KAIST Business School,
2012 Fall
FIN549 & 550: Green Technology Commercialization and Finance I & II

Jae Kyu Lee (이재규)

T,Th 10:00 – 11: 20 am. Rm 101

Version 2.2 (as of September 11, 2012)

1. Course Overview

Energy shortage and climate change problems are global issues that attract the attention of green technology development, green business creation, green finance and investment, government policy and international agreement. This course aims to study the green technologies from a business point of view eventually identifying the adequate role of green finance and investment not only to nurture the green business, but also to explore the opportunities of banking sector per se.

Without understanding the characteristics of green technologies, green business cannot be created. Basically, the green technologies such as solar cells and LED take a long time to pay them back, so the role of government is essential to stabilize and booster the green business. In this regard, we need to overview the global agreement and government policies about green growth, particularly the Korean government's technology finance police.

For this end, this course studies the managerial aspect of renewable energy technologies such as solar, wind, bio, geothermal, and ocean energies. The concept of hydrogen economy and fuel cell, and carbon capture and storage will also be studied as a breed of new energies. The unavoidable dependency on nuclear energy and safety concern will also be discussed to turn the risk to opportunity. The status of renewable energy industry will be examined by discussing the cases of leading players.

After having covered the supply side of green energies, this course studies the distribution and demand side of green business such as smart grid and energy storage; and energy savings in key sectors such as green transportation, building and LED lighting.

2. Objectives

Upon completion of this course, students are expected to understand the following subjects.

1) Opportunities and risks of creating new business with green technologies
2) Alternative renewable energies and marginal energies
3) Methods of energy savings in building, transportation, and lighting.
4) Role of carbon emission trading and CDM
5) Methods of carbon capture, storage, and reutilization
6) Necessity of safe nuclear energy as an unavoidable energy source
7) Global trend of coping with the climate change challenges and international agreements
8) Government policy on green growth and green finance

3. Textbook and References

Primary Readings

1. 22 Selected Readings from Harvard Business Publishing
2. Lecture Notes in English

References

1. Jae Kyu Lee et al., Design of Clean and Green Country (맑고 푸른 나라 설계), Money Plus 2011
2. Lecture Notes on Green Technologies (in Korean)

4. Contact

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Phone: 02-958-3968; 019-9162-4166

5. Teaching Framework

5.1 Interactive Lecture and Discussion

- Reading assignment and lecture note will be given in advance for preview study
- Discussion questions and preview questions will be given one or two weeks in advance for lecture and quiz
- Lecture will explain the key points of lecture note and discuss the issue given in advance.
- Quiz will be taken at the end of the class hour for the topic of the day.

5.2 Case Discussion

- Green business cases will be discussed in class. Student should prepare for the
- Green Finance and Investment Models and Cases

5.3 Term Project in Team

- Term project on industry study and company level case study will be conducted as team project
- Term project will be guided throughout the four steps: Pre-proposal, Proposal, Progress, Presentation with PPT, and Final report

6. Assessment Summary

6.1 Reading Assignment (10%)

- Read the assigned readings before the class hour. Preview questions will be identified to help the reading.
- Submit a printed report about the answers to the preview question in class
- The selected preview questions may be tested by quiz

6.2 Class Activity (20%)

- Case and Role Discussion
  - Discussion points will be announced in advance
- Post self introduction including interesting area and topics
  - This will be essential to find relevant project and study partners
- Class Participation
  - One absence without permission will be panelized by one percent point.
  - One late appearance without advanced permission will be penalized by 0.5 point.
  - No notebook PC will be allowed to use in class to avoid the distraction
- Post valuable materials that are discovered during the term project reference survey.
- Critiques on project presentations

6.3 In Class Quiz (40%)

- Quiz on the lecture of the day including the preview questions
- No mid term and final exam

6.4 Term Project (30%)

1) FIN549
   - Pre-proposal (10%)
     - Topic; Team Building, Research Plan,
   - Proposal (20%):
     - Research Objective, Literature Review, Research Method, Action Plan, Expected Outcome

2) FIN 550
   - Progress Report (10%)
   - Report in PPT (10%)
   - Presentation (10%)

- Project Team: Usually 3 members in a team
- Project owner post a plan and participants bid for acceptance

- Project Subjects: Case Study, Industry Study, Technology Review, Real Business Planning, or any research Issues. Example topics are:
  1) Green business case study: Story telling
  2) Planning the creation of new green business
  3) Review of green investment cases
  4) Review the trend of a green technology
  5) National policies on green finance
  6) Energy portfolio policy
  7) Green technology assessment models

