

THE PENNSYLVANIA STATE UNIVERSITY

Department of Energy and Mineral Engineering (EME)

Strategic Plan 2009-2014

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**College of Earth and Mineral Sciences
Department of Energy and Mineral Engineering**

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Executive Summary

Energy and Mineral Engineering (EME) is an interdisciplinary, diverse academic department dedicated to the safe, efficient, and environmentally responsible recovery, processing, and utilization of earth resources. Our vision is to solve the world's energy problems through high-quality, innovative teaching, research, and service. The Department is uniquely positioned to train students who will address the delicate balance between societal needs for more energy and mineral resources and the management, health and safety, and environmental impacts associated with the production, processing and utilization of these resources in a sustainable and responsible way. By leading students to become technically proficient, adaptable learners through development of skills in problem-solving, team-building, and communication, the Department reflects a strong commitment to become a caring community that inspires faculty, staff, students, and alumni to high levels of achievement in academia, government, industry, and broader society, both domestically and internationally. The Department will achieve its vision through teamwork that draws on its collective expertise, commitment to quality, desire for collaboration and cohesiveness, and sense of community. This, in turn, will place the Department on a trajectory toward vibrant and productive education and research programs designed to enhance the stature of each program in the Department at local, regional, national and international levels.

The EME strategic plan embraces six primary goals with multiple components. The six major goals are:

- Goal 1 – Enhance the Quality of Undergraduate Programs
- Goal 2 – Enhance the Quality of Graduate Education
- Goal 3 – Enhance the Quality of Sponsored Research
- Goal 4 – Grow a Global Presence
- Goal 5 – Play a Leadership Role in Energy Outreach
- Goal 6 – Ensure a Critical Mass of Faculty and Staff

All of these goals focus on achievements that will drive the Department and its faculty and students to high levels of national and international visibility in the debates on energy and mineral related issues. There are numerous components to each of the goals including strategic initiatives, mechanisms to drive them, and metrics to assess successful performances. Several of the strategic initiatives are transformational in nature, either from the perspective of potential impacts regarding research on complex energy and mineral related issues or of a new level of synergy emerging among faculty and students who will address these complex issues in research or practice. The major strategic and/or transformational initiatives are summarized below.

Enhance the Quality of Undergraduate Programs

- Establish a program for undergraduate research experience (PURE) to increase opportunities for undergraduate participation in research and interactions with graduate programs. Coupling PURE with the EMS CAUSE and EMSAGE as well as international

student exchange programs will enhance undergraduate research opportunities and international research and learning experiences.

- Create 'traveling' demonstrations and exhibits for public education venues which feature understandable science and information on key energy and mineral industry methods, challenges, research, history, and opportunities and increase the visibility of Department programs at Commonwealth Campuses, thereby promoting interest in energy and materials majors.
- Develop and secure funding for pipeline education programs (e.g., summer energy camp and 3+2 dual degree programs), through research grants and private-sector donations, to enhance the diversity of our student body with respect to underrepresented groups.
- Replace and modernize teaching facilities (e.g., laboratories) and methods of delivery.
- Attain ABET accreditation for the new Energy Engineering program and maintain ABET accreditation of the Department's engineering programs. This will promote among faculty and students the synthesis of perspectives relative to all energy options and their trade-offs in addressing critical issues emanating from a tremendously growing global demand for energy.

Enhance the Quality of Graduate Education

- Introduce five-year integrated B.S. and M.S. degree programs that will provide opportunities for undergraduate students in the Department to pursue graduate degrees and carry out research as well as pursue unique opportunities in industry, government and academia.
- Secure funding to foster and grow diversity in the graduate student body through research grants, endowed departmental lecture series, graduate fellowships, and the proposed EMS New Alliances for Graduate Education (NAGE) initiative.
- Enhance the department and program websites and the graduate admission process.
- Use the newly integrated graduate program in Energy and Mineral Engineering to transform the way highly interdisciplinary research and education is pursued. We will do the same with the proposed EMS Graduate Institute of Earth, Energy, and Public Policy.

Enhance the Quality of Sponsored Research

- Develop interdisciplinary research programs in clean coal conversion and carbon management, renewable energy resources, enhanced coal bed methane and hydrates recovery, fuel cells and hydrogen technology, the new Marcellus black shale reservoir, gas transmission, advanced transportation fuels, sub-surface engineering, energy risks and informatics, and energy management and policy. We will take advantage of the EMS Think Tank for Transformative, Earth, Energy and Materials Sciences (TEEMS).
- Seek new space and develop plan for better utilization of space to accommodate the continued growth in research, faculty and students.

Grow a Global Presence

- Champion the Sustainable Resource Management Initiative in AESEDA, take lead research role in the EMS Energy Institute, and develop strategic partnerships and alliances with other organizations and universities.
- Provide active support to the faculty in developing web-based teaching materials and extend the Department's web-based educational offerings to a targeted global market. This will enable on-line certificate and professional degree opportunities to be offered (e.g., the science and engineering of carbon management, industrial health and safety, and energy risks and informatics).

Play a Leadership Role in Energy Outreach

- Nurture the academic growth of faculty members and their continuous presence in the national and international scene through outreach activities and promote and encourage faculty to assume individual and partnership-based responsibilities and roles in national and international organizations, conferences and symposia, and energy policy debates.

Ensure a Critical Mass of Faculty and Staff

- Provide competitive and market based salaries and startup packages to attract and retain faculty and staff as our most valuable assets.
- Address the near-crisis need for additional technician support for the labs.
- Secure new tenure track and dedicated fixed term faculty positions for the identified research focus areas and revenue-generating online certificate and professional degree programs.

