Smart Energy, Big Data and Innovation Strategies

Lecturers/Instructors: Michael LaBelle

Credits: 3

Pre-requisites: none

Aims, Objectives and Learning Outcomes

This course will examine the development of smart cities and smart energy in the European Union. The emerging uses of smart energy technologies, interconnected with concepts of big data and transformation of the urban environment. Foundational material of the course is on innovation strategies and technology innovation process. Financing of new technologies, the commercialization process of niche technologies and energy savings potential of smart technologies are examined. The course will also address the use of big data in the energy sector and examine countries regulating and encouraging the use of data analytics. The market and policy impact new technologies hold for energy consumers is vast, the use of data analysis is transforming the energy sector. The EU's and national level innovation policies is a central starting point. The aims are:

- Learn stages of the innovation process from R&D to full commercialization of new technologies
- Regulatory and legal requirement of big data in the energy sector
- Theories to explain the innovation process in energy technologies
- Cross-disciplinary approach to education and how multiple perspectives join in the policy and business realm

Learning Outcome	**Assessment**	**Activities**	**Estimated Workload**
Ability to assess a stage of specific technology development; Define smart energy technologies; use of big data and analytics in the energy sector. Integrated energy planning	Group Poster on how a smart city and smart energy system works	Presentation	10 hours
Research and analysis skills. Greater ability to conduct research, organize data and analyze potential business or policy approaches.	6 page Energy Leader and technology paper: future smart energy technology, identify stages to commerialization (max 3,000 words), 50% of grade	report	26 hours
Critical thinking skills of reading, problem and solution identification and expressing opinion.	Blogs and presentations, 50% of grade	Report and presentation	15
Class and lectures	attendance	lectures	30 hours
Total hours			81

Course design

The course is based on an intensive weekend. There will be one pre-weekend session and one post-weekend session. The majority of the course runs from Friday evening to Sunday evening. The course is highly interactive and includes a range of field trips and guest speakers. Class learning is based on a case study method. It is imperative students do the readings before coming to class to be prepared for class discussions.

Assignments:

- Two blog entries, 600 words each. Student reflect on the first set of course readings. The first posts are due before the start of the long weekend. The second set of readings is due one week after the final class. The second entry reflects on the readings and the speakers, field trips and discussions. 30% of final grade (15 points x2).
- Group presentations in final class. Presentations are expected to include a mix of reflection on readings and what students learned from the weekend. 20% of final grade.
- Final paper, is a 3,000 word paper based on research and an interview with a leader within the smart city sector (see instructions below). 50% of final grade.

Session	Topic	Description
1	Smart cities: transforming local and digital landscapes	Introduction to transformation of urban digital and physical fabric of cities. What makes a city 'smart'? Overview of urban energy systems. Services and products on the demand side. Defining smart technologies
2	Innovation stages and innovation in energy technologies	Technologies crossing the Valley of Death; Types of innovation (e.g. disruptive, discontinuous); Examples of technologies moving from basic R&D to commercialization such as solar power
3	Role of regulation and policies in smart energy technologies	Examination of EU Smart Cities program; Energy Union objectives; Role of energy regulators and broader regulatory environment encouraging new technologies
4	Energy Innovation in the EU: from Shale gas to solar power	Broad look at the energy sector and types of cutting edge innovation done to date
5	Smart energy technologies in energy efficiency	Case study of Opower; current use of smart energy tech in energy efficient buildings;
6	Big Data in Energy	Data analytics influencing consumer demands and habits
7	Smart cities in the EU	Siemens case study and integrated transport, energy storage and production technologies
8	Final Case Study Presentations	Conclusions and presentation of projects and assessment

Assignments:

Assignment #1: Poster Presentation

Grade: 20%

Create a Power Point/Evernote/poster presentation of how a smart city works. Consider the role that more abstract concepts like the European Union Directives drive change by companies and governments. Layout the interaction of smart technologies in the city. Be prepared to explain how the market has changed over time for this technology and surrounding policies and regulations. Map out how these technologies may evolve over time in the city and create a sustainable and smart energy system. Finally, describe which stage certain technologies fit into an innovation cycle.

Key questions to answer:

1. What are key smart technologies in the city?

2. How are the technologies linked?
3. What social or environmental issue does it address?
4. What regulations and policies affect its operations?
5. Who are the stakeholders involved?
6. What would be the ideal country or city for your chosen technologies?

Assignment #2: Blog Readings

Grade 30%

Students will be divided into groups and will alternate assigned session readings. With the first student blogging and the other students commenting online in Moodle on the first student's summary. Then they alternate.