7. Lecture Schedule - Overview

FIN549: Green Technology Commercialization and Finance I

1. [Sep 4] Overview: Course Objectives and Syllabus
2. [Sep 6] Challenge of Global Warming and Green Growth Strategy
3. [Sep 11] Renewable Energies and Marginal Energies
4. [Sep 13] Carbon Emission Trading and CDM
5. [Sep 18] Carbon Accounting
6. [Sep 20]Framework Acts on Low Carbon Green Growth
7. [Sep 25] Green Technology Assessment and Investment
8. [Sep 27] Solar Energy: Technologies
9. [Oct 2] Solar Energy: Business
10. [Oct 4] Wind Power: Technology and Industry
11. [Oct 9] Offshore Wind Farm
12. [Oct 11] Green Investment Analysis with Wind Turbine Plant Case
13. [Oct 16] Fuel Cell and Hydrogen Energy
14. [Oct 18] Bio Energy
15. **[Oct 23] Term Project Proposal I**
16. **[Oct 25] Term Project Proposal II**

FIN550: Green Technology Commercialization and Finance II

17. [Oct 30] Ocean Energy: Tide and Current Energy
18. [Nov 1] Geothermal Energy and Heat Pump
19. [Nov 6] Waste Reuse
20. [Nov 8] Smart Grid and Energy Storage System
21. [Nov 13] Nuclear Energy and Safety
22. [Nov 15] Carbon Capture and Storage
23. [Nov 20] Electric Vehicles and Infrastructure
24. [Nov 22] LED Lighting and Green IT
25. [Nov 27] Green Building and Green City
26. [Nov 29] Water Shortage and Desalination
27. [Dec 4] Green Strategy: G-Transformation
28. [Dec 6] Green Marketing
29. **[Dec 11] Term Project I**
30. **[Dec 13]Term Project II**
31. **No Final Exam**

8. HBP Reading Pack

FIN549: Green Technology Commercialization and Finance I

1. **[Sep 4] Overview: Course Objectives and Syllabus**
2. **[Sep 6] Challenge of Global Warming and Green Growth Strategy**
3. **[Sep 11] Renewable Energies and Marginal Energies**
- Highland Capital Partners: Investing in Cleantech, HBS 9-811-009, Feb 4, 2011
4. **[Sep 13] Carbon Emission Trading and CDM**
- Susheel Tenguria, Mathew Taylor, and George Allayannis, "Carbon Credit Markets", Darden Business Publishing, UV 2543, March 1, 2011
- Andre Perold, Forest Reihardt, and Mikell Hyman, "International Carbon Finance and EcoSecurity", HBS, 9-208-151, Oct 24, 20-08
5. **[Sep 18] Carbon Accounting**
- Michael W. Toffel and Stephanie Van Sice, "Carbon Footprints: Methods and Calculations", HBR 9-611-075, July 20, 2011
6. **[Sep 20] Framework Acts on Low Carbon Green Growth**
7. **[Sep 25] Green Technology Assessment and Investment**
- George S. Day and Paul J.H. Schoemaker, Innovating in Uncertain Markets: 10 Lessons for Green Technologies, MIT Sloan Management Review, Vol. 52, No.4, Summer 2011
8. **[Sep 27] Solar Energy: Technologies**
9. **[Oct 2] Solar Energy: Business**
- First Solar in 2010, Stanford, SM-190, 10-01-2010
10. **[Oct 4] Wind Power: Technology and Industry**
- Vestas' World of Wind, HBS 9-511-121, July 11, 2011
11. **[Oct 9] Offshore Wind Farm**
- Cape Wind: Offshore Wind Energy in the USA, HBS 9-708, May 19, 2008
12. **[Oct 11] Green Investment Analysis with Wind Turbine Plant Case**
13. **[Oct 16] Fuel Cell and Hydrogen Energy**
- Fuel Cell Technology and Market Opportunities, UV 1988, Oct 13, 2009
14. **[Oct 18] Bio Energy**
- Amyris Biotechnologies: Commercializing Bio Fuel, HBS 9-610-031, Feb 25, 2010
15. **[Oct 23] Mid Term: Term Project Proposal I**
16. **[Oct 25] Mid Term: Term Project Proposal II**

FIN550: Green Technology Commercialization and Finance II

17. **[Oct 30] Ocean Energy: Tide and Current Energy**
18. **[Nov 1] Geothermal Energy and Heat Pump**
19. **[Nov 6] Waste Reuse**
- The European Recycling Platform: Promoting Competition in e-Waste Recycling, Stanford, GS-67, 08-28-2009
- Harvest: Organic Waste Recycling with Energy Recovery (A), HBS 9-611-033, June 14, 2012

20. **[Nov 8] Smart Grid and Energy Storage System**
- Rebecca Henderson et al., "The Smart Grid", HBS 9-310-072 May 19, 2010

21. **[Nov 13] Nuclear Energy and Safety**
- Richard Vietor and Forest Reinhardt, Duke Energy and the Nuclear Renaissance, HBS 9-712-002, Dec 8, 2011

22. **[Nov 15] Carbon Capture and Storage**
- American Electric Power: Carbon Capture and Storage, HBS 9-711-036, Oct 25, 2010

23. **[Nov 20] Electric Vehicles and Infrastructure**
- Environmental Enhancements in Road Vehicle Technologies, Stanford, OIT-74, 03-24-2008