Regarding budgeting, we will absorb the mandatory 1% recycle of permanent funds (about \$150K over 5 years), if necessary, by a combination of not filling a future position and depleting our general operating budget. This will potentially put severe strain on our operation and ability to effectively compete. EME will, however, continue to seek strategic growth in areas important to the University and EMS. This will require continuation of recycling of faculty positions upon terminations, with provisions that EME be returned the funds to hire junior faculty members, and the investment by the College in the transformational initiatives outlined above. We will strive to offset the negative impact of recycling permanent funds by generating temporary new revenues through online education, growth in research funding (i.e., research incentive fund (RIF)), salary release, Penn State Foundation, and support of alumni and friends. We are optimistic of our future and believe the next five years will be transformational for our relatively young and growing department.

Preamble

The Department of Energy and Mineral Engineering (EME) is a unique academic department in a unique college, which is well poised “to train students and develop new knowledge in the earth, energy, and material sciences needed to make the transition to a more sustainable use of planetary resources.” With a recent history of significant growth, the Department provides a vertically-integrated academic experience to its students who are trained to address issues involved in the production, processing, transportation, and utilization of minerals, fossil fuels, and other energy resources demanded by an ever-increasingly industrialized society. The department offers undergraduate and graduate degree programs, performs research and provides service in various disciplines associated with the lifecycle of energy and mineral resources, from discovery through production to end use, and the associated economic, environmental, and health and safety aspects of each stage. The Department provides ABET-accredited undergraduate degrees including the Bachelor of Science in Environmental Systems Engineering (BS ENVSE), the Bachelor of Science in Mining Engineering (BS MNGE), and the Bachelor of Science in Petroleum and Natural Gas Engineering (BS PNGE). Bachelor of Sciences degrees in Energy Business and Finance (EBF) as well as Energy Engineering may also be pursued. Students in ENVSE may specialize in the environmental health and safety engineering option.

At the graduate level, the Department of Energy and Mineral Engineering offers Master of Science and Doctor of Philosophy degrees in Energy and Mineral Engineering (MS and PhD in EME), with options in petroleum and natural gas engineering (PNGE), mining and mineral process engineering (MMPE), environmental health and safety engineering (EHSE), fuel science (FSC), and energy management and policy (EMP). Although not considered as options, EME graduate students may also focus their research on renewable energy, fuel cells and electrochemical engineering, geo-environmental engineering, subsurface science and engineering, and energy risks and informatics. The degree programs are intended to educate and prepare students for the practice of their profession in private industry, government and academia. All of the degree programs offered within the Department emphasize the fundamentals of engineering science and design with specialization courses to prepare students for a wide range of career opportunities. The Department maintains a close relationship with the Energy Institute, which provides faculty and students of the Department with access to world-class research facilities. Consistent with the College of Earth and Mineral Sciences vision to be a world leader in earth, materials, and energy sciences and engineering, the Department will collaborate broadly on interdisciplinary projects that tackle the grand challenges in earth, energy, and material sciences while pursuing additional opportunities for investment in innovative teaching and path-breaking research.

Mission Statement

We are an interdisciplinary, diverse department dedicated to the safe, efficient, and environmentally responsible recovery, processing, and utilization of earth resources.

The Department is uniquely positioned to train students who will address the delicate balance between societal needs for more energy and mineral resources and the management, health and safety, and environmental impacts associated with the production, processing and utilization of these resources in a sustainable and responsible way. As a student-centered Department, Energy and Mineral Engineering seeks to inspire students to become technically proficient, adaptable learners by developing skills in problem-solving, team-building, and communication. To achieve this, the Department promotes active learning and discovery to motivate its students to become lifelong learners. Consistent with EMS College initiatives, the Department will promote both the research and international experiences of its undergraduate students. These efforts, coupled with a strong drive to cultivate a richness in thought and experiences created by increasing diversity of the student body, reflects the Department's commitment to become a caring community that inspires faculty, staff, students, and alumni to high levels of achievement in academia, government, industry, and the broader society, both domestically and internationally.

Vision Statement

We solve the world's energy problems through high-quality, innovative teaching, research, and service.

The fields of recovery, processing, and utilization of energy and mineral resources are faced with unparalleled changes in terms of global and societal demands, environmental considerations, management issues, and technological developments. It is the Department's task to be aware of these changes not only to define a sensible strategic path but also to be ready to take full advantage of opportunities that come with the changes, consonant with sustainable development principles. Over the past few years, the Department has responded to the complex energy and material issues of society with foresight, vigor, and enthusiasm, and this approach will be redoubled over the next five to ten years. To achieve significant impacts on these complex issues, the Department will continue to create unique opportunities to attract the best and brightest students and faculty and maintain a position as a prominent student-centered, growth-oriented and quality-driven Department. The Department aspires to build an academic environment and diverse culture with broad perspectives that promote the highest forms of collegiality and collaboration among the faculty, students and staff. The Department will achieve its vision through teamwork that relies on its collective expertise, commitment to quality, desire for collaboration and cohesiveness, and sense of community. This, in turn, will place the Department on a trajectory toward vibrant and productive education and research programs designed to enhance the stature of each program in the Department at local, regional, national and international levels.

