

# ECEDHA

Electrical and  
Computer Engineering  
Department Heads Association

233 S. Wacker Drive, Suite 8400  
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## ECEDHA Energy and Power Educational Programs Development Workshop

Arlington, Virginia, USA

October 30 – November 2, 2010

### FINAL REPORT

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**ECEDHA Energy and Power Educational Programs Development Workshop**

**Arlington, Virginia, USA**

**October 30 – November 2, 2010**

**FINAL REPORT**

**Workshop Organizing Committee**

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- Anthony Kuh, Professor and Chair, Department of Electrical Engineering, University of Hawaii at Manoa
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*Available on the ECEDHA web site, [www.ecedha.org](http://www.ecedha.org)\*:*

1. Select *Special Meetings and Workshops* from the *Conferences* menu  
(On legacy site, select *Past Annual Conferences and Meetings* from the *Annual Conferences* menu)
2. Find **ECEDHA Energy and Power Educational Programs Development Workshop** under **Special Meetings and Workshops**
3. Select *Presentations*

\* Note: [www.ecedha.org](http://www.ecedha.org) will migrate to a new server with updated navigation in Spring 2011.

## **Introduction**

Electrical and computer engineering will be required to lead the development of advancements in energy systems technologies. While energy systems will be one of the primary areas of challenge in engineering in general, it remains the case that the electricity grid is, and will only grow in importance as, the backbone of energy systems. In addition, electrical systems will grow in importance as many systems including transportation “electrify” and move to the use of the electrical infrastructure. The development, deployment, and use of electrical energy systems technologies as well as the guarantee of their use in a secure, efficient and reliable manner will require a highly trained workforce educated in a broader range of technologies than the “power systems” engineers of a previous generation. This new generation of engineers will not only need to understand traditional power systems technologies but will also have to be expert in technologies not previously considered as a part of “power systems”.

Areas that are of growing importance as the new electrical energy infrastructure is developed include sensors and sensor networks, networking and communications, software systems development for modeling and control, and security. It is this integration of “power systems” with “information technologies” that will define the new energy systems infrastructure and the engineers that will be required to advance and use this infrastructure. The industry need for the development of the appropriate workforce in terms of the required expertise is exacerbated by the aging of the current power systems workforce and the impending retirements of many of its members.

It is against this background that the Electrical and Computer Engineering Department Heads Association (ECEDHA) with the support of the National Science Foundation and the Canadian Department of Foreign Affairs and International Trade hosted a workshop bringing together leaders from across North America in academia, industry and government. The workshop addressed the developments in energy systems technologies and the academic programs that will serve the needs of students in terms of their careers, of industry in terms of its short and medium term workforce requirements, and of society in general for reliable and sustainable energy systems in the long term.

Sessions within the workshop included keynote presentations, panel discussions, and workshop discussions by representatives of government and industry presenting the current and future energy systems landscape, the needs for faculty development, the expectations of students, the needs of facilities development, and the needs of industry.

This report summarizes the discussions and conclusion of that workshop and includes a complete set of presentation materials used by the various participants.

## Curriculum Development

The electrical and computer engineering curriculum must provide the foundation for future developments in electric energy systems. The nature of the problems facing energy systems now and in the future will require a methodology incorporating many different application-specific approaches. Challenging controls problems arising from complex grid interconnections will demand a “system of systems” approach; the modern ECE curriculum is uniquely positioned to provide this emphasis.

Solutions provided should not be “course” based but should instead integrate topics and techniques throughout the ECE curriculum. Universities should adopt strategies that are appropriate to their individual missions and student populations.

The following key points were developed in the discussion by all workshop attendees. The order of the bullet points has been altered from the order discussed to improve readability and provide a more coherent flow.

- The ECE curriculum should be positioned as the leading engineering curriculum for future developments in electric energy.
- Different universities will specialize or emphasize energy systems to greater or lesser extent as appropriate to their missions and objectives.
- A key component of curriculum development will be to ensure that students understand that sustainable electric energy systems are an essential component of ECE. This should be visible to students early in their education. Students should see the societal benefits and impact of these topics.
- Propagation of the concept of ‘course in a box’ and similar inexpensive techniques to cover the field are not suitable to address the energy area in a comprehensive education and research-oriented program.
- An introductory course in ‘**Fundamentals of Electrical Energy Systems Engineering**’ is envisioned to
  - Equip graduating engineers for day-to-day life relating to energy
  - Stress basic energy fundamentals, generation, utilization, and environment
  - Be tailored to local needs and placed in the program according to local requirements
- There should be mechanisms such as a project course for students to develop a **system of systems** approach – for example, projects involving power, power electronics, communication and computation.