24. **[Nov 22] LED Lighting and Green IT**
- Cree, Inc.: Which Bright Future?" HBS 9-711-457, March 2011
- Cree, Inc.: An Update, HBS 9-711-491, March 2011

25. **[Nov 27] Green Building and Green City**
- Rating Environmental Performance in the Building Industry: Leadership in Energy and Environmental Design (LEED): UV 2005, Sept 24, 2010

26. **[Nov 29] Water Shortage and Desalination**
- Intel: Exploring Market Opportunities in Water, HBS 9-412-100, April 2, 2012

27. **[Dec 4] Green Strategy: G-Transformation**
- Renato J. Orsato, Competitive Environment Strategies: When Does it Pay to be Green?, California Management Review, Vol. 48, No. 2, Winter 2006
- Global Climate Change and BP, HBS 9-708-026, Oct 20, 2009

28. **[Dec 6] Green Marketing**
- Jill M. Ginsberg and Paul N. Bloom, Choosing the Right Green Marketing Strategy, MIS Sloan, Vole 46, No.1, Fall 2004

29. **[Dec 11] Term Project I**
30. **[Dec 13] Term Project II**
31. **No Final Exam**

9. "Designing Clean and Green Country (맑고 푸른 나라 설계)"

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1 편 100 년을 내다보며 오늘에 서서

1. 맑고 푸른 나라 설계한다
2. 저탄소녹색성장기본법 – 녹색경제의 길잡이

2 편 신재생에너지와 경제성장의 동행

3. 태양에너지 수요는 정책이 관건이다
4. 풍력발전을 핵심 수출 산업으로
5. 식량 아닌 바이오연료가 미래 시장을 연다
6. 지열냉난방을 보급하고 지열발전은 수출기술로
7. 해양에너지의 잠재력 극대화한다
8. 폐기물 재활용은 계속되어야 한다
9. 연료전지로 수소연료 시대를 연다

3 편 안전한 원자력을 기원하며

10. 원자력 발전 외 대안이 없다

4 편 에너지 절약이 최대의 승부처이다

11. 전기자동차로 가는 길은 다양하다
12. 한국형 그린홈 모형을 그린다
13. LED로 친환경 조명을 밝힌다
14. 이산화탄소도 재활용한다

5 편 녹색 인프라 시대를 찾아

15. 스마트 그리드는 에너지 시장이다
16. 담수화는 도시수출의 기반
17. 그린 IT는 정보화의 새로운 지평
18. 그린시티는 종합생태계 산업이다

6 편 녹색 서비스 산업을 연다

19. 탄소배출 거래가 최적 구조로 인도한다
20. 녹색투자가 녹색산업을 결정한다

10. Lecture Schedule, Readings and Class Activities

1. [Sep 4] Overview: Course Objectives and Syllabus

A. Lecture
   1) Introduction of the course with the syllabus
   2) Is the global warm real? If yes, why? If not, why not.
   3) Is the global consensus on carbon reduction sustainable or a fad?
   4) Different scenarios in country counties

B. Assignment:
   1) Readings for the next class
   2) Post your resume in the class folder

C. HBP 2012
   1) None

D. Lecture note and reference note
   1) [001] Climate Change and Green Growth

E. Designing Clean and Green Country
   1) Give a copy free of charge for the registered students

F. References
   - IEA 2011 – PDF File (Korean Version)

2. [Sep 6] Challenge of Global Warming and Green Growth Strategy

A. Lecture
   1) What is the target of curbing the global warming?
   2) What are four methods of reducing carbon reduction?
      - Which method is more economical and environment friendly?
      - What is the optimal portfolio of carbon reduction plans?
   3) How can a country or a company grow economically as well as environmentally?

B. Assignment: Reading for the next lecture and quiz

C. HBP 2012
   1) None

D. Korean Reference Note
   1) [001] Climate Change and Green Growth (Continued)

E. Designing Clean and Green Country
   1) Ch 1: Introduction

F. References
   1) Adam Werbach, What do we mean by Strategy for Sustainability, HBP,2009
      - Conceptual framework

3. [Sep 11] Renewable Energies and Marginal Energies

A. Lecture
   1) What is the difference between renewable energies and new energies?
   2) What energies are renewable energies?
   3) What kinds of marginal energies exist on the planet?
   4) Will the fossil fuel disappear in 30 years? Why and Why not?
   5) Will the consumption of fossil fuel be reduced by 2050?
      - If yes, what will replace the fossil fuels
      - If no, how to reduce carbon emission of fossil fuels?

