**SYLLABUS**

**ENRGYENV 625E**  
*Energy, Markets, and Innovation*  
Fall 2018 EMBA Superterm  
**In-person:** September 23 – September 28, 2018  
**Distance:** October 13 – December 8, 2018

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<tr>
<th>Instructor</th>
<th>Teaching Assistant</th>
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<tr>
<td>Dan Vermeer</td>
<td>Jenna Weiner</td>
</tr>
<tr>
<td><a href="mailto:dv24@duke.edu">dv24@duke.edu</a></td>
<td>MBA/MEM Candidate 2018</td>
</tr>
<tr>
<td>Office hours: By appointment</td>
<td><a href="mailto:jenna.weiner@duke.edu">jenna.weiner@duke.edu</a></td>
</tr>
<tr>
<td>Office Phone: (919) 660-1966</td>
<td></td>
</tr>
<tr>
<td>Cell Phone: (919) 448-5555</td>
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**Description:** The energy industry is one of the most capital-intensive and fastest-growing industries in the world. Emerging economies are rapidly building infrastructures to meet the rising needs of their citizens, while developed markets are evolving their systems to balance reliability, cost, and environmental considerations. In this course, we will apply principles from economics, finance, and strategy to understand *energy transitions*, with a focus on electricity in the United States. Specifically, we will explore how supply and demand, industry structure, technology, and prices evolve over time. We will also explore how value is created in the industry, and how risks are managed. Finally, we will also examine the role of public policy and regulation in shaping energy markets. Many of these factors will be demonstrated in a simulation exercise called CarbonSim that we will host during the residency.

By using targeted readings, case studies, lectures, and guest lectures, we will observe how these dynamics play out in specific market and historical contexts. In addition, we will learn how to use practical analytical tools such as cost curve analysis to make empirically grounded business decisions. With this grounding, we will consider the practical, political, and market factors that should be considered in debates about energy security, renewable energy, natural resources, climate regulation, grid modernization and other hot topics. This class is designed to meet the learning needs of students with experience in the energy industry, but also to provide a valuable introduction to the energy industry for non-specialists.

**Course Requirements:**

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<td>Class attendance and participation (I)</td>
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<td>Sept. 24, 25, &amp; 26</td>
<td>Case/video assessments – 3 x 8 points each (I)</td>
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<td>Oct. 12</td>
<td><em>CarbonSim</em> debrief (T)</td>
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Evaluation criteria for this course include:
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- **Class attendance and participation (24%)**: Class attendance and participation is a crucial part of the learning process in this course. You will learn a great deal from the ideas of others in the class. It is essential that you come to class prepared to share your insights with others and to compare your perspective on the day’s topic with the perspectives of your peers. You will be evaluated on the quality of your engagement in the discussion, creative and thoughtful insights, and respect for others’ contributions. However, more is not better, so be prepared to contribute to a balanced conversation involving all participants.

- **Case/video assessments (24% total; 8 points each)**: Please submit three brief statements (~400 words in PDF format, 12-point text, single spaced) on the following case studies/videos: *Equinor (Sept 24), ENGIE (Sept 25)*, and *Dominion (Sept 26)*. Please note the guide questions in each class session description below.

- **CarbonSim team assessment (10%)**: The CarbonSim simulation (created by Environmental Defense Fund) teaches the principles of emissions trading and brings carbon markets to life. This tool allows program administrators to test options for market design, and trains investors and industry participants to design carbon portfolio management strategies. Students will work in teams to participate in a large group exercise on campus on Sept. 27 (facilitated by EDF). After the residency, teams will document and submit their learnings in a Team Debrief document. Please submit a ~800-word debrief, in PDF format using 12-point single-spaced text. See target questions below.

- **“Which Type of Power Plant?” case assessment (12%)**: Please write a memo (~1,000 words, in PDF format, 12-point single-spaced) providing a recommendation for the case study “Coal, Nuclear, Natural Gas, Oil, or Renewable: Which Type of Power Plant Should We Build?” See target questions below.

- **En-ROADS team assessment (10%)**: The En-ROADS simulation (created by MIT and maintained by Climate Interactive) allows student teams to explore how changes in global GDP, energy efficiency, R&D, carbon price, fuel mix, and other factors can impact carbon emissions, energy access, and global temperatures. This simulation program allows for testing of hundreds of factors, making it ideal for decision-makers in government, business, NGOs, and civil society. Students will work virtually in teams to complete the En-ROADS exercise, and document their strategy and insights in a Team Assessment document.

