Center for Public Service

March 16, 2018 Draft

Course Fact Sheet:

Portland State University's Edition 6.0 of The Smart Grid and Sustainable Communities Course

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For more information, including the course syllabi, faculty bios and registration, please visit the course website.

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Course Origins

The Smart Grid and Sustainable Communities was created in 2008 and launched in 2009 at Portland State University (PSU) at the request of and with critical staff and financial support from, Portland General Electric (PGE). PSU and PGE created an exploratory team led by Jeff Hammarlund,[1] Pamela Morgan,[2] and Gerald Sheblé.[3] Steve Hawke, PGE's Senior Vice President for Customer Service and Delivery at the time, provided additional encouragement and guidance.

The team was intrigued by the potential for what was then a rather fuzzy and just emerging set of concepts, technologies, applications, business models, and accompanying policy challenges and opportunities that might to transform the nation's century-old, centralized electric power system into a climate, renewable-energy, and consumer friendly "Smart Grid." We knew the electric grid was aging and being asked to do more than it was originally designed for. And we were aware that several respected visionaries were suggesting that it should be possible to modernize the grid to make it "smarter" and more resilient through the use of cutting-edge technologies, equipment, and controls that communicate and work together to deliver electricity more efficiently and reliably could provide many benefits. However, we also knew that such theories needed to be tested under "real world" conditions to make sure they would hold up. We hoped this class would provide a significant opportunity to examine whether the many promises associated with the Smart Grid could be fine-tuned and made valid given the Northwest's energy profile.

We concluded that Portland's and the Northwest's commitment to innovation and sustainability made it an ideal location to examine if and how the Smart Grid could encourage and enhance sustainable development with the help of a grid that was cleaner and more distributed, efficient, and intelligent.

When we started out, the concept of the Smart Grid was just emerging. So too was its relationship to other closely related and quickly evolving technologies, approaches, opportunities and challenges such as demand response, distributed generation, energy storage, synchrophasors, energy imbalance markets, electric vehicle charging options, grid defection and concerns about the "utility death spiral", and new strategies to enhance and integrate variable resources and its relationship to closely related technologies and approaches including demand response, distributed generation, energy storage, and the integration of variable resources.

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[1] Jeff Hammarlund was a member of PSU's Center for Public Service faculty for 24 years. He retired in 2016 but continues in a part-time role as Senior Fellow. He is also slowly phasing out his role as President and Principal Consultant with a small consulting firm, Northwest Energy and Environmental Strategies.
[2] Pamela Morgan was, at the time, PGE's Vice President for Regulatory Affairs and Strategic Planning, and is now President and Principal Consultant at Graceful Systems.
[3] Gerald Sheblé was, at the time, PSU's Maseeh Professor of Electrical and Computer Engineering, the Maseeh College of Engineering and Computer Science. He is now the principal consultant at MAXISYS and an Honorary Professor at the University of Porto.

As we delved into this topic and began to assemble and offer this course series, we learned and experienced many new things. They include:

- The issues at this intersection of electricity, information technology, and sustainability would prove both fascinating and complex;

- An appreciation that while the technologies associated with the Smart Grid, micro-grids, demand response, distributed generation, and energy storage are very important, it is equally important to explore the complex business, regulatory and policy issues and learn about various new players associated this transition.
- Amazement and delight as this course series would be recognized and heralded by the President of the United States, the governors and many members of Congress from the four Northwest states, the Secretary of Energy, and other energy educators and experts for its path-breaking features.

- Pride when this series began to attract graduate students and mid-career professionals, initially from throughout the Pacific Northwest, and later from around the world. This development would became more pronounced in 2013 when we began offering a variety of ways to participate in this course for those who were unable to attend some or all of the class sessions in person. These are described below.

We did not know it yet, but we were informed later that this was the first such course in the country so there was no blueprint to follow. In fact, our approach has now become a model for an innovative cross-disciplinary course that other universities have studied and adopted.

With the help of a team of colleagues from academia and the private sector, PSU has now offered five very different editions of this course, each exploring different aspects of this fascinating topic. The changes were necessary because the issues we have been exploring are not static. The technological, economic, natural, and societal environments within which electricity's creation, delivery and use occur are very dynamic. We have moved far beyond the original focus on the Smart Grid.

With Jeff's retirement from PSU in 2016 and the hiring of Dr. Hal Nelson in 2017, Edition 6.0 of this course, offered during Spring term 2018, will maintain the tradition of innovation that characterized the previous editions described below. Hal has eagerly accepted the role as the lead member of the faculty team. He has also ensured valuable continuity be hiring Mark Osborn, a prior member of the faculty team, to join him. He has also asked course founder Jeff Hammarlund to serve as a course advisor and guest speaker and is inviting other former guest speakers to return.

The Story of Our Interdisciplinary Approach

As the faculty team began to plan and develop this course in 2008, we realized that a topic as new, multi-dimensional, and complex as designing the Smart Grid for sustainable communities would require a multidisciplinary and interdisciplinary faculty team that could offer the knowledge, skills and perspectives of several academic disciplines, plus on-the-ground experience, and integrate them into a genuine "cutting-edge" interdisciplinary curriculum. We agreed that to be done right, this course would require several faculty members with knowledge and skills in a variety of academic fields and a willingness to collaborate in a cross-disciplinary context.

For example, depending on the topics we planned to cover in a particular course term, one person might take the lead on the policy and planning aspects of developing and integrating the Smart Grid infrastructure with the many other infrastructures it would need to integrate with in ways that would ensure" plug and play" interoperability (the electric transmission grid, the transportation system, the building and land use design and planning system, etc.) Another might take the lead on the power engineering aspects of the Smart Grid (integrating the Smart Grid with the existing power grid). Another might take the lead on the IT communications and controls aspects of the Smart Grid. This is essential because the Smart Grid involves a "shot-gun marriage" of the utility industry and the IT industry, two industries that have very different institutional cultures.