B. Assignment: Reading for the next lecture and quiz

C. HBP 2012
   1) Highland Capital Partners: Investing in Cleantech, HBS 9-811-009, Feb 4, 2011
      - Investment outcome for HCP
      - Contrast with high tech and cleantech

D. Korean Reference Note
   1) [003] Renewable Energies
   2) [003] Marginal Energies

E. References
   1) Gary Calendenen et al., “Coal, Nuclear, Natural Gas, Oil, or Renewable: Which Type of Power Plant Should We Build?”, Case Research Journal, 2010
      - 36 pages; Excellent overview
   2) Noel Maurer and Elisa Farri, Poweo: David and Goliath in the French Electricity Market, HBS 9-711-037, June 3, 2011
      - Electricity market case in French, 21

4. [Sep 13] Carbon Emission Trading and CDM

A. Lecture
   1) What should be the criteria of allowing carbon emission for a corporation?
   2) What are the approaches for emission trading?
   3) What is the difference between cap-and-trade system and carbon credit method?
   4) What are the typical markets for emission trading?
   5) Will the trade of carbon emission allowance and credit fulfill the carbon reduction at minimum cost?
   6) Review the article: Carbon Credit Markets

B. Assignment: Reading for the next lecture and quiz

C. HBP 2012

1) Susheel Tenguria, Mathew Taylor, and George Allayannis, "Carbon Credit Markets", Darden Business Publishing, UV 2543, March 1, 2011 - Find the meaning of the terminologies
   - Emission Trading Approaches
     - Cap and Trade
     - Baseline and Credit
     - Offset
   - Kyoto Protocol
     - Annex I and Non-Annex I countries
   - Clean Development Mechanism
     - CER (Certified Emission Reduction Credit)
   - Joint Implementation
   - Carbon Funds
   - CER Trading
     - Chicago Climate Exchanges
     - Europe Climate Exchange
   - Carbon Indices
2) Andre Perold, Forest Reihardt, and Mikell Hyman, "International Carbon Finance and EcoSecurity", HBS, 9-208-151, Oct 24, 20-08
   - Performance of carbon finance by EcoSecurity
   - Six Greenhouse Gases and Weights

D. Korean Reference Note
   1) [004] Carbon Emission Trading and CDM

E. Designing Clean and Green Country
   1) Ch 19: Emission Trading Leads to the Most Efficient Market

F. References
   1) American Electric Power: Investing Forest Conservation, Stanford, OIT-96, 03-09-2010
      - Excellent CDM business, Forest in Peru. Case
   2) Alliance for a Green Revolution in Africa (AGRA), HBS 9-509-007, Oct 28, 2009
      - Africa problems in general; Green ODA

5. [Sep 18] Carbon Accounting

A. Lecture
   1) How to measure the organization's carbon footprint?
      - Organizational vs. Product Footprint
   2) Emission factors
   3) Example case with Harvard Business School 2010
   4) Should the third party certify the corporate carbon emission report?

B. Assignment: Reading for the next lecture and quiz
C. HBP 2012
   1) Michael W. Toffel and Stephanie Van Sice, "Carbon Footprints: Methods and Calculations", HBR 9-611-075, July 20, 2011
      - Global warming potentials of green house gases
      - Carbon footprint calculators
      - Emission factors
      - Carbon footprint labels
D. Reference
   1) http://www.footprintnetwork.org

6. [Sep 20] Framework Acts on Low Carbon Green Growth

A. Lecture
   1) What is the legal structure of controlling carbon emission and leading the green growth?
   2) What are the characteristics of Renewable Portfolio Standard (RPS) policy in comparison with the Feed-In-Tariff (FIT) policy?
   3) What is the law that defines the carbon emission trading?
B. Assignment: Reading for the next lecture and quiz
C. HBP 2012
   1) None
D. Korean Reference Note
   1) http://www.law.go.kr/ (National Law Information Center: 국가법령정보센터)
   2) [003] Framework Acts on Low Carbon Green Growth (저탄소 녹색성장기본법): Korean and English Versions
      - Enforcement Decree (대통령 시행령)
   3) [003] 신재생에너지 공급의무화제도 관리 및 운영지침 (Law of Renewable Portfolio Standard): No English Version
   4) [003] 온실가스배출권의 할당 및 거래에 관한 법률 거래제도 법률 (Carbon Emission Allowance and Trading Law) - No English Version
E. Designing Clean and Green Country
   1) Ch 2: Framework Acts on Low Carbon Green Growth
F. References
   1) The California Global Warming Solutions Act (AB 32), Harvard Kennedy School, Case 1944.0, 2011
      - Impact of law, and politics

2) Michael B. Gerrard (Ed.), Global Climate Change and US Law, American Bar Association, 2007

7. [Sep 25] Green Technology Assessment and Investment

A. Lecture
   1) What are ten lessons for green technologies?
   2) What should be the criteria of assessing new green technology?
   3) Who evaluate the green technologies for investment?
   4) What is the role of government in motivating green investment?
   5) Certificate of Green Technology and Green Business
   6) Green Technology Assessment Model (KIBO and KoFC)
B. Assignment: Reading for the next lecture and quiz
C. HBP 2012
   1) George S. Day and Paul J.H. Schoemaker, Innovating in Uncertain Markets: 10 Lessons for Green Technologies, MIT Sloan Management Review, Vol. 52, No.4, Summer 2011
   - Excellent in the early lecture
D. Korean Reference Note
   1) [005] Green Technology Assessment and Investment
   2) Green Technology Certificate: www.greencertif.or.kr
   3) Classification of Green Technologies: http://www.greencertif.or.kr/TechClassList.do
   4) Korea Technology Finance Corporation (www.kibo.or.kr)
   5) Korea Finance Corporation (www.kofc.or.kr)
E. Designing Clean and Green Country
   1) Ch 20: Green investment determines green industry
F. References
   1) China Greentech Initiative, HBS 9-412-105, Feb 21 2012
   2) Cardiner Morse, Six sources of Limitless Energy, HBR, 2009
      - Long term technology

