development. To realize this vision, it is the Program's mission to provide a well-trained work force cognizant of the issues facing the energy industry today and in future generations. It is our mission to provide this trained work force by engaging students in research and education that is focused on the needs of the electric power community. Inherent to accomplishing this mission are several goals that the Program has established as a measure of success.

- Foster partnerships among SEM, EERC, industry, government, and other organizations participating in the Program.
- Consult with industrial sponsors to set a defined research agenda focused on shared research interest, needs, and opportunities.
- Develop students who are knowledgeable in industry relevant issues related to sustainable energy development through involvement in high quality focused education and research programs.
- Perform fundamental, high risk, in-depth research to develop new products and advance the state of knowledge; and to support the EERC's efforts on applied research focused on solving specific industry problems.
- Provide professional development opportunities for electric power industry personnel.
- Facilitate timely two-way transfer of knowledge between university and industry.
- Create opportunities for expanded programs and leverage funding of program members via external proposals.

- Continue development of faculty and staff at UND that will provide industry and government with expertise on sustainable energy development.

BENEFITS TO MEMBERS

The Program has been developed to maximize the benefits provided to its sponsors. The sponsors in the Program activities will realize these benefits through strong participation. Sponsor interaction takes place at several levels, including those summarized here.

Advise Program Activities

- Provide input into direction of the Program through annual advisory committee meetings.

Access to Trained Students

- Hire graduates with training specific to electric power / sustainable energy development.
- Access interns with electric power training.

Professional Development Opportunities for Employees

- College-level courses delivered to your site via DVD or web.
- Certificate programs available in topics germane to sustainable energy development.
- Avenue for Professional Engineers to obtain required training to maintain license.

Directed Research

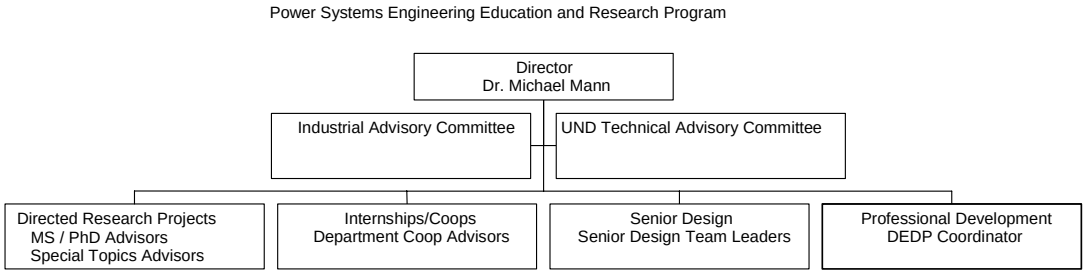
- Provide direction for and access results from industry related Master's and Ph.D. level research projects.
- Access literature surveys and research results developed by consortium sponsored projects.
- Provide input to and access student prepared white papers or research reports.

Input into Senior Design Projects

- Propose senior design projects related directly to your needs.
- Serve as industrial advisor to student design group.

PROGRAM MANAGEMENT

The program will be administered through the UND School of Engineering and Mines. Dr. Michael Mann, Director of the Engineering Doctoral Program, will serve as the program director. He will be responsible for coordinating the activities of the Program. The Program is structured to allow input from the Industrial Advisory Committee to flow through the UND Technical Advisory Committee so that program activities are well coordinated, reflect the industry developed needs, and have the support of UND faculty and students. The individual program areas will have the administrative oversight of the director, with technical oversight provided by student advisors in the respective areas.



Industrial Advisory Committee

Each of the Program's sponsors will have one representative on the advisory committee. The committee will meet on an annual basis with the primary tasks of 1) reviewing the results from the previous year and 2) developing research priorities for the upcoming year.

A structure to facility obtaining meaningful input from sponsors is proposed. Four weeks prior to the scheduled Industrial Advisory Committee Meeting sponsors will be asked to send in their list of priorities. These priorities will be tabulated and distributed back to the sponsors two weeks prior to the meeting to allow sponsors to begin prioritization. This should allow members

to prepare for the annual meeting and ensure maximum results, that is, to leave the meeting with the best action plan in place. Results from the previous year's work would also be distributed prior to the meeting to allow sponsors to formulate questions regarding the scope and quality of the work being preformed by the Program. Meetings can be held at UND, at one of the participant's sites, or as a virtual meeting.

