## Brothers, Sheila C

**From:** Hippisley, Andrew R
**Sent:** Thursday, March 21, 2013 4:23 PM
**To:** Brothers, Sheila C
**Subject:** Graduate certificate power and energy
**Attachments:** GraduateCertificatePowerEnergy-rev-Mar192013-c.pdf

This is a recommendation that the University Senate approve the establishment of a new graduate certificate: Power and Energy, in the College of Engineering.

Andrew Hippisley

# Proposal for a Graduate Certificate in Power and Energy

College of Engineering

**Proposal Contact: Dr. Yuan Liao**
453 F Paul Anderson Tower
Department of Electrical & Computer Engineering
Phone: 859-257-6064
Email: yliao@engr.uky.edu

**Date: September 14, 2010 (revised April 1, 2013)**

## Purpose and Background

The purpose of the proposed Graduate Certificate in power and energy is to provide students with state of the art knowledge in power and energy areas and produce well trained graduates in power and energy areas.

It is anticipated that there will be a substantial shortage of power and energy professionals in the national labor force in the near future. To help train more power and energy engineers, the Department of Energy (DOE) issued a call for proposals on power and energy workforce training in December 2009. The College of Engineering submitted a proposal and was awarded a grant to create a Power and Energy Institute of Kentucky (PEIK[1]) to train the next generation of power and energy professionals. As part of the proposal, we have proposed to offer a Graduate Certificate in Power and Energy. In close collaboration with industry, the Institute will combine existing UK College of Engineering power engineering courses with newly created courses to provide students with an attractive, clearly-marked pathway into the power engineering workforce.

The Graduate Certificate was approved by College of Engineering Faculty on January 27, 2011.

## Graduate Certificate Director

The Director will be appointed by the Dean of the Graduate School, upon recommendation of the Dean of Engineering. The current acting director for the Certificate will be PEIK Associate Director for the Graduate Program, Dr. Yuan Liao. Dr. Liao is a member of the College of Engineering faculty who has graduate faculty status in the University. The Certificate academic unit will be the College of Engineering.

## Admission Requirements

[1] (Note that the term "Power and Energy Institute of Kentucky", PEIK, as used above and in this report is a name of an organized faculty group, as allowed per Academic Regulation AR1:3 for a faculty group organized in response to external funding opportunity, in this case a $2.5M funding from the US Department of Energy. The request for official recognition of the PEIK name within the university has been filed but not yet approved. However, the requested approval of this certificate program should not be contingent on the final recognized name of the power and energy faculty group.)

The Certificate Director will be responsible for the certificate curriculum and matters such as: admission to and successful completion of the graduate certificate by students, enforcement of certificate requirements, maintenance of records, advising students on electives, and so forth.

Students who already are or will be enrolled in a degree program, or those who simply apply for Postbaccalaureate (non-degree) status in order to complete the certificate, are eligible to apply for admission. The certificate director may limit admissions so that faculty and other resources available are not overwhelmed.

The minimum requirements for admission to the graduate certificate curriculum are the same as those for post-baccalaureate status. Applications for admission to the Graduate Certificate will be reviewed by the certificate director, who will notify the Graduate School in writing of the student's admission. A student is encouraged to apply and be admitted to the certificate curriculum prior to taking any classes that will be counted towards completion of the certificate.

## Certificate Requirements

As required by the Graduate School, a student must maintain a minimum GPA of 3.0 in the set of courses required for completion of the graduate certificate. The curriculum of the certificate will consist of 15 credit hours, including four required courses and one elective course. The certificate curriculum is designed to permit completion within one academic year.

Certificate curriculum courses taken at graduate level by a student (undergraduate or graduate) before being admitted to the certificate curriculum will count toward the completion of the certificate.

However, certificate curriculum courses taken at undergraduate level can satisfy the requirement for course work in particular topics but do not count toward the completion of the certificate. The student still needs to take appropriate power and energy courses as suggested by the Certificate Director, a total of five courses (15 credits) in order to complete the certificate.

Graduate courses taken at other universities that are transferrable to UK may be counted toward the completion of the certificate at the discretion of the Certificate Director.