8. [Sep 27] Solar Energy: Technologies

9. [Oct 2] Solar Energy: Business

A. Lecture
   1) What are the types of technologies adopted for the photovoltaic power generation? Which technology is most cost effective at the moment, and what are the technologies of the future?
   2) What is the efficiency level reached by current PV technologies?
   3) What is the difference between photovoltaic power and concentrated solar power?

4) What is the supply chain of polysilicon solar cell system?
5) What is the potential of solar power and its limitation in efficiency and space usage?
6) Has the grid parity reached already?
7) Which country leads the manufacturing of polysilicon solar cells?
8) What made the First Solar a global leader in solar energy industry?
9) Hanwha has acquired Q-Cell. Is this a right decision?

B. Assignment: Reading for the next lecture and quiz

C. HBP 2012
   1) First Solar in 2010, Stanford, SM-190, 10-01-2010
      - Overview of solar cell technology, industry competitors
      - Solar value chain
      - Marketing strategy and business model
      - Financial strategy
      - Challenges
        - Changes in subsidy markets
        - Changing project finance environment
        - Increased competition
        - Technology risk
      - Carbon footprint of power generation technologies

D. Korean Reference Note
   1) [008] Solar Energy

E. Designing Clean and Green Country
   1) Ch 4: Subsidy determines the PV market

F. References
   1) Newspaper articles about the price of solar power
   2) Usha C.V. Haley and Douglas A. Schuler, Government Policy and Firm Strategy in the Solar Photovoltaic Industry, California Management Review, Vol. 54, No.1, Fall 2011
      - Excellent, Reading and discussion
      - Industry and Policy
   3) Suntech Power, HBS 9-710-013, Jan 31, 2012
      - Excellent case
   4) Suntech Power Holdings (A): The Pre-IPO Years, Stanford, E347-A, 01-11-2010
      - Good case
   5) Suntech Power Holdings (B): The Post-IPO Years, E347-B, 01-11-2010
      - Good Case
   6) REI's Solar Energy Program, Stanford BE-17, 12-2-2011

- Solar energy deployment program by Recreational Equipment Inc. in USA
- Good investment case

10. [Oct 4] Wind Power: Technology and Industry

A. Lecture
   1) What is the trend of wind power generation?
   2) What is the supply chain of the wind turbine system?
   3) What are the environmental side effects of wind turbine system?
   4) How has Vestas become the global leader in winder turbine manufacturing?
   5) What was the marketing strategy of Vestas?

B. Assignment: Reading for the next lecture and quiz

C. HBP 2012
   1) Vestas' World of Wind, HBS 9-511-121, July 11, 2011
      - Good overview of wind energy industry
      - Vestas' marketing strategy

D. Korean Reference Note
   1) [012] Wind Energy

E. Designing Clean and Green Country
   1) Ch 4: Wind turbines as an export industry

F. References
   1) Vestas Wind Systems A/S – Exploiting Global R&D Synergies, Ivey 909M79-2009-Case
      - Good R&D Strategy
   2) Note on Global Wind Industry, HBS 9-709-005, Oct 30, 2008
      - Industry review, 5 pages
   3) The Fox Islands Wind Project, Case A- HBS-9-810-129, Feb 15, 2011
      - Case project, 24 pages
   4) The Fox Islands Wind Project, Case B- HBS-9-810-129, Feb 15, 2011
      - Case project 4 pages, Complied from New York Times

11. [Oct 9] Offshore Wind Farm

A. Lecture
   1) Will the offshore wind energy replace the onshore?
   2) What are the challenging issues of offshore wind farms?
   3) How to compensate the expensive cost of offshore wind turbines?
   4) What were the environmental, safety, and social issues of Cape Wind project?
   5) What is the advantage and disadvantage of DC transmission?

