Course number	G-ENE20 63118 LE28				
Course title (and course title in English)	Energy Systems Analysis and Design Energy Systems Analysis and Design	Instructor's name, job title, and department of affiliation	Graduate School of Energy Science Associate Professor,OGATA　SEIICHI		
Target year	Master's students	Number of credits	2	Year/semesters	2024/Second semester
Days and periods	Tue.3	Class style	Lecture (Face-to-face course)	Language of instruction	English

[Overview and purpose of the course]

By Seiichi OGATA, Department of Socio-environmental Energy Science, Graduate School of Energy Science,

The framework and methodology for energy systems analysis and design in a region and/or/ country, especially related to a model-based approach, are introduced. Furthermore, the theories of energy supply-demand systems are discussed. Participants will develop a simple conceptual model by selecting some energy supply-demand systems as a study target.

[Course objectives]

To understand the basic knowledge and the modeling methodologies of Energy supply-demand systems.

[Course schedule and contents]

(1)〜(2) Statistics of energy supply and demand,
(3)〜(4) Numerical modeling of energy supply and demand,
(5)〜(6) Levelized Cost Of Electricity（LCOE)
(7)〜(8) Market Equilibrium
(9)〜(10) Electricity Market and Merit Order
(11)〜(12) A theoretical approach to energy supply-demand systems.
(13)〜(14) Liberalization of the energy industry
(15) Social acceptance of energy technologies.

[Course requirements]

None

Continue to Energy Systems Analysis and Design (2)↓↓↓

Energy Systems Analysis and Design (2)

[Evaluation methods and policy]

Discussion about modeling of energy systems and report submission.

[evaluation policy]
Will be evaluated according to the grade evaluation policy of the Graduate School of Energy Science

[Textbooks]

Instructed during class

[References, etc.]

（Reference books）

Introduced during class

[Study outside of class (preparation and review)]

Student will make a conceptual model for the energy supply-demand systems which the student has selected by himself/herself.
The work for conceptual modeling will be an assignment.

（Other information (office hours, etc.)）

*Please visit KULASIS to find out about office hours.

Course number	G-ENE20 63172 LE28		
Course title (and course title in English)	Energy Policy Energy Policy	Instructor's name, job title, and department of affiliation	Institute for Integrated Radiation and Nuclear Science Professor,UNESAKI HIRONOBU

Target year	Master's students	Number of credits	2	Year/semesters	2024/Second semester
Days and periods	Wed.1	Class style	Lecture (Face-to-face course)	Language of instruction	English

[Overview and purpose of the course]

Energy is dispensable for the welfare of humankind and sound development of social activities in the modern society. The stable supply of energy is influenced by circumstances of political issues and technological development. Based on the mid- to long-term forecast of energy supply and demand, various specific issues related to energy policy, including energy resources, environmental issues, trends in major countries, forecasts and predictions, will be discussed in this course.

[Course objectives]

To achieve ability
- to describe various energy resources used in modern society from both natural and social science,
- to describe the structure and objectives of energy policy of major countries including Japan,
- to comprehensively understand energy statistics and other data and describe it with relation to world energy trends

[Course schedule and contents]

Total of 15 classes will be provided.

1. Overview of energy policy
2. Energy resource: characteristics, supply and demand (1)
3. Energy resource: characteristics, supply and demand (2)
4. Renewable energy: characteristics, policy implementation (1)
5. Renewable energy: characteristics, policy implementation (2)
6. Nuclear energy: characteristics, policy implementation (1)
7. Nuclear energy: characteristics, policy implementation (2)
8. Energy and environment
9. Energy efficiency and energy policy
10. Energy policy of Japan and major countries (1)
11. Energy policy of Japan and major countries (2)
12. Forecasts and outlooks of energy supply and demand (1)
13. Forecasts and outlooks of energy supply and demand (2)
14. Energy poverty, Energy and Water, recent topics
15. Summary

Continue to Energy Policy(2)↓↓↓

Energy Policy(2)

[Course requirements]

Students who have already taken 「**エネルギー政策論**」（3146000）(Spring Semester / in Japanese) are not allowed to take this class.

[Evaluation methods and policy]

By attendance (30%) and research presentation / final report (70%).

Note: attendance to research presentation / submission of final report is not allowed in case of class attendance rate is less than 80%

[evaluation policy] Will be evaluated according to the grade evaluation policy of the Graduate School of Energy Science

[Textbooks]

Lecture materials will be distributed via PandA.

Attendees are recommended to review their own countries' recent energy policy trends, as well as the IEA World Energy Outlook executive summary, which could be downloaded from IEA Web page.

[References, etc.]