- Incorporation of a **system of systems** approach should be encouraged in capstone design courses.
- A second course in **“Energy System Design”** is envisioned to
  - Provide the ability to understand and design energy systems in a complex, multi-topical context
  - Stress the integration of energy, controls, power electronics, communications and hardware
  - Include a capstone design project or an actual course
  - Contain a strong emphasis on multiple systems orientation
  - Be tailored to local requirements

### **Facilities Planning**

Improved laboratory facilities to support education and research are essential to meeting the need for updated power engineering programs. The capital investment required for these facilities can reach \$150K for a full-blown research lab in power computing, and much more for high voltage or power semiconductors. Research labs for smart grid, systems and economics, sustainable energy systems, and high-power electronics will be somewhat less expensive to equip.

Instructional labs will also require significant investment. A typical figure for undergraduate core course laboratory facilities is \$1000 – \$3000/student. A more hardware-centric education will require greater capital investment. High-voltage engineering is particularly expensive. Many areas related to energy systems do not require “traditional” high-voltage equipment, although lab facilities for these areas do require NSF and industry support.

Approaching industry for help in developing facilities in partnership with NSF can help the funding challenge for new or improved lab facilities. In addition, there is a developing availability of integrated and scaled systems to allow for teaching of energy systems concepts to mitigate cost and space requirements. Other means of cost mitigation include

- Using local utilities as a resource for students to see/experience hardware systems;
- Developing non-proprietary software for real-time simulation;
- Developing regional facilities among a number of universities with virtual laboratory capabilities for remote access;
- Developing shared “common space” for all departments interested in energy systems engineering.

### **Industry Needs: Research**

Due to technological innovations, deregulation and other related issues, the electrical energy industry is undergoing rapid transformations. Consequently, future energy systems will be radically different from their legacy counterparts. Universities must recognize this fact and transform their educational programs accordingly. Success in these programs, for the most

part, is measured by the quality of research undertaken by them. It is also clear that research in energy systems is not focused for the “traditional customer” (utilities) alone. The following recommendations were made at the conclusion of the subject workshop as next steps:

- Recognize importance of properly showing value of research developments.
- Conduct NSF/EPRI Workshops to focus attention on topics of importance.
- Pursue NSF support for developing research laboratories in energy systems. This is an area where North American universities have lost their edge in some of these areas (e.g., high voltage). Use the university campus as a “test bed”.
- Stimulate initiatives with ambitious goals to create research funding for universities.
- Prepare a position paper make the case for support in particular areas.

Research in electric energy can be broadly classified into three major areas: basic research (theory), applied research (applications) and hardware and software (computation). The following list of topics is identified as potential areas of research needs, opportunities and challenges as they pertain to successful development of energy systems of the 21<sup>st</sup> century. However, this list is by no means comprehensive or complete.

- Topical Areas:
  - Focus for “islands” and micro grid vs. continental issues
  - Integration of sustainable resources
  - Electrification of transportation
  - Portable power
  - Wireless delivery of power
  - Energy efficiency
  - Automation of large integrated systems
  - Security and reliability
  - Move from preventive to corrective control (including policy component)
  - Energy systems monitoring for system state and predictive capabilities
  - How to take research to scale?

In summary, educational programs (both graduate and undergraduate) development in North American universities should consider these recommendations before embarking upon curricular and other pertinent changes.

### **Faculty Development**

The issue of strong faculty development in the area of power and energy is both challenging and complex, while being critical to the deployment of updated programs. The challenges have been mentioned before: the aging professorate and the changing nature of the field have resulted in a present shortage of qualified faculty and an inadequate pipeline for renewal. This is compounded by the fact that many universities over the previous two decades scaled back their energy systems facilities and now are ill-equipped to attract new faculty into a suitable

research/teaching environment. The situation is further complicated by the multi-disciplinary requirements of future energy systems programs and corresponding skill requirements of new faculty. Nonetheless, tremendous opportunities do exist in the current transformational context of power and energy. It was against this backdrop that the workshop breakout session produced the following recommendations:

- Priority should be placed on attracting young people to this field. Making a difference is important to young people and emphasizing the many opportunities for doing so can be used as an attractor. ECE heads need to understand the "new culture" of power engineering and promote it effectively.
- Additional ways to attract/recruit and train new faculty should include: (1) ensuring that the aging professorate encourages the next generation of energy professors; (2) ensuring that PhD students who are interested in faculty careers are developed with a focus in energy systems; and (3) cultivating multi-university projects and using them to identify potential new faculty.
- In conjunction with the above, additional resources should be made available. These should not only be in the form of ECE hiring budgets, but also as project seed grants and infrastructure, especially for multi-disciplinary efforts. Sharing of educational resources using cyber infrastructure would be helpful and should be encouraged.
- Collaborative/team efforts and mentoring should be recognized as key attributes of future faculty development in a broad field such as this. Without a truly rich and supportive working environment it will be impossible to achieve the levels of competency that the new power and energy programs demand. Furthermore, this approach needs to be communicated to new hires and a reward mechanism needs to be established.
- Special attention should be paid to the career path of new hires, as promotion and tenure issues may arise given the breadth (versus depth in some cases) of energy systems.
- General hiring recommendation: Dedicated searches should be pursued, as these generally produce better results than cluster hires.

### **Industry Needs: Workforce Development**

As the impending retirement of many industry veterans threatens the vitality and reliability of the power/energy industry, the need to increase the numbers of skilled entrants into the workforce is of tremendous importance. It is well recognized that industry will need more than

just replacements for retiring engineers to meet its challenges. Indeed, the integration of information and communication technologies within next-generation power infrastructure will require future professionals to have knowledge extending beyond the traditional power engineering boundaries (i.e. communications/sensor integration, distributed control, policy, software and security). The IEEE/PES Workforce Collaborative has already made substantial progress in addressing these challenges and reported its work in a previous workshop session. Building on its findings and gathering input from a broader cross section of attendees, this session produced the following recommendations:

- Relevant organizations (ECEDHA, IEEE/PES, etc.) should be working to create a single collaborative voice to advocate for power and energy engineering education and research. Building awareness, advertising available programs and highlighting industry opportunities would be possible elements of such a collaborative. Web-based resources would be extremely useful in this regard.
- Ways to strengthen/retain engineering talent in this area should include: (1) providing a biennial survey of power engineering programs; (2) offering scholarships in power and energy for undergraduates; and (3) aligning efforts with "women in non-traditional positions" initiatives.
- In conjunction with the efforts on curriculum development, emphasis needs to be placed on broadening the scope of power and energy to include more cyber-physical systems oriented efforts.
- A greater interaction between industry and universities should take place, with features including: industrial speakers spending time on campus; industrial presence on advisory boards; trips to industrial facilities; industrial based case studies and senior design projects; industrial participation in advanced electives; industry student internships; faculty sabbatical leave/summer work in industry; flexible certificate programs for continuing education; and increased collaborative research.

### **Student Expectations & Recruiting, K-12 Outreach**

Energy Systems should be a very “attractive” topic to students given the impact, societal need, and aspects of sustainability that it represents. These societal need and sustainability aspects provide a direct connection with environmental and global climate concerns, which can, in turn attract a diverse community of students. Energy Systems offers a unique topical area that will showcase ECE programs in a favorable light to prospective students seeking a career field that can “make a difference”.

The following actions are recommended:

- Host engineering open houses and summer programs that emphasize aspects of energy systems

- Target middle school or earlier – High school may be “too late”
- Target parents – understand opportunities (education and jobs) in energy systems
- Target high school counselors and science and math teachers
- Host “competition” through IEEE/PES that is energy systems focused (not Mechanical Engineering focused)
- Develop and expand energy-related student projects, such as projects supported by NREL to put windmills in schools. DOE, EPRI, State Energy Offices, local utilities and NSF are other agencies that can be considered in developing such programs.
- Ensure information about energy systems appears on ECE departmental websites to rebadge ECE to make it more attractive to prospective students.