Goals

Goal 1 – Enhance the Quality of Undergraduate Programs

Significant common issues and synergy exist among the EME undergraduate majors in Energy Business and Finance (EBF), Energy Engineering (ENENG), Environmental Systems Engineering (ENVSE), Mining Engineering (MNGE), and Petroleum and Natural Gas Engineering (PNGE). Efforts to enhance the quality of the undergraduate programs will focus on maintaining ABET accreditation while continuing to improve the overall educational experiences of EME students by emphasizing integrated, student-centered approaches to accomplishing the teaching, research, and service missions of the Department. Within the constraints of ABET requirements, curricula will be scrutinized for opportunities to achieve efficiencies that would ensure, to the extent practicable, that a critical mass of students is enrolled in each course, thereby enhancing the quality of the education provided and increasing the overall efficiency of the Department while maintaining the identity of the individual degree programs. Recruitment of a diverse, qualified student body is essential to achieving the goal of providing a dynamic, student-centered, educational experience. Significant effort will focus on developing recruitment strategies that will attract the quality and quantity of students needed to achieve this goal. Focusing on the globalization of business and its impacts, students will be provided opportunities related to the internationalization of the undergraduate curriculum that will include research and internship experiences. As part of the recruitment strategy, a concerted effort in public education relative to the Department's disciplines and the key issues revolving about the energy and mineral industries will be undertaken. More learner-centered approaches to improving the teaching environment will be employed in the ongoing process of modernizing and upgrading teaching facilities and methods of engagement. In addition, several mechanisms such as sponsored project design teams and stronger ties with the disciplines in the College of Engineering will broaden students' exposure to comprehensive interdisciplinary engineering approaches to problem-solving. On the general education front, efforts will be directed towards maintaining and enhancing the quality of instruction and the remarkable enrollment levels in general education courses that have seen total credit hours generated by EME move from 3,500 in 1999-2000 to over 20,000 in 2006-2007. In this way, students who take the EME general education courses will develop a better understanding of the vital significance of energy, minerals, environmental protection, and industrial health and safety in society. These courses should provide good exposure to the disciplines represented in EME. The success of this effort would be limited primarily by resource constraints.

Strategies

- Maintain academic program accreditations
 - Review academic program curricula to meet changing needs in engineering education.
 - Increase faculty and student interaction with industrial advisory committees and professionals in industry and business.

- **Attain ABET accreditation for the Energy Engineering program and reaccreditation for the Environmental Systems Engineering, Mining Engineering, and Petroleum and Natural Gas Engineering programs.**
- Enhance the educational experience by becoming a more student-centered department
 - Increase faculty and staff contact with freshmen and sophomore students.
 - Improve the retention of students through improved mentoring.
 - Toward the goal of producing leaders, challenge students to perform at higher expectation levels by enhancing undergraduate course offerings, laboratory experiences, and interdisciplinary research.
 - Create a student-centered undergraduate design and learning center.
 - **Establish a program for undergraduate research experience (PURE) to increase opportunities for undergraduate participation in research and interactions with graduate programs.** PURE would dovetail with the EMS Center for Advanced Undergraduate Study and Experience (CAUSE), which promotes interdisciplinary, problem-based learning opportunities for undergraduates. Further, close ties will be established with the Earth and Mineral Sciences Academy for Global Experience (EMSAGE), upon formation, to enhance undergraduate research opportunities and international research experiences, particularly related to senior capstone courses.
 - Seek a NSF Research Experience for Undergraduates (REU) program with an “Energy and the Environment” theme.
 - Enhance the hands-on experience of students by exposure to more field trips and encourage greater professional contact through participation in professional organizations and conferences.
 - Working through the EMS Academy of Scholars, encourage the best students to obtain a powerful experience through advanced course work, international experience, and service to the College and society.
- Design and implement innovative, effective recruitment strategies
 - Increase the development and strategic use of scholarship and diversity grants for undergraduate students.
 - Create a recruitment effort focused on attracting Honors College students.
 - Increase the visibility of Department programs at Commonwealth Campuses, thereby promoting interest in energy and materials majors.
 - Create ‘traveling’ demonstrations and exhibits for public education venues such as museums and exhibitions, which feature understandable science and information on key energy and mineral industry methods, challenges, research, history, and opportunities in Department programs.
 - While realizing physical and fiscal constraints, continue and enrich the content of the successful departmental general education courses to attract science- and engineering-based students. Pursue new course offerings that would enhance recruitment efforts.

- **Develop and secure funding for pipeline education programs (e.g., summer energy camp and 3+2 dual degree programs), through research grants and private-sector donations, to enhance the diversity of our student body with respect to underrepresented groups.**
- Seek the right balance of the number of students enrolled in the EME general education courses, while considering additional engineering course offerings that will attract the best students into the Department.
- Promote greater interaction of EME students with their colleagues in the College of Engineering through the Learning Factory, Eco-car, Solar Decathlon, and similar competitions and experiences.
- Encourage dual-major programs with relevant engineering departments.
- Sensitive to ABET program requirements, scrutinize curricula for opportunities to improve accredited programs and achieve efficiencies that would continue to create a cohesive, interactive, and efficient academic department.
 - Seeks ways that disciplinary topics may be restructured in curricula to better meet program-specific ABET criteria while achieving greater efficiency.
 - Identify/develop coursework for all degree programs that addresses industry-identified gaps in graduate skill sets, e.g., business acumen, writing and oral communication skills, interdisciplinary teamwork, and analysis of complex, multiple-impact issues.
 - Develop broad-based 5-year B.S./M.S. degrees in constituent disciplines within the Department.
- **Replace and modernize teaching facilities and methods of delivery.**
 - **Renovate and upgrade undergraduate instructional laboratories.**
 - Upgrade EME dedicated teaching rooms in Hosler to provide a pleasant learning environment and the latest technological teaching aids (e.g., acquire video-conferencing facilities).
 - **Provide a virtual computer lab that would allow users to remotely access the lab on the internet.** EME lab usage has expanded as the department enrollment has increased. This has placed more demand on lab usage. A virtual lab will increase the capacity of usage of the lab.
 - Identify opportunities for and encourage the development of distance-learning and web-based teaching materials, web-based workshops, and webinars.
 - Encourage undergraduate students to participate in research and take graduate-level courses to enrich their exposure to research, increase their career choices, and discern opportunities to pursue advanced degrees.