（Reference books）

Recommendation of related references (books, reports, journal papers etc) will be given during the class.

[Study outside of class (preparation and review)]

Recent energy situation are extremely fluctuating and dynamic; attendees are recommended to collect up-to-date information on energy policy and related topics.

（Other information (office hours, etc.)）

- Technical tour to power plants and energy-related facilities may be included as a part of the class.

*Please visit KULASIS to find out about office hours.

Course number	G-ENE20 63170 SE28		
Course title (and course title in English)	Future Energy:Hydrogen Economy Future Energy:Hydrogen Economy	Instructor's name, job title, and department of affiliation	Graduate School of Energy Science Professor,MCLELLAN， Benjamin

Target year	Master's students	Number of credits	2	Year/semesters	2024/First semester
Days and periods	Wed.1	Class style	Lecture (Face-to-face course)	Language of instruction	English

[Overview and purpose of the course]

This course will introduce the concepts and technology of the Hydrogen Economy. The course is intended to give insight into this topical area of research and its potential benefits and impacts.

[Course objectives]

The aim for the class is for students to understand each of the major phases in hydrogen energy infrastructure, and the main technologies considered. Students will learn technical, social, environmental and economic aspects of the systems. Through class discussions and a final report, students will hone their skills in argument and learn to identify critical criteria for technology assessment.

[Course schedule and contents]

The course will consist of lectures on key supporting technologies and system-wide aspects of hydrogen energy systems. The following themes will be discussed (order may change):

1. Introduction
2. Hydrogen sources and limitations
3. Hydrogen production: Carbon fuels
4. Bio-hydrogen production
5. Hydrogen production: Electro / thermo / chemical
6. Assessment: In-class discussion 1
7. Hydrogen storage and distribution
8. Hydrogen utilisation: fuel cells I
9. Hydrogen utilisation: fuel cells II
10. Hydrogen utilisation: engines / turbines / non-fuel
11. Assessment: In-class discussion 2
12. Hydrogen economy safety and society
13. Hydrogen economy economics and resources
14. Hydrogen economy environmental aspects
15. Feedback

Continue to Future Energy:Hydrogen Economy(2)↓↓↓

Future Energy:Hydrogen Economy(2)

[Course requirements]

None

[Evaluation methods and policy]

The following items of assessment are used (shown below). The specific requirements and assessment criteria are distributed in class.

Final report (Technology assessment in a specific country context) [50%]
Class discussion 1 - Hydrogen production (Discussion and handout) [10%]
Class discussion 2 - Hydrogen storage and utilisation (Discussion and handout) [20%]
Small exercises [20%]

Will be evaluated according to the grade evaluation policy of the Graduate School of Energy Science

[Textbooks]

Not used

[References, etc.]

（Reference books）

Introduced during class

[Study outside of class (preparation and review)]

Students will need to spend time researching a specific allocated country`s energy system and determining how to develop an appropriate hydrogen economy. This will be particularly before each class discussion.

（Other information (office hours, etc.)）

Basic knowledge of energy concepts and ability to apply mathematics is required.
Contact may be made via email for out-of-class discussion.

*Please visit KULASIS to find out about office hours.

Course number	G-ENE20 63174 LE17		
Course title (and course title in English)	Energy, materials and resources Energy, materials and resources	Instructor's name, job title, and department of affiliation	Graduate School of Energy Science Professor,MCLELLAN，Benjamin

Target year	Master's students	Number of credits	2	Year/semesters	2024/Second semester
Days and periods	Wed.2	Class style	Lecture (Face-to-face course)	Language of instruction	English

[Overview and purpose of the course]

Energy and materials are vitally linked, in their production and utilisation, and are crucial for society. All energy and materials are ultimately reliant on various resources, principal among which are the non-renewable mineral resources. This course will examine the bi-directional link of materials and energy, and the resources on which they are dependent - particularly critical minerals.

[Course objectives]

Students will obtain an understanding of various materials and the energy use in their production, as well as the use of various materials in energy systems. The concepts of material criticality will be introduced, and the students will obtain an understanding of the key elements of criticality assessment and its strategic importance.

[Course schedule and contents]

The general course topics will be as follows:
1. Overview of materials, energy and resources
2. Typical materials and energy lifecycles 1
3. Typical materials and energy lifecycles 2
4. Non-renewable resources and models
5. Renewable resources and models
6. Material criticality frameworks
7. Material criticality 1 - Supply Risk
8. Material criticality 2 - Vulnerability to Supply Restriction
9. Recycling and renewability
10. Substitutes and substitutability
11. Material criticality 3 - Environmental Impacts
12. Energy scenarios and materials - 1
13. Energy scenarios and materials - 2
14. Resource curse and social implications of energy
15. Feedback

The exact order of topics may change. Some additional topics - particularly classes with a focus on a particular material - may be added.