## Appendix I: Workshop Agenda

### **Sunday, October 31**

- 5:00 pm – 7:00 pm Registration
- 6:00 pm – 7:00 pm Welcome Reception

### **Monday, November 1**

- 7:00 am – 5:00 pm Registration
- 7:30 am – 8:30 am Continental Breakfast
- 8:30 am – 8:45 am Welcome Remarks
  - Ed Schlesinger, President, ECEDHA
  - Tom Peterson, Bob Trew, Kishan Baheti – National Science Foundation
- 8:45 am – 10:00 am Opening Keynotes – “State of the Grid”
  - Kishan Baheti, NSF Cyber Physical Systems - CPS
  - S. S. (Mani) Venkata, University of Washington
  - John McDonald, Director, Technical Strategy & Policy Development, GE Digital Energy
- 10:00 am – 10:15 am Break
- 10:15 am – 11:45 am Industry Panel Discussions (next-generation grid technologies)
  - David Curtis, Director of Asset Management Processes and Policies, Hydro One (Ontario)
  - Dora Nakafuji, Director of Renewable Energy Planning, Hawaiian Electric Co.
  - John McDonald, Director, Technical Strategy & Policy Development, GE Digital Energy
  - Roy Pratt, CTO Energy, HP Enterprise Services
- 11:45 am – 1:30 pm Keynote Luncheon
  - William Parks, Senior Technical Advisor, US Department of Energy
- 1:30 pm – 3:00 pm Academic Panel Discussion (state of P&E education)
  - Vijay Vittal, Arizona State University (moderator)
  - Tarlochan Sidhu, University of Western Ontario
  - Anjan Bose, Washington State University
  - Deepak Divan, Georgia Institute of Technology
  - Marija Ilic, Carnegie Mellon University
- 3:00 pm – 3:15 pm Break
- 3:15 pm – 4:45 pm IEEE-PES Power and Energy Engineering Workforce Panel Discussion
  - Peter Sauer, University of Illinois at Urbana/Champaign (moderator)
  - Dagmar Niebur, Associate Professor, Drexel University
  - Wanda Reder, VP, S&C Electric Company
  - Dennis Ray, Executive Director, Power Systems Engineering Research Center

- 4:45 pm – 5:00 pm
- 6:00 pm – 8:00 pm

#### Day 1 Wrap-Up

- Ed Schlesinger, President, ECEDHA
- Reception, Dinner and Keynote Speaker
- Mike Sullivan, SVP Operations, Pepco Holdings

### Tuesday, November 2

- 7:00 am – 5:00 pm
- 7:00 am – 7:30 am
- 7:30 am – 7:45 am
- 7:45 am – 8:15 am
- 8:15 am – 9:45 am

#### Registration

#### Continental Breakfast

#### Welcome and Workshop Instructions

#### Pre-workshop summary

- G. T. Heydt, Arizona State University

#### Workshop Sessions I

- Curriculum development
  - Moderator: Chanan Singh, Texas A&M
  - Commenter: Mesut Baran, NC State
- Facilities planning
  - Moderator: Kevin Tomosovic, University of Tennessee
  - Commenter: Udaya Annakage, U. Manitoba (Canada)
- Industry needs: research areas
  - Moderator: Vijay Vittal, Arizona State University
  - Commenter: Pete Sauer, University of Illinois Urbana/Champaign

- 9:45 am – 10:00 am
- 10:00 am – 11:30 am

#### Break

#### Workshop Sessions II

- Faculty development
  - Moderator: Ragu Balakrishnan, Purdue
  - Commenters: Langis Roy, Carleton U (Canada); Anjan Bose, Washington State University; Subbaram Naidu, Idaho State
- Industry needs: workforce development
  - Moderator: Wanda Reder, S&C Electric
  - Commenter: Noel Schulz, Kansas State
  - Student expectations & recruiting, K-12 outreach
  - Moderator: Ed Schlesinger, CMU
  - Commenter: Kodjo Agbossou, UQTR (Canada); Mariesa Crow, Missouri University of Science and Technology