Measures of Performance

- Attain/Maintain ABET accreditation of all departmental engineering programs.
- Increase enrollments in all degree programs while seeking a 25% growth in the Department by 2014.
- Achieve a Top Five ranking for departmental programs for which rankings exist.
- Track student involvement in domestic and international research experiences.
- Track program and departmental improvements responsive to feedback from student exit surveys and SRTEs.
- Track program and departmental improvements responsive to recommendations from industry and alumni advisory committees.
- Work to attain 100% job placement for graduates, and maintain a database of salary statistics.
- At least partially renovate and upgrade 100 % of instructional labs.
- Attain at least 25% of graduating students with research and/or international experience.

Goal 2 – Enhance the Quality of Graduate Education

EME possesses the unique strength of having faculty with a wide range of expertise in a broad cross section of disciplines that embrace all aspects of energy and minerals in society, and the complex environmental, business and safety issues related to them. Efforts to enhance and sustain the quality of graduate education and the diversity of perspectives among students in EME will focus on three main areas: curriculum and instruction, recruiting, and mentoring. Externally funded research experiences for undergraduate (REU) projects will provide an effective recruiting tool to attract a well-qualified and diverse pool of students into the masters and doctoral programs. Enhancing the formal mentoring program for junior faculty will help them become better advisors, teachers, and researchers in a collegial environment. Mentoring is also important to help graduate students improve their communication, teaching/learning, and grant-writing skills.

Strategies and Implementation

Curriculum and Instruction

- Leverage the interdisciplinary mix of disciplines participating in the newly integrated graduate program in Energy and Mineral Engineering (EME) to enhance strengths in options and promote synergy in the teaching, research and service missions of the Department. The integrated degree program will seek to ensure vigor in the specialized options and provide unique opportunities for students who wish to widen their skill sets and broaden their professional perspectives. Through this approach, the collaboration between the faculty and the graduate students in the Department will also be strengthened.

- **Introduce five-year integrated B.S. and M.S. degree programs that will provide opportunities for undergraduate students in the Department to pursue graduate degrees and carry out research as well as pursue unique opportunities in industry, government and academia.**
- Review course offerings for gaps in expertise needed to address research on energy and materials systems coupled with complex enviro-socio-politico-economic issues.
- Integrate teaching, research, and service in the graduate curriculum, while maintaining critical expertise of renowned faculty.
- Encourage faculty to develop opportunities for professional and public constituencies to take on-line certificate and professional degree programs aimed at developing a deeper understanding of complex issues related to the energy and minerals industries as well as methods of addressing the issues in a sustainable way.
- **Secure research funding to foster and grow diversity in the graduate student body and pursue interdisciplinary study of complex energy- and mineral-related issues.**
- **Secure funding for an endowed departmental lecture series and graduate fellowships.**
- Develop a broader array of graduate courses to target better integration of disciplines and perspectives in addressing complex energy and minerals related issues. We will take full advantage of opportunities offered by the proposed EMS Graduate Institute of Earth, Energy, and Public Policy.

Recruiting

- Increase the diversity and quality of incoming graduate students.
 - Establish externally funded REU programs.
 - Take advantage of the Summer Research Opportunities Program (SROP) to attract minority students to graduate study through research-based summer internships.
- Take advantage of the NSF-sponsored Northeast Alliance for Graduate Education and the Professoriate to recruit underrepresented students in advanced education in math, science, engineering and technology.
- Enhance the attractiveness of the Department's graduate program and its options to excellent undergraduate students in the Department.
- Improve advertisement and promotion of the graduate program and its options as well as the opportunities for graduate student support.
- Increase departmental external funding, scholarships, and fellowships to support at least 120 graduate students by 2014.
- Invite outstanding graduate applicants for expense-paid site visits.
- Establish several meaningful student exchange programs with distinguished universities, colleges and research institutions around the world.
- **Enhance department and program websites and the graduate admission process.**

Mentoring

- Mentor graduate students in preparation for academic and research careers.
- Enhance the formal mentoring program for junior faculty, which provides opportunities for strong cross-disciplinary research and creates a better climate for faculty, especially new female and minority faculty.
- Take advantage of the available career development programs for graduate students organized in collaboration with The Graduate School (e.g., The Graduate School Teaching Certificate, Writing Workshops, and Grant Writing).

Measures of Performance

- Develop new courses to address identified gaps in offerings related to research on energy and materials systems coupled with complex enviro-socio-politico-economic systems.
- Increase graduate enrollment by 25% by 2014.
- Pursue a 20% increase of endowments for graduate fellowships and lecture series.
- Through strong recruitment activities coupled with EMS and departmental efforts to grow scholarships and fellowships, increase the percent of female graduate students by 10%, the percent of minority graduate students by 10%, the percent of female faculty by 10%, and the percent of minority faculty by 10% by 2014.

