

PA 510 Smart Grid and Sustainable Communities: New Challenges. New Opportunities Winter Term 2011

Winter Term, 2011
Tuesdays 6:40-9:40 PM

Course website: <http://www.pdx.edu/eli/smartgrid>

Blackboard log in (for registered course participants): <http://bb.pdx.edu>, click on course title

Urban Center 303
506 SW Mill, 3rd floor
Portland State University

Faculty and Staff

- **Jeff Hammarlund**, Adjunct Professor and Senior Research Fellow, Mark Hatfield School of Government, PSU, and President, Northwest Energy and Environmental Strategies, hammarj@pdx.edu, 503-249-0240
- **Conrad Eustis**, Adjunct Professor, PSU's Executive Leadership Institute, and Director, Retail Technology Development, Portland General Electric, evening (preferred), c.eustis@gmail.com, 503-229-0621; day 503-464-7016,
- **James Mater**, Director, Co-Founder, and Smart Grid Interoperability Evangelist, QualityLogic, and Founding Board Member, Smart Grid Oregon, jmater@qualitylogic.com, 503-780-9796
- **Ken Nichols**, Energy Consultant, and former Director, Risk Management, TransCanada US, kwnichols@comcast.net, 503-803-0832
- Plus fabulous guest speakers.

Scope and Approach

This course series will examine a set of emerging concepts, technologies, applications, and business models, and the complex trade-off decisions related to transforming the nation's century-old, centralized power grid into a more climate, sustainable-energy, and consumer-friendly "Smart Grid."

Visionaries believe that this emerging "internet for energy" will enable individuals and businesses alike to participate in both the quality and quantity of energy they use to live and work, generating and storing energy from multiple sources, and managing the amount and timing of their use of that energy. The Smart Grid will integrate generation from both directions – home/business and central station plant – and move it as needed to meet load while incorporating solar panels, wind farms, fuel cells, plug-in hybrid electric vehicles, and other energy sources. This intelligent electric network will manage load shape and will achieve greater utilization than today. Its full value will be achieved when it is combined with an emerging participatory network model that enables consumers to actively manage their electricity consumption and sell back to the grid the surplus power they generate.

The concepts, technologies, and models addressed by this course hold the promise of a significant new paradigm for the generation, use and delivery of electric power that is more efficient, sustainable, robust, flexible, and environmentally sound, and that encourages a much higher level of consumer participation and control. Converting to the Smart Grid also opens up additional opportunities to make other infrastructures (including waste water, transportation, telecommunications, and natural gas) greener and more sustainable during the Smart Grid conversion process.

This will be the third year PSU has offered an interdisciplinary graduate level course on the smart grid. We have recruited a first-rate faculty with a wide range of backgrounds and are recruiting additional guest speakers. so we can continue to offer the cross-disciplinary approach that allows students to both deepen their specific areas of expertise with specialized faculty and work on projects in interdisciplinary teams with other graduate students and mid-career professionals from diverse backgrounds.

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The Smart Grid world continues to experience extensive and rapid change across key public policy, business, and technology dimensions. So we have decided to update our course, now called **The Smart Grid and Sustainable Communities: New Challenges, New Opportunities**.

This year's course will incorporate important developments since last spring. We will give particular attention to:

- The growth in understanding of the various ways the Smart Grid could support the development and integration of wind, solar and other intermittent energy resources expected to play a key role in our region's energy future;
- On-going efforts to design and implement the Pacific Northwest Smart Grid Demonstration Project, the largest of the federally-funded demonstration projects that will test Smart Grid technologies and functions across five Pacific Northwest states;
- Developments that are emerging as a result of the decision by the Oregon Public Utilities Commission to examine if and how utilities under its jurisdiction should develop "smart grid transition plans and related issues; and
- The implications of concerns raised by some consumer organizations such as the accuracy of smart meters, the impact of dynamic pricing on low-income and other vulnerable customer groups, access to and control of customer information, security, and strategies to spread the risk and costs of Smart Grid installations among utility ratepayers and shareholders.

The course serves two important audiences:

- Graduate students in engineering, information technology, public administration/policy, urban planning, business, economics, and related fields, and
- Current and emerging leaders from the utility, information technology, public administration, urban, transportation and water resource planning, business, and other fields.

It will continue to use the well-received, cross-disciplinary approach that allows students to deepen their specific areas of expertise with specialized faculty and work on projects in interdisciplinary teams with other graduate students and mid-career professionals from diverse backgrounds. To accommodate both newcomers and alumni from previous courses, and to ensure a "cutting edge" research seminar setting, course enrollment will be limited to 30 students.

Follow up Smart Grid courses – for the spring, and possibly the summer terms – are currently "under construction" and will likely involve the participation and guidance of additional faculty. However, our intent is to apply what students will have learned winter term to local "real world" case studies, and especially explore how the Smart Grid supports and enhances other aspects of sustainable development.

The course objectives for the Winter term sessions are to develop:

- A basic historical, institutional, and technical understanding of the current electric transmission and distribution grid and other power system operation fundamentals to establish a context for understanding what features of the power system and grid might be transformed under alternative Smart Grid scenarios.
- An understanding of the wide range of benefits and liabilities associated with the Smart Grid concept being advanced by various parties seeking to influence the public policy agenda setting-process.
- An understanding of the tools, techniques, and critical thinking concepts used in making trade-offs in the Smart Grid environment.
- An understanding of the role that information technology will play in advancing the Smart Grid.
- An appreciation for the range of emerging Smart Grid business opportunities, challenges, policy debates, regulatory proceedings, and models, with an emphasis on these activities in Oregon in particular and the Northwest more generally.
- An understanding of the challenges of introducing new technologies associated with the Smart Grid from the perspectives of entrepreneurs and venture capitalists, vendors, utilities, regulators, – and consumer advocates.
- An appreciation of the barriers to and challenges of communicating and collaborating in interdisciplinary and multi-disciplinary small group "learning communities" and in larger group settings, and an appreciation of successful strategies to overcome these barriers and challenges.
- An appreciation for the value of case studies as a tool to illustrate the benefits, challenges, and trade-offs

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of implementing Smart Grid initiatives.

Guest Speakers Winter Term

- **Joe Barra**, Director of Consumer Energy Resources, Portland General Electric
- **Diane Broad**, Director and Senior Consultant, Ecofys US
- **Ken Dragoon**, Senior Resource Analyst, Northwest Power and Conservation Council
- **Steve Hawke**, Senior Vice President, Customer Service, Transmission and Distribution, Portland General Electric
- **Roy Hemmingway**, Energy Consultant, Smart Grid Oregon Board Member, and former Chair, Oregon Public Utilities Commission
- **Chris Hickman**, President, Innovari Energy
- **Bob Jenks**, Executive Director, Citizens' Utility Board of Oregon
- **Rick Kriss**, Founder and Managing Director, KLATU Networks
- **Cheryl Linder**, Global Offering Leader, Energy and Utilities Industry, IBM Global Business Services
- **Mark Osborn**, Distributed Resources Manager, Portland General Electric
- **Robert Procter**, Senior Economist, Electric Rates & Planning, Oregon Public Utilities Commission and Lead Staff on UM 1460
- **Scott Shull**, Strategic Planner, EcoTechnology Innovations Program, and Director, Smarter Commercial Buildings, Intel Corp
- **Linda Rankin**, Senior Engineer, QualityLogic, and Former Course Faculty Member
- **Lauren Shapton**, Manager, Mass Market Programs, Portland General Electric
- **Jason Slami-Klotz**, Senior Policy Advisor, Northwest Energy Efficiency Alliance
- **Robert Topping**, Director of Industry Partnerships, Chemeketa Community College

Syllabus Winter Term

Week 1 (January 11) Introduction to the Topic and Class Participants

Participant registration, introductions, and expectations for the class

Agenda:

6:40 pm	Welcome
6:50 pm	Student introductions
7:10 pm	Faculty introductions
7:25 pm	Class logistics (Jeff and Ken)
7:40 pm	Break
7:50 pm	An Introduction to the Smart Grid (Jeff)
8:25 pm	The Smart Grid – A Remake After the First 120 Years (Conrad)
9:00 pm	Course introduction (Jeff)
9:15 pm	First assignment, reminders, Q and A
9:40 pm	Adjourn

Reading Assignment for Week 1:

Priority Reading:

Web link:

- Subscribe to free on-line *Smart Grid Newsletter* at <http://www.smartgridnews.com/artman/publish/index.html> and review updates throughout course.
- US DOE, *Enhancing the Smart Grid: Integrating Clean Distributed and Renewable Generation* http://www.oe.energy.gov/DocumentsandMedia/RDSI_fact_sheet-090209.pdf

Posted on Blackboard:

- US DOE, *Smart Grid Vision Statement (A Vision for the Smart Grid and What Is the Smart Grid?)*
- US DOE, *Enhancing the Smart Grid: Integrating Clean Distributed and Renewable Generation*
- Friedman-*The Energy Internet: Where IT Meets ET*

Week 2 (January 18)

- **Grid 101**
- **Formation of Small Group “Learning Communities” and Receive Group Assignment 1 (Data Analysis)**
- **Wiring the Smart Grid into History: The Historical Precedents of the Smart Grid, Part 1**

Class Objectives

1. Establish an appreciation for the already extensive and still blossoming Smart Grid literature.
2. Create a clear understanding between the technical differences between energy and power.
3. Develop a basic understanding of the current electric grid and power system that may be incrementally altered or transformed over time by the emerging Smart Grid.
4. Learn one conceptual framework for supporting the launching the Smart Grid or other “clean technology” based on a systems thinking approach.
5. Begin to develop a basic understanding of the relevant historical development of the electric industry, particularly the institutional deals and arrangements established over time, that Smart Grid proponents must address if they are to be successful in advancing the Smart Grid.
6. Meet, exchange contact information, and begin working with your Small Group Learning Community.

Agenda:

6:40 pm Class announcements

6:50 pm Grid 101: An Introduction to The Current Grid and Power System (*Conrad*)

8:05 pm Break

8:15 pm Tutorial on Blackboard and Google Groups (*Ken*)

8:45 pm Break into three small group “Learning Communities”, receive and begin preparations for Group Assignment 1 (Data Analysis)

9:15 pm A Framework for Jump Starting the Smart Grid and the Smart Grid and the Clean Tech Economy (*Jeff*)

9:30 pm Wiring the Smart Grid into History: The Historical Precedents of the Smart Grid, Part 1 (*Jeff*)

Reading Assignment for Week 2:

Priority Reading:

Course text:

- Fox-Penner, *Smart Power: Climate Change, the Smart Grid, and the Future of Electric Utilities*, chapters 1-7 (available at PSU bookstore textbooks under PA 510)
Posted on Blackboard:
- Litos Communications for US DOE, *The Smart Grid: An Introduction*
http://www.oe.energy.gov/DocumentsandMedia/DOE_SG_Book_Single_Pages.pdf (and on Blackboard)
- Hammarlund, *Oregon’s Role as an Energy Innovator: A Historical Perspective*
- Johnson and Suskewicz, *How to Jump-Start the Clean Tech Economy*
- NETL Modern Grid Initiative, *A Vision for the Modern Grid and Modern Grid Benefits*
- NETL Modern Grid Initiative, *Modern Grid Benefits*

Web link:

- Ebert, *Customers Right to Be Wary of Smart Grid* <http://www.nwenergy.org/news/the-transformer-january-4-2011/>

Additional Recommended Reading:

Posted on Blackboard:

- Johnson et al, *Reinventing Your Business Model*
- Hammarlund, *Draft Long Version of Oregon’s Role as an Energy Innovator*
- If the electricity industry is completely new to you, we suggest you review Energy Quest, *The Energy Story*, <http://www.energyquest.ca.gov/story/index.html>

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- If you are unfamiliar with the fundamental electricity concepts, we suggest you review Energy Information Administration, *Electricity Explained* http://www.eia.doe.gov/basics/electricity_basics.html and/or *Science of Electricity* http://tonto.eia.doe.gov/kids/energy.cfm?page=electricity_science-basics

Week 3 (January 24)

- **A Smart Grid Vision from One Local Utility Manager**
- **Wiring the Smart Grid into History: The Historical Precedents of the Smart Grid, Part 2**
- **Existing Utility Governance and Regulatory Models/ How Utilities Operate Today, Part 1**

Class Objectives:

1. Gain an appreciation of the Smart Grid vision of Portland General Electric, a local mid-sized investor-owned utility, directly from a senior utility manager.
2. Be able to summarize the key historical developments of the electric industry, particularly the institutional deals and arrangements established over time, that Smart Grid proponents must address if they are to be successful in advancing the Smart Grid (continued from Week 2).
3. Know the basic types of electric utilities in the US; for each type of utility, be able to describe the business model, governance structure, and how the utility is regulated and managed.
4. Understand the main operating divisions of a typical electric utility and the status of automated transactions among them.