B. Assignment: Reading for the next lecture and quiz
C. HBP 2012
   1) Cape Wind: Offshore Wind Energy in the USA, HBS 9-708, May 19, 2008

12. [Oct 11] Green Investment Analysis with Wind Turbine Plant

A. Lecture
   1) Wind Turbine Plant Project: Real Case
   2) Investment Analysis with Excel
B. Invited Speaker: Soyoung Yoo (Credit Evaluation Co.)
C. Hands on practice

13. [Oct 16] Fuel Cell and Hydrogen Energy

A. Lecture
   1) What is the primary fuel for the fuel cell power generation?
   2) Where can we generate hydrogen from?
   3) What kind of fuel cell technologies exist? What are the characteristics of PEMFC, MCFC, SOFC in terms of its operating temperature, catalysts, fuels and scale?
   4) Can the fuel cell compete with the battery in electric vehicle?
   5) How to store the hydrogen in fuel cell based vehicle?
B. Assignment : Reading for the next lecture and quiz
C. HBP 2012
   1) Fuel Cell Technology and Market Opportunities, UV 1988, Oct 13, 2009
   - Good review of fuel cell technologies and industry
D. Korean Reference Note
   1) [013] Fuel Cell
E. Designing Clean and Green Country
   1) Ch 9: Hydrogen energy era with fuel cell

14. [Oct 18] Bio Energy

A. Lecture
   1) What are the three generations of biofuels?
   2) What is the most suitable biofuel in combustion engine?
   3) What are the technical challenges in transforming biomass to biobutanol?
   4) What is the purpose of biorefinery?
   5) What is the advantage of biodiesel over ethanol according to the case study of Amyris in terms of pipe corrosion?

6) What is the advantage and disadvantage of biodiesel over petroleum based fuel in terms of carbon emission and price according to the case of Amyris?

B. Assignment: Reading for the next lecture and quiz
C. HBP 2012
   1) Amyris Biotechnologies: Commercializing Bio Fuel, HBS 9-610-031, Feb 25, 2010
      - Good case, 23
D. Korean Reference Note
   1) [014] Biofuel: Technology, Industry and Research
E. Designing Clean and Green Country
   1) Ch 5: Biofuel from non-food biomasses
F. References
   1) Arcadia Biosciences: Seeds of Change, HBS 9-709-019, Jan 3, 2011
      - Good Case, CDM in China, 19 pages

15. [Oct 23] Term Project Proposal Presentation I (No Mid Term Exam)
16. [Oct 25] Term Project Proposal Presentation II (No Mid Term Exam)

- Present the proposal with PPT and submit the proposal.

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17. [Oct 30] Ocean Energy: Tide and Current Energy

A. Lecture
   1) What are the types of ocean energies?
   2) What is the potential capacity of ocean energy in Korea and in the world?
   3) Why the environmentalists resist in building tidal power station?
B. Assignment: Reading for the next lecture and quiz
C. HBP 2012
   1) None
D. Korean Reference Note
   1) [017] Ocean Energy
E. Designing Clean and Green Country
   1) Ch 7: Maximize the potential of ocean energies

18. [Nov 1] Geothermal Energy and Heat Pump

A. Lecture

1) To generate power using steam turbine, we need steams. When the temperature of underground waters is lower than 100 degree, what technology in necessary for power generation?
2) What is the role of heat pump in heating and cooling the buildings?
3) What is potential capacity of geothermal power generation in Korea and in the world?

B. Assignment: Reading for the next lecture and quiz
C. HBP 2012
   2) None
D. Korean Reference Note
   3) [018] Geothermal Energy
F. Designing Clean and Green Country
   1) Ch 6: Geothermal energies for heating and cooling

19. [Nov 6] Waste Reuse

A. Lecture
   1) What is the portion of waste reuse in the renewable energies?
   2) What are four types of energies that can be created wastes?
   3) HBP: European Recycling Platform
      - What is the meaning of WEEE Directive?
      - What are the meaning of Extend Producer Responsibility and Individual Producer Responsibility
   4) HBP: Organic Waste Recycling
      - What is the recovery as percentage of generation for paper, glass, metals, and total materials according to the US Municiple Solid Waste statistics in 2008?
B. Assignment: Reading for the next lecture and quiz
C. HBP 2012
   1) The European Recycling Platform: Promoting Competition in e-Waste Recycleing, Stanford, GS-67, 08-28-2009
      - Good case, 25, reading and discussion
   2) Harvest: Organic Waste Recycling with Energy Recovery (A), HBS 9-611-033, June 14, 2012
      - Fuel creation, 14
D. Korean Reference Note
   1) [019] Waste Reuse and Recreation of Energy
   2) Designing Clean and Green Country
      - Ch 8
E. References
   2) Harvest: Organic Waste Recycling with Energy Recovery (B), HBS 9-

611-034, June 14, 2012
  - Fuel creation, 3
3) Terracycle: Outsmarting Waste, IMD 710, 26-04-2012
  - Venture new business and grow
4) Green Rubber: The Revolution of Rubber Recycling Business, ACRA, HK835
  - Malaysian Petra Group

20. [Nov 8] The Smart Grid and Energy Storage System

A. Lecture
  1) Why renewable energies need the smart grid?
  2) How the price of electricity is computed in the Korea Power Exchange?
  3) What are the key themes of the Jeju Smart Grid Project?
  4) What kinds of technologies exist for the energy storage system in the smart grid?
  5) HBP: Cisco Case
    - Who are actors of the smart grid?
    - What is the Cisco's vision of the Smart Grid?
    - What is the percentage of renewable energies for each states according to the Renewable Portfolio Standards?
  6) Discussion: Desertech; Asia Super Grid
B. Assignment: Reading for the next lecture and quiz
C. HBP 2012
  1) Rebecca Henderson et al., "The Smart Grid", HBS 9-310-072 May 19, 2010
  - Good review of smart grid and Cisco's view, 23
D. Korean Reference Note
  1) [020] The Smart Grid: Concept and Trend
E. Designing Clean and Green Country
  1) Ch 15 The Smart Grid as the Energy Market

21. [Nov 13] Nuclear Energy and Safety

A. Lecture
  1) Can renewable energies replace nuclear energies by 2050? Which country dare to attempt to this?
  2) Can Korea live without the nuclear power generation?
  3) Is nuclear power safe? How can we ensure it?
  4) Can we reuse the nuclear waste without violating the Nuclear Non-Proliferation Treaty?
  5) HBP: Duke Energy

- Which countries produce more than 30% of its national electricity by nuclear power plants?
- Which country produces the highest MW by nuclear power generation, and which country construct highest MW as of 2010?
- Why the primary reason that the cost of nuclear power in Korea is cheaper than those by the USA and Japan?
- After the Fukishima catastrophe in Japan, what were the attitudes of the USA, Germany, Italy, China and India respectively in constructing nuclear power plant?
- What are the types of fuels that Duke Energy uses for the power generation?

B. Assignment: Reading for the next lecture and quiz
C. HBP 2012
   1) Richard Vietor and Forest Reinhardt, Duke Energy and the Nuclear Renaissance, HBS 9-712-002, Dec 8, 2011
      - Good review of nuclear energy, 32, Industry review in the USA.
      - Complement with Korea case
D. Korean Reference Note
   1) [021] Nuclear Energy: Safety and Economy
E. Designing Clean and Green Country
   1) Ch 10: Do we have other alternatives beside nuclear energy?
F. References

22. [Nov 15] Carbon Capture and Storage

A. Lecture
   1) Which process takes highest cost in CCS: carbon capturing, delivery and storage?
   2) What are three stages of capturing carbon?
   3) Where can we store the billions of tons of carbon oxide each year?
   4) HBP: AEP Case
      - What is the architecture of IGCC?
      - What are four carbon strategies of AEP?
      - What is the purpose of carbon sequestration?
      - What is the cost recovery for the CCS investment?
B. Assignment: Reading for the next lecture and quiz
C. HBP 2012
   1) American Electric Power: Carbon Capture and Storage, HBS 9-711-036, Oct 25, 2010
      - Good review of CCS for power plant
D. Korean Reference Note

1) [022] CCS: Principle and Methods

E. Designing Clean and Green Country
   1) Ch 14: Carbon Oxide should be reused

F. References
   1) Clean Coal in the US and China: An Industry Note, Stanford, SM-183, 10-06-2009
      - Good review of clean coal, OGCC, and CCS relationship
   2) Total's Carbon Capture and Storage Project at Lacq (A): Risk and Opportunity in Public Engagement, Ivey W10378, 2011-09-21
      - Very good case for Europe case
      - Review of technologies for CCS and cost
   3) Total's Carbon Capture and Storage Project at Lacq (B): Gaining Public Acceptance of New Technology, W10380, 2011-09-21

23. [Nov 20] Electric Vehicles and Infrastructure

A. Lecture
   1) What motivates the automobile makers to develop electric vehicles?
   2) What are the types of electric vehicles?
   3) Can electric vehicle beat the internal combustion engine with biodiesel?
   4) What are the advantages and disadvantages of Online Electric Vehicle?
   5) HBP: Environmental Enhancement in Road Vehicle Technologies
      - Compare the Well-to-Wheels Efficiency (km/Wh) of hydrogen fuel cells, gasoline engine, hybrid, and electric vehicles. Which one is the most efficient and which is least efficient?
      - Compare the Well-to-Wheels CO2 Emission of hydrogen fuel cells, gasoline engine, hybrid, and electric vehicles. Which one emits CO2 least and which emits most?
      - What is the difference between Hybrid and Plug-in Hybrid EV?
      - What is the concept of CAFÉ?
   6) Handout
      - Note: Compare ICE, HEV, PHEV, EV and OLEV
      - Better Place Model
      - Discussion: Which model will win along the time?

B. Assignment: Reading for the next lecture and quiz

C. HBP 2012
   1) Environmental Enhancements in Road Vehicle Technologies, Stanford, OIT-74, 03-24-2008

D. Korean Reference Note

1) [023] Green Car

E. Designing Clean and Green Country
   1) Ch 11: There are many ways of going to the Electric Vehicle Age

F. References
   1) Scandinavian Airlines: The Green Engine Decision-Ivey 909M28, 2009
      - Airline impact, Good Case, 11

24. [Nov 22] LED Lighting and Green IT

A. Lecture
   1) What are the advantages and disadvantages of LED light over incandescent lamp in terms of cost, power, life time and cost of light [Hint: Cree case]?
   2) Compare the total cost of ownership among LED, fluorescent and incandescent lights?
   3) What is the percentage of consuming electricity for illumination?
   4) What is the meaning of backlighting?
   5) What are two approaches of Green IT?