Goal 3 – Enhance the Quality of Sponsored Research

The EME Department hosts research programs in the recovery, processing, and utilization of energy and minerals, and in the management of environmental and industrial hazards. All these endeavors will be strengthened and new opportunities will also be explored. To achieve this goal, the Department has identified a number of strategies with implementation components, as described below. The Department will further enhance the collegial atmosphere to promote high-quality research by fostering joint grant-writing efforts in order to increase the scholarly output in core research areas. In addition, the Department will promote collaboration and cooperation with other units, colleges and universities to develop strategic alliances to enhance interdisciplinary research, including International Alliances for Graduate Student Funding. In doing so, the Department will encourage high-risk, innovative research that has potential to transform society, and faculty members will be sought to volunteer for the proposed EMS Think Tank for Transformative Earth, Energy, and Material Sciences (TEEMS). Finally, the close research connection of the Department with the Energy Institute will be strengthened and, consistent with University and EMS emphases on energy research, a formal plan will be established for proposal cost-share and funding mechanisms in high-priority areas.

Strategies and Implementation

- Enhance a collegial atmosphere that will promote high-quality, interdisciplinary research
 - Foster joint grant-writing efforts for research and instrumentation.
 - Encourage faculty to attend workshops and technical conferences in their fields of specialization.
 - Establish topical departmental research symposia.
 - Through senior faculty mentoring, establish topical teams to generate research proposals aimed at developing junior faculty capability and independence.

- Develop additional strategic partnerships and alliances with EMS and other PSU units, as well as with other universities, companies, and national laboratories.
 - Establish interdisciplinary research programs and centers of excellence in the core research areas of the department, particularly by leveraging PSIEE, EMS and Energy Institute investments in the molecular modeling of coal structure and reactivity, clean coal to liquid and gas fuels, and carbon management including capture and sequestration. **Seek similar energy-related investments in hydrates, fuel cells and hydrogen technology, collaborative development of the new Marcellus black shale reservoir, gas transmission, enhanced coal bed methane recovery, renewable energy resources, advanced transportation fuels, sub-surface engineering, energy risks and informatics, and energy management and policy.** Consistent with University and EMS goals, the Department's goal is to be in the forefront of cross-cutting, application-driven, major energy research initiatives. We will take full advantage of opportunities from the proposed EMS New Alliances for Graduate Education (NAGE) and the Think Tank for Transformative Earth, Energy, and Materials Sciences (TEEMS) initiatives.
 - Leverage internal investments to develop more strategic, collaborative partnerships and alliances with industry and government in the above energy-related research focus areas.

- Develop a formal plan and priorities with the Energy Institute.
 - Evaluate guidelines for proposal cost share and research incentive fund allocation.
 - Set up mechanisms for funding future instrumentation and equipment purchases, research infrastructure upgrades and technical support staff.

- Seek deeper education and research collaboration with other units such as Material Science and Engineering, AESEDA, the Biomass Energy Center, Pennsylvania Transportation Institute (PTI), and the Propulsion Engineering Research Center.
- **Seek new space and better utilization of space for continued growth in research.**

- Strive for excellence in faculty performance and recognition by generating external research funding, releasing salary to the department, increasing significant roles in professional organizations (officer positions) and management of professional and scientific journals (Associate Editor, Editor-in-Chief), and generating high-impact publications.
- As research grows, enhance the quality of the research infrastructure, including the capability to maintain and replace equipment and the hiring of necessary technicians.
- Develop synergistic master agreements with more companies, through the Department or the Energy Institute, to establish research consortia focusing on new technology.

Measures of Performance

- The number and dollar value of new grants and contracts will be increased by 25% by 2014.
- The amount of research expenditures will be increased by 25% by 2014.
- The number of graduate students supported by externally funded projects will be increased by 25% by 2014.
- The number of publications in refereed journals and the number of high-impact publications will be increased by 25% by 2014.
- Working with faculty from other University units, develop three additional strategic alliances or partnerships with industry and government in key energy-related or other strategic areas.
- **Develop plan for meeting future space needs of new hires, new research, and more students (e.g., new or renovated space in the Energy Institute, Deike, Hosler and Steidle).**
- Develop plan for ensuring effective equipment maintenance and addressing laboratory issues.
- Place greater emphasis in the annual faculty review on significance of publications in addition to the number of publications, and on external high-profile service to the professional and scientific community (e.g., service on NRC panels, editing journals, and producing high-quality publications).

Goal 4 – Grow a Global Presence

In a global economy, business, technical, economic, and political decision-making is inextricably linked with the environmental, social, and sustainability impacts that affect nations and continents. The education of future leaders for any sphere of influence is an important, even critical aspect as persistent and potential complex problems are addressed now and in the future. The Department of Energy and Mineral Engineering accepts the responsibility to make important contributions concerning such problems, particularly as they relate to energy and mineral resource management. Thus the Department seeks expansion of its global efforts in

teaching, research and service in a strategic way. Accordingly, fostering international experiences of students is important to developing the breadth and depth of the scientific understanding of complex global issues related to the energy and mineral industries.

Strategies

- Consistent with the EMS initiatives of enriching the student experience and for creating the Earth and Mineral Sciences Academy for Global Experience (EMSAGE), develop departmental initiatives for generating cooperative, international partnerships to provide students with global experience.
- In strengthening the relationship with AESEDA, leverage the Department's unique array of expertise to **champion the Sustainable Resource Management Initiative**. For most African countries, economic development is directly related to the development of resource recovery industries such that the complex enviro-socio-politico-economic interactions are considered.
- **Extend the Department's web-based educational offerings to a targeted global market. This may include on-line certificate and professional degree opportunities in, for example, the science and engineering of carbon management, industrial health and safety, and energy risks and informatics. We will play an active role in the future EMS online Bachelor of Arts Degree program in Energy.**
- Through the proposed International Alliances for Graduate Student Funding, establish meaningful, collaborative partnerships with key universities in selected countries that are seeking to address significant global economic, health and safety, and environmental issues in energy and minerals.