Agenda:

6:40 pm Class announcements

6:50 pm A Smart Grid Vision from One Local Utility Manager (*Steve Hawke, Senior Vice President, Customer Service, Transmission and Distribution, Portland General Electric*)

7:50 pm Break

8:00 pm Wiring the Smart Grid into History: The Historical Precedents of the Smart Grid, Part 2 (*Jeff*)

8:50 pm Existing Governance and Regulatory Models (*Jeff*)

9:00 pm How Utilities Operate Today, Part 1 (*Conrad*)

9:40 pm Adjourn

Reading Assignment for Week 3:

Priority Reading:

- Portland General Electric, *PGE Energy Strategy*, http://www.portlandgeneral.com/our_company/news_issues/current_issues/energy_strategy/default.aspx and *Oregon's Energy Future: Working towards a Sustainable, Diverse, and Affordable Supply*, http://www.portlandgeneral.com/our_company/news_issues/current_issues/oregons_energy_future.aspx
- Portland General Electric, *Smart Meters*, http://www.portlandgeneral.com/our_company/news_issues/current_issues/smart_meters.aspx and *Smart Meters Frequently Asked Questions*, http://www.portlandgeneral.com/our_company/news_issues/current_issues/smart_meters_faq.aspx
- Portland General Electric, *Dispatchable Standby Generation* http://www.portlandgeneral.com/business/medium_large/products_services/dispatchable_standby_generation.aspx and *FAQ*, http://www.portlandgeneral.com/business/medium_large/products_services/faq.aspx
- Portland General Electric, *Electric Vehicles*, http://www.portlandgeneral.com/community_environment/initiatives/electric_vehicles/default.aspx

Additional Recommended Reading:

- Portland General Electric, *PSU and PGE Form Strategic Sustainable Alliance*, http://www.portlandgeneral.com/our_company/news_issues/news/03_30_2010_psu_and_pge_form_strategic_su.aspx

Week 4 (January 31)

- **How Utilities Operate Today, Part 2**
- **The Smart Grid Meets Standards, Interoperability and Security**
- **Presentations on Group Assignment 1 (Data Analysis)**
- **Presentations on Individual Assignment 2**
- **Receive Group Assignment 2 (Smart Grid Opportunities)**

Class Objectives:

1. Gain an appreciation for the challenges of achieving “plug and play” interoperability between smart grid components and applications,
2. Be able to summarize one of the three case studies and comment on the key lessons learned.
3. Be able to identify the key organizations working on smart grid standards and the status of achieving a national consensus on the standards,
4. Identify the critical smart grid components that absolutely must be made invulnerable to cyber-security attacks, and who is working on the cyber-security solutions.
5. Gain a better appreciation of smart grid opportunities in the residential, commercial, and industrial sectors through group presentations.

Agenda:

- 6:40 pm Class announcements
- 6:50 pm How Utilities Operate Today, Part 2 (*Conrad*)
- 7:05 pm Three case studies in Smart Grid Implementations: Realty and Challenges of Interoperability, Security and IT in the Smart Grid (*Linda Rankin, Senior Engineer, QualityLogic*)
- 8:05 pm Break
- 8:15 pm The Smart Grid Meets Security (*Linda*)
- 8:35 pm Small Group Presentations on Small Group Assignment 1 (EIA data; each group gets 7 minutes for presentation and 3 minutes for Q and A; remaining 10 minutes for class discussion)
- 9:15 pm Selected Presentations on Individual Assignment 2 (Literature Review/Recommended Readings: Faculty will ask two students in advance to offer short presentations on their recommended readings; they will be asked to introduce 1-2 of their readings and discuss why others should read them)
- 9:25 pm Receive and discuss Group Assignment 2 (Smart Grid Opportunities). What is an Opportunity in this Context?
- 9:40 pm Adjourn

Description:

Our guest speaker, Linda Rankin, is a former PSU Smart Grid course faculty member. Her background includes 25 years of increasing technical responsibility for design of microprocessor architectures. Currently, she is a key contributor to QualityLogic’s role in the PNW Regional Smart Grid Demonstration Project. She is pioneering and leading the evaluation of developing smart grid standards for inclusion in the project and developing the interoperability testing strategy and tools for testing of the Transactive Control System, the cornerstone technical contribution from the project.

Linda has studied three different smart grid implementations and will overview and analyze them in terms of the interoperability issues they illuminate. This talk will make the Smart Grid concrete by showing how today’s smart grid technology can actually be deployed but also has major interoperability standards challenges.

She will then point out how and where cyber-security matters in the smart grid and where it doesn’t. There is a lot of media and political hype and miss-information about smart grid cyber-security and Linda will help us understand what is real and what isn’t

Reading Assignment for Week 4:

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Priority Reading:

- National Institute of Standards and Technology, *NIST and the Smart Grid*, <http://www.nist.gov/smartgrid/nistandsmartgrid.cfm>
- Testimony before Congress by George Arnold, National Coordinator for Smart Grid Interoperability, NIST, July 1, 2010, <http://www.nist.gov/director/ocla/testimony/upload/DOC-NIST-testimony-on-Smart-Grid-FINAL-with-bio.pdf>
- July 1, 2010, Hearing before Congress, other testimony in addition to George Arnold at http://science.house.gov/publications/hearings_markups_details.aspx?NewsID=2917
- National Institute of Standards and Technology (NIST), Smart Grid Cyber Security Strategy and Requirements, Draft NISTR 7628, Introduction, http://www.nist.gov/smartgrid/upload/nistir-7628_total.pdf
- Gussin, Smart Grid: *Digging the Foundations*, <http://solveclimatenews.com/news/20090706/smart-grid-digging-foundations>

Additional Recommended Reading:

- Ramie, *Designing for the Smart Grid*, http://electronicdesign.com/article/power/designing_for_the_smart_grid.aspx
- Shin, *Overcoming Obstacles to a Smart Grid Future*, <http://solveclimatenews.com/news/20090504/overcoming-obstacles-smart-grid-future>
- National Institute of Standards and Technology (NIST), *NIST Framework and Roadmap for Smart Grid Interoperability Standards, Release 1.0*, chapters 1 and 3, http://collaborate.nist.gov/twiki-sggrid/pub/SmartGrid/IKBFramework/NISTFrameworkAndRoadmapForSmartGridInteroperability_Release1final.pdf
- Westervelt, *Four Months In, Cisco Moves to Dominate Smart Grid*, Daily Climate News and Analysis
- Carson, *Getting Smart: First Things First*, Intelligent Utility <http://www.intelligentutility.com/article/10/01/getting-smart-first-things-first> and *A Modest Proposal* <http://www.intelligentutility.com/article/10/01/modest-proposal>
- Leeds, Green Tech Media, *The Smart Grid in 2010: Market Segments, Applications and Industry Players*, <http://www.gtmresearch.com/report/smart-grid-in-2010>

Week 5 (February 7)

- **The Smart Grid Meets Sustainability, Balancing, and Trade-Offs Among Alternative Objectives**
- **Receive Individual Assignment 3 (Tradeoffs among Alternative Objectives)**
- **Achieving Interoperable Technologies**
- **Smart Pricing**

Class Objectives:

1. Understand the basic concepts used in sustainability evaluation and balancing, including the three pillars of sustainability and the triple bottom line.
2. Understand of the concept of power plant efficiency and the implications for CO2 emission impacts.
3. Appreciate the differences among main power plant variations.
4. Understand the classical economic evaluation of power plant worth for energy and capacity (power).
5. Understand the concept of “levelized cost of energy” and how this tool can be used to evaluate and compare “traditional” (such as coal or hydro) and “new” (such as demand response or wind generation) energy resource options.
6. Deepen your understanding of the challenges of achieving “plug and play” interoperability between smart grid components and applications.

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7. Understand the various electric commodities needed to run the power system, how these are priced in the wholesale market, and the process of using these price signals when pricing retail products and Smart Grid programs.