Governance of the Industrial Advisory Committee would be left to the sponsors. The Program envisions that an Executive Officer will be selected from the Committee who can interact on a continual basis with the Program Director.

UND Technical Advisory Committee

An internal advisory committee will be established and shall consist of one member from each of the participating engineering departments and the Energy & Environmental Research Center (EERC). The committee will make recommendations on the program direction based on input from the Industrial Advisory Committee, review internal proposals submitted by faculty for directed research projects and resolve internal issues. We have included a representative from the EERC on the committee to maintain a connection between sponsored work and ongoing EERC work, including sharing of equipment and augmenting larger EERC projects.

Directed Research

It is SEM's philosophy that research is a primary tool for training well rounded undergraduate and graduate students. To mesh this primary philosophy with sponsor's needs, the Program will utilize the priorities outlined by the Advisory Committee to develop research projects. This directed research can take the form of Doctoral dissertation work, Master's thesis, Honor's thesis, or a Special Topics course. The depth of work and the length to completion varies for each as indicated below.

- Research projects will be structured to include either a Master's thesis or a Doctoral dissertation. By definition of a thesis/dissertation, these projects will "make a significant contribution to the advancement of knowledge in the field". They also must be of suitable duration (1 ½ to 3 years) to allow the student to meet the requirements of his/her program. In addition to their thesis/dissertation, students are required to publish results of their work in journal and conference papers.
- Honors projects are performed by Junior or Senior students in the Honors Program, with the result of their year long program being an Honor's thesis.
- Students at both the undergraduate and graduate level many times have the desire to increase the depth of understanding on a specific topic. Through the guidance of a professor, the students receive 1 to 3 credits in a one-semester Special Topics Course. The results of their efforts include a literature survey, research paper, white/position papers, or journal articles.
- Special Topics Projects are typically 1 – 3 credit single-semester undergraduate projects designed to give the student experiential learning in a topic of mutual interest to the student and a faculty advisor. These Special Topic Projects expose the undergraduate students to real problems, providing them with experience in critical thinking and problem solving. Special Topics projects can be done in conjunction with a Masters or Doctoral student project, or may involve gathering exploratory data for making preliminary evaluations of research ideas.

Directed research projects may include fundamental and applied experimentation and modeling; economic and environmental assessments; system analysis; and/or computer simulations.

Research projects will be funded through the Program at a level to cover the stipend of one full-time graduate student, one undergraduate student, one month faculty summer salary, and will include money for research supplies, equipment, and travel. It will be the task of the UND Technical Advisory Committee to determine the projects to be funded. Professors will be provided with the research priorities developed by the Industrial Advisory Committee and asked to submit short proposals outlining their approach to meeting one or more of these research priorities. The Technical Advisory Committee will select proposals to fund based upon technical merit and match to the research priorities. The number of major research projects will depend upon the number of sponsors that have subscribed to the Program.

The student typically selects Honor's Projects and Special Topics subjects with input from the faculty. All students will be made aware of the activities and research priorities of the Program through the Program's web page. Research priorities will also be transmitted to interested students during their mandatory fall and spring academic advisement. This will maximize exposure to the Program's priorities and attract students to the projects of interest as designated by the Industrial Advisory Group.

Internships / Co-ops

The SEM encourages all of its students to participate in an internship/co-op during their tenure as a student at UND. Through the activities of the Program, SEM will be able to offer students with a background in power generation, transmission and distribution. Members can hire SEM students through their normal intern/coop program or work with the Program. The program director will assist in locating students with power generation, transmission and distribution experience from the Program.

Professional Development

The SEM has been providing accredited undergraduate engineering degrees to students at a distance for over ten years. Through their Distance Education Degree Program (DEDP), SEM has established capabilities to offer distance students the same course as on-campus students. College-level courses are now delivered to the student's site via DVD, or accessed through UND's web site.

Employees from all sponsoring organizations will have access to courses focusing on issues germane to the power industry. Courses can be taken for credit at the employer's site by enrolling through the university distance education system, but must be taken when the course is being offered to on-campus students. These university courses and EERC sponsored workshops will be used to develop certificate programs. SEM currently offers an Environmental Engineering Certificate. Others could be developed based upon demand from program sponsors.