B. Assignment: Reading for the next lecture and quiz

C. HBP 2012
   1) Cree, Inc.: Which Bright Future?" HBS 9-711-457, March 2011
   2) Cree, Inc.: An Update, HBS 9-711-491, March 2011

D. Korean Reference Note
   1) [024] LED
   2) [024] Green IT
   3) Designing Clean and Green Country
      - Ch 15: LED light as an energy saver

E. References
   1) Host Europe: Advancing CSR and Sustainability in a Medium-Sized IT Company, Ivey 910M42, 2010
      - Best case in Green IT to describe issues. But the solution is not fully described

25. [Nov 27] Green Building and Green City

A. Lecture
   1) What is the concept of active and passive houses?
   2) What are the alternative methods of saving energies in green building?
   3) What is the potential energy saving by passive houses?
   4) What does the LEED mean?
   5) HBP: Rating Environmental Performance by Design: LEED Certificate

- What are the consumption of energy and water by buildings, and production of greenhouse gases in the USA?
- What are the factors in measuring the environmental performance of a builing?

B. Assignment: Reading for the next lecture and quiz
C. HBP 2012
   1) Rating Environmental Performance in the Building Industry: Leadership in Energy and Environmental Design (LEED): UV 2005, Sept 24, 2010
      - LEED by US Green Building Council, Rating
D. Korean Reference Note
   1) [025] Green Building
E. Designing Clean and Green Country
   1) Ch 12: Green Home
   2) Ch 18: Green City

26. [Nov 29] Water Shortage and Desalination

A. Lecture
   1) What are the percentages of fresh ground water and surface water on the earth?
   2) What is the difference between distillation and reverse osmosis for the desalination?
   3) Why desalination plants are often constructed with power plants together?
   4) Which company is the global leader in desalination industry?
   5) HBP: Intel
      - What are three views of water industry to Intel?
      - Why started the water business in India?
B. Assignment: Reading for the next lecture and quiz
C. HBP 2012
   1) Intel: Exploring Market Opportunities in Water, HBS 9-412-100, April 2, 2012
      - Excellent case, Water and IT, 22
D. Korean Reference Note
   1) [020] Water and Desalination
   2) [026] Green City
E. Designing Clean and Green Country
   1) Ch 16: Desalination as foundation of new city development
F. References
   1) Wastewater Recycle: Public Relatins for a Controversial Technology,

Stanford, P-73, 3-27-2012
- Singapore Case, 14

2) A Note on Water, HBS 9-412-050, Feb 27, 2012
   - Good review, 19
3) Hyflux Limited and Water Sustainability – Treading Blue Oceans, NTU007, 9 Mar 2012
   - Good review of water markets global, 26
   - Singapore company case
4) Water Funds: Financing Nature's Ability to Protect Water Supplies, Stanford, OIT-104, 1-11-2011
   - Good for water fund status, 13

27. [Dec 4] Green Strategy: G-Transformation

A. Lecture
   1) What are four generic competitive environmental strategies according to Orsato?
   2) What are the new green business models of SK group?
   3) What are the new green business models of BP?
B. Assignment: Reading for the next lecture and quiz
C. HBP 2012
   1) Renato J. Orsato, Competitive Environment Strategies: When Does it Pay to be Green?, California Management Review, Vol. 48, No. 2, Winter 2006
      - Very good framework
   2) Global Climate Change and BP, HBS 9-708-026, Oct 20, 2009
      - Good review of refinery company
D. Korean Reference Note
   1) [027] Energy and Environment Business Strategy: SK Case
E. References
   1) Clarke: Transformation for Environmental Sustainability, Ivey W12820, 2012
      - Excellent case of transformation, 16
   2) Andrew Winson, Get Creative: Why Green Innovation is the Key to Business Growth – Even in Tough Time, Harvard Business Press, 2009
      - Excellent overview and vision, 20
   3) Pascual Berrone, Green Keys to Unlock Competitive Advantage, IESE Insight, 2009
      - Basic framework

28. [Dec 6] Green Marketing

A. Lecture
   1) What are four green marketing strategies according to Ginsberg and Bloom?
   2) What did not Wal-Mart enforce to keep the suppliers green?
   3) What is the effect of Wal-Mart green initiative?
   4) Handout
      - Wal-mart Case and its Impact

B. Assignment: Reading for the next lecture and quiz

C. HBP 2012
   1) Jill M. Ginsberg and Paul N. Bloom, Choosing the Right Green Marketing Strategy, MIS Sloan, Vole 46, No.1, Fall 2004

D. References
   1) Gregory Unruh, Building the Eco-System, HBP, 2010
      - Wal-mart Effect

29. [Dec 11] Term Project Presentation and Submit Report I

30. [Dec 13] Term Project Presentation and Submit Report II

31. [Dec 18] No Final Exam