Measures of Performance

- Working in interdisciplinary teams as part of the EMS Academy for Global Experience, develop three cooperative, international partnerships to provide EME students with global experiences.
- Through AESEDA and with EMS colleagues, champion the Sustainable Resource Management Initiative for development of sustainable resource recovery industries in Africa, which seek to address complex enviro-socio-politico-economic interactions.
- Seek an increase of the Department's international enrollment in web-based educational offerings.
- Seek mature collaborative partnerships with universities in selected countries that are trying to address significant global issues.

Goal 5 – Play a Leadership Role in Energy Outreach

The Department of Energy and Mineral Engineering possesses a unique structure and faculty mix that offers great opportunities and unique challenges. EME nurtures a variety of academic offerings associated with the lifecycle of energy and mineral resources and related environmental, health and safety, and management aspects of each stage. The long-term success of EME is decisively tied to the successes of each of our academic offerings. Through leadership and teamwork, the Department will strive to maintain and strengthen the identity and visibility of the Department's core degree programs and their presence on the national and international scenes. Concomitant with the strategic goals of the College of Earth and Mineral Sciences, the Department will lead and inspire faculty, staff, students, and alumni to build a stronger outreach and sense of community that will maintain the Department as unique, growth-oriented, student-centered, and quality-driven.

Strategies

- Enhance the visibility of the Department and its majors.
- Monitor and strengthen the visibility and identity of EME academic offerings in the national and international scene.
 - Promote the active participation of EME students in national and international research and student competitions.
- Grow web-based educational offerings.
 - Strengthen current web-based offerings.
 - **Provide active support to the faculty in developing web-based teaching materials.**
 - Develop a formal plan of collaboration with the World Campus and e-education Institute.
- **Nurture the academic growth of faculty members and their continuous presence in the national and international scene through outreach activities.**
 - **Promote and encourage faculty to assume individual and partnership-based responsibilities and roles in national and international organizations, conferences and symposia, and energy policy debates.**
 - Highlight the accomplishments of faculty members, as well as students and alumni.
- Capitalize on relationships with EME alumni
 - Form an annual alumni event on campus to promote the Department's successes and bring alumni from various programs together.
 - Increase the number of opportunities for informal faculty-student-alumni interactions.

- Inspire current and potential students by actively advertising what EME alumni do in their fields of specialization.
- Capitalize on relationships with constituent industries.
 - Facilitate the placement of 100% of EME graduates by monitoring and keeping academic offerings aligned with industry expectations.
 - Inform potential donors of successes, activities and needs.

Measures of Performance

- Survey national ranking of degree programs annually. A Top Five ranking for relevant programs is targeted.
- Determine the number of formal faculty interactions on issues of national or international significance. Involvement of 25% of the faculty is targeted by 2014.
- Track Department and program student enrollment numbers annually. A 25% increase for the Department and each program is targeted by 2014.
- Conduct and analyze data from a biennial assessment of constituents (industry, alumni, current students, and faculty) regarding the visibility of EME programs, graduates, and research. A 20% improvement of visibility measures is targeted by 2014.
- A target of 50% of EME faculty being professional society fellows and/or national officers of professional societies is sought by 2014.
- A target of 40% of EME faculty being actively involved with other University units is sought by 2014.

Goal 6 – Ensure a Critical Mass of Faculty and Staff

To achieve the aforementioned goals, the Department recognizes the importance of investing in the faculty, staff and infrastructure, including new physical facilities that can propel recent growth patterns to even greater ones in support of the University's and College's missions. The following action items are critical to continuing significant growth in Department-based strategically important areas to the University, and not simply sustaining what is in place:

- First, a high level of faculty retention must be maintained. To this end, **giving competitive salaries and raises proportional to successful effort and improving opportunities for professional and personal development in domestic and global venues are paramount in a very competitive environment where the best performers can go almost anywhere.**
- Second, if faculty members are lost to other opportunities, it is important to immediately begin recruiting high-caliber replacements. The pool of highly qualified and experienced candidates is small, and the job market is extremely competitive. Delay in aggressively seeking replacement faculty will likely result in losing the best

candidates. Anticipating the retirement or loss of faculty members in advance could allow more timely initiation of searches.

- Third, given the current growth patterns of the Department, the amount of funding available to address the energy and minerals industries' complex issues, and the multi-disciplinary expertise of the faculty, the size of the Department faculty will need to continue to grow. Energy and related issues are particularly strategic in nature and highly visible in the College and the University, and the Department is committed to elevating its research and education efforts to tackle the issues.
- Fourth, current growth patterns have generated greater loads on support staff as well. The Department staffing is at a crossroads in its capability to deal with further significant growth. Thus it has become important to reassess work distribution among staff members, looking for the most efficient and effective sharing of the load among them. **Particularly at a near-crisis stage is the demand on Department technicians, who appear to be woefully over-taxed.**
- Fifth, the anticipated further growth in faculty, research and increased demand on educational facilities by higher enrollments in the Department cries for a commensurate increase in staffing before the current staff is overwhelmed.
- **Finally, securing new tenure track and fixed term faculty positions for the identified research focus areas, revenue-generating online certificate and professional degree programs, and fast growing programs (e.g., EBF) is critical to the success of the planned strategic and transformational initiatives.**

