PA 573

Smart Grid and Sustainable Communities

Last Modified 26 May 2022

Dropbox Link to this document

Link to Speaker Table

Official (Old) Course Description

The course provides students with a basic understanding of Smart Grid technology, including grid modernization, internet of things (IoT) and the conditions that need to be in place for its success as a policy & planning tool for reducing CO2 emissions and adding sustainability and resilience to communities. Students will be provided with the historical development of the technology and its current status from the standpoint of policy and planning implementation.

Background

This course analyzes the issues surrounding the "modernization" of the electricity grid in the early 21st century. The old utility business model with a centralized grid run by regulated utilities or public power agencies has been inundated by a wave of technological breakthroughs, including plummeting solar panel and energy storage costs, proliferation of wind turbines, and continual development of cheap voice-activated electronic communication tools to enable smart domestic appliances and heating and cooling equipment to follow commands of the owner. With a host of disruptive business innovators, and demands for real-time electricity pricing that is more reflective of actual costs, the pace of grid modernization continues to increase.

This interdisciplinary course is co-taught by a team of academic and private sector specialists to prepare students to contribute to grid modernization as project developers, engineers, program managers, policy analysts, and other key positions. Coursework focuses on a team project and presentations with weekly guest speakers from industry and policy and may include optional field trips.

Course Information

Time: Tuesdays 6:40-9:20 Begins March 29th through June 7th
Room: In-Person in URBN ~~303~~ 205 and Via Zoom link below
CRN: 64510

Instructors

1. Hal T. Nelson, Ph.D., CFA
   Associate Professor
   Email: HNelson@pdx.edu
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2. Mark Osborn
Phone: 503.709.9373 (mobile)
osbornm@comcast.net

Technology Specialist/
Professional Development Coordinator
Josh Metzler
jmetzler@pdx.edu

Office Location: URBN 670L

Office Hours: Tues 4:00-6:00 & by appointment (preferred)
The best way to get in touch with me is via email. I will endeavor to respond to email/voice messages within 1+/-1 business day. Please include PA 573 in the subject line. Please do NOT use the CANVAS email.

I have office hours each Tuesday 4:00-6:00. You can join in person or via Zoom and wait in the virtual waiting room until I am done with the previous student.

https://pdx.zoom.us/j/6231944655 (Passcode: 1781)
One tap mobile
+16699009128,,127626903# US (San Jose)
+13462487799,,127626903# US (Houston)
Meeting ID: 127 626 903

If you are in the waiting room for a while, please text me on my mobile # above.
You can also schedule a meeting with me between 4:00 and 6:00 on Tuesdays via email.

The course is taught live in-person and simultaneously via Zoom, which provides several ways for students who live away from Portland or who expect to travel during the Spring. **Two Distance Learning** options are available for interested graduate students and mid-career professionals:

- **Live Streaming.** Participants can steam the class live on their computers. They can ask questions as well as participate in discussions with the help of 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.

Course Meeting Information

- To get to the class session from Canvas:
  - Log into Canvas
  - Select the class
  - Select Zoom Meetings

Topic: PA 573 Smart Grid NEW Zoom Link
Time: Apr 19, 2022 06:30 PM Pacific Time (US and Canada)

Please download and import the following iCalendar (.ics) files to your calendar system.
Join Zoom Meeting
https://pdx.zoom.us/j/84520543408
Meeting ID: 845 2054 3408

Telephone Commands:
*6 - Toggle mute/unmute
*9 - Raise hand
iPhone one tap mobile
+19712471195,,84520543408# US (Portland)
+17209289299,,84520543408# US (Denver)

Dial by your location
+1 971 247 1195 US (Portland)
Meeting ID: 845 2054 3408
Find your local number: https://pdx.zoom.us/u/kwDZprLyW

Course Competencies
PSU's Department of Public Administration has developed a list of "key competencies" that students are expected to develop through their various course and experiences at PSU. The following key competencies are supported by this course.

1. Conceptualize, analyze, and develop creative and collaborative solutions to challenge in public policy, leadership and management.

2. Assess challenges and explore solutions to advance cross-sectoral and inter-jurisdictional cooperation in public programs and services.

3. Demonstrate verbal and written communication skills as a professional and through interpersonal interactions in groups and in society.

4. Think critically and self-reflectively about emerging issues concerning public service management and policy.

Expectations, Logistics, and Course Policies

Remote Learning Practices
The course will be delivered synchronously meaning that we will be interacting in real-time! We are all getting used to online learning, so expect errors and be generous and empathetic to yourself and others in the class.