- **Final project – paper and presentation (20%)**
The electricity industry is currently undergoing profound shifts driven by new technologies, evolving policy priorities, emerging business models, and changing consumer needs and expectations. For your final project, please select one of the below innovations, and assess its potential impact on electricity markets, customers, and system over the next 10 years. You may consider this innovation globally, or narrow your focus to a specific geography, technology, or customer segment.
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You will write an individual paper on this topic. Imagine preparing this analysis to share with industry professionals and investors at a major “energy futures” conference. Your paper should be a minimum of 1,200 words, single-spaced – but you will not be penalized if it is longer. It may also include relevant tables or graphics, and must provide proper citations (in APA format). You should use multiple data sources and demonstrate the breadth of your research by considering different perspectives. Highlight any key assumptions or debates that impact your assessment.

In addition, you will prepare and deliver an 8-minute presentation, followed by 2 minutes Q&A in one of the distance sessions.

Innovations:

1. Distributed solar
2. Energy storage
3. Electric vehicles
4. Off-shore wind
5. Energy efficiency
6. Demand response
7. Microgrids
8. Carbon capture and storage
9. New nuclear
10. OTHER (topic to be approved ahead of time by instructor)

In your analysis, please consider the following questions:

1. What is the current use of this innovation in the electricity system, and how is it likely to evolve over the next 10 years?
2. What is the value proposition of this innovation for the electricity system – affordability? resiliency? customization? reduced environmental impacts? others? What are the potential drawbacks, risks, or liabilities?
3. How might economic, political, and social trends over 10 years (global or regional) interact with this innovation?
4. Using concepts learned in class, what impact might this innovation have on electricity supply and demand in the US?
5. How might electricity prices be affected by evolution of this innovation?
6. What enablers or barriers exist that might influence the development of this innovation?
7. What existing companies would be attractive investments in the scenario you describe? What kinds of new ventures would you expect to emerge in this space?

Your paper should be an objective analysis of your target innovation – including both the promise and the challenges of adoption. Please conclude with a summary recommendation to energy industry participants and investors about what developments they might anticipate in the coming decade, and how they should respond.
Course Overview

Pre-assignment: Please review the below materials, and come to class prepared to discuss the readings and Equinor case materials. Please note the additional readings that are listed under Session 1 below.

Please also note that brief case assessments are due on Monday, Tuesday, and Wednesday this week. Each submission should be based on the reading and discussion from the class before. It may be helpful to review these cases ahead of time so that you can focus on completing your assignment each day during the residency.

Background

  - Read Sections 4 (pp. 35-58), 8 (pp. 91-98), and 9 (pp. 101-116). You can also review optional sections 1-3, 5-7 for additional background.
  - Read Introduction, pp. xi-xxx.

Case: Equinor’s strategic repositioning (not a formal case study)


Session 1 (9/23): Introduction to Energy Markets and Innovation

Description: This session will include an overview of the importance of energy in the global economy, including share of global GDP, role in industrial production, geographic distribution of energy resources, trade flows, and different types of energy. Within electricity, we will review different fuel types, and explore the unique aspects of electricity (e.g. inability to inventory, regulation, lack of price transparency, externalities like environmental impacts). We will also introduce concepts that will be used in the course, including: industry and firm economics, economics of supply and demand, market price-setting, decision making across timescales, externalities, and effects of regulation. Finally, we will explore the case of Equinor (formerly Statoil), and assess the strategic choices the company has made in the context of changing energy markets, climate change, and future value creation in the industry.

Readings:

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Supplementary (optional):
- EDGE Seminar (10/11/17): *Gareth Burns, VP and Managing Director of Statoil Energy Ventures, Statoil/Equinor*. (See 27:00-1:33:00).

ASSIGNMENT: *Equinor assessment* due on Canvas on **Monday, September 24** by **4:00 PM ET**. Questions for Equinor reflection include:

1. Is Equinor’s rebranding effort another example of “greenwashing”, similar to BP’s failed attempt in the early 2000s? Or is it truly substantive?
2. Why might Equinor be more motivated to pursue a different strategy than the other oil majors? What similarities or differences do you note, relative to the other major oil & gas companies (e.g. Shell, BP, Exxon, Chevron)?
3. What key trends or discontinuities are they betting on? How much risk are they facing with these changes, and have these risks grown or receded through this change?
4. What specific investments are they making in the new energy economy? Are they missing anything critical? Should they be investing more or less at this stage?
5. Do you think this shift will work for Equinor?