Students comment on the required BLOG READING (as labeled in Moodle).

- The first student blog entry must be completed 24 hours before the final deadline. This must be 600 words and a maximum of 700 words.
- Other student must comment on blog entries within 24 hours, thus all readings and blog entries are done before students come to class. This must be at least 600 and a maximum of 700 words.
- All points will be lost for late submissions.
- If a student is unable to provide an entry within the full timeframe, they can post an entry before the other students do – just noting they needed to publish early.
- If a partner fails to submit their first entry, then the other students must provide the first reading summary on the original schedule before class.
- Students will decide for themselves who goes first – if a decision can't be made the professor will instruct the students of the order.
- The fourth entry is based on a review of the fieldtrip (see moodle for instructions)

Student #1: Students will write a 600 word summary on the key reading for the class. The blog entries must do the following:

- Describe in detail the key messages of the reading;
- Describe overall dilemma and the purpose in the reading;
- Describe how the reading ties into key concepts of the course (discussed in first class) – including other readings and speakers (there is always a secondary reading);
- A structured format with a clear introduction and conclusion are expected;
- Make your opinion known.

Student #2 and #3: On-line blog entry commentary

Students will be graded based on the useful and *critical* feedback they provide to their partner. Critical thinking skills are essential. The response needs to be a minimum of 600 words and a maximum of 700 words.

Critical written feedback should include:

- How well did they express their opinion?
- Does the student's analysis frame the reading well within other course content?
- Does the reading provide both a general overview and some specific comments, indicating a good understanding of the reading?
- Do you agree or disagree with their interpretation and analysis?

Assignment #3: Industry Leadership and Smart Energy Profile Article Instructions

50% of final grade

Description:

Students will write a 3000 word media profile of an energy industry leader, a company and the technology owned by the company. It is highly encouraged that students conduct a real interview with an executive in the (alternative) energy industry. The interview, or collected information about a person or company, is then written in an article like

format that also describes the company's activities as well as reflect the trends in the broader industry that the company is located in. **A minimum of 1000 words must be used to connect the interview/profile with the reading content of the course.** This must be clearly marked in the paper (subheading, footnote etc.) The paper as a whole must connect with the assigned readings for the course.

The first half of the paper needs to be focused on the industry leader and the second half needs to focus on the smart technology or service.

Style, format and references

The interview should be written in a casual business magazine style. Some examples of these are listed below and are also widely available on the internet. The best suggestion is to find one with the style that you like and to use the article as a template for your own article. Thus, the introduction, main body and conclusion can be used as an outline and guide to how your article can be written. It is absolutely necessary to have proper citations in your paper. There must be no unattributed sources; the papers will be submitted via Turnitin. The use of endnotes is required for this assignment. It is highly encouraged that students use the resources and assistance of the

Key issues to address:

Person:

- Who is the person?
- What do they do?
- Why is this company important?
- How did they get their start?
- What industries have they worked in?
- How is the energy industry (and more specifically the area the company is in) changing?
- What kind of education, skills or knowledge does it take to work in this area?
- How do they deal with constant technological change in the energy sector?
- How is government support connected to their business plan?
- How does the company deal with the push-pull of government policies and market demand?
- Why is their company unique and why will it be around in 3 years?

Technology:

- Describe the technology or service
- How does this technology fit to themes in the course?
- Connect the technology with at least three themes of the eight sessions. Such as 'role of regulation', 'smart cities' and Big Data in energy.
- How do the connects describe the role of the technology in the energy system?
- What does the future look like for this technology and company?

The grade will be assigned based on the following criteria:

- Reflects knowledge of lecture content and reading materials. This can seen in the questions asked and in the content of the article
- Additional reading and knowledge/insight of material from outside of class is shown
- The introduction frames the article well and the conclusion provides a precise summary
- The article is well structured, clear, focused, shows a professional presentation of the material, correct usage of terms and no mistakes or other faults
- Creativity and demonstration of significant effort in presenting the material and/or gaining access to interviewee will be recognized.
- Go outside of the boundaries of these suggested guidelines are encouraged, but the results must be better than if the guidelines were followed.
- The ability to follow assignment instructions
- A professional presentation of the material is a must.
- Addressing the questions and maintaining the overall focus of the assignment is very important

- The article may receive a lower grade based on the degree that the above criteria are met.