### Required courses

Students are required to take all of the following courses, a total of 12 credit hours.

| |
|---|
| **EGR540 Electric Power Economics and Public Policy** * (3 credit hours): This is an overview class that provides background on: Tariff/rate structures, the role of public service commissions, economic dispatch and generation/load balancing issues, demand management, environmental issues, regulated and deregulated markets, etc. |
| **EGR542 Electric Power Generation Technologies** * (3 credit hours): An overview of generation methods, including coal, nuclear, gas turbine, hydro, solar, wind, and biomass. |
| **EGR546 Electric Power System Fundamentals** * (3 credit hours): This course is an introduction to power transmission and distribution basics. |
| **EGR 649 Power and Energy Experiences** * (3 credit hours): Unique experiences through visits to a variety of energy-related sites and hear from topical experts. |

Courses with * are under development. EGR542 and EGR546 will be taught for the first time in Fall 2010 under the experimental course number EGR599. EGR540 and EGR649 will be taught for the first time in Spring 2011.

Learning outcomes of courses under development

***EGR546 Electric Power System Fundamentals***

Students completing this course are expected to be able to:

1. Perform basic calculations associated with the steady-state operation of balanced three-phase circuits.
2. Understand the basic principles of transformers, transmission lines, and the power-flow problem.
3. Perform basic fault analysis and have some knowledge of system protection.
4. Know the basics of power system control, including economic dispatch, and have a basic understanding of power system stability.
5. Understand modern trends, including distributed generation and smart grid applications.

***EGR540 Electric Power Economics and Public Policy***

Students completing this course are expected to be able to:

1. Describe the basic structure of power markets in a regulated and deregulated utility environment
2. Describe supply/demand dynamics in power markets
3. Understand how utility business regulations impact electricity utility operation and decision making
4. Plan the selection of new electric generation facilities within the power market structure of the utility
5. Apply public policy theory to power public policy issues
6. Plan the selection of new electric generation facilities within the current and future environmental regulatory environment.
7. Identify the unintended consequences of power public policy
8. Communicate professionally within the utility industry
9. Discuss issues within the utility industry using the general vocabulary of the industry
10. Understand how current and potential future market and environmental regulations affect the feasibility of engineering decisions and assumptions
11. Apply engineering economic analysis to engineering decision making
12. Understand how profession engineering organizations influence the public policy process
13. Develop strategies for influencing the public policy process

***EGR 649 Power and Energy Experiences***

Students completing this course are expected to be able to:

1. Understand and describe conventional and renewable electrical generation sources
2. Understand and describe electrical distribution systems
3. Understand and describe methods of controlling electrical power generation, distribution and storage
4. Understand and describe the policies and techniques of how and when electricity is generated, distributed, used and sold

**Elective Course**

Students are required to take one course from a list of elective courses in power and energy. The list of courses will be maintained by the Certificate Director, but it is expected to evolve as new courses in power and energy are developed across the College of Engineering. All of the elective courses are 3 credit hours. A list of existing courses currently appropriate as elective courses is given below, which are all existing courses:

| |
|---|
| **EE518 Electric Drives :** Study of principles underlying analysis and design of power conditioning motor drives. |
| **EE531 Alternative and Renewable Energy Systems:** Study of non-traditional, electric generating systems, and the use of renewable energy sources. Energy sources include solar, wind, hydro, and biomass/biogas. Generating technologies include both inverter based equipment and rotating machinery. |
| **EE535 (was 599/699) Power Generation, Operation and Control:** This course covers essential aspects of the energy management system of power systems. Will cover topics: power system economics, state estimation, power system stability, power quality, and fault location. |
| **EE536 (was 599/699) Power System Fault Analysis and Protection:** This course teaches computer based methods for performing balanced and unbalanced fault analysis of power systems, and principles for protecting power systems. |
| **EE537 Power System Analysis I:** Basic concepts relating to electric power systems, with emphasis on the determination of transmission line parameters, representations of components of a power system, and generalized network analysis techniques. |
| **EE538 Power System Analysis II: I**ntroduction to modern power system practices, basic transient and steady-state stability analysis with emphasis on digital techniques. |
| **EE539 Power Distribution Systems:** Electric utility distribution power systems, addressing topics such as configuration, equation, customer class data, phase balancing, distributed generation, etc. |
| **EE601 Electromagnetic Energy Conversion I:** Generalized electric machine theory; parameter determination. Energy conversion in continuous media including magnetohydrodynamics. |
| **EE603 Power Electronics:** Study of solid-state power electronic devices and their applications in power conditioned electric motor drive systems. Examination of control philosophies, steady-state models, and numerical simulation of characterizing differential equations. [To be revised to cover inverters, voltage- and current-sourced converters, compensators and power flow controllers, special purpose FACTS (Flexible AC Transmission System) controllers, Alternative energy integration (wind, solar)] |
| **EE699 Power system analysis using advanced software:** Computer aided methods for power system analysis and application of prevailing power system analysis software package to perform various types of analyses |
| **BAE 503 Fundamentals of Biorenewable Resource Engineering**: This course introduces students to the science and engineering of converting Biorenewable resources into bioenergy and biobased produces. Topics include: defining the resource base; physical and chemical properties of biorenewable resources; description of biobased products; methods of production for biorenewable resources; processing technologies for fuels, chemicals, fibers and energy; environmental impacts; and economics of biobased products and bioenergy. |
| **BAE 504 Biofuels**: An introduction to the basic principles for the production and utilization of biofuels with special emphasis on ethanol and biodiesel. Process chemistry of biofuels manufacturing, fuel properties and the use of ethanol in internal combustion engines and biodiesel engines will be discussed. |
| **BAE 599 Thermochemical Processing of Biomass**: Topics include combustion, gasification and pyrolysis of biomass. |
| **CME 515 Air Pollution Control:** Kinetics and equilibria of photochemical and "dark" atmospheric reactions. Atmospheric statics and dynamics including lapse rates, inversions, and vertical and horizontal air motion. Single and area source diffusion. Stack meterology. |
| **CME 599: Energy Systems:** Present and Future Technology: A study of current major electrical generation technologies in practice today including how fuels are recovered, processed and converted into electrical power. Coal, oil and gas, nuclear and renewable sources are considered along withthe environmental consequences and benefits of each fuel source, as well as howeach technology must adapt to meet future energy demands. |

| |
|---|
| **ME 530 Gas Dynamics**: Consideration of the mass, energy, and force balances applied to compressible fluids. Isentropic flow, diabatic flow, flow with friction, wave phenomena and one-dimensional gas dynamics. Application to duct flows and to jet and rocket propulsion engines. |
| **ME 548 Aerodynamics of Turbomachinery:** Turbomachinery is an important part of power generation in modern power plants, wind turbines, and hydroelectric power. Together, ME 548 and ME 549 cover a complete spectrum of power plant power generation systems. |
| **ME 549: Power Generation**: Modern power plants for electric power generation and cogeneration. Thermodynamic analysis of different concepts of power plants. Design studies of specific power plants. |
| **ME 563 – Basic Combustion Phenomena** (proposed to be renamed as Combustion I): This course provides students with basic knowledge on combustion principles, power generation systems and environmental concerns and control. |
| **ME 626 Advanced Heat Convection**: Comprehensive study of heat convection: derivation of equations of convection of mass, momentum, and energy; boundary layer equations; classical solutions of laminar convection problems, turbulent convection; analogies between momentum and energy. |
| **ME 699 Modeling of Resources Utilization for Sustainable Engineering:** This course is heavily devoted to energy resources. It covers advanced thermodynamics methods for assessment of energy flows applied to both energy and non-energy systems in the trans-disciplinary context of sustainable development. |
| **CE 533 Railroad Facilities Design and Analysis:** Principles of railroad location, construction, rehabilitation, maintenance, and operation with emphasis on track structure design and analysis, bridges and bridge loading, drainage considerations, track geometry effects, and operating systems analysis. Important to energy/power due to the extensive use of rail to transport fuel and combustion by-products for power generation. |
| **CE 602 Construction Administration:** Administration of construction companies and projects, organization, economics, material management, productivity models, labor and equipment tracking, quality control and managerial accounting. Construction labor relations, claims and construction financing are also discussed. Discusses manage processes for constructing industrial facilities. |
| **CE 599 Control of the Construction Project:** This course investigates the principles and practices for the control of budget and schedule for construction projects. Topics studied include: estimating construction costs and developing a project budget, planning construction operations and developing a project schedule, documenting and reporting of project progress and spending, and the management of change of contract amount, contract time, and contract scope of work. Energy related due to power plant construction planning and estimating processes. |
| **CE 652 Fundamentals of Water Quality Control II:** Theory and practices of wastewater treatment with emphasis on biological treatment processes for municipal and industrial wastewater treatment. Includes coverage of thermal pollution from industrial activity |
| **CE 582 Advanced Structural Mechanics:** Approximate methods of frame analysis; energy principles; flexibility and stiffness methods for trusses, frames, arches, non-prismatic members and flexible connections/supports; influence lines for statically indeterminate structures; introduction to plastic analysis; and use of available computer programs for structural analysis and matrix operations. Covers design methods for industrial structures. |
| **CE 672 Landfill Design:** This course deals with the geotechnical aspects of landfills for the disposal of municipal solid waste. Since landfill design is driven by state and federal regulations, time is taken to review these regulations. Landfills are evaluated as engineered systems consisting of multiple components. Each component is investigated individually, and methods are developed to predict and quantify the performance of these components so that appropriate materials, design criteria, and construction methods can be selected to assure that the landfill will function with minimal environmental impact. Landfills are required for power combustion by product storage and methane gas power generation. |

