Undergraduate Electric Energy Systems Curriculum

- **Is coupling this curriculum to Renewables/Storage, Smart Delivery and Efficient End Use (Green Curriculum) to attract more students to this field, is a good idea?**

  - Great idea to set the hook, but make sure to cover the fundamentals (coal, nuclear, and new transmission lines will be necessary for a long time – not just renewable technologies). Also, renewables are being connected to the existing system, must understand the existing system.
  - Some universities offer a lower-level, intro course in renewable energy and encourage students to take more advanced, technical courses – they explain the value of power engineering courses.
  - Other departments (non-EE) are creating renewable energy courses, competing for the students. We have to include renewable energy and do it early so can keep the students engaged and in EE.
  - Other people said that we should join forces with other departments, rather than compete. Cross-pollination with mechanical engineering for example.

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- **Are the fundamental Courses during first three years adequate basic background?**
  - Statistics is needed as a fundamental course. So are dynamics and controls.
  - Programming and digital courses should be required.
  - Biology and biochemistry should be required.
  - What's included in liberal arts courses? Are technical writing and verbal communications handled there, or do we have to teach those topics (e.g., for ABET)? Do they handle the political aspects of energy systems?

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- **Is it appropriate to have textbooks written specifically to support these courses?**
  - Sure, it's what professors do. It's a natural progression.
  - Notational differences between books / authors are confusing for students. It's hard to mix and match between textbooks.
  - It's difficult to determine what to put in, what to leave out. Every author and instructor struggles with this.

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- **Should these courses be backed-up by modern digitally-controlled hardware labs and simulation labs with state-of-the-art software?**
  - The laboratories at all stages of curriculum are very important. Students aren't coming in with much intuition – we really need laboratories in one way or another.
  - It might be nice to design hardware demos or labs that very specifically relate to renewable energy applications (e.g., emulate a wind turbine operation).
  - Students should be able to model a system in, say, PowerWorld.
  - Students don't have to conduct fundamental programming in this course, but use software to understand concepts.
  - Power systems has problems that often *have* to be simulated.
  - Like the idea of taking students to see real-world examples, such as the substation trip or a visit to an industrial site. Students love it too.
  - Labs take a lot of time, so can only do so much.
  - Like the use of freeware, so students can put it on their own computers

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- **Should these courses seamlessly lead to graduate courses and be a springboard for PhD research?**
  - A bit concerned that the proposed grad courses will still be a broad brush. More detailed than the undergrad courses, but perhaps not specific enough. Does this serve the students.
  - About 95% of students in undergrad courses are not going to graduate school – they're going into industry, and we need to prepare them to be good engineers. Once they get into grad school, you need to make those courses much more mathematical and theoretical.
  - If undergrad students are planning on grad school, encourage them to take more theoretical, fundamentals-based courses in undergrad.

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- **Is it important, in parallel, to meet the needs of Practicing Engineers by means of Distance Education (online courses similar to the in-class undergraduate courses)?**
  - Practicing engineers certainly need ongoing education. Don't know if they need the same curriculum as the undergrad courses or if it should be on-line or not, but something is needed for these people.
  - This industry is going through a massive amount of change, and people currently in the workforce need to be prepared. A 3-day course won't cut it, although there is a place for intensive short courses also.
  - Open courseware is available for people who put in the effort. Continuing education implies that the student wants instructor support and/or certification.
  - There are many continuing education options out there, it's up to an individual institution to decide whether and how much they want to offer.
  - Wonder about a 1-year master's or certificate (post-bachelor's) in renewable energy that would be credible and valuable for the student.

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- **Does this curriculum serve the needs of Utilities and other Electric Energy related Companies and enhance relationship between Universities and local Utilities and Industry?**
  - Some companies really don't care about renewables, don't care whether this is covered in the curriculum.
  - Engaging industries with curriculum design does enhance relationships.
  - Some industries expect to do a lot of training after hiring the student – they expect students to understand the basics and have fundamental design and problem solving skills.
  - Other industries are essentially asking for detailed training (rather than development of problem solving skills), wanting to reduce their own training budget.
  - We don't know where our students will end up – shouldn't train students to the specific needs of a local industry.
  - Listen to what the businesses request but filter it with your own understanding of student needs.
  - We are creating engineers for the future, not for today.
  - Consider what product you want to produce, and design the curriculum around that.