The final class will have student presentations.

Continue to Energy, materials and resources(2)↓↓↓

Energy, materials and resources(2)

[Course requirements]

None

[Evaluation methods and policy]

Evaluation in the subject will be based on:
Class performance: participation and short mid-term exercises (40%)
Final week presentation (10%)
Final report (50%)

These will be evaluated according to the grade evaluation policy of the Graduate School of Energy Science

[Textbooks]

Not used

[References, etc.]

（Reference books）

Reading list will be supplied on PandA.

[Study outside of class (preparation and review)]

Some short exercises will be provided for students to undertake out of class.
Pre-reading may be provided.

（Other information (office hours, etc.)）

Office hours are not set - consultation is available by prior appointment.

*Please visit KULASIS to find out about office hours.

Course number	G-ENE20 63167 SE17		
Course title (and course title in English)	Energy and SD Energy Systems and Sustainable Development	Instructor's name, job title, and department of affiliation	Graduate School of Energy Science Professor,MCLELLAN，Benjamin

Target year	Master's students	Number of credits	2	Year/semesters	2024/Second semester
Days and periods	Tue.2	Class style	Lecture (Face-to-face course)	Language of instruction	English

[Overview and purpose of the course]

This course will introduce key concepts of sustainable development, and engage students in understanding the interconnections of energy systems in the larger picture of sustainable development. The course finishes with a workshop applying these concepts to energy systems planning.

[Course objectives]

The goals of the course are for students to understand the breadth and complexity of sustainability and its implications for energy systems. Students will learn key concepts and frameworks, and apply critical thinking and team processes to the planning of sustainable energy systems in a given context. Technical, environmental and socio-economic topics and approaches will be covered.

[Course schedule and contents]

The course will consist of lectures and interactive sessions on the following key themes (order to be clarified in first session):
The course will consist of lectures and interactive sessions on the following key themes (order to be clarified in first session):
1. Introduction / Concepts in Sustainability
2. Energy in Lifecycles / Energy Systems
3. Renewable Energy Technologies
4. Non Renewable “ Clean ” Energy Technologies
5. Natural resource usage and sustainability
6. Emissions, Energy and Sustainability
7. Energy system configurations
8. Transitions and policy
9. Energy and Development
10. Global and local energy sustainability
11. Measuring Sustainability
12. Decision-making in Sustainable Development
13. Energy system design workshop I (12.5%)
14. Energy system design workshop II (12.5%)
15. Feedback

Continue to Energy and SD (2)↓↓↓

Energy and SD (2)

[Course requirements]

None

[Evaluation methods and policy]

Students will be evaluated on three major elements:
1. Participation in class activities and submission of out-of-class tasks aimed to solidify learning of concepts (40%)
2. Participation in the 2-3 week workshop capping-off the course (30%)
3. Submission of a final report (30%)

Will be evaluated according to the grade evaluation policy of the Graduate School of Energy Science

[Textbooks]

Not used

[References, etc.]

（Reference books）

Suggested reading:
Sustainable Energy: Choosing among options (Tester et al., 2005)
Other reading supplied via PandA

[Study outside of class (preparation and review)]

Students will be required to do occasional out-of-class preparation exercises.
Slides will be provided before the lecture via PandA so that pre-reading can be undertaken.
Other references will be given in class.

（Other information (office hours, etc.)）

Available by appointment.

*Please visit KULASIS to find out about office hours.

Course number			
Course title (and course title in English)	Simulation and Data Science Simulation and Data Science	Instructor's name, job title, and department of affiliation	Graduate School of Energy Science Associate Professor,IMADERA KENJI

Target year	Master's students	Number of credits	2	Year/semesters	2024/First semester
Days and periods	Fri.3	Class style	Lecture (Face-to-face course)	Language of instruction	English

[Overview and purpose of the course]

Simulation and data science are main research approaches based on computers in modern science. Simulation science can be defined as a deductive methodology to find an approximate solution of a given governing equation by using some numerical methods. On the other hand, data science is an inductive methodology that extracts and estimates the rules behind obtained data by using some mathematical statistics.

This course will help students to understand the basic theory of such simulation and data science and write the program by themselves, aiming to acquire the abilities at practical level.

[Course objectives]

By the end of this course, students should be able to:
(1) acquire the abilities to write the program by themselves with the programing language Python;
(2) understand some methodologies for solving ordinary differential equations numerically as the basics of simulation science;
(3) understand some methodologies for solving regression and classification problems as the basics of data science;
(4) apply the learned skills to their own research field by studying how the methodologies in (2) and (3) are utilized at the forefront of research.

[Course schedule and contents]

Week-1：Guidance
After the overall guidance of this course, Jupyter Lab, a web-based interactive computing platform for the Python programming will be installed to student ’ s laptop.

Week-2, 3, 4：Basics of Python
Students will learn the basic grammars of Python programming, NumPy/Matplotlib modules, and def/class statements. Students will also have some practical exercises by writing the programs for numerical integration and equation root finding.

Week-5, 6：Numerical schemes for ordinary differential equations
The Euler, Crank-Nicolson, and Runge-Kutta schemes will be learned as numerical methods for solving ordinary differential equations. Students will also write the related program by themselves.

Week-7：Single Regression analysis
The least-square method and the gradient-descent method will be learned for single regression analysis. Students will also write the related program by themselves.

Continue to Simulation and Data Science(2)↓↓↓

Simulation and Data Science(2)

Week-8, 9：Classification analysis (1)
Students will understand Neural Network (NN) models for classification analysis, and construct single-layer NN models by themselves.

Week-10, 11：Classification analysis (2)
A single-layer NN model constructed in 8th and 9th weeks will be extended to a multi-layer one. In addition, students will learn tensorflow, a kind of library for utilizing multi-layer NN models.

Week-12, 13：Multiple regression and classification analyses for real data
Multiple regression and classification analyses for real data will be performed by using a multi-layer NN model constructed in 10th and 11th weeks and tensorflow.

Week-14：Simulation and data science in plasma physics
In plasma physics, simulation and data science have become an important methodology. Students will study how both are utilized at the forefront of plasma research and acquire the abilities for applying these approaches to their own research field.

Week-15：Feedback

[Course requirements]

Basics of calculus are required.
Experiences for programming are expected but not required.

[Evaluation methods and policy]

The grading policy will be as follows:
(A) Mini tests (during every lectures): 30%
(B) Weekly reports: 40%
(C) Final report: 30%

[Textbooks]

Lecture slides and related Python programs will be uploaded on the PandA before lectures.

[References, etc.]

（Reference books）
Introduced during class

[Study outside of class (preparation and review)]

Students (especially beginners for programming) are expected to pre-study lecture slides on the PandA and solve some practices in advance.

Continue to Simulation and Data Science(3)↓↓↓

Simulation and Data Science(3)

（Other information (office hours, etc.)）

*Please visit KULASIS to find out about office hours.

Course number	G-ENE20 68022 LE28　G-ENE20 68022 LE77

Course title (and course title in English)	Advanced Energy Conversion Science Advanced Energy Conversion Science	Instructor's name, job title, and department of affiliation	Graduate School of Energy Science 変換科学専攻教員全員 Graduate School of Energy Science Professor,Jun HAYASHI Graduate School of Energy Science Professor,KAWANABE HIROSHI Graduate School of Energy Science Professor,SUMIGAWA TAKASHI Graduate School of Energy Science Professor,IMATANI SHIYOUJI Institute of Advanced Energy Professor,NAGASAKI KAZUNOBU Graduate School of Energy Science Associate Professor,HORIBE NAOTO Graduate School of Energy Science Associate Professor,ABE MASATAKA Graduate School of Energy Science Associate Professor,KINOSHITA KATSUYUKI Institute of Advanced Energy Associate Professor,YAGI JURO Institute of Advanced Energy Associate Professor,KOBAYASHI SHINJI Institute of Advanced Energy Associate Professor,MORISHITA KAZUNORI

Target year	修士・博士	Number of credits	2	Year/semesters	2024/Second semester
Days and periods	Wed.3	Class style	Lecture (Face-to-face course)	Language of instruction	English

[Overview and purpose of the course]

Electricity, power and heat required for our daily life are provided by the conversion of primal energy sources such as petroleum, coal, natural gas and uranium. In this lecture, graduate students will learn advanced energy conversion technologies and their principles to prevent environmental destruction and depletion of natural resources.

[Course objectives]

・Graduate students can understand subjects associated with the conversion, control and utilization of energy
・Graduate students can understand issues on advanced energy conversion technologies and their principles

[Course schedule and contents]

Latest topics about energy conversion systems and their functional design are lectured in an omnibus class. The following is a guide to what will be covered during the 15 weeks of the semester.

1. Combustion and power system [3-5 weeks](Kawanabe, Hayashi, Horibe)
・Thermal Efficiency and Pollutant Emissions in Internal Combustion Engines
・Hydrogen Energy System

Continue to Advanced Energy Conversion Science(2)↓↓↓

Advanced Energy Conversion Science(2)

・Engines and Fuels
・Laser Diagnostics for Combustion Research

2. Material design [3-5 weeks](Abe, Imatani, Kinoshita, Sumigawa)
・Functional Materials for Energy Conversion
・Energy Components and High Temperature Machine Design
・Nondestructive Evaluation for Energy Equipment and Materials
・Strength Evaluation of Nano-/Micro-materials for Energy Equipment

3. Nuclear fusion [4-6 weeks] (Yagi, Nagasaki, Kobayashi, Morishita)
・Fusion Energy Conversion
・High temperature liquids for energy conversion
・Energy Conversion System for Electromagnetic Waves in high temperature fusion plasmas
・Modeling of Radiation Damage Processes in Fusion Materials
・Energy conversion system for particle beam in high temperature fusion plasmas

4. Feedback [1 week]

[Course requirements]

None

[Evaluation methods and policy]

Attendance and report

[Textbooks]

Additional articles and documents are delivered if necessary.

[References, etc.]

（Reference books）

Introduced during class
Reference books are introduced in class.

[Study outside of class (preparation and review)]

To be announced in class.

（Other information (office hours, etc.)）

*Please visit KULASIS to find out about office hours.

Course number	G-ENE20 63392 LE28　G-ENE20 63392 LE77		
Course title (and course title in English)	Fusion Energy Science and Technology Fusion Energy Science and Technology	Instructor's name, job title, and department of affiliation	Institute of Advanced Energy Professor,NAGASAKI KAZUNOBU Institute of Advanced Energy Associate Professor,MORISHITA KAZUNORI Institute of Advanced Energy Associate Professor,KOBAYASHI SHINJI Institute of Advanced Energy Associate Professor,YAGI JURO

Target year	Master's students	Number of credits	2	Year/semesters	2024/Second semester
Days and periods	Tue.1	Class style	Lecture (Face-to-face course)	Language of instruction	English

[Overview and purpose of the course]

Subjects on the science and technology of the latest information on the development of fusion energy are offered from viewpoints of energy generation, technology, material and utilization

[Course objectives]

To understand basic knowledge and latest topics on energy generation, conversion,　control and utilization of fusion energy from the aspect of technology, materials and application.
To analyze and critically evaluate the energy systems technology on　which each students will be studying, and to discuss a strategy of study　from social, technical, environmental and sustainability aspects.

[Course schedule and contents]

The latest topics about the development of fusion reactors, their energy conversion systems, and material issues are lectured on 15 times in classes including feedback.

1. Fusion Energy Conversion (Yagi)
 (1)Development of Fusion Devices
 (2) Liquid metal and molten salt for fusion energy
 (3) Hydrogen production and CO_2 reduction by fusion

2. Control of fusion energy (Nagasaki)
 (4)Ignition condition
 (5)Magnetic confinement system
 (6)Confinement, transport and stability
 (7)Plasma heating

3. Magnetically confined fusion plasma experiments (Kobayashi)
 (8) Control of fusion plasmas
 (9) Coulomb collisions
 (10) Collision and relaxation processes
 (11) Utilization of high energy beams in fusion plasmas

4. Recent Progress in Fusion Structural Materials R&D (Morishita)

Continue to Fusion Energy Science and Technology(2)↓↓↓

Fusion Energy Science and Technology(2)

(12)Fusion blanket structural materials and their requirements for fusion application
(13)Effects of high energy neutron irradiation
(14)Modeling of radiation damage process in fusion materials
(15)Current status of fusion materials R&D

[Course requirements]

None

[Evaluation methods and policy]

Attendance and report(term paper) will be required. Evaluation will be based on the scores of each reports to be given as 100 point maximum.

[Textbooks]

Original materials are provided. Some materials are available on the web with limited access.

[References, etc.]

（Reference books）

to be introduced in the lecture

[Study outside of class (preparation and review)]

Occasional homeworks may be given to consider an energy related topics.

（Other information (office hours, etc.)）

always available upon appointments.

*Please visit KULASIS to find out about office hours.

Course number			
Course title (and course title in English)	Polymer Chemistry for Energy Science Polymer Chemistry for Energy Science	Instructor's name, job title, and department of affiliation	Graduate School of Energy Science Assistant Professor,OKAZAKI YUTAKA

Target year	Master's students	Number of credits	2	Year/semesters	2024/Second semester
Days and periods	Mon.2	Class style	(Face-to-face course)	Language of instruction	English

[Overview and purpose of the course]

This course will focus on polymer chemistry, which is an essential subject to design and characterize the organic-, inorganic-, and/or their composite-materials in relation to energy science.

[Course objectives]

To understand the basic concepts and theories of polymer chemistry, which is an essential subject to design and characterize the organic-, inorganic-, and/or their composite-materials in relation to energy science.

[Course schedule and contents]

In principal, the course will be offered as the following plan. However, it may change the order or the number of times for each theme depending on the progressive of the course.
(1) What is “ Polymers ” ?
(2) Basic properties of polymers
(3) Polymer synthesis, degradation, and recycle
(4) Thermal and mechanical properties
(5) Electrical properties
(6) Optical and photonic properties
(7) Supramolecular polymers
(8) Polymer gels
(9) Inorganic polymers
(10) Carbon materials
(11) Biopolymers
(12) Polymers for solar cells
(13) Polymers for fuel cells
(14) Polymers for vehicles
(15) Polymers for LEDs

[Course requirements]

None

Continue to Polymer Chemistry for Energy Science(2)↓↓↓

Polymer Chemistry for Energy Science(2)

[Evaluation methods and policy]

Evaluation will be based on oral presentation and reports (80 points) and class performance (20 points).
Oral presentation and reports will be assessed on the basis of achievement level for course goals. Evaluation for class performance includes attendance and active participation.

[Textbooks]

Not used
Not used

[References, etc.]

（Reference books）

Introduced during class
Introduced during class

[Study outside of class (preparation and review)]

Depending on the progressive of the course, attendees will conduct a research and consider their assigned parts.

（Other information (office hours, etc.)）

*Please visit KULASIS to find out about office hours.

*Please visit KULASIS to find out about office hours.

<table>
<tr><td>Course number</td><td colspan="7"></td></tr>
<tr><td>Course title (and course title in English)</td><td colspan="3">Renewable Energy: Present and Future
Renewable Energy: Present and Future</td><td colspan="2">Instructor's name, job title, and department of affiliation</td><td colspan="2">Graduate School of Energy Science
Program-Specific Assistant Professor,RABEMANOLONTSOA HARIFARA FENOHASINA</td></tr>
<tr><td>Target year</td><td>Master's students</td><td>Number of credits</td><td>2</td><td>Year/semesters</td><td colspan="3">2024/Second semester</td></tr>
<tr><td>Days and periods</td><td>Tue.4</td><td>Class style</td><td>Lecture
(Face-to-face course)</td><td>Language of instruction</td><td colspan="3">English</td></tr>
</table>

[Overview and purpose of the course]

Due to persistent environmental and financial issues associated with conventional energy sources, the significance of renewable alternatives such as solar, wind, and biomass is steadily increasing. This course aims to provide an overview of the principles and technologies behind diverse renewable energy sources while addressing their current challenges. Based on the technical, social, and economic challenges, the future prospects for each renewable energy source will be discussed.

[Course objectives]

To acquire fundamental knowledge of the principles and technology associated with diverse renewable energy sources and to explore current issues related to each. Additionally, the course aims to develop the skills necessary for engaging in class discussions and preparing a final report that articulates perspectives on the future of renewable energy.

[Course schedule and contents]

The course will consist of lectures based on the following key themes.

1. Introduction to Renewable Energy (2 weeks)
2. Solar Energy (2 weeks)
3. Wind Energy (1 week)
4. Hydropower (1 week)
5. Geothermal Energy (1 week)
6. Biomass Energy (3 weeks)
7. Ocean Energy (1 week)
8. Energy and Environment (2 weeks)
9. Final Presentation (2 weeks)

The exact order of topics may change. Some additional topics may be added.

[Course requirements]

None

Continue to Renewable Energy: Present and Future(2)↓↓↓

Renewable Energy: Present and Future(2)

[Evaluation methods and policy]

Evaluation will be divided into two components: presentation and discussion (80%), and attendance (20%). The final presentation and discussion will be assessed based on the achievement level of the course goals.

[Textbooks]

Not used

[References, etc.]

（Reference books）

Introduced during class

[Study outside of class (preparation and review)]

Depending on the progression of the course, attendees will conduct research and consider their assigned parts.

（Other information (office hours, etc.)）

*Please visit KULASIS to find out about office hours.

Course number	

Course title (and course title in English)	From Carbon Neutral to Carbon Negative From Carbon Neutral to Carbon Negative	Instructor's name, job title, and department of affiliation	Graduate School of Energy Science Professor,MCLELLAN, Benjamin Institute of Advanced Energy Senior Lecturer,ARIVAZHAGAN RAJENDRAN

Target year	Master's students	Number of credits	2	Year/semesters	2024/First semester
Days and periods	Fri.2	Class style	Lecture (Face-to-face course)	Language of instruction	English

[Overview and purpose of the course]

To deepen the knowledge of carbon neutrality and the potential to move even further beyond to carbon negative societies. To understand and discuss the relevant sectoral and national barriers and strategies.

[Course objectives]

By the end of the course, students will have advanced knowledge and a high-level understanding of carbon neutrality and carbon negative solutions from technological, environmental, policy and socio-economic perspectives.

[Course schedule and contents]

The course will cover the following topics over 15 weeks, including feedback. The order will be announced on the first day of class.
(introduction)
1. Definition of carbon neutrality and carbon negative
(measurements)
2. Life Cycle Assessment (LCA) and carbon neutrality
3. Carbon footprints - standards and methods
(technology)
4-8. Technology for zero-carbon energy (I) (Non-carbon fuels and power)
 i) Solar energy
ii) Wind energy
iii) Geothermal energy
iv) Biomass energy
Materials for carbon-free energy production and conservation
9. Technology for zero-carbon energy (II) (CCS)
10. Negative-emissions technology (BECCS)
11. Energy Efficiency
(policy and promotion mechanisms)
12. Carbon offsets, carbon pricing
13. Sectoral approaches for net-zero emissions (ZEH, ZEB)
14. Policy for institutional innovation (National; International)
15. Feedback

Continue to From Carbon Neutral to Carbon Negative(2)↓↓↓

From Carbon Neutral to Carbon Negative(2)

[Course requirements]

None

[Evaluation methods and policy]

The evaluation is based upon these factors. Out of a possible 100 points:
1. Essays (60 points).
2. Class participation and short exercises (40 points).

[evaluation policy]
Will be evaluated according to the grade evaluation policy of the Graduate School of Energy Science

[Textbooks]

Not fixed

[References, etc.]

（Reference books）

[Study outside of class (preparation and review)]

Students may have some requirement for pre-class preparation and short exercises to complement and reinforce the class learning.

（Other information (office hours, etc.)）

Instructors may be contacted by e-mail (provided in class).

Students who previously took "Carbon Neutrality" cannot take this class.

*Please visit KULASIS to find out about office hours.

Course number			
Course title (and course title in English)	Environmental Economics Environmental Economics	Instructor's name, job title, and department of affiliation	Graduate School of Global Environmental Studies Professor,TAKEUCHI Kenji

Target year	Master's students	Number of credits	2	Year/semesters	2024/First semester
Days and periods	Mon.3	Class style	Lecture (Face-to-face course)	Language of instruction	English

[Overview and purpose of the course]

This course will provide a basic understanding on the economics of environmental policy at the introductory level. The course covers normative and positive analysis of environmental issues from the economic point of view.

[Course objectives]

Students learn how to frame and discuss environmental issues and policy in terms of economic theory and empirical evidence.

[Course schedule and contents]

Session 1. The Environment and Economics [1], Normative and Positive Economic Analysis [2]
Session 2. Social Choice [3], Efficiency and Markets [4], Market Failure [5]
Session 3. Making Decisions about Environmental Programs [6], Demand for Environmental Goods [7]
Session 4. Hedonic Price Theory [8]
Session 5. Household Productions [9]
Session 6. Constructed Markets [10]
Session 7. Regulating Pollution [11]
Session 8. Feedback
Session 9. Emission Prices and Fees [12]
Session 10. Property Rights [13]
Session 11. Regulation with Unknown Control Costs [15], Audits, Enforcement, and Moral Hazard [16]
Session 12. International and Interregional Competition [19]
Session 13. Environment, Growth, and Development [20]
Session 14. Discussion
Session 15. Feedback
* Numbers in square brackets are chapters in the textbook.

[Course requirements]

None

Continue to Environmental Economics(2)↓↓↓

Environmental Economics(2)

[Evaluation methods and policy]

Contribution to discussion session 50%
Final Exam   50%

[Textbooks]

Charles D. Kolstad 『Environmental Economics』 （Oxford University Press, 2011）

[References, etc.]

（Reference books）

Introduced during class
A reading list will be available by the start of the course.

[Study outside of class (preparation and review)]

Students are expected to read the assigned papers and prepare for the discussion in the class.

（Other information (office hours, etc.)）

Office Hours: Please schedule an appointment by email.

*Please visit KULASIS to find out about office hours.

Course number	

Course title (and course title in English)	Energy Future of the Asia-Pacific Region Energy Future of the Asia-Pacific Region	Instructor's name, job title, and department of affiliation	(一財)アジア太平洋エネルギー研究センター IRIE KAZUTOMO Part-time Lecturer,GLEN E. SWEETNAM Graduate School of Energy Science Professor,SHIMODA HIROSHI

Target year	Master's students	Number of credits	2	Year/semesters	2024/Second semester
Days and periods	Fri.4	Class style	Lecture (Face-to-face course)	Language of instruction	English

[Overview and purpose of the course]

This course will show possible future energy landscape based upon the APEC Energy Outlook. This graduate level course is designed to develop critical thinking about effective energy policies. Energy policy alternatives and challenges in three APEC subregions will be examined in depth to highlight the trade-offs between energy affordability, security, and sustainability.

[Course objectives]

The goals of the course are to convey to students the diversity and dynamics of energy markets in the Asia Pacific region, including demand and supply challenges facing APEC member economies and how the APEC member governments are planning to address those challenges.

[Course schedule and contents]

The course will consist of lectures and interactive sessions on the following key themes:

1. Introduction: Overview of the APEC Energy Demand and Supply Outlook and modelling approach
2. Energy Demand/Supply Analysis and Energy Efficiency
3. Buildings and Industrial Energy Demand
4. Transport Energy Demand
5. Power and Heat
6. Coal
7. Natural gas
8. Oil
9. Renewable energy
10. Hydrogen
11. Case Studies in Southeast Asia as the most rapidly growing subregion
12. Case Studies in North America as Major Energy Consumers and Producers
13. Case Studies in China as the largest energy consume
14. Wrap-up: Possibility of Net-zero or Carbon Neutrality, and Implications for Energy Security and Resilience
15. Feedback

Continue to Energy Future of the Asia-Pacific Region(2)↓↓↓

Energy Future of the Asia-Pacific Region(2)

[Course requirements]

The course will assume that the students already possess a basic knowledge of current energy policies, energy economics, and the structure of the energy industry.

[Evaluation methods and policy]

Students will be evaluated on two major elements:

1. Active Participation (50%)
2. Submission of a final report (50%)

Grading is done according to the evaluation policy of the Graduate School of Energy Science.

[Textbooks]

Not used

[References, etc.]

（Reference books）

SOM Steering Committee on Economic and Technical Cooperation (SCE), Energy Working Group (EWG) 『APEC Energy Demand and Supply Outlook 8th Edition Volume I & II』 （2022）

[Study outside of class (preparation and review)]

Preparation, review and assignment will be given in the class.

（Other information (office hours, etc.)）

Available by appointment.

*Please visit KULASIS to find out about office hours.

Course number			
Course title (and course title in English)	Computational Methods for Material Science Computational Methods for Material Science	Instructor's name, job title, and department of affiliation	Graduate School of Energy Science Program-Specific Assistant Professor,Jo Ju-Yeon

Target year	Master's students	Number of credits	2	Year/semesters	2024/Second semester
Days and periods	Tue.3	Class style	Lecture (Face-to-face course)	Language of instruction	English

[Overview and purpose of the course]

This lecture provides an introduction to the computational modeling of physical and chemical systems. This includes atomistic simulations, such as ab-initio and classical molecular dynamics, as well as recent machine-learning and data-science applications. These tools can be used to predict functional material properties, and as such, they play an important role in energy science, allowing us to design materials from the bottom up - to make materials greener, lighter, stronger, and more energy efficient. In this course you will gain hands-on training in both the fundamentals and applications of the theoretical methods key to your research problems.

[Course objectives]

To understand the basic concepts, theories, and methods of computational physics/chemistry, which is an essential tool to design and characterize the materials for energy technologies.

[Course schedule and contents]

[Week 1] Introduction : What can we do with computational Physics and Chemistry?
[Week 2 - 3] Introduction to scientific computing in Python
[Week 4 - 7] Theory and practice using classical mechanics : molecular dynamics simulations
[Week 8 - 11] Theory and practice using quantum mechanics : ab initio calculations
[Week 12 - 14] Recent developments in Data Science and Machine Learning for Materials Science
[Week 15] Feedback

[Course requirements]

Programming experience would be helpful but is not required.

[Evaluation methods and policy]

The final grade will be based on: mini reports at every practice (50%) and a final report (50%).

[Textbooks]

Not used

[References, etc.]

（Reference books）

Frank Jensen 『Introduction to Computational Chemistry, 3rd Edition』 （John Wiley & Sons）

Continue to Computational Methods for Material Science(2)↓↓↓

Computational Methods for Material Science(2)

Daan Frenkel and Berend Smit 『Understanding Molecular Simulation: From Algorithms to Applications, 3rd Edition』 （Academic Press）

[Study outside of class (preparation and review)]

A guidance for the preparation, review and assignment will be given in the first class (week 1).

（Other information (office hours, etc.)）

*Please visit KULASIS to find out about office hours.