ONR/NSF/DOE-funded Workshop:

Electric Energy Systems Curriculum for Sustainability

Napa, California
February 7-10, 2013
Group Effort

- UMN Colleagues
- Project Advisors and Mentors
- Past and Present Students
- CUSP™ Colleagues
- Workshop Organization

www.CUSP.umn.edu
Sponsors

- Center for Electric Energy
- NSF / NASA/ EPRI
- ONR – Terry Ericsen, Peter Cho
- DOE
Recent Grants:


5. **DOE** Grant “A Nationwide Consortium of Universities, led by the University of Minnesota, to Revitalize Electric Power Engineering Education by State-of-the-Art Laboratories”
Electric Power

Source: DOE
Why the need for Reinvigorating Electric Energy Education?
Mission:

• Develop a Complete Curriculum in Electric Energy Education

• Enable *all* universities to
  - Provide a first-rate education and
  - Graduate students in large numbers
Example – Harnessing Wind Energy

Power Electronics Converters

0 – 690V
10 – 60 Hz

Generator

34.5 kV
60 Hz

0

161 kV

Low-Voltage Ride-Through

Time
Undergraduate Curriculum -

Only 3 Senior Electives

Complementary Courses:
- Analog/Digital Control
- DSPs, FPGAs
- Communication
- Programming Languages
- Policy Issues

Students are Broadly Trained.
Student Enrollments -

![Graph showing student enrollments from 1999 to 2011.]

- PE
- PS
- ED

- 33 students in 1999
- 112 students in 2011
Courses Developed

- Fundamentals-based
- Tightly Coupled
- Use commonality
  - in-depth coverage
  - more topics
- State-of-the-art labs
Power Electronics: First Course

• Switching Power-Pole as a Building Block

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\[ + \quad \quad - \quad V_d \]

\[ i_A(t) \quad e_A(t) \]

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\[ ac \text{ motor} \]
Electric Drives: First Course

- Systems View including PPU and Control
Power Systems: First Course

Software-based Lab
Graduate Courses under Development

1. Graduate Course on Power Electronics (collaborative effort)
2. Graduate Course on Power Systems (collaborative effort)
3. HVDC Transmission Systems (Ani Gole)
4. Electric Machines and Drives: Modeling and Control (Mohan)
5. Power Generation, Operation and Control (Bruce Wollenberg)
6. Designing Electric Machines (Jim Hendershot)
7. Power System Protection (Pratap Mysore)
8. Wind Energy Essentials (collaborative effort)
9. Electricity Markets (Ross Baldick)
10. ?
11. ??
12. ???
Welcome

Welcome to CUSP™, the Consortium of Universities for Sustainable Power. This consortium will include universities that have come together to utilize, collectively evolve and promote the curriculum developed at the University of Minnesota – Twin Cities with the help of funding from various organizations including NSF, ONR (Office of Naval Research), NASA and EPRI.

Available Courses

Join Now!!

Become a member and get access to all the resources. Joining is easy - fill an online request here.

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Each course consists of the following:

1. List of Course Learning Objectives
2. Textbook
3. Video clips for each lecture:
   - approximately 30 such video clips
   - average of 15-minutes long
   a. Captions
   b. PowerPoint Slides
   c. Concept Quizzes
4. In-class discussion problems
5. Hardware Lab + Manual
7. Online Homework Problems using Moodle
8. A Discussion Forum

You are free to use as much of it, or as little of it, and use it in a way that you want it – not necessarily how we use it.
Uniqueness of Our Approach

• **Force Multiplier:**
  – Aimed at faculty to provide all the resources that are needed
  – Teaching the Teachers!

• **Archiving Institutional Knowledge:**
  – Reaching out to best experts in the world

• **Evolving these Courses to keep them Current:**
  – Consortium of 165 Universities
DOE-funded Consortium
“A Nationwide Consortium of Universities to Revitalize Electric Power Engineering”
($4,175,423)

79 Universities

“These 79 schools represented about 25% of all the graduates in electrical engineering in 2008.” – William P. Robbins
Nationwide Dissemination through ONR/NSF Funding

• Over 100 schools are using our course material
Agenda Today

• DOE Consortium – Bill Robbins
• Pedagogy – Ned Mohan

Lunch

• Laboratories
• Poster Session / Reception
Agenda Tomorrow

• Importance of Reform in EES
• Graduate Curriculum

Lunch

– Curriculum Advisory Board (Chair: Denny Branca)
– ECE Dept Heads/Deans (Chair: Dr. Emir Macari)

• Working Group Reports
• Open Discussion
• Dinner + Presentation by Kirk Dewey
Estimated Levelized Cost of New Electricity Generating Technologies in 2016 (2009$/megawatt hour)