Senior Design

Engineering students in all disciplines are required to complete a yearlong capstone design. In Electrical, Civil, and Mechanical Engineering this usually entails the design, manufacturing, and testing of a specific product. Chemical Engineering seniors perform a feasibility of constructing a process plant or implementing/adding on environmental control systems. They evaluate different alternatives, develop the process flow, size and spec equipment, and develop preliminary cost estimates.

In all cases, students are allowed to select their own project. However, faculty members provide the students with a list of "preferred" projects. Members of the Program are encouraged to provide a listing of projects for consideration by the capstone design students. Although not a requirement, Program sponsors are encouraged to become fully engaged in the project by providing input into the design. Sponsors may elect to serve as advisors to the student's group if

they so desire. A portion of the budget has been set aside to provide financial assistance and incentives for students choosing to work on Program related projects.

BUDGET

UND is seeking $150,000 to establish the Power Systems Engineering Education and Research Program. This amount will allow UND to initiate two major research initiatives, deliver at least one new course per year, provide support and incentives for senior capstone design projects, involve undergraduates in Program related research, and to establish the infrastructure required to sustain the Program. Funding above the initial $150,000 will be utilized to fund additional research initiatives and course offerings.

Membership to the PSEERP is $15,000 per year and a three year commitment is required. This entitles the sponsor to one vote on the Industrial Advisor Committee, access to all results generated from directed research, input into Senior Capstone Design Projects, and access to industry related courses.

UND plans to solicit funding from several state and federal agencies including the North Dakota Industrial Commission, the North Dakota Department of Community Affairs State Energy Office, the Department of Energy, the Environmental Protection Agency, and the National Science Foundation to match all industrial dollars.

SUMMARY

The electric power industry has been undergoing a transformation from a regulated monopoly to a deregulated industry. In addition, social pressures related to global warming, sustainable energy development, renewable energy portfolios, and environmental responsibility is increasing. Although the SEM currently provides a good engineering foundation and the EERC offers students an opportunity for hands-on training, the utility of our graduates can be

improved with a broader emphasis on all aspects of sustainable energy, where sustainable energy includes clean coal technologies, emerging renewable technologies, and the infrastructure needed to make them technically and economically viable.

A core group at UND is beginning to address some of these issues through the SUNRISE (SUstainable eNergy Research, Infrastructure and Supporting Education) Initiative. SUNRISE was established by scientists and engineers from UND and NDSU in response to a solicitation from the National Science Foundation. Sustainable energy, as defined by the SUNRISE group, includes the sustainable use of coal in addition to the more traditional renewable energy technologies. The proposed PSEERP program will become a vital part of SUNRISE by providing an important industrial component. The Program will address top industry research needs, examine new, innovative technologies, and provide unbiased, peer-reviewed results while training the next generation of experts.

– End of prospectus –

QUALIFICATIONS

Faculty at the School of Engineering and Mines have been involved in both teaching and research related to the electric utility and process industries. A listing of related courses currently taught is provided as Table 1. A partial listing of research projects, including senior design projects conducted in the past five years is given in Table 2.

Table 1. Partial Listing of Energy & Environmental Related Courses Currently Taught

Air Pollution Control	Metallic Corrosion	Hazardous Waste Management
Fuel Technology	Fluidized-Bed Combustion	Industrial Wastes
Energy Resources and Policy	Engineering	Control Systems I and II
Alternative Energy Systems	Environmental Engineering I, II,	Power Systems I and II
Water Sampling and Analysis	III, and IV	Advanced Electrical Engineering
Distributed Networks	Advanced Heat Transfer	Problems
Gas Turbines	Internal Combustion Engines	Thermodynamics