**Session 2 (9/24): Economics of Demand**

Description: To understand the dynamics of energy demand, we will evaluate the primary demand segments (Industrial, Commercial, Residential, Agriculture), understand their seasonality, intraweek, and intraday demand profiles, and assess the implications of their inability to inventory. We will also highlight relevant technological changes and consumer preferences and their implications for energy markets. Finally, we will discuss the case study of ENGIE and evaluate the risks and opportunities created through their recent strategic transformation.

Readings:
- **Case, Part I**: *ENGIE: Strategic Transformation of an Energy Conglomerate (2016)*. Available on Canvas.

ASSIGNMENT: *ENGIE assessment* due on Canvas on **Tuesday, September 25** by **11:15 AM ET**. Questions for ENGIE reflection include:

1. What is ENGIE’s view of the new energy customer? How are they different? What risks or opportunities does this new type of customer create for ENGIE?
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2. Who are ENGIE’s competitors? Are they positioned well to compete in these markets?

3. How is ENGIE trying to evolve their capabilities to serve their new market opportunity? What else could they do?

4. Is Mr. Sakduang too optimistic about the new world of energy? Are they moving faster than the market? Is there a risk of retrenchment that would leave them exposed? Might Mr. Sakduang face the same fate as the former CEO of NRG, David Crane?

5. What are the biggest barriers to ENGIE’s success? Would you invest in ENGIE? Why or why not?

Session 3 (9/25): Utility Strategy: Disruption or Continuity?

Description: Today’s session will dig deeply into the internal drivers and external context of an investor-owned utility (IOU). In this session, we will evaluate the various fuel choices (coal, natural gas, nuclear, hydro, solar, wind, etc.) used in electricity generation in terms of the capital costs, fixed costs, variable costs, and environmental footprints of each source. We will explore the unique pricing dynamics in the electricity market and identify strategic implications for operators. Finally, we will discuss Dominion Resources’ choice about participating in regulated vs. unregulated markets, and their current efforts to construct the Atlantic Coast Pipeline.

Readings:
  o See also Dominion’s web site on the Atlantic Coast Pipeline and do a Google search to understand perspectives and criticisms of different stakeholders.

ASSIGNMENT: Dominion assessment due on Canvas on Wednesday, September 26 by 7:45 AM ET. Questions for Dominion reflection include:

1. What are the pros and cons of participating in regulated vs. unregulated markets? Which should Dominion prioritize?

2. Based on your recommendation, how would Dominion’s various stakeholders react? How should Dominion engage with these stakeholders to move their strategy forward?

3. Natural gas figures prominently into Dominion’s current strategy, as demonstrated by their investment in the Atlantic Coast Pipeline. Is this priority appropriate? How confident should they be in this long-term investment in natural gas?
4. Should Dominion be moving more aggressively on renewables? Why or why not?

5. Some critics think that siting the Atlantic Coast Pipeline in the poorest regions of the Southeast is just another example of environmental injustice. Do you agree? How should Dominion weigh the potential economic benefits to these communities relative to the environmental risks? Is it worth it to pursue this strategy despite the potential reputational damage to the company?

Session 4 (9/26): Climate, Risk, and Business Strategy

In this session, we will investigate the implications of climate change for the energy industry, and for the global economy overall. One of the primary drivers of global change is the pressure to rapidly decarbonize our economy, but there is heated debate about the urgency of the problem, solution pathways, risks, investment approaches, and responsibilities of different parties. While this discussion has largely been driven (or blocked) by governments and international bodies, the energy industry sits in the center of this debate, and faces daunting challenges about what technologies to implement, where to invest, how to engage in the policy process, and many other issues. This discussion will be an important context for the choices made in the En-ROADS simulation in the following session.