- Interactive video conferencing is an art, not a skill! Feel free to ask questions via audio when you have them. However, the timing of asking is the art-part:
  - Wait for the speaker to pause, or until you think they are about to pause, before inserting your question. (Also make sure your audio is unmuted).
  - Listen for others speaking and yield the mic when in doubt. Talking over others and interjecting repeatedly makes for a less successful session.
- We will be using the interactive tools that are built-in to Zoom.
  - One set of tools is nonverbal feedback in the participants button at the bottom: click on that and there are icons for what you are feeling: Raise hand, away, need a break, go slower, faster, yes, no.
- We will be dividing into smaller groups for a discussion using Zoom's Breakout Room feature to assign students into groups for a short period of time so you may discuss things together.

- We will be recording the Zoom sessions for later review and integration
    - Because the sessions will be recorded, and I don't know what all gets recorded, be careful about what you write in the chat and say in the chat rooms. Do not communicate personal information that you don't want others to see!!

Technical Issues

- Everybody should remember to breathe deeply at all times. We are going to make this work the best we can and beyond that not worry about it.
    - Please use my office hours to schedule a time to meet with me to let me know how the course is going for you
- Join 10 minutes early the first session to get tech issues ironed out.
- If the Zoom meeting fails, look for an email from me on next steps
- If your internet bandwidth is limited, call in to Zoom on the 877#, and use the computer for video.
    - If the audio keeps breaking up, then turn off the video and let me know via that chat function the audio quality was bad.
- If you don't have internet access at home check this out: https://www.digitalinclusion.org/free-low-cost-internet-plans/
- Two student computer labs will remain open during spring term — with proper health practices in place — in the first floor of Millar Library and in the basement of Fariborz Maseeh Hall.
- OIT has laptops to check out for students who need them (maybe): https://library.pdx.edu/study-spaces-computers/equipment/
- OIT has released an early version of a new Virtual Computer Lab (VLAB) service for students at vlab.pdx.edu. VLAB lets students remotely access a selection of academic software applications from their personal computers, which can make it easier for students to complete coursework by removing some physical and financial barriers. To learn more, visit the VLAB help article. Please be patient as OIT works out the kinks.

- Bring-your-own-device (BYOD): We are attempting to make this course paper-free, and as such, we will view materials electronically during class. If you need additional time to view these materials, then you will need to bring an electronic device that is suitable for viewing documents and PDFs.
- Cell phones and laptops: Please make sure that your cell phone ringer is turned off. If you have an emergency call during class, please be sure to make it outside the classroom. Laptops are viewed as a privilege and can be used for taking notes, but ***students are not to use laptops or cell phones for extra-curricular activities during class***.
    - Please do not surf the web or answer emails during class;
        - Students doing so will be penalized in their course participation component.
- Pass/No-Pass: Due to the new remote learning requirements, PSU is allowing students to temporarily take courses via Pass/No Pass option. The Public Administration department allows grades of B- or better to qualify for Pass. Any Pass/No Pass courses will not count towards your GPA except for CoVid allowances.
    - *If you think you may use this grading option, I have a strong preference that you do it by week 3 at the latest.*
- **Ethics: Plagiarism is a no-no and is grounds for failing the class and expulsion from PSU**.
    1. For- credit students: Cite all sources if you are paraphrasing, and use quotation marks if you are quoting. Scientific and Professional Ethics require that the work

you do in this course must be your own. Feel free to build on, react to, criticize, and analyze the ideas of others but, when you do, make it known whose ideas you are working with. You must explicitly acknowledge when your work builds on someone else's ideas, including ideas of classmates, professors, and authors you read. If you ever have questions about drawing the line between others' work and your own, ask and I will give you guidance.

- **Course papers may be required to be submitted through TurnitIn, a plagiarism software platform.**
- You can collaborate on the homework, but your submitted work should be your own. In many cases in the past, "joint" homework answers have been incorrect. If I suspect copying, I may give unannounced in-class quizzes to test for comprehension of the homework knowledge domains.

- Late work. Late work is accepted, but will result in penalties for tardiness of one full letter grade. This is done for equity reasons to level the playing field for those who manage to turn their work products in on time. Incompletes are not granted except in the case of hardship.
- Attendance. Graduate students are expected to attend all classes. Students who are unable to attend class must seek permission for an excused absence from me or my teaching assistant. *Per Department policies, unapproved absences or late attendance may result in a lower grade for the course*. If a student has to miss a class, s/he should arrange to get notes from a fellow student and is strongly encouraged to obtain the missed material.
    - If you observe a religious occasion on the same day as class, please let me know prior to the day of observance.

  Since the course modules will be recorded and available offline students who are not able to attend will be required to view the videos prior to the next week's class.