Transformational Thrusts and Vehicles for Achieving Them

Among the six major goals are dispersed several thrust areas that are transformational in nature, either from the perspective of potential impacts regarding research on complex energy and mineral related issues or of a new level of synergy emerging among faculty and students who will address these complex issues in research or practice. Driving the transformations is realization that a sustainable world must tackle the complex issues related to energy and mineral extraction, processing, and utilization, and particularly develop technology that will mitigate or eliminate deleterious impacts on people, the environment, and the economy. The primary thrusts that are transformational in one perspective or the other follow:

- The enhancement of the new Energy Engineering program and achieving ABET accreditation for it will promote among faculty and students the synthesis of perspectives relative to all energy options and their trade-offs in addressing critical issues emanating from a tremendously growing global demand for energy.
- The establishment of the Program for Undergraduate Research Experience (PURE) and linking with the EMS Center for Advanced Undergraduate Study and Experience (CAUSE) will uniquely promote interdisciplinary, problem-based learning opportunities for undergraduates, and transform student perspectives and their pursuit of career choices. Coupling these with the proposed Earth and Mineral Sciences Academy for

Global Experience (EMSAGE) will further enhance undergraduate research opportunities and international research experiences, particularly related to senior capstone courses. Taking this approach a step further by linking with the proposed EMS Academy of Scholars will pursue the same goals for our best students, who will likely be key future leaders.

- Transforming public perspectives on complex energy and mineral related issues, based on understandable science, and using demonstrations and exhibits that will travel throughout Pennsylvania to educate the public will have long-term impact as the complex issues are addressed locally, state-wide, and nationally.
- Developing and securing funding for pipeline education programs (e.g., summer energy camp and 3+2 dual degree programs), through research grants and private-sector donations, will enable us to enhance the diversity of our student body with respect to underrepresented groups. Likewise, securing research grants, endowed departmental lecture series, and graduate fellowships will foster and grow diversity in the graduate student body.
- Replacing and modernizing teaching facilities (e.g., laboratories) and methods of delivery is absolutely essential in producing the next generation of skilled workforce.
- The newly integrated graduate program in Energy and Mineral Engineering (EME) will transform the way that highly interdisciplinary research is pursued and will enhance the mixing of perspectives as complex energy and mineral related issues are addressed. The program will widen the skill sets of students involved and broaden their professional perspectives. Identified strategic interdisciplinary research areas include clean coal conversion and carbon sequestration, renewable energy resources, enhanced coal bed methane and hydrates recovery, fuel cells and hydrogen technology, the new Marcellus black shale reservoir, gas transmission, advanced transportation fuels, sub-surface engineering, energy informatics, and energy management and policy.
- Seeking new space and developing a plan for better utilization of space to accommodate the continued growth in research, faculty and students is crucial to our success.
- Introducing five-year integrated B.S. and M.S. degree programs will provide opportunities for undergraduate students in the Department to pursue graduate degrees and carry out research as well as pursue unique opportunities in industry, government and academia.
- Enhancing the Department and program websites as well as the graduate admission process will increase the pool of excellent graduate students that enter the department.
- As the faculty develops new opportunities for professional and public constituencies to take on-line certificate and professional degree programs in such areas as the science and engineering of carbon management, industrial health and safety and energy informatics, they will also be developing a deeper understanding of complex issues related to the energy and minerals industries as well as methods of addressing the issues in a sustainable way. Ultimately, over time, this approach will transform public knowledge of these issues and help inform the political process with good science.
- Through the EMS New Alliances for Graduate Education (NAGE) and the establishment of several meaningful student exchange programs with distinguished universities, colleges and research institutions around the world, which will focus on complex energy

and mineral related issues on a global basis, the perspectives of EMS and EME students and faculty will be transformed significantly.

- Focusing on developing additional strategic partnerships and alliances within EMS and with other PSU units, as well as with other universities, companies, and national laboratories will transform the Department's interdisciplinary research capability while also transforming the very fiber of the core research areas of the department and better leveraging EMS Institutes investments. These efforts will assist Penn State's and EMS's goal of being in the forefront of cross-cutting major energy research, including public-policy aspects. In particular, it is essential for EME to champion the Sustainable Resource Management Initiative in AESEDA, take lead research roles at the Energy Institute, and develop strategic partnerships and alliances with other organizations and universities.
- By encouraging and facilitating the faculty to assume significant individual and partnership-based responsibilities and roles in national and international organizations, conferences and symposia, and energy policy debates, Penn State will be recognized as playing a major outreach role and will help transform U.S. and global perspectives on complex energy and mineral related issues through good science. To this end, the Department will encourage strong participation by faculty in the proposed EMS Think Tank for Transformative Earth, Energy and Material Sciences (TEEMS).
- Attracting, retaining and ensuring a critical mass of faculty and staff, our most important assets, is crucial to the success of our strategic initiatives. In particular, the urgent need for new tenure track and dedicated fixed term faculty positions for the identified research focus areas and the revenue-generating online certificate and professional degree programs cannot be ever-emphasized.