Table 2. Example of Projects Undertaken at UND SEM during the Past 5 Years

SUNRISE - NSF Sustainable Energy Research Initiative	Novel Concepts for Carbon Based Fuel Cells
Mercury Oxidation via Barrier Filters	Dynamic Testing of Gasifier Refractory Corrosion
Thermoeconomic Modeling as a Tool for Advancing the Electric Power Industry	Investigation of Mercury Control Technologies
Low Cost Creation and Separation of Syngas for use in Distributed Combined Heat, Power and Hydrogen Systems	Addressing System Integration Issues Required for the Development of Distributed Wind-Hydrogen Energy Systems
Mercury Capture in a Wet Scrubber	Development and Dissemination of PEM Fuel Cell Education Modules
Characterization of Sorbents for use in Fluid Bed Combustors	Cofiring of Biomass at the University of North Dakota
Combustion Research Furnace System to Support Research and Teaching Associated with the Energy Engineering Program at UND SEM	Hydrogen Production and Transport
Evaluating Soy-Derived JP8 Blends for Aircraft Applications	Advanced Prediction Tools for Ash Formation and Deposition in Coal-Fired Boilers
Two-Step Acid Treatment of Coal for Removal of Mercury, Sodium, and Sulfur	Undergraduate Interdisciplinary Research Emphasizing the Application of Environmental Chemistry to Address Societal Issues
Methanol Production from Natural Gas	Developing Commodity Chemicals from Crop Oils
	CO_2 Recovery from Coal-Fired Power Plants
	Methanol from Coal Gasifier-Derived Phenol

The various departments within SEM have been developing specialized research equipment to investigate energy related problems. Examples include a 19-kW combustion furnace equipped with a fabric filter and wet scrubber, a gas and steam turbine, a corrosion test chamber, various power electronic and control equipment, catalysis and sorbent test apparatus, TGA and other techniques to study gasification kinetics, wastewater treatment facilities, bench-top equipment to investigate a wide variety of chemical processes, and analytical support. We are equipped to address operational and environmental issues facing the combustion technologies, and to perform exploratory research on future uses of lignite utilizing technologies such as Fisher Tropes for the production of commodity chemicals and utilizing lignite in advanced gasification technologies. SEM faculty also can often obtain access to equipment at the EERC.

The program manager, Dr. Michael Mann, has been working with the electric power industry for over 25 years. He began his career at the EERC where he worked on a wide variety

of projects ranging from mitigating operational problems in conventional coal-fired systems, development activities in bubbling and circulating fluidized bed combustion, development of advanced technologies including coal gasification and direct-fired turbines, emission control, coal-water slurry development, and wastewater treatment. His specialty while at the EERC was using a systems approach to address performance issues in advanced energy systems firing coal and biomass, emission control, and the development of energy strategies based on thermodynamics and economics. Since he joined the faculty in the Department of Chemical Engineering he has continued his research in advanced power systems and emissions control, and has began to develop expertise in renewable and sustainable energy including clean coal technologies, wind energy and hydrogen generation and use. A resume of Dr. Mann is included in the appendix. Other faculty that are teaching energy related courses, supervising energy related senior design and/or special topics courses, and who are active in research are listed in Table 3.

Table 3. Faculty with Interests in the Energy Sector

Faculty Member - Department	**Principal Area of Expertise**
Michael Mann – Chemical Engr	Advanced power systems, systems integration
Wayne Seames - Chemical Engr	Particulate and trace element emissions, oil refining
Frank Bowman – Chemical Engr	Atmospheric modeling
Hossein Salehfar – Electrical Engr	Renewable energy, power systems and electronics
Forrest Ames, Mechanical Engr	Gas turbine heat transfer and aerodynamics
Nanak Grewal – Mechanical Engr	Heat transfer, fluid beds
Evgenuui Kozliak – Chemistry	Biological treatment for sulfur and mercury removal
Darrin Muggli – Chemical Engr	Catalytic removal of VOC, SCR catalysts
Harvey Gullicks – Civil Engr	Waste & wastewater treatment, contaminated media cleanup
Chuck Moretti – Civil Engr	Environmental Engineering
Will Gosnold – Geology	Global climate change, CO_2 sequestration
Scott Korom – Geological Engr	Ground water remediation
Manohar Kulkarni – Mech Engr	Energy mgmt, energy optimization of thermal systems, NDE

VALUE TO NORTH DAKOTA

The benefits of this program have been summarized in the prospectus. The primary value

of the proposed initiative is the development of human resources. This program is designed to develop our students for industries that are of vital importance to the State of North Dakota. As the state continues to expand its energy industry, and as the current generation begins to retire, the demand for well trained engineers will continue to increase. There are limited opportunities for North Dakota graduates to remain in North Dakota. The power sector provides one such opportunity, and we want **North Dakota** graduates to be prepared to fill this need.