Since PSU can afford to pay just one faculty member, PGE offered to provide significant underwriting support during the course's first year. PGE also offered to continue to provide funding support at a lower level in future years so long as:

- PSU continued to deliver a first-rate course that continued to meet PGE's long term needs; and
- PSU demonstrated a serious effort to secure underwriting support in future years from other businesses and organizations that might want to send some of their "best and brightest" mid-career professionals to this course. In particular, PGE encouraged PSU to attempt to secure underwriting support from BPA, Intel, and local IT and Smart Grid companies that might want to encourage some of their future leaders to take this course.

PGE senior management said they understood that the Smart Grid's success requires an unprecedented amount of collaboration among and between companies in very different industries, including the utility industry that has traditionally been conservative and risk-adverse and the IT industry that has traditionally been entrepreneurial and innovative. It will also require significant collaboration between both of these industries and the public sector, with planners, design professionals, and others interested in creating vibrant and sustainable communities, and perhaps most important of all, with its customers.

After teaching the course two years in a row, PSU decided to begin offering this course during alternating years. As promised, PGE continued to provide funding at the lower level they had agreed to in 2010, 2011, 2013 and 2015 (the course was not taught in 2012, 2014, or due to other faculty commitments.) To our delight, in 2013, Intel and Veris Industries also stepped up to fill the funding gap as additional underwriters. Meanwhile, Climate Solutions and Smart Grid Oregon (now Smart Grid Northwest) continued to help with course marketing to their members and supporters.

We plan to solicit support from those companies and organizations that have helped sponsor this course in the past. We are also seeking to recruit additional course underwriters. Without their help, we will not be able to offer this course. Their support helps us in three crucial areas:

- Providing modest compensation for one of the two core faculty members discussed below (for Spring 2018 this will be Mark Osborn).

- Supporting a significant portion of the travel and accommodation cost of our first-rate guest presenters who come from out of town. (Our guest presenters are committed to the objectives of this seminar series so it is very rare for any presenter to require a speaking fee. We work with them to keep travel and accommodation expenses as low as possible. However, we will not be able to recruit such extraordinary speakers without paying for their basic expenses.)

- Contributing a small portion of the additional Distance Learning expenses involved in making this course series available on computers and in distance learning centers around the world.

The Innovative Features of the Course

From the beginning, the class has been quite innovative. Our course:

- Serves two critical audiences: (1) graduate students in engineering, information technology, public administration/policy, urban planning, business, economics, law, and related fields; and (2) mid-career professionals from the utility, information technology, public administration, architecture, urban and transportation planning, business, legal, and related communities who are interested in the topic as a part of their professional development. Both audiences benefit from the other's presence in the class.

- Uses the different academic and experience backgrounds of its faculty to combine academic theory and research with real world challenges ("Making Oregon and the Northwest our Classroom") for the benefit of the students.

- Includes nationally and regionally known experts in the curriculum to bring students additional perspectives. In past classes, these speakers have included the chairman of the Federal Energy Regulatory Administration, the chairman of the Colorado Public Utilities Commission, and Smart Grid thought leaders from California, Illinois, Texas, Ohio, New York and elsewhere. Other speakers have included the Executive Director, National Regulatory Research Institute, the Managing Director of Global Smart Energy, and Executive Editor of *Smart Grid News*; the Director of Pacific Northwest Smart Grid Demonstration Project; the Chairman Emeritus, The Brattle Group, the authors of some of our texts; and many more. A full list of previous course speakers is provided later in this fact sheet. The experience and insights of these speakers complement the multi-disciplinary faculty to provide a rich experience for students and enable them to produce outstanding work on the policy topics they tackle.

- Combines students into interdisciplinary small group "learning communities" that require communication, learning, and the completion of group assignments across traditional disciplines. We believe that an ability to communicate across traditional disciplines is critical to designing electricity systems and services for empowered energy end-users and sustainable communities. It is also a skill that is highly valued by employers interested in positioning their companies for a successful future. We complement the inter-disciplinary teams with small "affinity groups" that allow students to work on projects from within the perspective of their traditional disciplines.

- The first five editions of this course involved a series of two courses that covered two consecutive terms to deepen the learning experience. The first term focused on providing students the basics to engage with the issues of technology, empowered energy end-users and sustainable communities and exposing them to work in multidisciplinary student teams. The second term deepened students' knowledge base, with a primary emphasis on application of knowledge to "real world" projects that identify and test how to progress toward empowered energy end-users and sustainable communities. Examples of actual projects our multidisciplinary small group learning communities addressed in 2010, 2011 and 2013 include:

- Three different projects associated with PGE's Salem Smart Power Project;
- Strategies for the Smart Grid to Support Emerging Eco-Districts and District Energy Systems in Portland;
- Exploring the Connections between Smart Grid and Vehicle-to-Grid: Opportunities and Challenges in Oregon;
- The Smart Grid's Role as an Enabler of Renewable Energy Integration in Oregon and the Pacific Northwest;
- Strategies to Include Low-Income and Other Vulnerable Consumers as Smart Grid Beneficiaries;
- A Lighting Energy Efficiency and Demand Response Strategy for the Portland State University Campus;
- A Smart Meter Consumer Data Study.