Evaluation: For-Credit Students

1. You are required to compose a group research paper that integrates the course learning objectives into an arena of your choosing (40%).
    a. There will be a paper proposal handed out that will outline the research design and methods assignment
        i. The proposal is a ~1 page document that discusses
            1. One paragraph background on why the topic is important
            2. What are 1-2 barriers for the technology, program or policy you are researching/
            3. What are the criteria that you will be using to evaluate the technology, program or policy? These are efficiency (cost), effectiveness (penetration, energy savings, load shifting, etc), equity (how are different customer segments impacted), externalities (mitigating CO2, etc)
            4. Key research question(s) that will be addressed in the paper.
            5. Analysis techniques you expect to use: levelized cost of energy comparisons, benefit-cost analysis, penetration simulations, SWOT analysis, etc.
            6. Types of data that will be collected and sources.
            7. Key audience (community partner, journal target)

ii. More information on the research paper will be given out at a later date.

Research ideas are in the research interests tab here: https://docs.google.com/spreadsheets/d/1tcuYxjihgDYbHAIao3Bw5-Vg9MfAmyBLQeX0Asmt5f0/edit#gid=619055644

iii. Each member of the group will be graded on the quality of their own unique contribution to the paper. Each group member's effort on the paper will be graded by their peers.

1. Working in a group is optional—you may prepare your own paper.

iv. You are expected to be able to write at the graduate level, including concise summaries of policy concepts and results. I may refer you to the writing center: http://www.pdx.edu/writing-center/

b. Students are expected to give a short presentation of their research topic the last week of class. This "mini-conference presentation" is a key learning outcome (15%)

2. Two homework assignments (25%)
   a. The first homework assignment is for you to prepare a half page (single spaced) with: 1) your biographical information (see example) 2) your energy related career interests 3) A fun fact about you. 4) Two or Three smart grid technical or policy issues that you are interested in. Give a 1-2 sentence description of each of your interests. The bio information goes in the Google Doc here:
   b. Energy analysis of smart grid topics (more information on a handout to be distributed later. Due in Word Doc format on CANVAS >Assignments> HW#1
3. Course participation consists of two elements weighted equally (20%). Both are due at 6:40 PM each week; one based on the current week's readings, and one based on the previous weeks speaker's comments.
   a. Before Class Preparation (BCP): This assignment is based on the upcoming week's readings and due on Canvas>Assignments at 6:40 pm on Tuesday night prior to each week's course session.
      i. AFTER completing the week's readings, carefully craft one question **for the speaker** that you develop on your experience and the reading material. The question can be a clarification of the material, an extension of the speaker's material, a linkage between the speaker's material and other course reading. It can also identify logical inconsistencies in the material, question the "conventional wisdom" or ask questions about evaluative criteria that the speaker did not cover (ie equity, externalities, effectiveness, efficiency, or empowerment). These questions will be shared on the discussion board as possible for the speaker Q&A.
   b. After Class Discussion: This assignment is based on the **previous week's speaker's comments** (and the associated readings for the previous week) and is for your fellow students and the co-instructors. It is due on Canvas>Assignments or Canvas>Discussions>Week# at 6:40 pm on Tuesday night after each week's course session.

i. The discussion question can be a follow on question from your BCP, something that sparked your interest from the class discussion, or it can be linking the previous week's readings to the upcoming week's readings. Please read the following blog on how to write engaging discussion questions: https://www.eduflow.com/blog/how-to-write-discussion-questions-that-actually-spark-discussions

c. NEW: to better integrate student discussion questions, we are adopting student's suggestions from the mid-term survey. You need to read all the student After Class Discussion posts each week and reply to one. Replying a thread each week is now part of the participation element of the class.

Evaluation: Professional Development (ProDev) Participants

- Professional development participants MUST complete the assignment to prepare a one paragraph bio on their history, interests, and future plans/desires. Here is the link to the Google Doc: https://docs.google.com/document/d/1_5qz3LzNmCq-knIkWrG9j_BCsPH64rSMjk7mv-gEJT4/edit?usp=sharing
- ProDev Participants are strongly encouraged to join one of the research paper groups and offer their sage counsel to their peers.
- ProDev Participants are also encouraged to bring in relevant news articles / reports to share with the class.
- NOTE: If you take the class through the professional development option, you will not be able to retroactively have it count towards the Graduate Certificate in Energy Policy and Management. If you think you may want to pursue the certificate, I suggest that you enroll for the class as for-credit.

Grading Scale

Your grade will be calculated using the following scale. Grades with plus or minus designations are at my discretion.