A second value to the state is the establishment of a directed research program, focused on applied fundamentals. Many times applied research will lead to an answer, but the available time and funding for the project does not allow the "whys" to be answered. An advantage of student based projects, especially at the graduate level, is that the student is required to develop a fundamental understanding of their work which includes answering the "whys". Also, graduate students are required to novel exploratory perform research. This allows innovative solutions to be developed. Ideas/solutions conceived and developed at the fundamental level, can be demonstrated through interaction with the EERC and our industrial partners. In addition, the scope of the projects to be undertaken in the program will be selected by the Industrial Advisory Committee, and therefore should represent those areas most important to the State. The breadth of expertise from the UND faculty will allow the program to address many of the issues currently facing the industry.

A third benefit is UND's ability to offer classes through their distance degree program allowing Professional Engineers to obtain the required training to maintain their license. The program also provides the opportunities for employees of North Dakota to continue their education in areas directly related to the energy industry.

TIMETABLE

We are seeking to establish a long-term program at the University of North Dakota. With this proposal we are seeking a three-year commitment to provide adequate time for the program to demonstrate that it is clearly meeting the stated objectives. As we meet the program objectives, we are confident that the members will continue to support the program. As stated in the management plan, the program would be reviewed annually by the Industrial Advisory Committee. At that meeting, all of the ongoing and completed projects will be reviewed, and the direction for the next year's work discussed. The timing of reports will vary, depending upon the nature of the project. For example, special topics projects (literature reviews and short projects) are typically semester based projects and will generate reports at the end of each semester. Senior Design project results are presented each May. The timing of graduate work depends on the nature of the project, and may last for over one year. To facilitate the transfer of these reports, the project will maintain a web site. All reports will be posted upon completion, allowing members to have access to the latest work performed by the various groups participating in this program.

BUDGET

UND is seeking $150,000/yr to establish the Power Systems Engineering Education and Research Program. This amount will allow UND to initiate two major research initiatives, deliver at least one new course per year, provide support and incentives for senior capstone design projects, involve undergraduates in Program related research, and to establish the infrastructure required to sustain the Program. Funding above the initial $150,000 will be utilized to fund additional research initiatives and course offerings.

Standard membership to the PSEERP is $15,000 per year and a three year commitment is

required. This entitles the sponsor to one vote on the Industrial Advisor Committee, access to all results generated from directed research, input into Senior Capstone Design Projects, and access to industry related courses. Companies that employ only a small number of engineers may negotiate a lower rate with limited benefits. Because the NDIC represents a large fraction of the energy industry in the state, we are requesting $45,000 per year for three years. It is anticipated that the additional $105,000 required to reach our target will be obtained from regional energy companies.

UND also plans to solicit funding from the North Dakota Department of Community Affairs State Energy Office, the Department of Energy, the Environmental Protection Agency, and the National Science Foundation to match all industrial dollars.

A breakdown of the budget is provided in Table 4.

Table 4. Budget for the proposed PSEERP

	Year 1	Year 2	Year 3	Total
UND Faculty	$36,900	$36,900	$36,900	$110,700
Student Stipends	$43,500	$43,500	$43,500	$130,500
Travel	$1,386	$1,386	$1,386	$4,158
Operating Expenses	$18,500	$18,500	$18,500	$55,500
Equipment	$10,000	$10,000	$10,000	$30,000
Indirect Cost	$39,714	$39,714	$39,714	$119,142
Total Project Cost	$150,000	$150,000	$150,000	$450,000

Budget Details

1. Personnel

Direct project salaries are estimated based on the scope of work and prior experience. UND Faculty allowance includes one month summer salary allocated to the Program Manager, one month summer salary allocated to two research faculty who will be leading graduate level research projects and an academic overload salary for one faculty member to cover the cost of offering one new course each year.

Student Stipends include Graduate Research Assistantships for one PhD and one M.S. student per year. Undergraduate salaries are included to hire two undergraduate students for a full summer.

2. Fringe Benefits

Fringe benefits are estimated for proposal purposes only, on award implementation, only the true cost of each individual's fringe benefit plan will be charged to the project. Fringe benefits are comprised of the following: social security, state retirement, TIAA-CREF, health insurance, unemployment, worker's compensation, life insurance, and disability. Estimated rates are 20% for faculty, $750/12 month year for graduate students, and 0% for undergraduate students. The fringe benefits are included in the UND Faculty and Student Stipend budget lines in Table 4.

3. Travel

Travel is estimated based on UND travel policies, which include estimated GSA daily meal rates. Travel includes trips for faculty and students to visit member facilities.

4. Contractual

No contracts are proposed in the performance of this work.

5. Operating Expenses

Laboratory and analytical-related supplies included in the "supplies" category includes laboratory supply items and minor equipment items including, but not limited to chemicals, consumable lab supplies, labware, and consumable gases.

Office supplies include items specifically related to the proposed project and may be such items as pens, pencils, paper clips, printer paper and toner cartridges, notebooks (if needed), Post-It notes, computer diskettes, transparencies or other presentation materials, duplicating materials or charges, and other miscellaneous items required to complete the project.

Instructional supplies included in this budget be used for those costs associated with the audio/video capture and delivery of the special courses that will be offered to our members. Instructional supplies may also include items required to senior design projects, including but not limited supplies required to build small prototypes of student's designs.

General supplies include those required to support senior capstone design projects and competition, and may include cash awards to students and books or other engineering supplies to be awarded to students. Included in this category are printing and other costs associated with promotion of the Center. This category also includes the cost associated with the annual project review meeting, including meals for the participants.

6. Equipment

An equipment budget of $10,000 per year is included to allow research faculty to purchase equipment that is necessary to perform the selected research projects. All equipment purchases must be approved by the Program Director.

7. Indirect Costs

The indirect cost rate included in this proposal (39.6%) is the federally approved rate for the University of North Dakota. Indirect costs are calculated based on the Modified Total Direct Costs (MTDC), defined as the Total Direct Costs of the project less individual items of equipment $5,000 or greater and subcontracts in excess of the first $25,000 for each award.

8/9. Total Amount Requested / Matching Funds

The source and amount of funds required to complete this project are provided below. We are currently seeking support from the utility community.

Source	Yr 1	Yr 2	Yr 3	**Total**
Utility Support	$105,000	$105,000	$105,000	$315,000
NDIC	$45,000	$45,000	$45,000	$135,000
Total	**$150,000**	**$150,000**	**$150,000**	**$450,000**

The University of North Dakota will provide tuition waivers to the graduate students participating in this program. This cost, estimated at $16,000 per year is not shown in the budget provided in Table 1.

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Vitae

Academic Record
B.A., Chemistry, Mathematics, Mayville State University, 1979
M.S., Chemical Engineering, University of North Dakota, 1981
M.B.A., Business Administration, University of North Dakota, 1987
Ph.D., Energy Engineering, University of North Dakota, 1997

Experience

2005-*present*	Chair, Department of Chemical Engineering, University of North Dakota
1999-*present*	Associate Professor of Chemical Engineering, University of North Dakota
2000-*present*	Director, Engineering Doctoral Program, University of North Dakota
1999-*present*	Senior Research Advisor, UND Energy& Environmental Research Center
1994 – 1999	Senior Research Manager, Advanced Processes and Technologies, EERC, UND.
1985 – 1994	Research Manager, Combustion Systems, EERC, UND.
1981 – 1985	Research Engineer, Wastewater Treatment and Reuse, EERC, UND

Specialty Fields:
Performance issues in advanced energy systems firing coal and biomass
Emission control
Development of energy strategies based on thermodynamics and economics
Renewable and sustainable energy

Selected Publications Related to Present Work

Pacheco, E.H.; Mann, M.D.; Hutton, P.N.; Singh, D.; Martin, K.E.; "A Cell-Level Model for a Solid Oxide Fuel Cell Operated with Syngas from a Gasification Process", *Int. Journal of Hydrogen Energy*; 30 (**2005)** 1221-1233.

Pacheco, E.H.; Biaku, C.; Peters, A.; Salehfar, H.; Mann, M.D.; "An Advanced PEM Fuel Cell Performance Prediction Model", *Journal of Power Sources*, **2005**, (revision in review).

Bandyopahday, G.; Bagheri, F.M.; Mann, M.D.; "Reduction of Fossil Fuel Emission in US: A Holistic Approach Towards Policy Formulation" , *Energy Policy*; **2005**, (in review)

Corporan, E., Reich, R., Monroig, O., DeWitt, M., Larson, V., Aulich, T., Mann, M., and Seames, W., "Impacts of Biodiesel on Pollutant Emissions of a JP-8 Fueled Turbine Engineer", *Journal of Air & Waste Management*, **2004** (in press).