Readings:

Session 5 (9/27): CarbonSim Simulation:

Description: We will divide the class into teams to experiment with the CarbonSim simulation, in order to explore design choices for the introduction of carbon markets. The goal of the simulation is to evaluate – from the perspective of market creators and market participants – the implications of specific choices regarding the design of carbon markets. Teams will be evaluated based on the insights generated from the exercise rather than superior performance. These insights will be shared in the debrief session the following day, and then documented in an team assignment completed by October 12 at 11:59 PM ET.

Readings:
- Preliminary materials for the CarbonSim simulation. Available on Canvas.

Supplementary (optional):
Session 6 (9/28): Reflections, Guest Speaker, and Distance Preparation

A. Reflections on the CarbonSim Simulation: Each team will reflect on their decisions and outcomes from the CarbonSim simulation and the dynamics that emerged. In the debrief discussion, we will explore analogies to real world carbon market choices and debates. We will pay special attention to design choices, consequences, incentives, tradeoffs, emergent strategies, and surprises that occurred in the simulation.

B. Guest speaker: Tim Krysiak, Equinor

C. Overview of Distance Sessions, course assignments, and final project: In this final in-person session, we will review the upcoming distance sessions, describe assignments, and discuss the final project.

Readings:

Distance Session 7 (10/13): Environment, renewables, and subsidies

Description: In this session, we will introduce the growing importance of environmental impacts (particularly carbon emissions), the various methods for including these concerns in the economic equation (either through taxes or subsidies), and the market reactions to these efforts. We will also discuss how these dynamics affect R&D investment, shape capital flows and alter economic incentives. Finally, we will review a recent report from the International Renewable Energy Agency that describes a roadmap for energy system transformation to 2050.

Readings:
  - Read Chapters 1-3.

Supplementary (optional):
- TED Talk: David Mackay (2012)

ASSIGNMENT: CarbonSim team assessment due on Canvas on Friday, October 12 by 11:59 PM ET

Distance Session 8 (10/27): Power Plant Economics
Description: Power companies have a wide range of factors to consider in selecting fuel sources to run their facility. Some of these factors are related to the economics of fuel and electricity generation while others relate to the interests of various stakeholders. In the prior simulation, our task was to decide whether to run assets, and at what price, based on economic factors. In this case, we will consider how generators make long-term, capital-intensive bets on fuel and plant options, based on assumptions about the market and future trends. In our distance session, please be prepared to share your recommendation for which type of plant PowerCo should build.

Readings:
- **Case**: “Coal, Nuclear, Natural Gas, Oil, or Renewable: Which Type of Power Plant Should We Build?”

ASSIGNMENT: Case recommendation due on Canvas on **Friday, October 26** by **11:59 PM ET** – Please write a memo (1,000 words) providing a recommendation for the case study “Coal, Nuclear, Natural Gas, Oil, or Renewable: Which Type of Power Plant Should We Build?”

- In your assessment, please consider the following questions (Note: you do not need separate sections on each question; just be sure to address all questions in your overall assessment):
  - Which technology is best (e.g. oil, natural gas, coal, or renewables)?
  - Which issues should be considered?
  - What features of the various options are important and why?
  - Which option is most financially attractive?
  - Who are the primary stakeholders, and what views will they likely have?
  - How should PowerCo balance financial and other considerations?

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**Distance Session 9 (11/10): Energy Markets, Energy Futures**

In this session, we will discuss key insights and issues raised by the En-ROADS simulation. We will also connect some of these issues to the wider themes of the previous discussions in the class. We will also explore how these trends are playing out in real time by discussing BNEF’s Energy Outlook 2018.

Reading/Video:

ASSIGNMENT: In preparation for this class, please work with your team to explore options in the **En-ROADS simulation, and write a team assessment note** due by **Friday, November 9 at 11:59 PM ET**.
Questions to consider in the simulation:

Please draft and submit a summary report (including relevant graphics from the simulation) summarizing your proposal.¹ Your proposal should address the following considerations:

1. **Proposal.** What were your settings in the simulation? How did you choose each of the settings? What “2100 Temperature Increase” did you achieve? These selections should be included in a graphic slide on the first page of your report, similar to below:

   ![Team B•M•W: Renewables, Efficiency, CCS](image)

   - **Our recommendations:**
     - Renewables subsidies S/SI 2012-2030
     - Carbon tax 5$/ton starting 2020
     - GDP 3% growth rate
     - 0% drop of energy intensity for new capital
     - CCS