- In 2015 we created four multidisciplinary student teams. Each team worked for a specific "client". The client for two teams was the Northwest Power and Conservation Council, which was in the process of developing its Seventh Northwest Power Plan. The Council staff was interested in our assistance in developing background information that could help inform the Plan. One team offered guidance to the Council on the development of a **Regional Demand Side Management Strategy**. The other team provided the Council with a **Northwest Smart Grid Technology Assessment Study.** The third student team provided Portland General Electric with an **Assessment of How Microgrids Can Support a PGE's Grid Resilience Strategy**. The fourth student team developed a **Assessment of Community Power Options to Support the Goals of the Living Cully Ecodistrict.** The client for this study was the four Cully-neighborhood based organizations that are members of the Living Cully EcoDistrict.

- Concludes with a conference or public forum at which the student teams present their findings and recommendations to government and business leaders. For example, in 2011, each of the student teams offered a presentation and a briefing book for the members of simulated "Governor's Blue Ribbon Advisory Panel on Oregon's Smart Grid Policy." While the panel had no official standing, it consisted of people who could easily serve on such a panel and was chaired by the governor's actual senior advisor on jobs and the economy. Many of these recommendations were incorporated in the governor's actual Ten-Year Energy Plan. In most cases, the student teams are guided and supported by advisory teams comprised of many of the region's top technical and policy experts.

- Reaches across the globe. Beginning in 2013, PSU expanded the availability of this course to interested parties throughout the Northwest region and beyond with the capabilities of PSU's Distance Learning Center. Ultimately, our "distance learning participants" included people from other parts of the United States and from universities in other nations, including China, Mexico, India, and Iraq. We hope to expand the level of regional, national, and international participation in 2018. PSU's Center for Public Service is happy to work with participating universities and utilities to provide graduate course level credit for students of participating universities (3 credits per quarter) and Certificate of Completion for mid-career professionals who are interested in advancing their careers but do not need university credit.

Three Distance Learning options are available for interested graduate students and mid-career professionals:

- **Video Conference.** Participants who can access participating Distance Learning Centers can see the class presentations and view and interact with the faculty, guest speakers, and other students in real time on large screens.
- **Live Streaming.** Participants can steam the class live on their computers. They can ask questions and participate in discussions with the help of Gmail Chat or similar options.
- **Media Archive**. Each class and presentation will be captured and stored for later viewing on your computer. A link will be provided for access to the archived media, which should be available the next day.

Plans for the Spring Term 2018 Course (Edition 6.0)

PSU has decided to pilot-test a one-term version of this course during Spring term 2018. However, the other innovative features described above will remain. Some of the details associated with the 2018 edition are still being developed. However, the topics will include:

- An introduction to the existing grid and the grid transformation process that is currently underway;
- The emergence of new (and some say "disruptive") technologies and financing approaches, the resulting calls for new business and regulatory models associated with the "utility death spiral", and their relationship to the Northwest's energy profile;
- How grid modernization can enhance the value and effectiveness of wind, solar and other valuable but intermittent renewable energy resources;
- Key energy policy issues, challenges and opportunities that have emerged or are on the horizon as a result of this grid transformation;
- California's role as a hub or energy innovation;
- New strategies to support the integration of more wind, solar and other cleaner but more intermittent and distributed forms of energy;
- The emerging roles of Energy Imbalance Markets and new approaches to distribution system operations and planning;
- Challenges and opportunities associated with "Internet of Things", communications standards & interoperability, and cybersecurity;
- Grid defection, solar technologies, and net metering policies;
- New technologies and approaches to energy storage;
- The role of microgrids and "community solar" strategies;
- The benefits of energy system resilience to address earthquakes, tsunamis, and other natural disasters;
- Emerging and next generation technologies and approaches.

The course closes with a small Public Forum during which student teams will present their recommendations to their "clients" and community leaders.

Course Value and Results

By any measure, the four previous editions of this course have been a success. The quality and enthusiasm of the graduate and professional development students has been exceptional, the course evaluations have been consistently stellar, and a number of course alumni have received excellent job offers and advancements. The class has earned the praise of many leaders, including the Secretary of Energy, all four Northwest governors, and both Oregon Senators.

The course has attracted PSU graduate students from the various engineering programs, business, economics, public policy, urban planning, and more. Employers funded most of the students who have taken this course through our professional development option. Companies who have sponsored their employees as students include high tech companies, government agencies, small firms, and non-profits. While taking this class, students have worked for such organizations as the Bonneville Power Administration, the Northwest Power and Conservation Council, investor-owned and consumer-owned utilities throughout the Pacific Northwest, the Department of Energy's Pacific Northwest National Laboratory, the Oregon Public Utilities Commission, several other state agencies, Metro, the City of Portland's Bureau of Planning and Sustainability, the Energy Trust of Oregon, Northwest Energy Efficiency Alliance, Navigant, PECI, McCullough Research, Lockheed Martin, Oregon Institute of Technology, Christiansen Electric, CH2MHill, several Northwest law firms with significant energy law practices, consumer and environmental advocacy organizations, Intel, IBM, and several other high tech, IT, and Smart Grid companies, energy efficiency and renewable resource consulting firms, and more. So far, at least 16 participants with PhD's have taken the class. Several course alumni have started their own consulting companies.

Course faculty continue to received inquires from potential employers asking for suggestions and recommendations of recent course alumni; we are most often asked to recommend students who are both strong technically and able to thrive in the interdisciplinary teams.

All three of the major national Smart Grid related on-line and print magazines and newsletters - *Smart Grid News, Smart Grid Today*, and *Intelligent Utility* – have run positive articles on this class. Secretary of Energy Steven Chu said the course represents the "invention of the wheel" for the kind of introductory interdisciplinary graduate level Smart Grid and clean energy course he hoped other universities would adopt around the country. The class was also featured and praised in one of the most respected books on this subject, *The Advanced Smart Grid: Edge Power Driving Sustainability* (Carvallo and Cooper, 2011). In early 2013, Nancy Sutley, the chair of the White House Council on Environmental Quality, met with the course's lead faculty member to brainstorm on how the White House might encourage other universities to develop similar courses. This was after the White House contacted the course faculty to see if the President might be able to sit in a course session during his visit to Portland; we were honored and delighted to find a way for this to happen but security and timing issues ultimately precluded it.

Student Testimonials

Leah Y Parks, Associate Editor, ElectricityPolicy.com & Electricity Daily
"The Smart Grid class is a class that should not be missed by anyone interested in staying abreast of the current developments in the Smart Grid and learning about where our 21st century electricity infrastructure is headed.

The lead professor, Jeff Hammarlund, puts together a team of expert professors as teachers who have actual experience working in the field. They all bring important and often eye-

opening perspectives. The course material is relevant and informative.
Jeff creates an environment of mentoring, community, learning and an unsurpassed place for networking. In addition to motivated and exciting graduate students from PSU, there are also individuals from a great breadth of professional expertise in the industry. The team of teachers is very top notch, but Jeff's sincere love of supporting and encouraging his students, young and old, is a breath of fresh air. After leaving the university, professionals often find it hard to encounter a truly mentoring environment. Jeff creates not only a space for learning, but a place where students and teachers engage in bi-directional mentoring and support.

It was a great pleasure meeting such a diverse group of people. I personally developed friendships with colleagues and met a person (currently an attorney) who had attended the same graduate engineering program that I had at Stanford University. He 15 years back and I 10 years back. When working on the project, my group was composed of professionals from whom I learned a lot and motivated graduate students whom were a pleasure to work with and whom we all took great joy in seeing land amazing internships directly from work done during this course. One of the professionals in my group also shares my passion for energy storage and we continue, one year and a half years later, to meet at energy storage conferences around the country, inform each other of important storage initiatives happening in Portland, and share e-mails when we find a good story.
Now back to course content: This course looks at what Smart Grid gismos as well and infrastructure will be needed and are expected in the present and near future. The course gets course attendees involved in projects where students are pushed to think about and initiate a process of working out the nuts and bolts of how our grid architecture must evolve to meet the needs of a 21st century grid.

Knowing what is coming is important. The utility industry is changing at breakneck speed. Barclays downgraded the entire electric sector of the U.S. high-grade corporate bond market to underweight. There is an expected consumer shift to solar + storage from dropping prices. This shift portends grid defection in the next few years in parts of the country. Customers continue to be inundated with new gismos like the "Nest" and the technology industry is putting pressure on the utility industry as well. Google, Microsoft, and Solar City are all interested in becoming players in this field and are not necessary working with the existing utilities.

Jeff is the type of person who truly wants his students to learn about the electricity industry, create bonds, engage in bi-directional mentoring, and to help their career flourish. He is not only successful, intelligent and a guru in the field, but he brings other gurus and experts together to learn and teach each other. Everyone in the class is both a student and a teacher, a mentor and being mentored at the same time.
This is a special and unique learning environment. A graduate student should come because of the amazing learning and connections to be made. A professional should come for the chance to not only learn from some of the top professionals in the field, but for the chance to meet colleagues, special students, and experts in an exciting and cutting edge class."

Abraham Mooney, P.E. Signals Engineer, TriMet "You can't have a future of renewable energy without the Smart Grid; it as simple as that. In the current paradigm generation follows load, ramping up and down to accommodate. All the flexibility in the system is built into the generation side. The future will turn that on its head. Load must follow generation with consumers carrying the flexibility. The flexibility is handled via the 'internet of things' where consumers decide when and how to use electricity. Do I care most about price? Instead do I want the most green energy? Or perhaps I'm a dinosaur and I don't care about either of these options and I just want the power on demand, the most expensive option. The way (and the when) we use power will be optional and subject to market demands. Odd

as it may seem, this new paradigm is the only way to accommodate the variability of renewable energy sources. Jeff Hammarlund's course will talk you through the ins and outs of this incredibly complex technical and political paradigm change. It's the wave of the future."

Ben Walsh, Principal, Mitler Construction Management, Green Builder "The course structure directly engages participants with current industry leaders and issues. The timeliness of the subject matter and the instructors' and presenters' depth of expertise make for an exceptional educational opportunity and, in my experience, value for the professional development dollar."

Ken Kaufmann, Partner, Lovinger Kaufmann LLP. "DSGSC is a worthwhile course for every professional interested in expanding his or her breadth of understanding of technical and policy issues related to the Smart Grid. The lectures focus on hot topics in the Smart Grid field, are delivered by articulate experts, and generate lively conversation among the students, each of whom brings a unique perspective from his or her diverse academic and professional background. The course deepened my understanding of the subject matter and fostered many new professional friendships. I recommend it for professionals seeking to stay abreast of Smart Grid developments as well as for students planning to work in the electric energy industry."

Ryan Edge Research Analyst, Solar Electric Power Association, Washington DC "It was the most comprehensive and incisive study of the technologies, policies, issues and business models required of the next iteration of the electric grid. The faculty is leaders in their respective fields and a formidable ensemble. The course led directly to the job I have today working to integrate solar and develop enlightened utility business models."

Chris Chambers - past participant "As a former student of the class I have to award it the best course in my whole program. The reading is fascinating because the operation of the power grid is basically a big secret yet crucially important to how fast we can build solar, wind, and drive electric vehicles. But the most valuable feature is probably the chance to work in small groups with professionals. Those projects gave me a window to a suite of soft skills we don't talk about in our other courses (time keeping, large document management, overall workflow) and a tremendous chance to network.

I was referred for my first career job by someone I met in the class, and a project I did gave me the experience to qualify. I have included that PSU advanced lighting projection project in nearly every cover letter I've sent out in the past year, and talked about it in every interview. I have not talked about my HR case study or Supreme Court decision ever. Even if it weren't a path to employment, it's one of the most interesting subjects in natural resource policy."

Kirsten Midura, **Senior Consultant, Navigant** "I took the course during the last round, and I found it to be an essential class for anyone interested in the Smart Grid or advanced metering infrastructure. Jeff Hammarlund is one of the most brilliant and entertaining lecturers I have had in my academic and professional careers. Furthermore, this class provides a great opportunity to expand your professional network and share knowledge with like-minded individuals. I would highly recommend this class to anyone who is even remotely interested in the future of energy and energy technology."

Guest Presenters and Advisory Team Members

The faculty team is in the process of identifying and recruiting a stellar group of nationally and locally known guest presenters and student team project advisors for 2018's Edition 6.0 course. It is premature to list the guest presenters we are targeting for 2018 at this time. However, we can provide a sense of the exceptional quality of the guest presenters, panel members, and advisors by providing a list of individuals who have participated in those roles during the five course editions we have offered so far. The quality of presenters we are recruiting for this year will be no less stellar. The speaker and project advisor affiliations were correct at the time they joined us for specific sessions. Many past presenters have since moved on to other positions.

Guest Presenters (during the 2009, 2010, 2011, 2013 and/or 2015 course series) include:

- **Lisa Adatto**, Oregon Director, Climate Solutions; and course alum;
- **Dr. Jennifer Allen**, Director of PSU's Institute for Sustainable Solutions and Associate Professor of Public Administration;
- **Ron Ambrosio**, IBM Distinguished Engineer & CTO, Smarter Energy Research, Thomas J. Watson Research Center, New York;
- **Joe Barra**, Director of Customer Energy Resources, Portland General Electric;
- **Rob Bennett**, Executive Director, Portland Sustainability Institute;
- **Jess Berst**, Managing Director, Global Smart Energy, and Executive Editor *Smart Grid News*;
- **Ron Binz**, Principal, Public Policy Consulting, and former Chairman, Colorado Public Utilities Commission;
- **Jeff Bissonnette**, Policy Director, Citizen's Utility Board of Oregon;
- **Kit Blair**, Manager of the National Control Center and Manager of Generation Dispatch, Iberdrola Renewables;
- **Diane Broad**, Director and Senior Consultant, Ecofys US;
- **Clark Brockman**, Director of Sustainable Resources, SERA Architects;
- **Rex Burkholder**, Metro Councilor;
- **Andrew Campbell,** Energy Policy Advocate and Advisor; former Senior Advisor to two California Public Utilities Commission Commissioners;
- **John Cooper**, President, Ecomergence; formerly Technical Lead for Smart Grid, Austin Energy, then Vice President for Utility Solutions, GridNet; co-author, *The Advanced Smart Grid; Edge Power Driving Sustainability*;
- **Craig Dean**, Manager of Real Time Trading, Iberdrola Renewables
- **Dr. Eduardo Cotilla-Sanchez**, Assistant Professor, Electrical and Computer Engineering, Oregon State University

- **Ken Dragoon**, Research Director, Renewable Northwest; Manager, Systems Analysis and Integration and Senior Resource Analyst, Northwest Power and Conservation Council; and a former course faculty member;
- **Patty Durand**, Executive Director, Smart Grid Consumers Collaborative;
- **Ryan Edge**, Research Analyst, Solar Electric Power Association (and a course alum)
- **Michael Early**, Executive Director, Industrial Customers of Northwest Utilities;
- **Dr. Conrad Eustis**, Director, Retail Technology Development, Portland General Electric; later a course faculty member;
- **Wayne Embry**, Founder and Managing Partner, Reference Capital Management;
- **Tony Faris**, Electrical Engineer, Bonneville Power Administration;
- **Rob Ferraro**, Electrical & Renewable Energy Engineer, Portland General Electric
- **Dr. Peter Fox-Penner**, author of *Smart Power,* and Chairman Emeritus, The Brattle Group;
- **Hannah Friedman**, Technical Research Director, Portland Energy Conservation, Inc.; and a course alum;
- **J. R. Gonzalez**, P.E., Administrator, Safety, Reliability & Security Division, Oregon Public Utility Commission;
- **Mike Gravely**, Manager, Energy Systems Research, California Energy Commission;
- **Erich Gunther**, Chairman, CTO and Co Founder, EnerNex;
- **Lee Hall**, Smart Grid Program Manager, Bonneville Power Administration;
- **Don Hammerstrom**, Senior Engineer and Project Manager, Pacific Northwest National Laboratory, US Department of Energy;
- **Steve Hawke**, Senior Vice President, Portland General Electric;
- **Dr. Judith Heerwagen**, J.H Heerwagen & Associates; Program Expert, US General Services, Office of Federal High Performance Buildings;
- **Roy Hemmingway**, Energy Consultant and former Chair, Oregon Public Utilities Commission;
- **Scott Hempling**, Executive Director, National Regulatory Research Institute;
- **Bill Henry,** Analyst, EQL Energy, class blogger, and course alum;
- **Carol Haertlein**, Smart Grid Grant Specialist, PNGC Power;
- **Chris Hickman**, President, Innovari Energy;
- **Bob Jenks**, Executive Director, Citizens' Utility Board of Oregon;
- **Steve Jennings**, Chief Marketing Officer, BPL Global;

- **Jeromy Johnson**, Environmental Engineer, Advisor to Josh del Sol and Take Back Your Power: Investigating the "Smart" Grid, and creator of his own website*, Protect Your Family from EMF Pollution*;
- **Michael Jung**, Policy Director, Silver Spring Networks, and later, a course faculty member;
- **Bobby Kandaswamy**, Director, Intel Capital;
- **Dr. David Kathan**, Senior Economist and Group Manager, Office of Energy Market Regulation, Federal Energy Regulatory Commission; and
- **Patrick Keegan***,* Vice President, Residential Utility Solutions, Ecos; and a course alum;
- **Dr. Dmitry Kosterev**, Electrical Engineer, BPA Transmission Planning; Chair, Modeling and Validation Work Group, and Chair, Planning Implementation Task Team, North American SynchroPhasor Initiative;
- **Rick Kriss**, Founder and Managing Director, KLATU Networks;
- **Cheryl Linder,** Global Offering Leader, Energy and Utilities Industry, IBM Global Business Services; and a course alum;
- **Bruce Lovelin**, Chief Engineer/Systems Engineering Manager, Central Lincoln PUD;
- **Richard Lowenthal**, CEO, Coulomb Technologies;
- **Dr. Loren Lutzenhiser**, Professor of Urban Studies and Planning, PSU;
- **Lisa Magnuson**, Senior Director of Marketing & Brand Programs, Silver Spring Networks;
- **Eran Mahrer**, Vice President, Research and Strategy for Strategy for the Solar Electric Power Association;
- **James Mater,** Co-Founder and Director, Quality Logic, Inc., and Founder, The Oregon Smart Grid Start Up Project; and later a course faculty member;
- **Hillary McBride**, Community Relations Officer Emerald People's Utility District;
- **Dr. Ron Melton**, Director, Pacific Northwest Smart Grid Demonstration Project; Administrator, GridWise Architecture Council; and senior technical leader for Smart Grid Research and Development Projects, Pacific Northwest National Laboratory;
- **Pamela Morgan**, President and Principal Consultant, Graceful Systems LLC; founding course faculty member;
- **Tim Morrow**, Balancing Authority Operator, Portland General Electric;
- **Terry Oliver**, Chief Technology Innovation Officer, Bonneville Power Administration; and a course alum;
- **Brent Olsen**, Program Manager, Dispatchable Standby Generation, Portland General Electric;

- **Ron Pernick**, Managing Partner, Clean Edge. Inc., and Adjunct faculty, PSU School of Business Administration;
- **Rob Pratt**, GridWise Program Manager, Pacific Northwest National Laboratory, US Department of Energy;
- **Will Price**, Energy Resource Analyst II, Eugene Water and Electric Board;
- **Dr. Robert Procter**, Senior Economist, Electric Rates & Planning, Oregon Public Utilities Commission;
- **Steve Pullins**, President, Horizon Energy Group, and Team Leader, Modern Grid Strategy, National Energy Technology Laboratory;
- **Thomas Puttman,** PE, AICP, LEED AP, Sustainable Infrastructure Lead, David Evans and Associates;
- **Linda Ratkin**, IT professional, visionary for PSU Smart Grid Living Laboratory; a course alum and later a course faculty member;
- **Alexis Ringwald,** Co-founder and CEO. LearnUp; former Director, Business Development, Serious Energy at Serious Materials; formerly Co-founder and Director of Business Development at Valence Energy, Co-Director, Climate Solutions Road Tour, Fulbright Scholar, The Energy and Resources Institute, New Delhi;
- **Joey Ross**, Manager, Innovative Solutions, Portland General Electric;
- **Anders Rydaker**, President, District Energy St. Paul and President, Ever-Green Energy;
- **Tony Seba**, "Clean Disruption Expert" and author of *Clean Disruption of Energy and Transportation*;
- **Scott Shull***,* Strategic Planner, Eco Technology Innovations Program, and Director, Smarter Commercial Buildings, Intel Corp;
- **Lisa Schwartz**, Senior Associate, Regulatory Assistance Project; later director, Oregon Department of Energy, currently Team Leader, Electricity Markets and Policy Group, Lawrence Berkley National Laboratory;
- **Lauren Shapton,** Manager, Mass Market Programs, Portland General Electric;
- **Mark Shanahan**, former Executive Director, Ohio Air Quality Development Authority; formerly Energy Advisor to then Ohio Governor Ted Strickland;
- **Scott Shull***,* Strategic Planner, EcoTechnology Innovations Program, and Director, Smarter Commercial Buildings, Intel Corp;
- **Jason Slami-Klotz**, Senior Policy Advisor, Northwest Energy Efficiency Alliance; anda course alum;
- **Dr. Aaron Snyder**, Director, Smart Grid Labs, EnerNex;
- **Matt Spaur**, Advanced Metering and Smart Grid Market Development, Itron, Inc.;
- **Pamela Sporborg**, FERC Compliance Analyst, Portland General Electric;

- **John Stafford**, Vice President Conservation Solutions, Sensus;
- **Tom Starrs**, Vice President, Market Strategy and Policy, SunPower Corporation;
- **Chris Thomas**, Policy Director, Citizens Utility Board of Illinois;
- **John Thornton**, Vice President, Manufacturing & Supply Chain, Porteon Electric Vehicles, Inc.; and a course alum;
- **Dr. Robert Topping**, Interim Director and Director of Strategic Initiatives, Regional Education and Training Center (RETC); and a course alum;
- **Jaimes Valdez**, Policy Director, Northwest Sustainable Energy for Economic Development (Northwest SEED); and a course alum;
- **Kevin Walker**, Chief Operating Officer, Iberdrola USA; formerly Senior Vice President and Chief Information Officer, American Electric Power, and President and Chief Operating Officer, American Electric Power (AEP) Ohio;
- **Kevin Watkins**, Vice President of Engineering, PNGE Power;
- **Jon Wellinghoff**, Chairman of the Federal Regulatory Commission;
- **Dan Williams**, Chair of the Northwest Power Pool's Market Assessment and Coordination (MC) Leadership Committee, and Portland General Electric's MC Lead.

During the Spring Term, multidisciplinary student teams work on "real world" projects. They are supported and mentored by members of the faculty team, but also by members of Project Advisory Teams who have been recruited as a result of their technical and/or policy expertise. Advisory Team members from 2009 onward have included:

- **Lisa Adatto**, Oregon Director, Climate Solutions; and a course alum;
- **Tomm Aldridge**, Principal Consultant, Ergsense/Energy Research Group, and recently retired Director of Internet of Things Technology Acceleration, and Energy and Sustainability Research Labs at Intel;
- **SA Anders**, Director of Operations, Citizens Utility Board of Oregon; Board Treasurer, Smart Grid Consumer Collaborative; now Smart Grid Projects and Projects manager, Portland General Electric; and a course alum;
- **Rob Bennett**, CEO, Ecodistricts;
- **Joe Barra**, Director of Customer Energy Resources, Portland General Electric;
- **Kathleen Belkhayat**, Business Sector Project Manager and Strategic Energy Management Project; and a course alum;
- **George Beard**, Strategic Alliance Manager, PSU;
- **Fletcher Beaudoin**, Long-term Sustainability Planner, PSU; and a course alum;
- **Greg Bingham**, Project Manager, Merchant Transmission & Resource Integration, Portland General Electric;

- **Jennifer Blake**, New Construction-Major Renovation/Lighting Specialist, Evergreen Consulting;
- **Scott Bolton**, Vice President, External Affairs, Pacific Power;
- **Shanna Brownstein**, Manager Governmental & Community Affairs, NW Natural, and founder of Women in Sustainability and Environment (WISE);
- **Bill Campbell,** Principal, Equilibrium Capital Group, and Board Chair, EnergyRM;
- **Ken Corum**, economist/consultant, former lead for the Northwest Power and Conservation Council's Pacific Northwest Demand Response Project
- **Joan Effinger**, Project Manager, Emerging Technologies, Portland General Electric
- **Tony DeFalco**, Living Cully Coordinator, Verde;
- **Ryan Fedie**, Engineering Manager, Energy Efficiency, Bonneville Power Administration, and course alum;
- **Tom Foley**, Smart Grid Oregon Board Member; former board chair, Energy Trust of Oregon; and senior staff, Northwest Power and Conservation Council;
- **Jason Franklin**, PSU's Director of Campus Planning and Design;
- **Mark Fuji**, Capital Construction Project Manager, PSU;
- **Mark Gregory**, Associate Vice President for Finance & Administration, PSU;
- **Roy Hemmingway**, Energy Consultant, Smart Grid Oregon Board Member, and former Chair, Oregon Public Utilities Commission;
- **Bill Henry**, Senior Associate, EQL Energy, and former Analyst at Ecofys, and an alum in this and other PSU energy classes;
- **Mike Hoffman**, Co-Founder, Powermand and Senior Energy Analyst, Pacific Northwest National Laboratory;
- **William Holmes**, Partner, K&L Gates;
- **Andria Jacob**, Senior Manager, Energy Programs and Policy, City of Portland Bureau of Planning and Sustainability;
- **Dwayne Johnson**, Co-founder and Partner, ScaleUp Partners LLC and self-described "Social Alchemist";
- **Dr. David Kathan**, Senior Economist and Group Manager, Office of Energy Market Regulation, Federal Energy Regulatory Commission;
- **Jess Kincaid**, Senior Operations and Policy Analyst, Oregon Department of Energy;
- **Tom Konicke,** Portland Manager, Energy & Facilities Services, McKinstry;

- **Dr. Wayne Lei**, Director, Research and Development and Smart Grid Programming, Portland General Electric;
- **Benjamin Lyon**, Utility Program Manager, Enlighted, Inc.;
- **John McArthur**, Sustainable Transportation Program Manager, Oregon Transportation Research and Education Consortium, (OTREC);
- **Catriona McCracken**, General Counsel and Regulatory Program Director, Citizen's Utility Board of Oregon;
- **Preston Michie**, former Assistant General Counsel and current contract lawyer/consultant, Bonneville Power Administration;
- **Mark Miller**, Account Executive Long Term Sales and Purchases, Bonneville Power Administration;
- **Noel Mingo**, Utilities Manager, PSU;
- **Scott Nelson**, Oregon Governor Kitzhaber's Senior Advisor on Jobs and the Economy;
- **Ken Nichols**, Principal at EQL Energy and a former Director at Ecofys, and former faculty member and course alum;
- **Mark Osborn**, Distributed Resources Manager, Portland General Electric; later a course faculty member;
- **Elizabeth Paul,** Director, Business Model and Program Development; Lead, Program Development and Strategic Intent, Portland General Electric;
- **Dr. Robert Procter**, Senior Economist, Electric Rates & Planning, Oregon Public Utilities Commission;
- **Mark Rehley,** Senior Manager Technology and Product Management, Northwest Energy Efficiency Alliance;
- **Dave Robertson**, Vice President for Public Policy, Portland General Electric;
- **Kelly Sanders**, Senior Product Manager, Northwest Energy Efficiency Alliance;
- **Maty Sauter**, T&D Analyst, Strategic Asset Management, Portland General Electric;
- **Vijay Satyal**, Senior Policy Analyst at WECC and formerly Senior Policy Analyst at ODOE;
- **Dr. Kevin Schneider**, Principal Research Engineer, Pacific Northwest National Laboratory; Affiliate Assistant Professor, University of Washington; and adjunct Professor, Washington State University;
- **Dr. Gerald Sheblé,** Professor and Ausgrid Chair in Electric Power Economics, School of Electrical Engineering and Telecommunications, University of New South Wales, Australia; and founding course faculty member;