Letter Grade	Grade Point	Description	Learning Outcome
A	4.0	Complete mastery of course material and additional insight beyond course material	Insightful
B	3.0	Complete mastery of course material	Proficient
C	2.0	Gaps in mastery of course material; not at level expected by the program	Developing
U	0	Unsatisfactory	Ineffective

Grading Details

Letter Grade	Range	Letter Grade	Range
A	93-100	C+	77-79
A-	90-92	C	73-76
B+	87-89	C-	70-72
B	83-86	Let's talk	<70
B-	80-82		

- Grade Appeals: If you want to appeal a grade that you received on a work product, please submit a short written summary of your argument as well as relevant documentation. Grade change requests will not result in a lower grade being given.

Required Course Readings

All students are **required** to buy the following book:

- Peter Kelly-Detwiler. (2021). *The Energy Switch: How Companies and Customers are Transforming the Electrical Grid and the Future of Power.* Prometheus Books.

If you buy it online, be sure to get expedited shipping as we will be using it immediately. Handouts from other book chapters will be given for the reading assignments. Additional readings are in the Modules folder.

In addition to the course text, **other required** journal articles and book chapters will be posted on CANVAS and emailed to you each week.

- If something is missing please email Prof. Nelson immediately: hnelson@pdx.edu
- Optimal readings are always coming across our desks. The syllabus may contain TBA (to be announced) when we have yet to find an optimal reading to exhibit the learning goals of the week. Thus, the syllabus should be considered a living document that will change over the course of the term. *The most current version can always be found on CANVAS and you should consult it before doing the readings each week*. Never fear: We will email you the final list of readings each week.
- The industry if full of horrible acronyms. Please see a handy cheat sheet here.

Recommended Readings

We reserve the right to distribute additional readings as the term progresses. We will usually bring some elements of the recommended readings into the class discussions, so some familiarity with them (i.e. quick scan) on your part will be beneficial to your learning environment.

Great information can be found on energy policy and management in the NW through the local industry newspaper, Clearing Up. You need to sign up in the Clearing Up tab Google Sheet with your name and PSU email here:

Important Due Dates

- HW#1: 5 April on CANVAS
- Bios on Google Drive: 19 April (Pro-Dev Students)
- HW#2: ~~17 May~~ 19 May at 6:40 on CANVAS
- Final paper due: 10 June at 6:40
    - Paper Proposal Due: 3 May at 6:40
    - Student research presentations: 7 June at 6:40 pm in-class
        - DRAFT DUE 5 June

Course Modules, Guest Speakers, & Assignments (SUBJECT TO CHANGE): Readings are listed below and can be *accessed by clicking on the Topic's hyperlink*.

Please note that all our sessions are being recorded and speakers and students are presenting as individuals, not as members of any organization.

Date	Week	Topic (Each session is recorded and placed in its Canvas>Module>Week# Folder)	Guest Speaker	Assignment Due
29 Mar	1	Class Overview, Teams, Projects – Grid 101 (part 1)	Osborn & Nelson	
5 April	2	Grid 101 (part 2) – Electric Power Fundamentals Don't forget about the handy energy acronym cheat sheet here	Osborn	HW#1 Due on Google Doc (Grad Students)
12 April	3	Grid Modernization Parts A & B: **A)Forecasting** **B) Infrastructure Funding**	Josh Keeling (Cadeo) confirmed. Jeff Hammarlund (PSU)	
19 April	4	Energy Resilience and Energy Equity	Jen Yoshimura. (PNNL) Confirmed	Bios on Google Doc Due (Pro-Dev Students)
26 April	5	Grid-Interactive Efficient Buildings	Alexi Miller (New Bldgs Inst) Confirmed	
3 May	6	Customer-Sited Microgrids	Kevin Whitener (PGE) Confirmed	Draft Paper Proposal Due (Grad Students
10 May	7	Energy Storage Technologies	Shawn Shaw (Camelot Energy Group) Confirmed	
17 May	8	Electric Vehicles and Charging Infrastructure Solar Policy & Battery Management	Nelson and Osborn (PSU) confirmed	HW#2 Due 19 May on CANVAS (Grad Students)
24 May	9	Cyber Security	Bob Bass (PSU) (Confirmed) Julia Babcock & Chip Corbett (OSU)	
31 May	10	Emerging Grid Technologies	Jenny Roehm (Schneider Elec) Confirmed	5 June Draft PPTs due (Grad Students)
7 June	11	Smart Grid Public Forum Class will be held at its normal time during finals week.	Students	Student research presentations **10 June** Final paper due 640 PM. All work products due 640 PM.

- Final Team Paper Due on Assignments >Final Paper on 10 Jun (6:40)
- Team Evaluations Due on Modules>Assignments>Team Evaluation on 10 June (6:40)
- All Materials for Class Due on 10 June (6:40)

COURSE MODULES AND READINGS: Note If there is a discrepancy between what is on the syllabus and what is on Canvas>Modules>Week#, please use THIS document as the master source.

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Week 1

Class Overview, Teams, Projects, Grid 101 (part 1)

- Peter Kelly-Detwiler. (2021). Chapters 1 & 2.

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Week 2

Grid 101 (part 2)

Required Readings:

- Peter Kelly-Detwiler. (2021). Chapters 3&4. (Skim 1&2 if you didn't get to them last week)
- The Energy Imbalance Market (EIM) and Extended Day Ahead Market
    - If you haven't heard of the EIM check out this 1 page overview as well as the 2021 annual report news announcement here.
    - The EIM is for the 5-minute "real-time" market yet most electricity is traded on the "day ahead" market. Western stakeholders are working to expand the EIM to the day-ahead market. There is a good overview of it in:
        - St John, J. (2019). The Extended Day-Ahead Market: A Western US Grid Plan Emerges. Greentech Media. Available here.
        - More detailed and current information is available on the CAL ISO website here
- Bush, S. F. (2014). *Smart grid: Communication-enabled intelligence for the electric power grid*. John Wiley & Sons. Ch 4. On Canvas.

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Week 3

Grid Modernization: Forecasting and Infrastructure Funding

Guest Speakers: Josh Keeling (Cadeo) confirmed. Jeff Hammarlund (PSU)

Required Readings:

- Peter Kelly-Detwiler. (2021). Chapters 5, 6, 11.
- Paaso, A., Burica, N., & Burg, R. (2022). Realizing the Value of DERs: A Utility Perspective. *IEEE Power and Energy Magazine*, 20(2), 39-46. On Canvas.
- Cadeo. (2021). Appendix G: PGE DR and Flexible Load Potential-Phase 1 EXECUTIVE SUMMARY ONLY. 7 July. Also, check out the Distribution System Plan report here. Appendix G is here
- NREL. (2021). LA100: The Los Angeles 100% Renewable Energy Study. Executive Summary. March. https://www.nrel.gov/docs/fy21osti/79444-ES.pdf
- Hammarlund, J. (2022). The Dance of Legislation: A Chronology of Events and Efforts to Get the Build Back Better Bill through the Senate (See Word Doc: Do the best you can with the time you have).
    - Skim: The Dance of Legislation-A Chronology.pdf
    - Read other articles as interested in the list in the word Doc above.

Supplemental Readings

- PGE. (2021). *Understanding My Bill: Guide to charges and other important information*. https://portlandgeneral.com/help/help-topics/understanding-my-bill
- APPA. (2016). *Rate Design Options for Distributed Energy Resources*. Pp. 1-8.& one rate design of your choice. (Take the 20% PV generation on pp 1-5 with a grain of salt: PV penetration in most states is in single digits. But it's an important topic: Especially when we get to discussions of decommissioning the gas grid) https://www.publicpower.org/system/files/documents/ppf_rate_design_options_for_der.pdf

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Week 4: Energy Resilience & Energy Equity

Guest Speaker: Jen Yoshimura (PNNL)

Required Readings:

- Fox-Penner, P. (2020). *Power After Carbon*. Chapter 5: The Fragmented Future. Pp 65-81 ONLY. On Canvas.
- Samuelson, H., Baniassadi, A., Lin, A., González, P. I., Brawley, T., & Narula, T. (2020). Housing as a critical determinant of heat vulnerability and health. *Science of the Total Environment*, 720, 137296. On Canvas.
- Nelson, H. (2020). *What if We Build It and Nobody Comes*? MP4 Presentation at Transactive Energy Systems Conference. December. On Canvas.
- Baker et al. (2019). The Energy Justice Workbook. https://iejusa.org/workbook/ Pp. 1-25 ONLY
- Tarekegne, B. W., Pennell, B. G., Preziuso, D. C., & O'Neil, R. S. (2021). Review of Energy Equity Metrics (No. PNNL-32179). Pacific Northwest National Lab. On Canvas.
- https://www.eenews.net/articles/want-more-solar-panels-good-luck-connecting-to-the-grid/

Supplemental Readings

- DOE. (2022). Are you Ready? Preparing Homes for Extreme Weather. Peer Exchange Call. March. SKIM. On Canvas.
- Peart, N. (2021). How Indigenous Communities Are Building Energy Sovereignty. Yes! Magazine. 21 Aug. https://www.yesmagazine.org/environment/2021/08/18/indigenous-communities-energy-sovereignty
- FERC. 2022. https://www.ferc.gov/OPP

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Week 5: Grid Interactive Efficient Buildings

Guest Speaker: Alexi Miller (New Buildings Inst)

Mid-Course Survey

Required Readings:

- Peter Kelly-Detwiler. (2021). Chapter 12.
- US DOE. (2021). A National Roadmap for Grid Interactive Efficient Buildings. 17 May. CHAPTERS 1-3 plus an additional chapter of your choosing. Located here.
- Carmicheal, C. (2018). Show me the money: The business opportunity for grid-interactive buildings. Greenbiz

https://www.greenbiz.com/article/show-me-money-business-opportunity-grid-interactive-buildings

- GSA Green Building Advisory Committee Advice Letter on Building & Grid Integration https://www.gsa.gov/cdnstatic/Bldg%20Grid%20Integration%20Advice%20Letter%202-21-19%20-%20508.pdf
    - Read the first 3 pages and read part 1. Skim part 2, part 3, and brief case studies on p23.

Supplemental Readings

- Amann, J., R. Srivastava, and N. Henner. 2021. Pathways for Deep Energy Use Reductions and Decarbonization in Homes. EXECUTIVE SUMMARY. Washington, DC: ACEEE. aceee.org/research-report/b2103
- Hledik, B. et al. (2021). An Assessment of Electrification Impacts on the Pepco DC System. SKIM. Located here.
- Sepúlveda-Mora, S. B., & Hegedus, S. (2021). Making the case for time-of-use electric rates to boost the value of battery storage in commercial buildings with grid connected PV systems. *Energy*, *218*, 119447. Located here
- APPA. (2020). Moving Ahead with Time of Use Rates. Located here.
- Miller, A. et al (2020). New Metrics for Evaluating Building-Grid Integration. https://newbuildings.org/wp-content/uploads/2020/11/NewMetricsForEvaluatingBuildingGridIntegration.pdf

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Week 6

Customer Sited Microgrids and California

Guest Speaker: Kevin Whitener (PGE)

Required Readings:

- Fox-Penner, P. (2020). *Power After Carbon*. Chapter 11: Governing a Really Smart Grid. On Canvas. [Hint: SI = Service Integrator which is a distribution utility that integrates competitive Energy Services Companies (ESCOs) in deregulated markets].
- SEPA. 2021. SEPA Microgrid Playbook and Design Framework. 29 July.
- Maloney, P.(2018). BTM storage is booming in Ontario. Utility Dive. 20 Aug.
- CPUC. (2021). Microgrid Incentive Program: Implementation Plan Workshop. Oct. 26.
- Cohn, L. (2019). Earthquake Worries Prompt Oregon Cities to Install Microgrids for Resiliency. *Microgrid Knowledge*. 4 Oct.
- Deign, J. (2020). So, What Exactly Are Virtual Power Plants. *GreenTech Media*. 22 Oct.

Supplemental Readings

- More Information on the California Microgrid Docket is here
    - The main behind-the-meter microgrid program in CA is the Self Generation Incentive Program: its incentives and funding are here
- Information on the HI Microgrid Tariff can be found here

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Week 7

Energy Storage Technologies

Guest Speaker: Shawn Shaw (Camelot Energy Group)

Required Readings:

- Peter Kelly-Detwiler. (2021). Chapter 10.

- Rogers, E. (2022). How to Build a Better Battery. *Vox*. 18 April. Located here.
- Stover, D. (2022). We're going to need a lot more grid storage. New iron batteries could help. *MIT Technology Review.* 23 Feb. Located here.
- Energy Trust of Oregon. (2017). Energy Trust Electric and Gas Avoided Cost Update for Oregon for 2018 Measure and Program Planning. 8 Aug. Highlighted version here.
- **Policy Reading:** Energy Storage Association. (2019). Energy Storage Incentive Programs. February. Available here.

Supplemental Readings

- Energy Trust of Oregon. (2021). Potential Non-energy Benefit Inputs to Energy Trust of Oregon Cost-effectiveness Tests UM 2114 Workshop on Energy Trust and Energy Efficiency. Located here. More information on the low-income workshop under UM 2114 on the OPUC website here
- Cole, W. et al. (2021). Cost Projections for Utility-Scale Battery Storage: 2021 Update. NREL. June. Located Here.

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Week 8: EVs and Charging Infrastructure and Solar Management
Mark Osborn and Hal Nelson (PSU), Professional development students (ProDev)

In-Class activity: A Fun Student Debate**.**
Resolution: California should end its current net-metering (NEM) program because of cross-subsidies that mainly benefit single-family customers.
Instructions: There are two teams; the affirmative that argues in support of the resolution and the negative argues against it (maintaining NEM in its present form). Each team will have 3 speaking opportunities.
The debate structure will be:

1. Affirmative Introduction (3-5 mins)
2. Negative Introduction (3-5 mins)
3. Moderator Cross Examination (5+ mins)
4. Negative Rebuttal (3 mins)
5. Affirmative Rebuttal (3 mins)

Content:
1. The introduction presents a) main, and b) supporting arguments in support of, or attacking, the resolution.

- Includes your definition of key terms
- Define how you are framing the problem:
  - efficiency/cost-effectiveness
  - policy effectiveness (outcomes from the policy)
  - equity or social justice considerations
  - externalities
  - other considerations such as political feasibility, etc.
- Includes evidence for your position: readings from course or outside readings

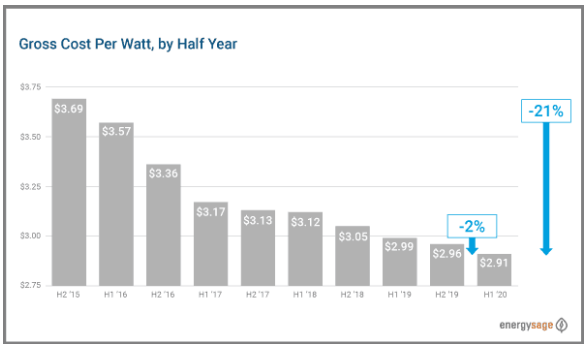
2. The rebuttal respond to the other teams introductory statements and the cross examination and restates the team's arguments.

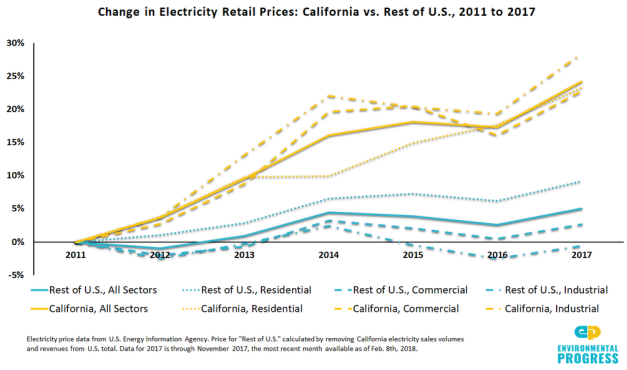
Preparation: Each team member needs to develop an argument and find evidence to support it. Members should also identify evidence to undermine the other team's anticipated arguments. You can screen share your arguments or you can just present them verbally.
Remember this is for fun and to learn about NEM, not to score points with Mark and Hal. That being said, in order to motivate y'all to adequately prepare the winning team will get a modest prize.

Background: NEM is a policy that gives residential customers with solar panels credits for the electricity generated in excess of their site's use. In effect, meters run backwards when generation exceeds consumption in any given period. This is "netted" out at the end of the monthly billing period. A background on NEM is here.

The CPUC recently put an indefinite pause on its proposed decision to reform its NEM program. It was opposed by the Solar Energy Industry Association and members (among others). The concerns are: a) that the NEW policy is paying too much for solar, b) the main beneficiaries of solar are single family detached households, c) and those program costs are being imposed on low-income resident disproportionately.

Regarding a) consider the following two graphs: the falling costs of solar systems, and the rising residential rates.





the net effect of those two structural changes has been lost efficiency that is causing "rate-class equity" problems. There is a great report on the larger issues around the affordability of energy in CA here.

Required Readings:

- Peter Kelly-Detwiler. (2021). Chapter 13.
- St. John. J. (2022). Is 'vehicle-to-everything' charging ready for prime time? *Canary Media*. 27 April.
- Frost, J., et al. (2020). Electric Vehicles Are Driving Electric Rates Down. *Synapse-Energy*. 20 June. Also see this NRDC blog here.

Policy Process Readings

- Lazar. J. (2011). Electricity Regulation In the US: A Guide. *Regulatory Assistance Project.* READ Chapters 7 & 8. Skim other sections you are interested in.
- American Geophysical Union. (ND). Determining your Ask. Located here.

Debate Readings (in addition to readings in the background section above)

- APPA. (2016). *Rate Design Options for Distributed Energy Resources*. Pp. 1-8.& one rate design of your choice. (Review From week 3)
- Gearino, D. (2021). Inside Clean Energy: The Rooftop Solar Income Gap is (Slowly) Shrinking. *Inside Climate News*. 15 April. Located here.

Supplemental Readings

- St. John. J. (2020). Grid Edge Mega-Trends: The Challenge of Integrating Distributed Energy Resources on the Grid. *GreenTech Media.* 2 July.

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Week 9

The Power Grid & Cyber-Security

Guest Speaker: Bob Bass (PSU) Confirmed. Julia Babcock & Chip Corbett (PSU)

Required Readings:

- Peter Kelly-Detwiler. (2021). Chapter 14.
- Fox-Penner, P. (2020). *Power After Carbon.* Chapter 12: Energy Service Utilities. On Canvas. Available here
- Widergren, et al. (2019). The Plug and Play Electricity Era. *IEEE Power & Energy Magazine*. Sept/Oct. Available here
- Chan, K., Kim, Y., & Jo, J. Y. (2022, January). DER Communication Networks and Their Security Issues. In *2022 IEEE 12th Annual Computing and Communication Workshop and Conference* (CCWC) (pp. 0785-0790). IEEE. On Canvas. Available here
- Trabisch, H. (2022). The fight for a national clean energy transmission system emerges on three fronts. *Utility Dive.* Available here

For the Cybersecurity Exercise

- DOE-OTT. 2021. Advancing Cybersecurity to Strengthen the Modern Grid. Jan. Available here
- League of Oregon Cities. (2022). Cybersecurity issues facing local governments. Scroll through to pp. 20-31. Available here
- PSU cyber program

In-Class Exercises

- **Cybersecurity Threat Landscape**

https://docs.google.com/presentation/d/1oQ_hAMUcMBH_vOhyaEIdll6hdcQCNWS7/edit?usp=sharing&ouid=118102468416916389403&rtpof=true&sd=true

- **Cybersecurity Smart Grid Tabletop Exercise**

https://docs.google.com/presentation/d/1YHjEXSLWKRltx6xgKulLNDTuShGk0VzW/edit?usp=sharing&ouid=118102468416916389403&rtpof=true&sd=true

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Week 10

Emerging Grid Technologies

Guest Speaker: Jenny Roehm (Schneider Electric)

Required Readings:

- Peter Kelly-Detwiler. (2021). Chapters 9 & 15.
- Cazalet, et al. (2020). Complete & Low-Cost Retail Automated Transactive Energy Systems (RATES). June. EXEC SUMMARY & P. 34-41. Available here

- Schneider Electric. (2022). *Grid to Prosumer: An End-to-End Approach to DER Management*. May. Available here READ PP 1-5, 28-37. SKIM THE REST.
- Schweikert, A and Deinart, M. (2021). Vulnerability and resilience of power systems infrastructure to natural hazards and climate change. *WIREs Climate Change.* Available here

  OR
- Dugan, J., et al. (2021). Application of Mobile Energy Storage for Enhancing Power Grid Resilience: A Review. *energies.* 14. 6476. Available here

Supplemental Readings

- Bertoldi, P. et al. (2022). Prosumerism and Energy Sustainability. JRC Report 126571. SKIM. Available Here

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Week 11 7 JUN: Class will be held at its normal time (Room TBD)
Group Presentations & Smart Grid Public Forum

DUE: DRAFT PPTs for Review 3 June (Friday) at 640 pm
DUE: Final paper 10 June (Friday) at 640 pm
DUE: All class assignments 10 June (Friday) at 640 pm

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ADDITIONAL COURSE POLICIES

Accommodations for Students with Disabilities: PSU values diversity and inclusion; we are committed to fostering mutual respect and full participation for all students. My goal is to create a learning environment that is equitable, useable, inclusive, and welcoming. If any aspects of instruction or course design result in barriers to your inclusion or learning, please notify me. The Disability Resource Center (DRC) provides reasonable accommodations for students who encounter barriers in the learning environment. If you have, or think you may have, a disability that may affect your work in this class and feel you need accommodations, contact the Disability Resource Center to schedule an appointment and initiate a conversation about reasonable accommodations. The DRC is located in 116 Smith Memorial Student Union, 503-725-4150, drc@pdx.edu or https://www.pdx.edu/drc

If you already have accommodations, please contact me to make sure that I have received a faculty notification letter and discuss your accommodations.

Please be aware that the accessible tables or chairs in the room should remain available for students who find that standard classroom seating is not useable.

- Mental Health Resources: Graduate school is a context where mental health struggles can be exacerbated. If you find yourself struggling, please ask for help. If you wish to seek out campus resources, here is some basic information about mental health resources at PSU: https://www.pdx.edu/shac/counseling

Title IX Discrimination and Harassment Policy**:** As an instructor, one of my responsibilities is to help create a safe learning environment for my students and for the campus as a whole. We expect a culture of professionalism and mutual respect in our department and class. You may report any incident of discrimination or discriminatory harassment, including sexual harassment, to either the Office of Equity and Compliance or the Office of the Dean of Student Life.

- Please be aware that as a faculty member, I have the responsibility to report any instances of sexual harassment, sexual violence and/or other forms of prohibited discrimination. If you would rather share information about sexual harassment or sexual violence to a confidential employee who does not have this reporting responsibility, you can find a list of those individuals. For more information about Title IX, please complete the required student module Creating a Safe Campus in your CANVAS.