2. **Meeting Goals:** Please comment on how well your proposal balanced the below considerations.
   a) **Climate:** Make as much progress as possible towards limiting postindustrial temperature increase to two degrees C.
      - **Questions:** How well do you think your proposal does regarding meeting climate goals? If not well, why is this acceptable to you?
   b) **Economy:** Support economic health. Drive a global energy transition that would least disrupt the economy and most address poverty.
      - **Questions:** If the world followed your recommendations, how would the economy be different in 2030? In what ways better? In what ways worse?
   c) **Equity:** Provide a solution that is fair for the poor and the rich.
      - **Question:** To what extent does your proposal seem fair and equitable regarding the rich and the poor?
   d) **Environment:** Minimize non-climate-related harmful effects on the environment.
      - **Question:** How much did you solve climate problems but create other environmental challenges?
   e) **Viability:** Be sure your solution could happen if human civilization was at its best.
      - **Question:** What would it take for your proposal to be realized?

3. **Implications:**

¹ There is no required length for this report. Remember that this is a high-level proposal, so the text must be concise and direct. As a guideline, I suggest ~3 pages, including the proposal graphic.
a) **Winners/Losers.** Who would be the biggest winners globally in your proposal future? Biggest losers?
b) **Role of business.** What would be required of global business to make your proposal happen? Which industries would require the most significant transformation in thinking and leading?
c) **Getting started.** For your proposal to be implemented, what would need to be the priorities for business, civil society and government over the next two years?

4. **Reflections**
   a) **Risks:** What are the risks of pursuing this strategy? Which are known and which are unknown?
   b) **Surprises.** What surprised you about the behavior of the energy system as captured in this simulation?
   c) **Group diversity of views.** What were the components of your proposal that attracted the most debate and disagreement? What were the principles that differed underneath the debate?

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**Distance Session 10 (11/24): Team presentations (Group A)**

**Description:** Teams will present highlights from their final papers. They should prepare a 10-minute summary to share in the session, which is followed by a 5-minute Q&A with the instructor and other students. Please develop a slide deck overview (template will be provided) to use in the webinar.

**Reading:**
  - Read Chapters 4-6.

**Supplementary material (optional):**
  - Read selectively to find the sections relevant to your final paper and presentation.

**ASSIGNMENT:** Slide deck overview on final project due on Canvas by **11:59 PM ET on Friday, November 23 (for Group A teams presenting this session)**

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**Distance Session 11 (12/8): Team presentations (Group B)**

**Reading:**
  - Read Chapters 7-9.

**ASSIGNMENT:** Slide deck overview on final project due on Canvas by **11:59 PM ET on Friday, DECEMBER 7 (for Group B teams presenting this session)**.

**ALL Final Papers (Group A and Group B) – due on Canvas by 11:59 PM ET on Monday, December 10.**
A Note on Late Assignments: Your grade will be adjusted downward by one full grade level for each day it is late, unless approved beforehand.

Fuqua Honor Code: Duke University is a community of scholars and learners, committed to the principles of honesty, trustworthiness, fairness, and respect for others. Students share with faculty and staff the responsibility for promoting a climate of integrity. As citizens of this community, students are expected to adhere to these fundamental values at all times, in both their academic and non-academic endeavors.

The Fuqua School of Business Honor Code applies to all aspects of this course. The nature of each assignment indicates the type of communication and consultation that is permitted. Work that is described as an individual effort is to be your work alone, without consultation or assistance from any other person. Work that is described as a team effort is to be your team’s effort alone, again without consultation or assistance from anyone else. If you are uncertain about the nature of any assignment, please ask the instructor in advance.

Details on the Fuqua Honor Code can be found HERE. Please review the code before the first class.
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Appendix – Resources for Students

See below a list of resources that will help you deepen your understanding of the energy industry and its history, priorities, and debates.

Newsletters:

- Axios Generate
- American Energy Society
- Utility Dive (several sector newsletters)
- VERGE Weekly

Web sites:

- Greentech Media
- Greenbiz
- r/energy
- Climate Central

Podcasts:

- The Energy Gang
- Interchange (subscription required)
- The Energy Transition Show
- Columbia Energy Exchange
- Long Now: Seminars about Long-Term Thinking

Energy Thought Leaders

- David Roberts
- Amy Myers Jaffe
- Geoffrey Styles

Books: