B ME 493 Sustainable Energy in Japan (5 cr)

Autumn 2019 (Early-Start)

At UW Bothell August 26 - 30 (UW1-110)
At Ehime University in Japan: September 5 - 19

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Introduction

Offered in collaboration with the Faculty of Engineering at Ehime University in Matsuyama, Japan, this course covers topics in thermodynamics and political economy related to the ongoing transformation of Japan's energy system.

Before the explosions and reactor core meltdowns at the Fukushima Daiichi nuclear power plant following the 2011 Tohoku earthquake and tsunami, nuclear plants supplied one-third of Japan's electric power. Since then, most of the contribution from nuclear power has been replaced by other sources. Fossil fuels filled the gap at first, causing a spike in greenhouse gas emissions, a surge in imports of oil and gas, and a consequent fall in the country's energy self-sufficiency (now only 7.4%, compared with 92% in the US). More recently, solar power has taken off, spurred by a generous feed-in tariff. Wind and other renewable sources have lagged for various reasons, including limited availability of land, difficulty interconnecting with the grid, and lack of economic incentives. Last year, the government unveiled a new energy strategic plan: By 2030, renewables are expected to make up 22 to 24 percent of the energy supply, with 56 percent from fossil fuels, and 20 to 22 percent from nuclear power. The targets are as ambitious as they are controversial. For example, with fewer than 10 of Japan's 60 nuclear power plants in operation, nuclear power provided less than 3 percent of electricity output in 2017; and even after several years of rapid growth, non-hydro renewables supplied less than 10 percent of electricity output. Fossil fuels, which provide more than three-quarters of electricity supply today, are still expected to supply 56 percent of electricity output in 2030, a source of alarm for many environmentalists.

To drive progress toward Japan's strategic energy goals while maintaining its commitment to lower greenhouse gas emissions will require significant investments in research and new technology. To that effect, the government has been ramping up support for R&D directed at producing hydrogen without emitting greenhouse gases, improving fuel cells, capturing CO_2 and converting it into hydrocarbons, speeding deployment of solar and wind power resources, and enhancing the capacity of the grid and electricity markets to accommodate variable electricity generation. Meanwhile,

nuclear plants that comply with stiff new safety measures are being restarted, often in the face of strong public opposition. Perhaps what most distinguishes national policy is its focus on creating a hydrogen economy, which is also gaining traction in some European countries but is not generally considered a priority in the US.

The course begins at UW Bothell in the week following the end of summer term in August. Five four-hour sessions are planned, along with a field trip to a local electric power plant. In the second week, the class travels to Matsuyama, Japan, for two weeks of seminars, field trips, and lab activities at Ehime University. At Ehime, students will have the opportunity for hands-on work with Mechanical Engineering faculty and grad students in the Sustainable Energy Lab, which has cutting-edge equipment for the study of combustion, hydrogen production, and fuel cell chemistry. Lessons in Japanese culture and society are included, and students will have the opportunity for an optional weekend homestay with a Japanese family.

Learning Objectives

After completing the course, students should be able to:

1. Apply mass and energy balances to analyze combustion processes involved in thermal power generation.

2. Describe components and operation of thermal power generating plants, specifically natural gas combined cycle and light water nuclear plants, and assess their environmental impacts, economics, and prospects for Japan.

3. Describe and analyze technologies for renewable and alternative energy technologies, including wind, solar, geothermal, carbon capture, and hydrogen, and assess their prospects for incorporation into Japan's energy system.

4. Describe how an integrated electric power system works, and assess how economics, regulations, and politics influence its evolution in Japan.

5. Describe Japan's short and long-term energy strategy and analyze it within the larger context of the country's history, environment, and natural resource base.

6. Navigate daily life in Japan, recognize cultural differences, and work with a deeper global awareness and outlook.

Course Texts

You don't need to buy any textbooks for this class. The material you need to know will be in notes and readings in Canvas. The books below may be helpful as references.

1. Yunus A. Cengel and Michael A. Boles, *Thermodynamics: An Engineering Approach* (any edition). This is the textbook for B ME 331.

2. Steven W. Blume, *Electric Power System Basics for the Nonelectrical Professional*, 2nd Edition (Wiley-IEEE Press, 2016). Available online through UW Libraries.

3. B.K. Hodge, *Alternative Energy Systems and Applications*, 2nd Edition (Wiley, 2017). This is a good textbook on energy from a mechanical engineering perspective.

4. Christopher Goto-Jones, *Modern Japan: A Very Short Introduction* (Oxford University Press, 2009). Available online through UW Libraries.

Assignments

	Description	Weight
1	On-line quiz on summer reading (due end of day 10/26)	10%
2	One-page field trip report (due end of day 10/28)	10%
3	Pre-trip quiz on Japanese culture and survival Japanese (10/30)	10%
4	Participation	10%
5	Lab presentation (at Ehime)	20%
6	Final exam (take-home, due 9/27)	20%
7	4-page reflection essay (due 10/4)	20%

Assignment Descriptions

On-line quiz on summer reading: This on-line quiz will be made available in Canvas one week before the first class meeting. Questions are drawn from the readings assigned over summer. These readings should be completed before the first day of class. Take the quiz and submit it in Canvas by 11:59 pm August 26.

Field trip report: In one page, describe your take-aways from the 8/28 field trip to the Frederickson power plant. What did you learn? How did it contribute to your understanding of power generation? Format your essay in 12-point Times New Roman font, single-space. Upload the report as a pdf file into Canvas by 11:59 pm 8/28.

Oral Japanese language quiz: Each student will demonstrate ability to engage in very basic conversation in Japanese using expressions learned in class (8/30).

Participation: Students will be assessed on the level and quality of their participation in all scheduled activities.

Lab Work and Final Presentation: Students will prepare and give a PowerPoint presentation summarizing what they did and learned in their lab activities carried out at Ehime University. Labs will be done under supervision of faculty and graduate students in Ehime's Mechanical Engineering and Materials Engineering laboratories. Presentations are scheduled for morning of 9/17 at Ehime.

Take-home exam: The final exam will be posted in Canvas on or before 9/20. It will cover the technical content as well as Japanese culture, society, and energy. Expect a mix of problems, short answer and essay questions. Problems are to be solved on green engineering paper; short answer and essay should be typed out. When you're finished, scan the problems, append them to the typed pages, and upload all pages as a single pdf in Canvas by 11:59 pm on 9/27.

Reflection essay: In about 4 pages (1,000 - 1,250 words), write about your two or three most important take-aways from the course regarding Japan's energy situation. What is it doing right? What is it doing wrong? What would you change and why? Format your essay in 12-point Times New Roman font, double-space, with one-inch margins. Convert the final draft to pdf and upload it into Canvas by 11:59 pm on 10/4.

Grading Policies

A list of STEM School policies and resources available to students can be found here: https://www.uwb.edu/getattachment/stem/about/stem-policies/Classroom-Policies-STEM-FC-1-12-17.pdf

Grading: Tests are graded on a 100-point scale and the score converted to the 4-point scale using the following linear conversion: ≥95=4.0, 94=3.9, 93=3.8, 92=3.7, 91=3.6, 90=3.5,...,85=3.0,..., 80=2.5,...,65=1.0, 62=0.7 (lowest passing grade), ≤62=0. Essays and other assignments are graded directly on the 4-point scale.

Late work: Late submissions will not be accepted without a legitimate explanation. At the instructors' discretion, a late penalty of 0.5 grade points per day may apply. Missing classes or scheduled activities without a valid excuse will reduce the class participation component of the course grade.

Schedule

Pre-course preparation (during summer)
Read assigned parts of *Electric Power System Basics for the Nonelectrical Professional* posted in Canvas.

August 26 - 30: UW Bothell, Room UW1-110
The schedule of topics covered at UWB will be as follows:

Monday, August 26 (9 am - 1 pm)
1. Travel and safety when studying abroad
   Guest: Mr. Daniel Brencic, Office of Global Affairs
2. Thermodynamics review and gas mixtures
3. Combustion: Conservation of mass
4: Japanese language

Tuesday, August 27 (9 am - 1 pm)
1. Combustion: Conservation of energy
2. Energy and the environment
3. Wind power
4. Japanese history

Wednesday, August 28 (9 am - 11:30 am, followed by field trip to Frederickson)
1. Solar power
2. Power systems operations and economics

Field trip to Frederickson Power Plant (249 MW natural gas combined cycle):
Leave campus ~11:30 am, return ~5:30 (UW vans)

Thursday, August 29 (9 am - 1 pm)
1. Discussion of Frederickson tour
2. Geothermal energy
3. Energy from hydrogen
4. Japanese society

Friday, August 30 (9 am - 1 pm)
1. Nuclear power
   Guest: Dr. Jon McWhirter, TerraPower LLC
2. Energy in Japan
3. Japanese culture
4. Japanese language quiz

September 5 - 19: Ehime University
Students are required to arrive at Matsuyama Airport September 5 between 5 and 9 pm Japan time. Staff from Ehime University will greet students and transport them by bus to their accommodations at the Share House.

Class meetings are held at Ehime University in Matsuyama, Japan. Daily activities include lectures, lab activities, and field trips. Our work centers on energy technologies that are the subjects of research in Ehime's Faculty of Engineering. These include hydrogen production, fuel cell chemistry, and combustion reactions. Field trip destinations are projected to include a utility-scale solar PV power plant, local electric and gas utility companies, a builder of sustainable homes that blend traditional and modern building practices, the Hiroshima Peace Memorial, and Miyajima Island.

A tentative schedule of activities in Japan during September is shown below.

Date	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
	Thursday	Friday	Saturday	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	Monday Nat'l holiday	Tuesday	Wednesday	Thursday
AM		SH 9:00 Share house Orientation 215 10:00 Student Orientation	215 10:00 Lecture Prof.Collins	Ishiteji temple Meet @ Dogo clock Visit traditional house Visit modern house	215 Yonden?	Laboratory work orientation (Itagaki)	M Laboratory work	MG 9:00 Laboratory work	215 10:00 Lecture Sustainable Energy in Japan by Moriwaki-sensei	Home stay	Home stay	MG 7:30 Hiroshima Day trip Peace Park and Peace Museum 13:00 Lunch @ Rivers Garden Restaurant	Laboratory presentation	Free	Departure
Lunch	Share House Check in	Lunch	Lunch		Lunch	Lunch			Lunch		Lunch				
PM		MG 13:30 Matsuyama Castle	MG 12:30 Tea Ceremony @Ninomaru		MG 14:00 Daiichi Gas Company	Laboratory work	Review of Labo work	Review of Labo work	215 13:30 Orientation for Home Stay			Miyajima, World Heritage Site	215 13:00 Japan's energy policy Prof.I Hyonyon		
Evening		MG 18:00 Welcome party			Lecture from Material Sicence		Lecture from Mechanical Engineering	Prepartion of power point slide for presentation	MG 18:00 Home stay pick up			Dinner @ Service Area Return 21:55	Sayonara Party @Izakaya		
Trans portation	Micro bus(fuzoku) 12:00-18:00 ———— Micro Bus 18:00-22:00			Micro Bus 8:00-20:00								Bus 7:30-22:00			Micro Bus 12:00 - 21:00
Notes															

215 = Room 215 202 =Room202 SH = Pick up near Share House MG = Meet at main gate of EU Johoku campus