- **Tim Smith**, Director of Urban Planning, SERA Architects;
- **John Sorenson**, Executive Director, N2e; and a course alum;
- **Ann Steeves**, Operations Manager, Business Continuity Emergency Management, Portland General Electric;
- **Marvin Surhan**, IBM Intelligent Utility Network;
- **John Thornton**, President, CleanFuture; Energy Advisor, Northwest Food Processors Association, Vice President, Manufacturing & Supply Chain, Chair, Industry Advisory Committee, Drive Oregon; Porteon Electric Vehicles; and a course alum;
- **Jaimes Valdez**, Policy Manager, Northwest Sustainable Energy for Economic Development (Northwest SEED); formerly Energy Policy Analyst and Renewable Energy Specialist with City of Portland's Bureau of Planning and Sustainability, where he managed Solarize Portland and Solar Forward; and course alum;
- **David Van't Hof**, Energy Consultant/Attorney, David Van't Hof Legal and Strategic Services, and course alum
- **Ben Walsh**, Principal, Miter Construction Management (green builder), and course alum;
- **Kevin Watkins**, PNGE Power Vice President of Engineering;
- **Kevin Whitener**, Smart Grid Project Manager, Portland General Electric;
- **Lorie Wigle,** General Manager, Eco-Technology Program Office, Intel Corporation;
- **Bryce Yonker**, Executive Director, Smart Grid Northwest, and Director of Business Development at Clean Edge.

Instructor Biographies

Dr. Hal Nelson

Hal T. Nelson, is an associate professor in the Department of Public Administration at Portland State University. His teaching interests include Data Science, Smart Grid, Energy Policy, Energy Justice, Public Policy Process, Intro to Public Policy, and other classes.

Dr. Nelson researches environmental, social and economic sustainability, primarily in the energy sector. He recently completed a grant from the National Science Foundation's Civil Infrastructure System program that applies an agent-based model of socio-political conflict to the permitting of energy infrastructure projects. Dr. Nelson's private sector research includes the development of big-data software tools to improve energy efficiency and energy equity for residents in apartment buildings.

Mark Osborn

Mark T Osborn is an independent consultant and Senior Technology Advisor to QualityLogic, Inc. He has extensive energy industry experience developing and managing Distributed Energy Resource (DER) projects -- solar, energy storage, demand response and distributed generation. He is currently focused on the mission to improve interoperability and data

integrity reporting for DER communications systems. As adjunct professor at Portland State University, Mark has co-taught "PA573 The Smart Grid and Sustainable Communities" since 2012. His most recent electric utility experience was Smart Grid Manager for Portland General Electric.

Key DER projects developed by Mr. Osborn include: 1) The Salem Smart Power Project, featuring a 5MW, 1.25MWh battery energy storage facility aiding renewable power integration; residential and commercial demand response; distribution automation; and a microgrid for an entire distribution feeder; 2) America's First Solar Highway Project -- the first installation of a solar array along an interstate highway; which includes a 104kW demo-project at I-5/I-205 and the Baldock Solar Station -- a 1.75MW array at an I-5 rest area near Wilsonville, OR.; 3) the Northwest's largest rooftop solar project -- a 3.5MW thin-film warehouse roof installation; 4) the Dispatchable Standby Generation program – at over 125 MWs, it is the nation's largest networked installation of customer-owned paralleled distributed generators for utility peaking & operating reserves support.

Mark has authored numerous articles & papers on DER, including:

- **"Readying Your Facility for Energy Storage and Microgrids"** Osborn, M. and Kennedy, J. (Cadmus), 20th biennial ACEEE Summer Study on Energy Efficiency in Buildings, August 2018. https://aceee.org/files/proceedings/2018/#/paper/event-data/p193

- **"Energy Storage in the Northwest"** Osborn, M., Wang, J., Shaw, S. (Cadmus), Proceedings from Smart Grid Northwest's 2017 Northwest Demand Response + Energy Storage Summit, September 2017. https://cadmusgroup.com/cp/energy-storage-in-the-nw/

- **"Demand Response in the Northwest"** Osborn, M., Wang, J., (Cadmus), Proceedings from Smart Grid Northwest's 2016 NW Demand Response Symposium, September 2016. https://cadmusgroup.com/papers-reports/demand-response-in-the-northwest/

- "**Interoperability: Why Policy Makers Should Make It Their Personal Mission**" Osborn, M,
(Five Stars International), ElectricityPolicy.Com, October 2015.
https://www.qualitylogic.com/wp-content/uploads/2016/06/Osborn26Oct2015.pdf

- **"Emerging Changes in Electric Distribution Systems in Western States and Provinces"** prepared for the Western Interstate Energy Board (WIEB)/State-Provincial Steering Committee (SPSC), April 29, 2015, Author(s): Frances Cleveland, Xanthus Consulting International; Mark Osborn, Five Stars International, Ltd., Ken Nichols & Bill Henry, EQL