Examples:
http://www.fastcoexist.com/1680303/meet-the-woman-who-can-convince-even-republicans-to-use-solar-power

http://www.capitalinsights.info/features-edition-5/positive-charge.aspx

Readings

Session 1: Smart cities and smart energy systems:
MacKay, David JC. *Sustainable Energy - Without the Hot Air*. 1st ed. UIT Cambridge Ltd., 2009.

Global Energy Assessment. "Global Energy Assessment: Toward a Sustainable Future," 2012. http://www.iiasa.ac.at/web/home/research/researchPrograms/Energy/GEA-Summary-web.pdf. Pg 42-46

Session 2: Innovation stages and innovation in energy technologies:
LaBelle, Michael, and Mel Horwitch. "The Breakout of Energy Innovation: Accelerating to a New Low Carbon Energy System." In *Handbook of Global Energy Policy*. Wile y Blackwell Publishers, 2013.

Wüstenhagen, Rolf, and Emanuela Menichetti. "Strategic Choices for Renewable Energy Investment: Conceptual Framework and Opportunities for Further Research." *Energy Policy* 40 (January 2012): 1–10. doi:10.1016/j.enpol.2011.06.050.

Rogers, Everett M. *Diffusion of Innovations*. 4th edition. New York: Free Press, 1995.

Session 3: Role of regulation and policies in smart energy technologies:
Wüstenhagen, Rolf, and Emanuela Menichetti. "Strategic Choices for Renewable Energy Investment: Conceptual Framework and Opportunities for Further Research." *Energy Policy* 40 (January 2012): 1–10. doi:10.1016/j.enpol.2011.06.050.

Reinaud, Julia, Nicolas Clinckx, Katia Ronzeau, and Paul Faraggi. "Scaling up Innovation in the Energy Union to Meet New Climate, Competitiveness and Societal Goals." Capgemini Consulting, May 26, 2016. http://i2-4c.eu/wp-content/uploads/2016/06/i24c_EURICS_final.pdf.

Session 4: Energy Innovation in the EU: from Shale gas to wind power:
LaBelle, Michael. "A State of Fracking: Building Poland's National Innovation Capacity for Shale Gas." *Energy Research & Social Science* 23 (January 2017): 26–35. doi:10.1016/j.erss.2016.11.003.

Hellsmark, Hans, and Staffan Jacobsson. "Opportunities for and Limits to Academics as System Builders-The Case of Realizing the Potential of Gasified Biomass in Austria." *Energy Policy* 37, no. 12 (2009): 5597–5611. doi:10.1016/j.enpol.2009.08.023.

Session 5: Smart energy technologies in energy efficiency:
Bergek, Anna, Staffan Jacobsson, Bo Carlsson, Sven Lindmark, and Annika Rickne. "Analyzing the Functional Dynamics of Technological Innovation Systems: A Scheme of Analysis." *Research Policy* 37, no. 3 (2008): 407–29. doi:10.1016/j.respol.2007.12.003.

Ornetzeder, Michael, Magdalena Wicher, and Jürgen Suschek-Berger. "User Satisfaction and Well-Being in Energy Efficient Office Buildings: Evidence from Cutting-Edge Projects in Austria." *Energy and Buildings* 118 (April 2016): 18–26. doi:10.1016/j.enbuild.2016.02.036.

Session 6: Big Data in Energy

Ponce, Pedro, Kenneth Polasko, and Arturo Molina. “End User Perceptions toward Smart Grid Technology: Acceptance, Adoption, Risks, and Trust.” *Renewable and Sustainable Energy Reviews* 60 (2016): 587–98. doi:10.1016/j.rser.2016.01.101.

Koseleva, Natalija, and Guoda Ropaite. “Big Data in Building Energy Efficiency: Understanding of Big Data and Main Challenges.” *Procedia Engineering* 172 (2017): 544–49. doi:10.1016/j.proeng.2017.02.064.

Session 7: Smart Cities in the EU

Kylili, Angeliki, and Paris A. Fokaides. “European Smart Cities: The Role of Zero Energy Buildings.” *Sustainable Cities and Society* 15 (2015): 86–95. doi:10.1016/j.scs.2014.12.003.

Darby, Sarah J. “Smart Energy Technologies in Everyday Life. Smart Utopia?” *Energy Research & Social Science* 1 (2014): 240–41. doi:10.1016/j.erss.2014.02.002.

Vassileva, Iana, Erik Dahlquist, and Javier Campillo. “The Citizens’ Role in Energy Smart City Development.” *CUE 2015 - Applied Energy Symposium and Summit 2015: Low Carbon Cities and Urban Energy Systems* 88 (2016): 200–204. doi:10.1016/j.egypro.2016.06.055.

Session 8: no readings