## Certificate Outcomes

Upon completion of the certificate, students should

1. have the ability to not only understand the material learned but also to apply what they have learned in new situations.

2. have a broader background and perspective on power and energy issues that includes areas outside technical engineering issues, such as economics, public policy, societal impact.

3. have the ability to take a systems approach to the complex behavior of coupled human, technical and natural systems, behavior that can't be adequately understood by engineers educated within traditional disciplinary boundaries.

All three outcomes will be assessed for all students completing the certificate.

## Award of the Certificate in Power and Energy

When the student has successfully completed the last course required for the Graduate Certificate, the student shall notify the Director. The Director shall send a completed, signed Graduate Certificate Completion Form to the Dean of the Graduate School verifying that the student has fulfilled all the requirements for the certificate and requesting award of the certificate. The form requires a listing of the courses completed by the student for the certificate and the grades earned therein. The form is to be accompanied by the printed copy of the student's certificate prepared by the Director for signature by the Dean. The Graduate School shall officially notify the University Registrar of the award of the certificate for posting to the permanent transcript.

## The Associated Faculty Teaching Courses for the Certificate, and the Departments They Represent

The list below shows the Faculty of Record responsible for the certificate implementation and development:

| |
|---|
| **Dr. Rodney Andrews: (Chemical and Materials Engineering, and Director, Center for Applied Energy Research):** thermochemical conversion processes for coal and biomass, carbon fiber and composites, activated carbon materials, pitch chemistry and characterization, synthesis and application of carbon nanomaterials |
| **Dr. Y.T. Cheng: (Chemical and Materials Engineering): Nanostructured** materials for electrochemical energy storage |
| **Dr. Donald Colliver, (Biosystems Engineering):** P.E. PM-FASHRAE. Energy efficient and green facility design, thermal and electrical solar energy, codes and standards |
| **Dr. Aaron Cramer (Electrical and Computer Engineering):** Power system analysis and power electronics. |
| **Dr. Paul Dolloff (Electrical and Computer Engineering):** (Adjunct) Power delivery (transmission and distribution) and distributed generation. Teaching includes Power Distribution Systems, System Protection, and Renewable/Alternative Energy Systems. Senior Engineer in the R&D Department of East Kentucky Power Cooperative, an electric utility. |
| **Dr. Larry Holloway: (Chair of Electrical and Computer Engineering and TVA Professor).** Experience in administration and project management, including industrial extension and professional development education programs. Research and teaching area in systems and control. |
| **Dr. Yuan Liao (Electrical and Computer Engineering):** Power transmission and distribution, system protection and fault monitoring, power market, power system optimization and economics. Former experience in power technology and equipment industry (ABB). |
| **Dr. Steve Lipka: (Associate Director, Center for Applied Engineering Research, and adjunct faculty, Electrical and Computer Engineering):** materials and device development for electrochemical energy storage systems, including systems for distributed electric utility grid. |
| **Dr. Johné Parker (Mechanical Engineering) :** former ASME/AAAS Congressional Fellow in the office of Senator |