Agenda:

6:40 pm Class Announcements

6:50 pm Sustainability, Balancing, and Trade-Offs Among Alternative Objectives (*Conrad*)

8:00 pm Receive and Discuss Individual Assignment 3 (Trade-Offs Among Alternative Objectives; Due February 21) (*Conrad*)

8:10 pm Break

8:20 pm Achieving Interoperable Technologies in the Smart Grid (*James Mater, Co-Founder and Director, Quality Logic, Inc., Founding Member, Smart Grid Oregon, Member SGIP Test and Certification Committee*)

9:00 pm Smart Grid and Smart Pricing (*Ken Nichols*)

9:40 pm Adjourn

Description:

Faculty member James Mater has been deeply involved in Smart Grid interoperability standardization since early 2008. He has been recognized by GWAC and SGIP for his contributions in developing the Smart Grid Interoperability Maturity Model and leading the SGIP Test and Certification efforts to develop standards for standard's certification programs. He is also QualityLogic's representative to the Pacific Northwest Smart Grid Demonstration Project Review Board and is co-leading the work group in standards for the Project. James will provide a high level overview of the US efforts to develop smart grid standards, including the key organizations involved and the relationship between them.

Ken Nichols, energy industry veteran, has experience trading wholesale power and natural gas, and managing the risk around this activity. He managed a trading company from 1997 to 2001 that worked in California and West Coast markets, and recently was Director of Risk Management for gas pipeline company TransCanada. Mr. Nichols will discuss some of the changes in wholesale power markets and contrast markets in the east, California, and the Pacific Northwest. He will also cover how wholesale pricing can make its way to consumers in a way that allows more energy programs and technologies to participate in the operation of a very complex machine, the grid.

Reading Assignment for Week 5:

Priority Reading:

Course text:

- Fox-Penner, *Smart Power*, chapters 4, 8-9, and Appendix B

Web links:

- Wikipedia, *Triple Bottom Line*, http://en.wikipedia.org/wiki/Triple_bottom_line
- Toffel, *The Encyclopedia of Earth, Sustainability*, (offers summaries of 5 alternative sustainability frameworks), <http://www.eoearth.org/article/Sustainability>
- Wikipedia, Cost of Electricity by Source, http://en.wikipedia.org/wiki/Levelized_cost#Calculations (focus especially on section of levelised energy cost)
- Zero Waste Alliance, *Sustainability Frameworks* (provides summaries of and links to 10 alternative sustainability frameworks), <http://www.zerowaste.org/lrc/sustain.htm>
- "Standardization of a Hierarchical Transactive Control System" PNNL White Paper, Hammerstrom, Oliver, Melton, Ambrosio. www.gridwiseac.org/pdfs/forum_papers09/don-business.pdf

Blackboard:

- Hammarlund and Ozawa, *City Life: Sustainable Portland*
- Lesh, *Planning for the Future*

Additional Recommended Reading:

Web links:

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- Hammerstrom et al, *Pacific Northwest GridWise Testbed Demonstration Projects, Part I. Olympic Peninsula Project (executive summary)*,
http://gridwise.pnl.gov/docs/op_project_final_report_pnnl17167.pdf
- Ellis, *Dynamic Pricing, Fairness, and Consumer Advocacy*,
http://www.energypulse.net/centers/article/article_display.cfm?a_id=2286

Blackboard:

- Hammarlund and Ozawa, *The Sustainability Challenge: The Experience of One American City*
- Hammer, *Development that Adds Up-Accounting for the Social Bottom Line of Triple Bottom Line Investment-A Review of Current Practice and Application to the Portland Metropolitan Region*
- McDonald, *The Interoperability Challenge for Smart Grid Development-An Update* (from www.electricitypolicy.com)
- Government Accountability Office, *Electricity Grid Modernization: Progress Being Made on Cybersecurity Guidelines, but Key Challenges Remain to be Addressed*, January 2011

Week 6 (February 14) How the Smart Grid Might Support Significant Sustainability Benefits: Opportunities and Challenges

Class Objectives:

1. Have a basic understanding of the wide range of benefits that advocates believe the Smart Grid will be able to support.
2. Have a deeper understanding of the sustainability-related benefits that advocates believe the Smart Grid will be able to support.
3. Have an even deeper understanding of selected sustainability-related technologies, business models, and benefits that advocates believe the Smart Grid will be able to support. These technologies and benefits involve and include: information-based and customer-driven energy efficiency, demand response, demand-side storage, the more successful back-up and integration of wind and other intermittent renewable resources, the more successful use of distributed generation resources, and the conversation electric vehicles into electricity storage and load management resources.
4. Understand the “real world” opportunities and challenges that have emerged so far with the research and demonstration, and pilot testing selected sustainability-related technologies and benefits.

Agenda:

6:40-6:50 pm Class Announcements

6:50-7:20 pm An Introduction to How the Smart Grid Can Support Sustainable Benefits: Opportunities and Challenges (*Conrad*)

7:20-8:00 pm How the Smart Grid Can Support Energy Efficiency and Demand Response-Opportunities and Challenges (*Jason Slami-Klotz, Senior Policy Advisor, Northwest Energy Efficiency Alliance*)

8:00-8:10 pm Break

8:10-8:50 pm How the Smart Grid Can Support Integration of Wind and Other Intermittent Resources - Opportunities and Challenges (*Ken Dragoon, Senior Resource Analyst, Northwest Power and Conservation Council*)

8:50-9:30 pm How the Smart Grid Can Support Demand-Side Storage - Opportunities and Challenges (*Diane Broad, Director and Senior Consultant, Ecofys US*)

9:30-9:40 pm Additional Class Discussion and Q and A

Note: Mark Osborn, PGE Distributed Resources Manager, and Joe Barra, PGE Director of Consumer Energy Resources, will discuss two additional technologies and benefits (distributed generation and electric vehicles) during our field trip.

Reading Assignment for Week 6:

Priority Reading:

Course text:

- Fox-Penner, *Smart Power*, chapters, 5, 9,10, and Appendix A

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Blackboard: As a reminder of the primary Smart Grid benefits, review the following posted under readings for weeks 1 and 2:

- DOE, *Smart Grid Vision Statement (A Vision for the Smart Grid and What Is the Smart Grid?)*
- NETL Modern Grid Initiative, *A Vision for the Modern Grid and Modern Grid Benefits*
- NETL Modern Grid Initiative, *Modern Grid Benefits*
- Hammarlund, *Introduction to the Smart Grid* (PowerPoint slides 13-25)

Also see these new postings for Week 6:

- Broad, *Smart End-Use Energy Storage and Integration of Renewable Energy*.
- Sloni Ktutz, *FERC Policy on Demand Response and Order 719*.
- Dragoon, *Valuing Wind Generation on Integrated Power Systems* (pre-publication edition), Sections 12.3-12.5, chapter 14, pp. 203-206, Chapter 14, pp. 203-206 and Section 14.2 pp. 207-10

Web links:

- Eustis, Host and Hammerstrom, *Appliance Interface for Grid Responses*, http://www.gridwiseac.org/pdfs/forum_papers/103_106_paper_final.pdf
- Northwest Power and Conservation Council, *Sixth Northwest Conservation and Power Plan, Appendix K The Smart Grid*, http://www.nwcouncil.org/energy/powerplan/6/final/SixthPowerPlan_Appendix_K.pdf
- Sedano, Levy and Goldman, *Demand Response with and without Smart Grid*, NARUC Winter Meeting 2010, http://www.narucmeetings.org/Presentations/6_DR-SG%201%20LevyNARUC-WinterMeet-DR-Concepts-Feb2010-Final-020810.pdf
- Key and Wakefield, *Smart Grid Demonstrations Focus on Integrating Distributed Energy Resources*, <http://www.smartgridnews.com/artman/uploads/1/epr SmartGridDemo.pdf>
- Leeds, Green Tech Media, *The Smart Grid in 2010: Market Segments, Applications and Industry Players*, Chapters 1 and 2, <http://www.gtmresearch.com/report/smart-grid-in-2010>.
- *Smart Grid News*, *The ABC's of EV's*, http://www.smartgridnews.com/artman/publish/End_Use_Electric_Transportation/SPECIAL-ISSUE-The-ABCDs-of-EVs-1815.html
- *Smart Grid News*, *End Use: Energy Efficiency*, http://www.smartgridnews.com/artman/publish/End_Use_Efficiency/
- *Smart Grid News*, *Demand Response*, http://www.smartgridnews.com/artman/publish/Technologies_Demand_Response/
- *Smart Grid News*, *Storage*, http://www.smartgridnews.com/artman/publish/Technologies_Storage/

Additional Recommended Reading:

- Sickinger, *The Oregonian*. *FERC Commissioner John Wellinghoff Says Northwest Utilities May Need to Catch Up with National Trends* (Blackboard)
- Lee and Hawiger, *Application before California PUC for Rehearing of Decision 10-12-04*
- California Energy Commission, *Community Choice Aggregation Project*, http://www.energy.ca.gov/pier/project_reports/CEC-500-2008-091.html
- Global Data's *Vehicle to Grid Market Analysis* <http://www.prlog.org/11163723-vehicle-to-grid-v2g-global-market-analysis-and-forecasts-to-2020.html> and Jesse Berst's critique at http://www.smartgridnews.com/artman/publish/Technologies_DG_Renewables/Smart-grid-connected-EVs-to-become-booming-market-claims-new-report-3395.htm
- *Smart Grid News*, *FERC Unveils Proposed Rule Reforms for Integrating Renewable Energy* http://www.smartgridnews.com/artman/publish/Technologies_DG_Renewables/FERC-unveils-proposed-rule-reforms-for-integrating-renewable-energy-3299.html
- FERC, *National Assessment and Action Plan on Demand Response*, <http://www.ferc.gov/industries/electric/indus-act/demand-response/dr-potential.asp>
- Smith, *Scaling Demand Response through Interoperability in Commercial Buildings* http://www.smartgridnews.com/artman/uploads/1/smith_gi10.pdf

Week 7 (February 21)

- **The Smart Grid Meets State Regulation and Stakeholder Politics**
- **Small Group Presentations of Assignment 2 (Opportunities)**

- **Hand in Individual Assignment 3 (Trade-Offs Among Alternative Objectives)**
- **Receive Group Assignment 3 (Establishing Evaluation Criteria)**

Class Objectives:

1. Understand the “patchwork quilt” of oversight roles, responsibilities, areas of authority, and limits to that authority in regards to federal and state regulators, local jurisdictions, and other stakeholders interested in influencing the development of smart grid policy and programs in Oregon.
2. Understand the differences and distinctions between federal and state oversight responsibilities.
3. Understand what smart grid policy issues are and are not within the jurisdiction of the Oregon Public Utilities Commission (OPUC).
4. Understand the primary roles and responsibilities of OPUC staff, commissioners, and Administrative Law Judge.
5. Understand the major types of proceedings taken by the OPUC.
6. Understand the key issues and primary participants involved UM 1460, the current investigation into smart grid planning activities among investor-owned utilities serving customers in Oregon.
7. Gain a better appreciation of smart grid opportunities in the residential, commercial, and industrial sectors through group presentations.

Agenda:

6:40 pm Class Announcements

6:50 pm Panel Presentation: The Smart Grid Meets State Regulation and Stakeholder Politics (*Roy Hemmingway, Energy Consultant, Smart Grid Oregon Board Member, and former Chair, Oregon Public Utilities Commission, and Robert Procter, Senior Economist, Electric Rates & Planning, Oregon Public Utilities Commission and Lead Staff on UM 1460*)

8:00 pm Break

8:10 pm Continuation of Panel Presentation

8:30 pm Q and A and Class Discussion

8:45 pm Group Presentation – Opportunities Assignment

(One group will be selected to present their opportunities for 25 minutes. The other two groups will receive 5 minutes to offer different perspectives on the same opportunities or discuss entirely different ones. The next 10 minutes will be for Q&A and discussion. Each group’s short papers and presentation slides will be posted on Blackboard for the entire class to examine.)

9:30 pm Receive and Discuss Group Assignment 3 (Criteria for Evaluating Smart Grid Plans). Due March 14.

9:40 pm Adjourn

Note: Individual Assignment 3 due February 21 but no in-class presentations are scheduled.

Reading Assignment for Week 7:

Priority Reading:

Class text:

- Fox-Penner, *Smart Power*, chapter 5.

Web links:

- Jung, Nichols, and Rankin, *Rethinking Regulation-Five Challenges to Aligning the Smart Grid and Utility Regulation*, Smart Grid Oregon, <http://www.smartgridoregon.org/Resources/Documents/Rethinking%20Regulation%20V6A%20011611.pdf>
- Procter, *Staff Closing Comments on UM 1460, An Investigation into Smart Grid Objectives and Action Items*, <http://edocs.puc.state.or.us/efdocs/HAC/um1460hac16915.pdf>
- Procter, *Staff Opening Comments on UM 1460, An Investigation into Smart Grid Objectives and Action Items*, see especially Attachment Staff Proposed Guidelines for Utility Smart Grid Plan (SGP) (“Strawman”), <http://edocs.puc.state.or.us/efdocs/HAC/um1460hac84748.pdf>
- Brown and Salter, *Smart Grid Issues in State Law and Regulation*, September, 2010, <http://www.galvinpower.org/smart-grid-issues-state-law-regulation-white-paper>

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- Schwartz, Regulatory Assistance Project, *Smart Policies Before Smart Grids: How State Regulators Can Steer Investments Toward Customer-Side Solutions*, August, 2010, http://raponline.org/docs/RAP_Schwartz_SmartGrid_ACEEE_paper_2010_08_23.pdf
- Moskowitz and Schwartz, Regulatory Assistance Project, *Smart Grid or Smart Policies-Which Comes First?* July, 2009, http://www.raponline.org/docs/RAP_IssuesletterSmartGridPolicy_2009_07.pdf
- Synapse Energy Economics, *Prudence and Used and Useful Concepts* http://www.synapse-energy.com/expertise/cap_prudence.shtml

Additional Recommended Reading:

Web links:

- Visit the Oregon Public Utilities website for UM 1460, <http://apps.puc.state.or.us/edockets/docket.asp?DocketID=15928> and view the comments of at least three intervening parties such as Smart Grid Oregon, Portland General Electric, and Citizens Utility Board of Oregon (CUB). It will probably be most helpful to focus on the closing comments of these parties but you may find some of the opening comments interesting as well. Your objective at this point should be to get a sense of the basic positions of at least these three parties; you are welcome to view the comments of other parties as well.
- Cowert, *Financing the Smart Grid: Costs, Rates, and Public Policy*, September, 2010, http://www.raponline.org/docs/RAP_Cowert_FinancingtheSmartGridIEAMadrid_2010_09_28.pdf
- Schwartz, Regulatory Assistance Project, *State Perspectives on Smart Grid*, August, 2010, http://www.raponline.org/docs/RAP_Schwartz_SmartGridLearningNetwork_2010_10_21.pdf
- Ferry, *Restructuring a Green Grid-Legal Challenges to Accommodate New Renewable Energy Infrastructure, Environmental Law* (Pre-publication symposium draft), <http://www.lclark.edu/livewhale/download/?id=3580>
- Tomain, *Steel in the Ground: Greening the Grid with the iUtility, Environmental Law* (Pre-publication symposium draft), <http://www.lclark.edu/livewhale/download/?id=3579>

Blackboard:

- Stanton-*The Smart Grid-Enabled Energy Services Utility-How Utilities Can Become Sustainable by Selling Less*, http://www.nrri.org/pubs/electricity/NRRI_smart_grid_strategy_feb11-05.pdf
- Lesser, *The Use and Useful Test-Implications for a Restructured Electric Industry, Environmental Law*, 2002.
- Stelzer, *Regulation Really Works*
- Cosello, *Ways for Regulators to Use Performance Measures*

Week 8 (February 28)

• The Smart Grid Meets the Consumer

Class Objectives:

1. Understand the nature of the debate over whether consumers in general and different types of customers in particular should be supportive of or weary about the smart grid.
2. Develop an appreciation for how utilities, technology vendors, consumer advocates, and other stakeholders are interpreting the existing data and information about consumer understanding of and attitudes about the smart grid (and its relationship to the broader context of the energy ecosystem and the many pressing demands upon it).
3. Understand the issues, pros and cons, and concerns around the time varying or dynamic pricing (including time of use rates, critical peak pricing and real-time pricing) and how this impacts consumer acceptance of the smart grid.
4. Develop a basic understanding of how utilities, technology vendors, consumer advocates, and other stakeholders interpret and address other customer concerns (such as cost, privacy, security, health, and who should be responsible for paying for smart grid-related costs and risks – utility customers, shareholders, society (taxpayers), or some other social entity or group).

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5. Develop a sense of at least one IT company's views on how technologies and educational efforts can be designed to enhance consumer awareness of how they are currently using energy and how they might do so more efficiently in the future.

Agenda:

6:40 pm Class Announcements

6:50 pm Panel Presentations: The Smart Grid Meets the Consumer (*Bob Jenks, Executive Director, Citizens' Utility Board of Oregon; Lauren Shapton, Manager, Mass Market Programs, Portland General Electric; Scott Shull, Strategic Planner, EcoTechnology Innovations Program, and Director, Smarter Commercial Buildings, Intel Corp*) (Each speaker will have 40 minutes for opening presentation and 5 minutes to respond to clarifying questions)

8:20 pm Break

8:30 pm Continuation of Panel Presentations

9:15 pm Q and A and Class Discussion

9:40 Adjourn

Reading (and Viewing) Assignment for Week 8:

Priority Reading (and Viewing):

Class text:

Fox-Penner, *Smart Power*, chapter 4

Blackboard:

- *Electricity Journal*, Overview of Special Series of Articles on Dynamic Pricing (July 2010) Note: this series of articles is available on Blackboard under Additional Recommended Reading. If you choose to read them, we recommend you do so in the order they are discussed in this overview. If you are a huge dynamic pricing advocate, we particularly recommend you read the more skeptical articles to help you test your assumptions. If you are a huge skeptic, we recommend you read the more supportive articles for the same reason.
- Smart Grid Consumer Collaborative-2011 *State of the Consumer Report*
- AARP, National Association of State Utility Advocates, National Consumer Law Center, Consumers Union, and Public Citizen, *The Need for Essential Consumer Protections-Smart Metering Proposal and the Move to Time-based Pricing* (read at least executive summary)
- Brattle Group for Edison Foundation, Institute for Electric Efficiency, *The Impact of Dynamic Pricing on Low Income Customers* (read at least executive summary)
- Brockway, *The Impact of Dynamic Pricing on Low-Income Customers: An Analysis of the IEE Whitepaper, A Report to the Maryland Office of the People's Counsel*

Web links:

- GridWise Global Forum, September 22, view session on *Engaging the Consumer* (Parts 1-3) <http://www.gridwiseglobalforum.org/agenda/>
- Valocchi, Juliano, and Schurr, *Lighting the Way: Understanding the Smart Energy Consumer*, IBM Global Business Services, <https://www-935.ibm.com/services/us/gbs/bus/html/gbs-emerging-energy-preferences.html>
- Valocchi, Schurr, Juliano & Nelson, *Plugging in the Consumer: Innovating Utility Business Models for the Future*, IBM Global Business Services, https://www-935.ibm.com/services/us/gbs/bus/pdf/ibv_g510-7872-00_plugging_in.pdf
- Ebert, *Customers Right to Be Wary of Smart Grid* <http://www.nwenergy.org/news/the-transformer-january-4-2011/> (reread from week 2 readings)
- Rowland, *Regulatory Reflux-Smart Grid Resistance*, Intelligent Utility, http://www.nxtbook.com/nxtbooks/energycentral/iu_20100910/#/20
- Lombardi, *Informed Consumers Conserve for Cash, Study Says*, http://news.cnet.com/8301-11128_3-20032205-54.html
- Lombardi, *Electricity Use Curbed by Pricing? Not Exactly*, http://news.cnet.com/8301-11128_3-20015964-54.html?tag=mncol:txt
- Carson, *Data Privacy Efforts Underway*, <http://www.intelligentutility.com/article/11/02/data-privacy-policy-efforts-underway>
- Rowland, *Smart Grid Backlash Plays the Health Card*,

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<http://www.intelligentutility.com/article/10/08/smart-meter-backlash-plays-health-card>

- Rowland, *Time-of-use rates or peak-time rebates? An Economist and a Sociologist Debate Electricity Pricing Issues*, <http://www.intelligentutility.com/article/11/02/time-use-rates-or-peak-time-rebates>

Additional Recommended Reading:

Blackboard:

- Bunzel-*Is Flat Fair?*
- Faruqi-*The Ethics of Dynamic Pricing*
- Hogan-*Fairness and Dynamic Pricing*
- Hanser- *On Dynamic Prices- A Clash of Beliefs?*
- Alexander-*Dynamic Pricing? Not So Fast! A Residential Consumer Perspective*
- Brand- *Dynamic Pricing for Residential Electric Customers- A Ratepayer Advocate's Perspective*
- Ablondi, *Consumer Attitudes and the Benefits of Smart Grid Technologies*
- Carson, *Consumer Advocates at the Smart Grid Table*
- Carson, *Consumer Concerns About Smart Grid*

Web links:

- Smart Grid Consumer Collaborative Website, <http://smartgridcc.org> (surf website to get a sense of their issues and approach)
- Berst, *Feeling the Smart Grid Love*, http://www.smartgridnews.com/artman/publish/News_Commentary/Feeling-the-smart-grid-love-3506.html
- Smart Grid Consumer Collaborative, *A Smart Grid Even a Child Can Understand*, <http://smartgridcc.org/consumer-engagement/a-smart-grid-even-a-child-can-understand>
- LaMonica, *Are Consumers Ready for the Smart Grid* http://news.cnet.com/8301-11128_3-10287240-54.html
- California PUC, *Independent PG&E Smart Meter Testing Website*, <http://www.cpuc.ca.gov/PUC/energy/Demand+Response/solicit.htm>

Week 9 (March 7)

- **What Is Next for the Smart Grid? A Public Lecture by Chris Hickman and Cheryl Linder**
- **Distribute and Discuss Take Home Final Exam**

Class Objectives:

1. Distribute and discuss take home final exam.
2. Understand the current “state of the art” thinking about models of innovation that best apply to the Smart Grid.
3. Understand the roles that government and various stakeholders can and should play to support Smart Grid innovation.
4. Ask your “burning questions” and engage in discussion with industry leaders on these topics.

Agenda:

6:40 pm Meet in regular room for class announcements

6:45 pm Distribute and Discuss Final Exam. Exam Due March 17, 8 pm

7:00 pm Adjourn to Parsons Gallery on Second Floor for **What Is Next for the Smart Grid?** Co-sponsored by PSU College of Urban and Public Affairs, Center for Public Service, and Smart Grid Oregon

7:00 pm Introduction of Panel Speakers (*Phil Keisling, Director of Center for Public Service*)

7:05 pm *Chris Hickman, President, Innovari Energy* (50 minutes, plus 5 minutes to respond to clarifying questions)

8:00 pm *Cheryl Linder, Global Offering Leader, Energy and Utilities Industry, IBM Global Business Services* (50 minutes, plus 5 minutes to respond to respond to clarifying questions)

8:55 pm Q and A with panel members and group discussion

9:20 pm Adjourn

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Questions we have posed to panel members:

- What models of innovation are most likely to be successful when applied to the Smart Grid? Why?
- Where is innovation in the Smart Grid arena most likely to come from, and who will be the most likely innovators?
- Can Smart Grid innovation occur without the support of the federal and state governments? How important are the government's legislative, regulatory, financial, research and development, agenda-setting, organizing, and educational roles?
- What roles should businesses, the IT industry, and venture capital play to support Smart Grid innovation?
- What is the likely impact of third party participation, including start-ups, new entrants, and existing companies?
- What are the most appropriate roles for investor-owned and consumer owned utilities, system operators, vendors, aggregators, and consumers?
- Can and will vertical utilities innovate? Will/can/should regulators seek to “force” utility innovation? Why or why not? Is so, how?

Reading Assignment for Week 9

Priority Readings:

Class text:

- Fox-Penner, *Smart Power*, chapters 10-13 and conclusion.

Blackboard:

- Anderson, *Saving the Smart Grid-Hype, Hysteria, and Strategic Planning*
- Gohn and Wheelock, *Smart Grid Ten Trends to Watch in 2011 and Beyond*, Pike Research
- Nidumolu, et al, *Why Sustainability Is Now the Key Driver of Innovation*
- Brown and Salter, *Can Smart Grid Technology Fix the Disconnect between Wholesale and Retail Pricing?*
- Asmus, *Microgrids, Virtual Power Plans and Our Distributed Energy Future*
- Pasqualetti, et al, *The Silver Bullet Myth of Sustainable Energy Savings*
- Rokach, *Unlocking the Smart Grid*
- Blumenthal, *Northwest May Blaze US Path to Green Grid*

Web links:

- Valocchi, Juliano and Schurr with Linder, *Switching Perspectives: Creating New Business Models for a Changing World of Energy*, IBM Global Business Services, <http://www-935.ibm.com/services/us/gbs/bus/html/ibv-electric-utility-innovation.html>
- World Economic Forum, *Accelerating Successful Smart Grid Pilots*, http://www3.weforum.org/docs/WEF_EN_SmartGrids_Pilots_Report_2010.pdf
- Fox-Penner, *The Smart Grid-Enabled Energy Services Utility: How Utilities Can Become Sustainable by Selling Less*, <http://www.thesolutionsjournal.com/node/750>
- Rowland, *Top Three Smart Grid Utilities: San Diego Gas & Electric, Austin Energy, and PG&E Corp*, http://www.nxtbook.com/nxtbooks/energycentral/iu_20110102/#/16

Additional Recommended Readings:

Blackboard:

- Culver-*High-Value Energy Storage for the Grid-A Multi-Dimensional Look*
- Lovins, *Does a Big Economy Need Big Power Plants?*
- Brown, et al-*Some Characteristics of Emerging Distribution Systems Considering the Smart Grid Initiative*
- Chassin-*What Can the Smart Grid Do for You? And What Can You Do for the Smart Grid?*
- Cavoukian et al, *-Smart Privacy for the Smart Grid*

Week 10 (March 14)

- **The Smart Grid Meets Jobs and Business Opportunities**
- **Small Groups Discussion of Take Home Final Exam**

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Class Objectives:

- Develop an understanding of the business challenges and opportunities associated with the Smart Grid in particular and clean energy economy more generally.
- Develop an understanding of the potential for job creation and economic development associated with the Smart Grid in particular and clean energy economy more generally.
- Brainstorm in your small group learning community on approaches to address the take home final exam.

Agenda:

6:40 pm Class Announcements

6:50 pm Panel Presentation: The Smart Grid Meets Jobs and Business Opportunities (*James Mater; Rick Kriss, Founder and Managing Director, KLATU Networks; Robert Topping, Director of Industry Partnerships, Chemeketa Community College*)

8:25 pm Break

8:35 pm Q and A with panel and class discussion

8:45 pm Small group learning communities brainstorm on final exam

9:40 Adjourn

Reading (and Viewing) Assignment for Week 10

Priority Readings:

Class text:

- Fox-Penner, *Smart Power*, chapters 11-13 and conclusion (again!)

Blackboard:

- Pernick, et al, *Carbon Free Prosperity 2025- How the Northwest Can Create Green Jobs, Deliver Energy Security, and Thrive in the Global Clean-Tech Marketplace* (see especially chapter on Smart Grid)
- KEMA (for Gridwise Alliance), *The US Smart Grid Revolution, KEMA's Perspective for Job Creation* (read at least executive summary)
- Zeller, *Utilities Seek Fresh Talent for Smart Grids*, *New York Times*
- Rifkin, *Leading the Way to the Third Industrial Revolution and a New Distributed Social Vision for the World in the 21st Century*

Web links:

- Clean Edge, *California, Oregon, and Massachusetts Lead List of Top 10 Clean Energy States*, <http://www.cleandedge.com/about/pr/CELI2010v%20Final.pdf>
- Northwest Energy Efficiency Task Force, Work Group #5, *Building the Energy Efficiency Workforce of the Future, Final Report*, <http://www.nwcouncil.org/energy/neet/workgroups/5/Default.htm>
- Pew Charitable Trusts, *The Clean Energy Economy: Repowering Jobs, Businesses and Investments Across America*, http://www.pewcenteronthestates.org/uploadedFiles/Clean_Economy_Report_Web.pdf (read at least the executive summary)
- Goldman, Peters, et al, *Energy Efficiency Services Sector-Workforce Education and Training Need*, *Lawrence Berkley National Laboratory*, read at least executive summary), <http://eetd.lbl.gov/ea/ems/reports/lbnl-3163e.pdf>
- US Department of Energy, *Workforce Trends in the Electric Utility Industry*, http://www.oe.energy.gov/DocumentsandMedia/Workforce_Trends_Report_090706_FINAL.pdf (read at least the executive summary)
- American Public Power Association, *Workforce Planning for Public Power Utilities*, <http://www.publicpower.org/files/PDFs/WorkForcePlanningforPublicPowerUtilities.pdf> (read at least the executive summary)
- Glaeser, *Why Green Energy Can't Power a Job Engine*, *New York Times*, <http://economix.blogs.nytimes.com/2011/01/18/why-green-energy-cant-power-a-job-engine/?pagemode=print>
- Green and Walsh, *Greener Pathways: Jobs and Workforce Development in the Clean Energy Economy*, (read at least executive summary), <http://www.cows.org/greenerpathways/>

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- Intelligence2 Debates, *Clean Energy Can Drive America's Energy Economy, Pro and Con*, March 8, 2011, <http://intelligencesquared.us.org/index.php/past-debates/americas-house-divided-renewable-energy/> (lots of interesting information under "Research in Depth")

Additional Recommended Reading:

Blackboard:

- Pernick and Wilder, *Clean Energy Trends 2010*, CleanEdge
- Pernick and Wilder, *The Clean Tech Revolution: The Next Big Growth and Investment Opportunity*, Chapter 6 (Smart Grid)
- Mazza, *Poised for Profit - Powering Up the Smart Grid: A Northwest Initiative for Job Creation, Energy Security, and Clean, Affordable Electricity*
- King, *Can a Green Economy Survive in a Policy Vacuum? Scientific American*
- Ritter, *Re-energize the Economy*, *New York Times*
- Ritter, *Colorado's New Energy Economy*, *Forbes.com*
- Environment New Service, *Clean Energy Jobs Top Priority in Obama's State of the Union Address*

Web links:

- National Commission on Energy Policy, *Taskforce on America's Future Energy Jobs*, Bi-Partisan Policy Center, <http://www.bipartisanpolicy.org/library/report/task-force-americas-future-energy-jobs>
- Smart Grid News, *Making the Business Case for Smart Meters*, http://www.smartgridnews.com/artman/publish/Technologies_Metering_Resources/Video-replay-Making-the-business-case-for-smart-meters-3226.html
- Berst, *Smart Grid Leadership: The Top Ten "Smartest" States in 2009*, http://www.smartgridnews.com/artman/publish/commentary/Smart_Grid_Leadership_The_Top_Ten_Smartest_States_in_2009-546.html
- Hayward et al, *Post-Partisan Power, How a Limited and Direct Approach to Energy Innovation Can Deliver Clean, Cheap Energy, Economic Productivity and National Prosperity*, American Enterprise institute, Brookings Institution, and Breakthrough Institute, 2010, <http://www.aei.org/docLib/Post-Partisan-Power-Hayward-101310.pdf>
- Hayes, Rafkin and Byrd, *Analysis of Clean Energy Workforce Needs in Oregon*. 3E Strategies for Office of the Governor, http://www.3estrategies.org/Documents/SOWreport_Final_may.pdf

Other Course Information

Optional Field Trip:

The optional class field trip to view Portland General Electric's Smart Grid-related facilities and speak with PGE experts will take place on Saturday morning, March 5. More information will be provided in class.

Here is a tentative schedule:

- | | |
|----------|---|
| 8:40 am | Begin security at 3 World Trade Center (go up escalator to PGE lobby) |
| 9:00 am | Trip participants break into two groups. One group joins Steve Hawke for tour of Control Center; the other joins Mark Osborn for tour of Distributed Resources Control Center. |
| 9:30 am | Steve and Mark switch groups so everybody sees both centers. |
| 10:00 am | Both groups meet in a nearby conference room |
| 10:05 am | Steve Hawke, PGE Senior Vice President, Customer Service, Transmission and Distribution, finishes the portion of his presentation on PGE's Smart Grid vision did not get to in class on January 24. |
| 11:00 am | Mark Osborn, PGE Distributed Generation Manager, will present PGE's distributed generation strategy and FAST utility-scale battery storage program |
| 11:40 am | Joe Barra, PGE Director of Consumer Energy Resources, will discuss PGE's electric vehicles strategy |
| 12:15 pm | Joe Barra demonstrates the only publicly available quick charging station in the US |

Evaluation of student work:

Course evaluations and grades will be based on student performance in four areas: the individual or group assignments as a whole will count for 40% of the grade, the take home final exam will count for 40%, and class

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participation, observance of due dates, and attendance will count for the remaining 20%. Students taking the course for professional development are strongly urged to participate actively in their small group learning communities. This is where a significant amount of your learning will take place. Some organizational sponsors may require an evaluation of performance as a condition for reimbursing course payment. Faculty will follow their direction and/or we will establish an understanding with the organizational sponsor. Unless the company sponsor advises us otherwise, we will not assume that professional development students will take the final exam. However, we will expect all students to participate in and complete other group and individual assignments. Faculty will ask all students to complete an anonymous evaluation of the small group learning community process as a whole and of the participation level and performance of each small group member. This information will be factored into the evaluation of each student's performance in the course.

Final exam:

The take home final exam will be delivered in class, most likely on March 7; it will be due on or before 8 pm on March 17. Further instructions will be included with the exam. **Unless arrangements have been made with the faculty well in advance, late assignments and exams will be assessed a late penalty of one grade increment for every day late. Please plan your schedule accordingly.** Please email Jeff Hammarlund in advance if you will need to miss a class session. Arrange for someone else in class to pick up the class handouts for the missed session. Please come to class on time and turn all cell phones off.

Faculty office hours:

Jeff Hammarlund: Wednesday 1-3 pm and by appointment, 503-249-0240 and hammarj@pdx.edu

Conrad Eustis: By appointment, call Conrad at 503-229-0621

James Mater: By appointment, call James at 503-780-9796