- 11:30 am – 12:30 pm
- 12:30 pm – 1:30 pm
- 1:30 pm – 3:00 pm
- 3:00 pm

#### Workshop Readouts

#### Keynote Luncheon

- Ned Mohan, University of Minnesota

#### Final Report Preparation

#### Adjourn

## **Appendix II: Workshop Attendees**

<b>First Name</b>	<b>Last Name</b>	<b>Affiliation</b>
Ali	Abur	Northeastern University
Kodjo	Agbossou	Université du Québec à Trois-Rivières
Dionysios	Aliprantis	Iowa State University
Udaya	Annakkage	University of Manitoba
Alhussein	Aouzeid	National Science Foundation
Kishan	Baheti	National Science Foundation
Venkataramanan	Balakrishnan	Purdue University
Mesut	Baran	North Carolina State University
Nagy	Bengiamin	California State University, Fresno
Maura	Borrego	National Science Foundation
Anjan	Bose	Washington State University
Tim	Brown	University of Colorado, Boulder
David	Castanon	Boston University
Bing	Chen	University of Nebraska, Lincoln
Chiou	Chen	Miami University
Yaobin	Chen	Indiana/Purdue University
Mariesa	Crow	Missouri University of Science & Technology
David	Curtis	Hydro One (Ontario)
Sajal	Das	National Science Foundation
Dennis	Derickson	California Polytechnic State University
Satinderpaul Singh	Devgan	Tennessee State University
Shirshak	Dhali	Old Dominion University
Deepak	Divan	Georgia Institute of Technology
Alejandro	Dominguez-Garcia	University of Illinois at Urbana/Champaign
Samir	El-Ghazaly	National Science Foundation
Mehdi	Etezadi	University of Nevada, Reno
David Wenzhong	Gao	University of Denver
Helen	Gill	National Science Foundation
Lawrence	Goldberg	National Science Foundation
Ravi	Gorur	Arizona State University
G. T. (Jerry)	Heydt	Arizona State University
Marija	Ilic	Carnegie Mellon University
Jalali	Jalal	Youngstown State University
John	Janowiak	International Engineering Consortium
Ken	Jenkins	Pennsylvania State University
Thottam	Kalkur	University of Colorado, Colorado Springs
Gerry	Kane	University of Tulsa
Krishna	Kant	National Science Foundation
Sue	Kemnitzer	National Science Foundation
Barbara	Kenny	National Science Foundation
Michelle	Klein	International Engineering Consortium
Samuel	Kozaitis	Florida Institute of Technology
Mohan	Krishnan	University of Detroit Mercy
Anthony	Kuh	University of Hawaii
Vladimir A	Labay	Gonzaga University
Fred J	Looft	Worcester Polytechnic Institute
H.S.	Mallikarjuna	Saint Louis University

George	Maracas	National Science Foundation
Cherian	Mathews	University of the Pacific
Gary	Mary	Georgia Institute of Technology
John	McDonald	GE Energy
Ned	Mohan	University of Minnesota
James	Momoh	Howard Univeristy
Bob	Morley	Washington University in St. Louis
Yi	Murphey	University of Michigan, Dearborn
Subbaram	Naidu	Idaho State University
Dora	Nakafuji	Hawaiian Electric Company
Dagmar	Niebur	Drexel University
Anil	Pahwa	Kansas State University
Bill	Parks	US Department of Energy
Thomas	Peterson	National Science Foundation
Roy	Pratt	HP Enterprise Services
Zhihua	Qu	University of Central Florida
Saifur	Rahman	Virginia Tech Advanced Research Institute
Dennis	Ray	University of Wisconsin, Madison
Wanda	Reder	S&C Electric
Langis	Roy	Carleton University
Sumit	Roy	University of Washington
Peter	Sauer	University of Illinois at Urbana/Champaign
T. E. (Ed)	Schlesinger	Carnegie Mellon University
Noel	Schulz	Kansas State University
Tarlochan	Sidhu	University of Western Ontario
Chanan	Singh	Texas A&M University
Mark	Smith	Purdue University
Mike	Soboroff	US Department of Energy
Guru	Subramanyam	University of Dayton
Michael	Sullivan	Pepeco Holdings
George	Thomas	University of Louisiana, Lafayette
Kevin	Tomsovic	University of Tennessee - Knoxville
Robert	Trew	National Science Foundation
R.L.	Tummala	San Diego State University
Barbara	Tyran	Electric Power Research Institute
Suresh	Vadhva	California State University
S. S. (Mani)	Venkata	University of Washington
Vijay	Vittal	Arizona State University
Tim	Vogt	St. Cloud State University
Richard	Voyles	National Science Foundation
David	Wollman	National Institute of Standards & Technology
Jiann-Shiou	Yang	University of Minnesota, Duluth
Muhittin	Yilmaz	Texas A&M University, Kingsville
Nicolas	Younan	Mississippi State University

### **Appendix III: IEEE-PES Power and Energy Engineering Workforce Panel**

Panelists: P. W. Sauer, D. Niebur, W. Reder, D. Ray

This panel presented the possible role of ECE departments in addressing future power engineering workforce issues. The presentations began with a discussion of the opportunities for collaboration between traditional electric power engineers and other ECE disciplines. The emerging smart grid concept has included virtually all other areas of ECE – communications, computing, control, signal processing, nanotechnologies, physical electronics, circuits, electromagnetics, and material science.