| |
|---|
| Byron Dorgan (D-ND) during 2005-06; Senator Dorgan is a senior member of the Senate Appropriations; Energy and Natural Resources; and Commerce, Science and Transportation Committees and Chair of the Democratic Policy Committee. Professor Parker has research interests in systems and controls and science & technology policy. |
| **Dr. Vijay Singh (Electrical and Computer Engineering):** Solar energy harvesting, including advanced photovoltaics and nanostructured solar cell devices. |
| **Dr. Joseph Sottile (Electrical and Computer Engineering):** Electrical system protection and safety, detection of electrical component incipient failure, and electrical energy management. |
| **Dr. Timothy Taylor (Civil Engineering):** P.E. Infrastructure development and management, nuclear power construction, infrastructure public policy, energy economics. |

As members of this group depart, the remaining members will recommend replacements to the Dean of the College of Engineering, who will make the appointment.

The certificate program was developed with input from several groups:

1. The Power and Energy faculty working group in the college of engineering defined the structure of the certificate and will continue to provide oversight to its administration. The working group corresponds to faculty participants from multiple engineering disciplines who are involved in the Power and Energy Institute of Kentucky (PEIK) sponsored by the Department of Energy grant mentioned above. Beyond the existence of the grant, this advisory group membership will be defined by appointment of the Dean of the Graduate School, upon recommendation of the Dean of Engineering. Leadership of this faculty group currently resides with the Chair of Electrical and Computer Engineering, as the Principal Investigator of the PEIK grant from DOE. The leadership of the group in the future will be by appointment of the Dean of Engineering.
2. There is also a Power and Energy External Advisory Board that was established as part of the initial grant. This group includes representatives from industry and government. This group reviewed and influenced the structure of this proposed certificate program. This advisory board will continue into the future to provide advice on power and energy courses and the undergraduate certificate.
3. As part of the requirements of the founding grant, there is a Power and Energy Internal Advisory Board, consisting of department chairs of each of the engineering departments associated with the program (Biosystems Engineering, Chemical and Materials Engineering, Civil Engineering, Electrical and Computer Engineering, Mechanical Engineering, and Mining Engineering). This board has also reviewed and influenced this proposed certificate program.

## Assessment for the Certificate Program

Assessment for instructors and courses within the Certificate Program will be performed in standard university fashion via regular teaching and course evaluations. Assessment for students in the program will be through course grades in the program, with a minimum GPA requirement as discussed above.

The overall Certificate Program will be assessed through regular review of the Power and Energy faculty and the Power and Energy External Advisory Board (both mentioned above). The

External Advisory Board consists of industry representatives that will provide feedback on the material covered in the curriculum and on the quality of the students coming through the certificate program. The enrollment numbers in the program will also be regularly reviewed and will be considered an assessment measure, as the original goal of the US Department of Energy funding for this program was to produce students with power and energy knowledge and skills, as taught by the curriculum of the certificate program.

UK
THE UNIVERSITY OF
KENTUCKY

College of Engineering
Department of Electrical and
Computer Engineering
453 F Paul Anderson Tower
Lexington, KY 40506-0046
859 257-8012
fax 859 257-3092
www.engr.uky.edu

September 20, 2010

Dean Blackwell
The Graduate School
University of Kentucky
Lexington, KY 40506

Dear Dean Blackwell,

This letter is to indicate my support for the proposed Power and Energy Graduate Certificate. This certificate is being proposed as part of the Power and Energy Institute of Kentucky (PEIK), initiated as part of a recent $2.5 million grant from the US Department of Energy. The purpose of the Institute is to educate more engineers for power and energy careers, and is being driven by concerns of the Department of Energy that there are not enough such engineers to address the national need.

The Certificate provides students a structured curriculum in power and energy. The curriculum is designed to allow integration into multiple engineering graduate degree programs. It will allow students to have their focus coursework recognized by a certificate, and the knowledge represented by the certificate is intended to give students a competitive edge in the power and energy job market.

The attached proposal was reviewed by the multidisciplinary faculty and research staff associated with PEIK on September 14, 2010. This included Yuan Liao, Joseph Sottile, Johne Parker, Tim Taylor, Don Colliver, YT Cheng, Paul Dolloff, Vijay Singh, Larry Holloway, Jim Neathery (CAER), and Sheila Medina (CAER).

We are excited about the new Institute and this opportunity to position the University of Kentucky as a leading institute in power and energy. The proposed graduate certificate is an important part of the Institute education program. I strongly endorse the proposal.

Sincerely,

Larry Holloway
TVA Professor of Electrical Engineering
Chair, Department of Electrical and Computer Engineering
Director, Power and Energy Institute of Kentucky (PEIK)

Approved by College of Engineering Faculty - 01/27/2011

Richard J. Sweigard
rsweigar@engr.uky.edu
7-8827

## Brothers, Sheila C

**From:** Nikou, Roshan
**Sent:** Monday, November 21, 2011 2:54 PM
**To:** Anderson, Heidi Milia; Blackwell, Jeannine; Brothers, Sheila C; Gill, Sharon; Hanson, Roxie; Jackson, Brian A; LaRoche, Adrea S.; Lindsay, Jim D.; Nikou, Roshan; Price, Cleo; Swanson, Hollie; Woltenberg, Leslie N
**Cc:** Rosie Carey; Maynard, Leigh; Taylor, Timothy R; Rouhier-Willoughby, Jeanmarie; Payne, Jeffery; Pfeifle, William; Jones, Nancy C; Braun, Michael E; thebensaunders@gmail.com
**Subject:** Transmittals
**Attachments:** Grad Certificate Power and Energy.pdf; Masters in Art Administration.pdf; AAD 600 Propsal Packet.pdf; AAD 610 proposal Packet.pdf; AAD 620 Proposal Packet.pdf; AAD 630 Proposal Packet.pdf; AAD 640 Proposal Packet.pdf; AAD 650 Proposal Packet.pdf; AAD 660 Proposal Packet.pdf; AAD 699 Proposal Packet.pdf; AAD 730 Proposal Packet.pdf; AAD 740 Proposal Packet.pdf; AAD 750 Proposal Packet.pdf; ACC 555.pdf; AEC 531.pdf; CE 508.pdf; CE 509.pdf; CPH 605.pdf; KHP 592.pdf; MCL 595.pdf

TO: Hollie Swanson, Chair and Sheila Brothers, Coordinator
Senate Council

FROM: Brian Jackson, Chair and Roshan Nikou, Coordinator
Graduate Council

The Graduate Council met on November 17, 2011 and approved the following program, Certificate, and course proposals and is now forwarding them to the Senate Council to approve.

**Program**
New Masters in Art Administration
New Graduate Certificate in Power and Energy

**Courses**
AAD 600, New, Arts Administration Technologies
AAD 610, New, Financial management for Arts Organizations
AAD 620, new, Management and Leade4ship in the Arts
AAD 630, New, Marketing Research and Planning for Arts Organizations
AAD 640, New, Principles of Fundraising
AAD 650, New, The Arts and the Law
AAD 660, New, Social and Cultural Entrepreneurialism
AAD 699, New, Internship in Arts Administration
AAD 730, New, Marketing Strategies and Applications for Arts Organizations
AAD 740, New, Fundraising Teaching
AAD 750, New, Capstone Course in Arts Administration
ACC 555, New, Forensic Accounting and Fraud Examination
AEC 531, New, Agricultural Price Analysis
CE 508, New, Design and Optimization of Construction Operations

CE 509, New, Control of the Construction Project
CPH 605, Change, Epidemiology
KHP 592, Change, Choreography
MCL 595, New, Topics in Folklore and Myth

*Roshan Nikou*
*The Graduate School*
*The University of Kentucky*
*101 Gillis Building - 0033*
*Phone: (859) 257-1457*
*Fax: (859) 323-1928*
*Roshan.Nikou@uky.edu*

*"Be Kinder than necessary, for everyone you meet is fighting some kind of battle".*