Zhao, Y., Mann, M.D, Pavlish, J.P., Mibeck, B.A.F.; Dunham, G.E.; Olson, E.W.; "Application of Gold Catalyst for Mercury Oxidation by Chlorine", *Environmental Science and Technology*; **2005** (in press).

Mukjerjee, B.; Hurley, J.P.; Mann, M.D.; "Assessment of Filter Dust Characteristics that Cause Filter Failure During Hot-Gas Filtration", *Energy and Fuels*, **2005** (in review).

Zhao, Y., Mann, M.D, Olson, E.S.; Pavlish, J.P; Dunham, G.E., Mibeck, B.A.F.; "Effects of SO_2 and NO_x on Mercury Oxidiation and Reduction", *Journal of Air & Waste Management***, 2005** (in press).

Singh, D.; Pacheco, E.H.; Hutton, P.N.; Patel, N.; Mann, M.D.; "Carbon Deposition in an SOFC Fueld by Tar-Laden Biomass Gas: A Thermodynamic Analysis", *Journal of Power Sources*, 142 (**2004)**, 194-199.

Pacheco, E.H., Mann, M.D.; "The Rational Approximation Method in the Prediction of Thermodynamic Properties for SOFCs" *Journal of Power Sources* **2004** 128 (1): 25-33.

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Karki, S.; Mann, M.D., Slahlefar, H.; "Energy and Environment in the ASEAN: Challenges and Opportunities" *Energy Policy* **2003** 33 (4): 499-509.
Mann, M.D.; Knutson, R.Z.; Erjavec, J.; Jacobson, J.P.; "Modeling Reaction Kinetics for a Transport Gasifier", *Fuel* 83 **2004** 1643-1650.
Pavlish, J.P.; Sondreal, E.A.; Mann, M.D.; Olson, E.S.; Galbreath, K.C.; Laudal, D.L.; Benson, S.A. "A Status Review of Mercury Control Options for Coal-Fired Power Plants" *Fuel Process. Technol*. **2003**, 82: 89-165.
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Sondreal, E.A.; Benson, S.A.; Hurley, J.P.; Mann, M.D.; Pavlish, J.H.; Swanson, M.L.; Weber, G.F.; Zygarlicke, C.J. "Review of Advances in Combustion Technology and Biomass Firing". *Fuel Processing Technology* **2001**, 71 (1-3), 7-38.
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Mann, M.D.; Hajicek, D.R.; Henderson, A.K.; Moe, T.A. EERC Pilot-Scale CFBC Reveals Influence of Coal Properties. *Power Eng.* **1993**, *97* (3), 33–37.
Mann, M.D.; Collings, M.E.; Botros, P.E. Nitrous Oxide Emissions in Fluidized-Bed Combustion: Fundamental Chemistry and Combustion Testing. *Prog. Energy Combust. Sci.* **1992**, *18*, 447–461.
Galegher, S.J.; Mann, M.D. Measurement and Characteristics of Emissions from a Gas Liquor Fed Cooling Tower. *Atmos. Environ.* **1985**, *19* (3), 389–396.
Mann, M.D.; Willson, W.G.; Hendrikson, J.G.; Winton, S.L. Gasifier Wastewater Treatment, Phase I: Cooling Tower Assessment. *Environ. Prog.* **1985**, *4* (1).

Synergistic Activities

Director Energy Engineering Ph.D. Program, 2000 – present
Chemical Engineering ABET coordinator; 2000 – 2005
Chemical Engineering Distance Education Degree Program Coordinator 2000 – present
Chemical Engineering Undergraduate Co-op Coordinator, 1999-2005
Bush Program Assessment Resource Team member; 2003 – present

Awards

Olson Professorship for excellence in teaching and research, 2003
NSF CAREER Grant, 2001.
Nominated: UND Foundation Faculty Achievement Award for Excellence in Research, 2005
Chemical Engineering Department -2005 Fellows of the University Award of Excellence in Research
Certificate of Recognition for Outstanding Training, U.S. Agency for International Development/ Institute of International Education, 1992 and 1993