With the focus on renewables, electrification of transportation, intelligent metering, customer demand response, and wireless interfaces, applications that require collaboration among multiple ECE disciplines abound. These energy-based technologies are being driven by a growing population and energy density requirements, the cost of energy in terms of pollutants and scarcity of resources, dependence on imported oil, environmental constraints on CO<sub>2</sub> emissions and air quality concerns.

In addition, the need to have a secure electric energy infrastructure and a vibrant investment market have escalated the need for advances in these new technologies on a global scale. The country of Korea has initiated a major initiative to create products that enable the smart grid in homes, business, on the road, and in the electric generation/transmission and distribution arenas. The Koreans have recently signed a memorandum of understanding with the State of Illinois to stimulate collaboration between Korea and the U.S. to leverage resources to create new market opportunities.

Features of this smart grid and its opportunity to create jobs include access to information, decentralized vs. centralized control, interoperability, cyber security, communications, privacy, investment cost, risk, grid stability, reliability, protection, and operating with two-way power flow. The components of a smart grid include automatic controls, information technology, standards, power electronics, computer engineering, marketing, economics, systems theory, energy conversion, public policy, signal processing, transmission and distribution engineering, and engineering physics. This means that ECE curricula need to examine whether the following areas are adequately addressed: direct digital control, power system dynamics and stability, power quality and signal analysis, middleware migration, environmental and policy issues, reliability and risk assessment, economic analysis, energy markets, and new concepts of power system protection. Electric power and energy is a tremendous opportunity for ECE growth. This energy nucleus is surrounded by Information and Communication Technology, Materials, Life Sciences, Production, Transportation, and Nanotechnologies.

A recent US workforce survey (2007 – 2009) of 55 electric and gas utilities, and electric cooperatives totaling about half of all US electric and gas employees indicates that half of all engineers will need to be replaced by 2014. This is based on a current average age of about 50. In addition, the need for faculty to train new graduate students and teach courses in this area is

critical to achieve the needed increase in new engineering talent. For example, university research is critical to the production of new PhD graduates who will become the new faculty at our universities. Therefore, increasing funding for university research is key to replacing the aging faculty.

In response to this projected need, the IEEE Power and Energy Society (PES) has created the Power and Energy Engineering Workforce Collaborative:

<http://www.ieee-pes.org/workforce>

This collaborative has the following five-year goals:

- Double the number of power engineering BS graduates
- Provide \$4M in new undergraduate engineering scholarships per year
- Create 2,000 internships in the US per year
- Hire 80 new power faculty members in the US
- Raise university research funding to \$50M per year
- Create five university centers of excellence to conduct power research and education

A major scholarship program is being developed by the IEEE/PES to make progress toward these goals. In addition, activities to promote student participation at IEEE meetings and K-12 interest are being enhanced. Some resources that can assist departments in this process include the following:

- PES-Careers for U.S. and Canada:  
[www.pes-careers.org](http://www.pes-careers.org)
- 2007 NSF workshop report:  
<http://www.ieee-pes.org/workforce/workforce-collaborative>
- Collaborative Action Plan:  
<http://www.ieee-pes.org/workforce/workforce-collaborative>
- The Center for Energy Workforce Development:  
[www.cewd.org](http://www.cewd.org)
- Power Systems Engineering Research Center (PSERC):  
[www.pserc.org](http://www.pserc.org)
- Coming new gateway for students on PES website

The technologies needed for this growing area include all IEEE societies and all ECE disciplines. ECE department heads have a rare opportunity to capture the interest and enthusiasm of the young students and faculty in the energy area. The interest of students and funding agencies in smart grid technology including the electrification of transportation and sustainable energy sources is growing daily and represents the largest shift in technology focus in recent years.

Given the current market trends, ECE is uniquely positioned to lead energy educational efforts. This represents a significant growth opportunity. Successfully assuming a leadership position will require a strong foundation in power likely realized through investment in applicable curriculum, faculty, research, industry collaboration and student outreach.

# ECEDHA

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