Twenty-first Century Energy (21CE) - Fall 2018

Professor Martha Crawford mcrawford@hbs.edu
Office hours: by appointment Morgan T89
Assistant: Katie Cross kcross@hbs.edu

Description

This course is designed for students who want to explore how the energy sector can economically prevent and mitigate global climate change in the near term, and what emerging technologies and business models are the most promising in the longer term.

Energy is a necessity to all life-forms and ecosystems. Access to affordable and readily available energy has been a cornerstone of economic growth in all highly developed economies. In emerging economies, securing a reliable energy supply is one of the keys to future economic and social progress, to build a better quality of life.

Globally, most of the energy consumed today comes from hydrocarbons—crude oil and natural gas. Transportation—whether by road, boat, air, or train—is almost completely fueled by products derived from crude oil. Over the past five decades, it has become increasingly clear that the energy choices that humanity makes are impacting the earth's natural systems and climate in likely irreversible ways.

Even with unprecedented improvements in energy efficiency seen in the last two decades, and projected to continue, global energy demand is still expected to grow by nearly one-third by 2050. Meeting growing demand for energy in an environmentally responsible manner is thus a critical challenge facing business leaders in the 21st century.

Historically, industrial actors in the energy sector have been seen as resistant to addressing climate change. We'll look at how private firms have begun to play a major role in reducing greenhouse gas emissions, using emerging technologies and innovative business models.

Using real-world cases, we will explore the catalysts for change that are affecting large incumbent energy firms, and creating new opportunities for energy start-ups.

Course Content and Organization

"Twenty-first Century Energy" offers students the opportunity to develop a business-focused, practical understanding of energy in the 21st Century. In four modules, it traces the historical energy "value chain"—from fossil fuels, to renewables, to improved transmission and distribution of electricity, to "smart consumption" and "digitalization" of energy.

The arc of the course offers students perspective on how decarbonization, decentralization, and digitalization are converging to massively disrupt the energy sector in the twenty-first century, with major implications for incumbents and start-ups, alike.

In class discussions, students will explore how business models are evolving in response to environmental concerns, technological innovations, and geo-political forces. Students will learn

to apply a three-pronged approach to assess the value and sustainability of various new energy business models through economic, environmental and political lenses.

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The course's **four modules** roughly follow the historical energy value-chain:

Module 1 – Fossil Fuels and Climate Change

Cases expose students to the important role played by fossil fuels in achieving high standards of living in OECD countries in the twentieth century, as well as to the challenges the sector faces in the twenty-first century due to the increasingly recognized impact of greenhouse gas emissions and climate change. Policy mechanisms and economic instruments to address these emissions will be explored, as will the economic and environmental viability of "technological fixes" such as carbon capture and sequestration.

Module 2 – Lower-carbon Energy Sources

In the second module, cases explore to what extent future energy demand is likely to be met by lower-carbon energy sources including nuclear (Generation III and small modular reactors), solar, hydropower, biomass, wind, and hydrogen. For each major technology, costs and risks and scalability are explored as well as related regulatory frameworks and social concerns.

Module 3 – Electricity Transmission and Distribution

The course's third module explores how traditional electricity and distribution systems, based on centralized, large-scale production, function. Cases expose how electricity utilities make decisions regarding investment and innovation, and how new policy frameworks are evolving to disrupt this status quo. Other cases explore the importance of large-scale electricity storage, micro-grids, and advanced metering systems, as vectors for decentralization of transmission and distribution.

Module 4 – Smart-use and Digitalization of Energy

The final module of the course features cases that examine the implications of digitalization, and the convergence of IT and energy systems, for future business models in the energy sector. Cases explore the roles of electric vehicles, LED lighting, smart neighborhoods, energy efficient buildings, and new business models integrating the internet of things (IoT).

Course Format and Requirements

The majority of the sessions will be class discussion of cases and selected additional short readings related to the case. When possible (on average once per week), case protagonists will be invited to class to comment on the discussion and offer additional perspective.

Students who enroll in 21CE are often interested in careers as business executives, consultants, or entrepreneurs in the energy sector, or as financial experts in energy or infrastructure investment. Some simply have an interest in understanding what can realistically be done to address climate change while maintaining economic growth.

While 21CE attracts many students who have prior work experience in the energy industry, energy neophytes can also thrive in the course. Tutorials and supplementary readings are

available on request[1], and Professor Crawford is always ready to meet with students to give specific advice or readings.

Grading

Grading is based on in-class participation (50%) and on performance on a term project which involves the writing of a paper (50%). Student projects will be done by small teams, and will examine an emerging energy issue and related business model(s).

[1] Students with no prior energy background may wish to acquire the book, "Energy in the 21st Century," (J. Fanchi and C.Fanchi. World Scientific Publishing, 4th edition, 2017), as a useful background reference, when reading the cases.

Twenty-first Century Energy – EC course, Fall 2018

Module 1: Fossil fuels and climate change

1. Keystone XL Pipeline
2. Valero Energy Corp and Tight Oil
3. The US Shale Revolution
4. Israeli Offshore Gas Production
5. Pricing Carbon: The Birth of the BC Carbon Tax
6. Global CCS Report 2017
7. Carbon Engineering
8. SASOL: US Growth Program

Module 2: Decarbonizing the energy supply

9. Generation III Nuclear
10. NuScale Power
11. Colbun and the Future of Chile's Power
12. Orsted: Offshore Wind Goes Global
13. KiOR: Catalyzing Clean Energy?
14. Off-Grid Solar in Africa
15. Husk Biomass to Power in Rural India

Module 3: Electricity Transmission and Distribution

16. Duke Energy and the Nuclear Renaissance
17. AEP: Facing the Challenges of Distributed Generation
18. Digitalization at Siemens
19. Korea Telecom in the New Energy Markets
20. ConEd considers blockchain
21. Groom Energy Solutions: Selling Efficiency

Module 4: Smart Use and Digitalization of Energy

22. Elon Musk's Big Bets
23. Daimler: Reinventing Mobility
24. Spectio: A Digital Lighting Company
25. Project presentations
26. Project presentations
27. Project presentations

Module 1: Fossil fuels and Climate change

September 6, 2018 ENERGY | Class 1: Keystone XL Pipeline

Materials

Case: Keystone XL Pipeline [Case 713039]

Assignment

1. Is construction of the Keystone XL pipeline in the national interest? Is it a matter of eminent domain?
2. How do you assess Keystone's handling of the pipeline project? Why has the project generated so much debate?
3. What advice would you give to Robert Jones?

September 7, 2018 ENERGY | Class 2: Valero Energy Corp and Tight Oil

Introduction

Studying Valero Energy Corporation, one of the world's largest independent refiners, allows us to think about the economics and politics of North American oil markets, building on last week's discussions of Keystone and the upstream parts of the industry.

Materials

Case: Valero Energy Corporation and Tight Oil [Case 713083]

Assignment

1. How will Valero be affected by governmental decisions about the Keystone pipeline and about the lifting of restrictions on crude oil exports?
2. Valero's corporate scope contrasts with the vertically integrated structures of the traditional "oil majors." What are the costs and benefits of this choice?
3. Should Valero invest in the topper of the hydrotreater?

September 13, 2018 ENERGY | Class 3: The US Shale Revolution

Introduction

In recent years, horizontal drilling and hydraulic fracturing ("fracking") have transformed domestic oil and gas supplies in North America, with important consequences for global energy markets and for world geopolitics. Today's case gives us an overview of the technological, economic, and political aspects of this phenomenon.

Materials

Case: The US Shale Revolution: Global Rebalancing? [Case 717056]
Supplemental video:
Animation of Hydraulic Fracturing

Assignment

1. Who have been the major beneficiaries of the US shale revolution? Who has been hurt?
2. If you were asked to advise the Trump administration about its policies with respect to oil and gas exports, what would you say?

3. The case uses the phrases "energy independence" and "energy security" without defining either. More recently, Energy Secretary Perry has spoken of "energy dominance" without defining it. What do you think these phrases mean?
4. Is "energy independence" or "energy dominance" a sensible objective for the US government? What are the implications for energy markets? For the energy industry?

September 14, 2018 ENERGY | Class 4: Israeli Offshore Gas Production

Introduction

During the summer of 2018, Noble Energy and the Delek Group, together with the Israeli Ministry of National Infrastructure, Energy, and Water, continued to pursue options for national gas exports. After decades of working together to develop Israel's offshore natural gas resources in the Eastern Mediterranean, the two companies were engaged in export contract negotiations with LNG operators in Egypt, Cyprus, Greece, and Italy, and had to make some hard choices such as deciding to whom they should export and when?

Materials

Case: Israel - An Energy Leviathan? [Case 719004]

Assignment

1. How big a deal for Israel is the discovery of offshore gas?
2. Why has it taken so long to develop the offshore NG fields?
3. How much gas should the country export? To whom?