Budgetary Considerations

The University's current plan of mandatory 1% recycle of permanent funds will place severe strain on our operations and ability to retain our best faculty and remain at the cutting edge of energy research. In the worst case scenario of 1% recycle of department permanent funds each of the next five years without any returns, this will translate to about \$30K per year or \$150K over the 5 years. We will painfully absorb this through a combination of not filling a future position and reducing our general operating budget. It should be pointed out however that not filling a faculty position in a time of rapid increases in student enrollment at both the undergraduate and graduate levels will severely impact our legacy and other programs. Since the above recycle strategy will in time completely deplete our general operating budget, we will have to find other sources of revenue to survive. We plan to offset the negative financial impact of the recycle by generating temporary funds through online education, growth in research funding (RIF), salary release, Penn State Foundation, and support of alumni and friends.

EME, like the College, does not believe this is the time to take a defensive stance but a time to proactively push forward the strategic initiatives outlined even in times of recycle. During the past 5-year period, the EME faculty has successfully recaptured recycled funds through innovation and by pursuing growth opportunities. EME attained investments from the University and the Penn State Institutes of Energy and the Environment (PSIEE) to grow energy issues-

related capability. Thus, from among the four alternative recycle scenarios cited in the Provost's strategic planning guidelines for implementing the five year strategic plan, EME will continue to seek continued growth in strategic areas important to the University and EMS, as framed by Scenario 4 ("the College must recycle 1% of its permanent funds each of the five years but can expect to be returned all recycled funds, plus an increment of 5% of the College's current base budget all for strategic investment"). This will require continuation of recycling of faculty positions upon terminations, with provisions that EME be returned the funds to hire junior faculty members, and the investment by the College in the transformational initiatives outlined in this strategic plan.

The budget provided at the end of this document is based primarily on the assumption that development funds will be raised to undertake most of the proposed strategic initiatives. In particular we propose to raise \$6 million for renovating/upgrading all instructional labs within the engineering programs in the Department. A virtual computer lab that will expand the capacity of our current computer lab remotely to all students will be developed for about \$150K. We also propose to raise \$100K and \$150K per year for the Program for Undergraduate Research Experience (PURE) and Scholarship/Diversity funds respectively.

On graduate education and research, we have budgeted for about \$700K for graduate assistantships (stipend and tuition) to support about 20 students per year. We also estimate about \$1 million in startup funds/renovations and \$1.25 million in cost share over the five years of the strategic plan.

As part of the effort to develop revenue generating online certificate and professional degree programs, we estimate that it will cost \$100K per year to develop the courses. We propose to hire dedicated fixed term faculty for about \$60K per year to help with the online courses. Through retirements and or program growth, EME expects funds from EMS to hire new faculty. In addition, EME has budgeted to hire a technician to support our undergraduate instructional labs.

Summary Statement

The Department of Energy and Mineral Engineering with its instructional, research and service programs is positioned well to enhance current performances and to define new, transformational research directions for its students and faculty with coherent and realistic objectives. The faculty and the Department administration are committed to expend the necessary efforts to achieve the EME vision of maintaining vibrant and productive education and research programs that will enhance the stature of each program in the Department at local, regional, national and international levels. Furthermore, EME is confident that the high-quality educational experience that the Department strives to give to the students will be instrumental in preparing them to assume leadership roles within industrial, governmental, and academic circles – both domestically and internationally. The next five years should be transformational for the relatively young and growing Energy and Mineral Engineering (EME) Department.

EME Strategic Plan Budget Priorities*

<u>Need</u>	<u>2009-10</u>	<u>2010-11</u>	<u>2011-12</u>	<u>2012-13</u>	<u>2013-14</u>	
Goal 1: Undergraduate Education						
PURE	100K	100K	100K	100K	100K	
Design/Learning Center	30K	20K	5K	0	0	
Field Trips	5K	5K	5K	5K	5K	
Recruitment	15K	15K	15K	15K	15K	
Scholarships/Diversity Funds	150K	150K	150K	150K	150K	
Traveling Demo/Exhibits	20K	10K	5K	5K	5K	
Pipeline Program	20K	20K	20K	20K	20K	
Instructional Labs (10)	500K	2 million	2 million	1.1mil	550K	
Virtual Computer Lab	150K	50K	20K	10K	5K	
Sub-Total	990K	2.37mil	2.32 mil	1.405 mil	850K	
Goal 2: Graduate Education						
Graduate Assistantships	700K	700K	700K	700K	700K	
Endowed Lecture series	10K	10K	10K	10K	10K	
SROP	10K	10K	10K	10K	10K	
Promotional/Travel	10K	10K	10K	10K	10K	
Exchange Program	20K	20K	20K	20K	20K	
Sub-Total	750K	750K	750K	750K	750K	
Goal 3: Sponsored Research						
Leverage/Cost Share	250K	250K	250K	250K	250K	
Startup/Renovations	500K	300K	100K	50K	10K	
Maintenance & Repairs	50K	50K	50K	50K	50K	
Sub-Total	800K	600K	400K	350K	310K	
Goal 4: Global Presence						
EMSAGE	50K	50K	50K	50K	50K	
e-courses development	100K	100K	100K	100K	100K	
Sub-Total	150K	150K	150K	150K	150K	
Goal 5: Energy Outreach						
Faculty/student Development	50K	50K	50K	50K	50K	
Web-based materials	100K	100K	100K	100K	100K	
Sub-Total	150K	150K	150K	150K	150K	
Goal 6: Faculty and staff						
New Faculty (TT)	75K	75K	75K	75K	75K	
New faculty (Fixed term)	60K	60K	60K	60K	60K	
Technician support	40K	40K	40K	40K	40K	
Sub-Total	175K	175K	175K	175K	175K	
Total	3.015 M	4.195 M	3.945 M	2.980 M	2.385 M	<u>16.520 M</u>

*Although not accounted for after the first year of the budget, a 4% increase is expected yearly.