September 20, 2018 ENERGY | Class 5: Pricing Carbon: The Birth of the BC Carbon Tax

Materials

Case: Pricing Carbon: The Birth of British Columbia's Carbon Tax [Case KS1170]

Assignment

1. What are the most important factors that influence the public acceptability of carbon pricing? (in short term, in long term?)
2. What are the pros and cons of cap and trade? Of carbon taxes?

September 21, 2018 ENERGY | Class 6: Global CCS Report 2017

Materials

PDF: Global CCS Report 2017

Assignment

1. Is CCS likely to be a major contributor to reducing GHG emissions? Under what conditions?
2. What would be the acceptable marginal cost of CCS for it to be a commercially viable option?

September 26, 2018 ENERGY | Class 7: Carbon Engineering

Introduction

Dr. David Keith had developed Carbon Engineering as a start-up out of Calgary's Research Transition Facility. Focused on capturing CO2 directly out of the air, the start-up was aimed at finding pragmatic ways to fight climate change. Keith and his team were considering preliminary construction bids for a plant prototype that had come in at five times higher than expected.

Materials

Case: Carbon Engineering [Case 814040]

Assignment

1. What do you see as the strengths and weaknesses of the first business plan that Keith prepared for Bill Gates? (see Exhibit 4, pages 15-19)
2. As a potential investor, would you buy in to Carbon Engineering's business model? Why or why not?
3. What are the top three things that could "go right" and the top three things that could "go wrong" for Carbon Engineering?
4. What can CE do to make sure the "go rights" actually happen, and make the "go wrongs" avoidable or survivable?

September 27, 2018 ENERGY | Class 8: SASOL: US Growth Program

Materials

Case: Sasol: US Growth Program [Case 714034]

Assignment

1. Why is Coal-to-Liquids technology interesting? Under what circumstances is it a commercially viable option?
2. How strong is SASOL's GTL value proposition in the US context?
3. Would you invest in SASOL's growth plan in the United States?

Module 2: Lower carbon energy sources

September 28, 2018 ENERGY | Class 9: NuScale Power

Materials

Case: NuScale Power - the Future of Small Modular Reactors [Case 715004]

Assignment

1. What are the strengths and weaknesses of NuScale's business model?
2. What were the root causes of NuScale's difficulties?
3. How likely is the NuScale SMR to be a gamechanger in the long run?

October 3, 2018 ENERGY | Class 10: Colbun and the Future of Chile's Power

Materials

Case: Colbun and the Future of Chile's Power [Case 713047]

Assignment

1. Which of the power supply options discussed in the case has the lowest expected costs? What are the main risks associated with each option, and how can Colbun manage them?
2. From a societal perspective, do you think that it would be beneficial if the Aysen dams were built? Why or why not?
3. What advice would you offer Bernardo about his strategy?

October 4, 2018 ENERGY | Class 11: Orsted: Offshore Wind Goes Global

Materials

Case: Orsted Goes Global [Case 918404]

Assignment

1. How did Orsted come to have such a dominant position in European offshore wind markets?
2. How important is the US market to Orsted? Will the same business model work?
3. How should Orsted construct its bid for the MA project?

October 10, 2018 ENERGY | Class 12: Biomass to Liquid (BtL) fuels: Generations I and II

Materials

1. Article: "Global Biofuels at the Crossroads: An Overview of Technical, Policy, and Investment Complexities in the Sustainability of Biofuel Development" by K Araujo, D. Mahajan, R. Kerr and M. de Silva, Agriculture 2017. www.mdpi.com/journal/agriculture. READ pages 1-7 and pages 11-16
2. Article: "Renewable Fuel Standard: Potential Economic and Environmental Effects of U.S. Biofuel Policy: Report in Brief," US National Academy of Sciences, 2011.

Assignment

1. How do you assess the overall sustainability of Gen I and Gen II biofuels? (environmental, economic, social points of view)
2. Who have been the "winners" and "losers" after the first decade of implementation of the US Renewable Fuel Standard?
3. Why has the double-digit supply growth seen prior to 2010 tapered off in recent years? How do you project it will evolve in the next decade?

October 11, 2018 ENERGY | Class 13: Horizon18 Conference

October 17, 2018 ENERGY | Class 14: Off-Grid Electric: Strategic Financing for Growth

Materials

Case: Off Grid Electric: Strategic Financing for Growth [Case E556-PDF-ENG]

Assignment

1. How interesting is the off-grid solar market in Africa?
2. What are the strengths and weaknesses of OGE's business model?
3. What value do you place on the company at the time of the Series D? (use DCF method and data in Exhibit 7)
4. Evaluate the Series D term sheets. Should OGE select Zouk Capital or Solar City? Why?

October 18, 2018 ENERGY | Class 15: Husk Biomass to Power in Rural India

Introduction

Husk Power operated in rural villages in India, Nepal, Uganda, and Tanzania, converting rice husks into electricity. From 2007 to 2013, 80 plants had been constructed, and 250,000 villagers were supplied electricity through micro-grids. With a change of management in view in 2014, it was time to reconsider strategic growth priorities and adjust the team accordingly.

Materials

Case: Husk Power [Case 815023]

Assignment

1. Why is Husk so far behind its original 2007 plan? What are the top three things that Husk managers can do to accelerate their deployment rate going forward?
2. Based on Exhibits 9 and 11, how much money should Husk try to raise in its upcoming financing?
3. As an investor, what do you see as the strengths and weaknesses of Sinha's new plan for realizing Husk's promise? What advice would you give Sinha?

Module 3: Electricity, Transmission, and Distribution

October 25, 2018 ENERGY | Class 16: Engie: Transformation of an Energy Conglomerate

Introduction:

In 2014, Engie (formerly known as Gaz de France), a 194 year old multinational energy company based in France and the largest independent power producer in the world (115

GW of installed capacity), owned and operated the world's most extensive natural gas distribution networks, and had 2.2 million retail electricity customers in France. Despite its size and strength, Engie announced a major shift in its strategy and operating model after a precipitous drop in fossil fuel prices in the 2010s. Isabelle Kocher, the incoming CEO, embarked on a strategic transformation, declaring: "the name of the game is to take the lead in the new energy world."

Materials:

Case: ENGIE: Strategic Transformation of an Energy Conglomerate [Case SM256-PDF-ENG]

Assignment:

1. What sparked Engie's "strategic epiphany" that a transformation was necessary? Was it premature?
2. Why did Engie choose SolaireDirect as an acquisition target?
3. How quickly should Engie integrate SolaireDirect into its matrix organization (geography x métiers) following the acquisition, and why?

October 26, 2018 ENERGY | Class 17: KT Corporation in the New Energy Market: Smart Grids

Introduction

Since 2014, when Chang-Gyu Hwang had joined KT Corporation (formerly known as Korea Telecom), the group had been pursuing diversification options. Although KT was South Korea's oldest and largest telecommunications operator, one of the five potential growth areas the group had focused on was the energy sector. Convinced that the energy industry was moving towards a service market enabled by information and communications, KT had developed "KT-MEG" as the world's first "total energy management" platform, and had begun testing use cases.

Materials

Case: KT Corporation in the New Energy Market [Case 718051]

Assignment

1. How urgent is it that KT Corp diversify its activities?
2. Is KT Corporation on a convergence path with traditional utilities?
3. Should Hwang focus KT's energy activities expansion on developed countries, where there is more investment in clean energy, or in developing countries, where the ICT infrastructure is much weaker?

October 31, 2018 ENERGY | Class 18: AEP: Facing the Challenges of Distributed Generation

Introduction

As solar, wind, and micro-grids expand, American electric utilities are increasingly faced with the prospect of losing sales. What's more, such distributed generation has been widely subsidized, either with tax incentives to encourage low-carbon alternatives, or through "net metering." In most states, regulated utilities are required to purchase surplus electricity from customers at retail prices, far above their avoided costs. This has led to "abandoned assets" and economic losses for utilities.

Materials

Case: American Electrical Power: Facing the Challenges of Distributed Generation [Case 716008]

Assignment

1. Is distributed generation a significant threat to regulated utilities? To AEP?
2. How effective have been AEP's efforts to deal with net-metering thus far?
3. What advice would you give Akins about dealing with net-metering and, more broadly, distributed generation, going forward?

November 1, 2018 ENERGY | Class 19: Elon Musk's Big Bets

Introduction

From 2014 to 2016, Elon Musk had undertaken several big and risky initiatives, to dramatically expand the scale and scope of Tesla's business. With Tesla's acquisition of Solar City in 2016, Musk announced his vision that Tesla would become "the world's only vertically integrated energy company offering end-to-end clean energy products to our customers." Ramping up vehicle production, completing the Gigafactories, and growing SolarCity each required significant capital investments at a time when Tesla was still losing money.

Materials

Case: Elon Musk's Big Bets

Questions

1. From an energy point-of-view, how revolutionary is Musk's vision for Tesla?
2. Why did Tesla's stock price fall after its merger with SolarCity?
3. What are Tesla's biggest risk factors going forward? What could go wrong? What needs to go right?

November 8, 2018 ENERGY | Class 20: Innovation at the Utility: Consolidated Edison's Experience

Introduction

New York state was an early mover in the deregulation of its electricity markets, and had only allowed monopolistic control to remain in distribution. The six investor-owned utilities operating in the state were not guaranteed returns on generation, as this function regulated the utilities' revenues, by approving or rejecting the new rates. Con Edison therefore reacted quickly to assess the implications of the NY PSC's 2014 proposal entitled "Reforming the Energy Vision" (REV) which outlined a utility regulation framework that would be a drastic departure from the status quo. Earning Adjustment Mechanisms (EAMs) to be integrated in the rate base could change incentives and favor technological innovation. Feeling increasing pressure from distributed generation and storage, and hearing proponents of blockchain and other digital technologies predict major disruptions to the way electricity was transmitted and distributed, Con Edison's Utility of the Future team had worked diligently to define recommendations for action.

Materials

Case: Innovation at the Utility: Consolidated Edison's Experience

Questions

1. Is Con Edison's business model as an electric utility robust?
2. Will the new Earnings Adjustment Mechanisms (EAMs) create incentives to innovate at the utility?
3. Is blockchain likely to be a game changer for utilities?

Module 4: Digital and off-grid energy

November 9, 2018 ENERGY | Class 21: Energy Efficiency Lessons from Australia

Materials

Energy Efficiency: Towards the End of Demand Growth - edited by F. Sioshansi
Read:
Chapter 13: "Crouching Demand, Hidden Peaks: What's Driving Electricity Consumption in Sydney?"
Chapter 18: "What Comes After the Low-Hanging Fruit?"
*click the "view online" button and you can navigate to individual chapters

Questions

1. What three factors explain Sydney's decline in electricity consumption?
2. Is Sydney's "peak electricity demand" a thing of the past? Or is it just crouching, waiting to spring back?
3. To what extent can a service-focused approach to energy management push for behavioral changes?

November 15, 2018 ENERGY | Class 22: Groom Energy Solutions: Selling Efficiency

Materials

Case: Groom Energy Solutions: Selling Efficiency [Case 613054]

Questions

1. If implementing energy efficiency measures is a “win-win,” why has progress been so slow?
2. How strong is Groom Energy’s value proposition?
3. What advice would you offer Guerster about Groom Energy’s growth strategy?

November 16, 2018 ENERGY | Class 23: Spectio: A Digital Lighting Company

Materials

Case: Spectio: A Digital Lighting Company [517002]

Questions

1. How strong is Spectio's value proposition?
2. Which of the options that Sean Marshall is considering (end page 1) are the most promising to make Spectio's present project portfolio profitable?
3. Should Spectio widen its customer focus to other segments, like commercial and outdoor lighting, or continue to focus on warehouses?

November 28, 2018 ENERGY | Class 24: Digitalization at Siemens

Materials

Case: Digitalization at Siemens [Case 717428]
NOTE: Chief Strategy Officer, Horst Kayser, will join the class via video link, and will comment and lead a Q&A at the end of class.

Questions

1. What does Siemen's "Vision 2020" aim to do?
2. Contrast Siemens' and GE's approaches to industrial digitalization (pages 13-14). What are their strengths and weaknesses?
3. What advice would you give CSO Kayser, regarding addressing the emerging market of digitalization of electric utility grids?

November 29, 2018 ENERGY | Class 25: Daimler: Reinventing Mobility

Materials

Case: Daimler: Reinventing Mobility [Case E642]

Assignment

1. How realistic is Chairman Zetsche's ambition that Daimler will lead in all four strategic areas? (see excerpt from Zetsche's letter, pg. 8)
2. Was it wise to establish CASE as a separate business unit? What advice would you give to Stark?
3. Considering the macro and industry trends, how do you expect Daimler's business to change in the next 5-10 years?

December 5, 2018 ENERGY | Class 26: Project Presentations

December 6, 2018 ENERGY | Class 27: Project Presentations

December 7, 2018 ENERGY | Class 28: Project Presentations