Renewable Energy: Principles, Application, and the Rise of Bioenergy

Department: Fudan International Summer Session

Course Code			
Course Title	Renewable Energy: Basic Principles and Use in our Society		
Credit	2	**Credit Hours**	36+3 tutorial hours (one credit hour is 45 minutes)
Course Nature	□Specific General Education Courses □Core Courses ■General Education Elective Courses □Basic Courses in General Discipline □Professional Compulsory Courses □Professional Elective Courses □Others		
Course Objectives	To introduce Chinese and international students to the general knowledge of renewable energy, including global energy needs; sources; potential; processes for generation, usage, storage, and transportation; local applicability; and current frontiers of developments. To then guide students to more specialized areas of technical, environmental, or policy-based aspects, with a special focus on system integration and sustainable development.		
Course Description	This course is designed for 1st-4th grade undergraduates of all disciplines and backgrounds. The contents of the course will include both general and specialized options, with the latter designed to accommodate students of non-science and technology backgrounds. The general knowledge includes basic concepts in energy and energy systems, types of energy and their supply and demand, and major categories of renewable energy sources and potential. Considering the varied background of the students, the contents will be more inclined towards an overview instead of technical details. The course will then move on to bioenergy, introducing various categories such as energy crops, agricultural and industrial waste, municipal waste, and algae as renewable energy feedstock, and outline the related thermal, physical, chemical, and biological processes. The material will then be examined through integrated lenses such as i) process optimization, ii) integration into existing energy and economy networks, and iii) balanced sustainable development objectives.		

Course Requirements (Pre-requisites):

The course will be taught by three lecturers, primarily in English but with Chinese learning aid if required. One guest lecturer might be invited to deliver some specialized content, according to the course schedule and students' interest. Students from all disciplines will be accommodated, but it is recommended that they possess a basic knowledge in natural science. Moderate-to-good English ability will also be helpful. The teaching team may be adjusted in the future according to the needs and interests of the students.

Teaching Methods:

The course credit will be 2, with a total teaching period of 36 credit hours, and an additional tutorial section of 3 hours. The main part of the course will be lectures using interactive class activities, including short discussions, questions and answers, and games. One possible off-campus visit or guest lecture may be arranged.

The course will contain one mid-term test on the content taught so far, in the form of open-ended questions. One open-scope and individualized assignment will be designed for each student, based on interactive discussions between the students and the lectures. The assignment will be due at the end of the term and taken as the final assessment. A presentation will be delivered by each student as a form of interactive learning.

Instructor's Academic Background:

The lead lecturer is Prof. Marie Harder, a Foreign Thousand Talent professor of Fudan since 2011. During her academic career at Brighton University, UK., Professor Harder has had extensive research and teaching experience in both natural and social sciences, including waste management and recycling, renewable energy, sustainable development, and values systems. Since she joined Fudan, her research interest has partly been focused on comprehensive municipal waste treatment and reutilization, including waste sorting and biogas production.

Prof. Harder will be assisted by Assoc. Prof. Zhang Yi, who specializes in environmental engineering and biological processes, but is also of considerable experience in the field of renewable energy and biomass feedstock. She will focus on solar energy, algae and biodiesel, energy storage, and system integration, as well as provide Chinese teaching aid and organize class activities.

Prof. Xiuping Zhu will further expand the course with her research experience on water/wastewater treatment and renewable energy recovery. She joined Fudan University on September 2021, as a Young Thousand Talent professor. She will teach the contents on wind, hydro, and ocean energy, and electricity and grid.

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Course Schedule:

Week I:

Session 1: Introduction and overview (Marie Harder)

General background on energy, energy generation and usage (historical, and current): How renewables can help sustainability problems

Session 2: Solar energy (Zhang Yi)

Solar radiation and insolation, passive solar, solar thermal and solar PV

Session 3: Hydro and wind energy (Zhu xiuping)

Hydropower, Large hydro and pumped storage, wind turbine and wind farm

Week II:

Session 4: Renewable energy from the ocean (Zhu Xiuping)

Wave, tidal, salinity gradient, ocean current and thermal energy

Session 5: Renewable energy from the ocean (Zhang Yi)

Geothermal, nuclear, and a brief introduction on biomass

Session 6: Overview on bioenergy (Marie Harder)

Biomass and waste, photosynthesis and energy crops, thermal processes for bioenergy generation

Week III:

Session 7: Algae and its conversion to biodiesel (Zhang Yi)

Algae and its growth, algae lipids, algae harvest, processing and conversion to biodiesel

Session 8: Energy crop, farm waste and municipal sludge to biofuel (Zhu Xiuping)

Fermentation and the production of bioethanol with energy crops, anaerobic digestion and the production of biogas with municipal waste and farm waste.

Session 9: System integration and mid-term (Marie Harder)

Municipal solid waste and its reutilization, hybrid systems, social and environmental concerns, mid-term test and updates on the final assignment

Week IV:

Tutorial

Session 10: Electricity generation, transmission, distribution and storage (Zhu Xiuping)

Power generation, electricity grid, battery and supercapacitor for electricity storage

Session 11: Energy carrier, transportation, storage and conversion (Zhang Yi)

Traditional energy carriers, fossil fuel and their characteristics, transportation of energy in solid, liquid and gaseous forms, renewable energy storage as heat and electricity, Energy conversion for storage of RE

Session 12: Final assessment

The form of assessment will be explained in the 1st session, and its topic gradually shaped during the course through interactive discussion. A presentation and a written report will be delivered in the last session.

The design of class discussion or exercise, practice, experience, and so on:

Short discussion sessions will be integrated into the lectures, and one off-campus visit might be arranged, to renewable energy-related facilities like biogas plant and wind farm. Questions might be given at the end of a session, to be answered in the next one. Teaching aid, both real and virtual,

might be used One major assignment will be given to all the students, which is to be finished by the end of the term. In the last session, presentations by the students will be given on their assignments, to introduce their classmates to various topics of renewable energy.

Grading & Evaluation:

60% of the credit will be given based on the quality of the major assignment. The topic of the assignment will be fixed after the mid-term, and its topic be determined by the individual student and the lecturers together. The students will conduct in-depth research on a proposed or assigned renewable energy-related topic which is very contemporary, including answering several critical-thinking questions posed by the instructors. Checks of its progress will be conducted every session and the final assessment at the end of the term. In the final form, the assignment will include a presentation to the whole class, written answers to the questions, and a portfolio of 5 articles chosen to represent the topic. The oral and written forms will make up for 20% and 40% of the total credits, respectively.

A mid-term test in written form will constitute 15% of the total credit. The remaining 25% will be marked according to class attendance and participation in discussions.

Teaching Materials & References (Including Author, Title, Publisher and Publishing time):

Godfrey Boyle, Renewable Energy: Power for a Sustainable Future, Oxford University Press, 2012, 3rd edition

David JC MacKay, Sustainable Energy-without the Hot Air, UIT Cambridge Ltd., 2009, 1st edition, with electronic updates

John Twidell and Tony Weir, Renewable Energy Resources, Routledge, 2015, 3rd edition

Charles Kutscher, Jana Milford, and Frank Kreith, Principles of Sustainable Energy Systems, 2019, CRC Press, 3rd edition

Aldo da Rosa and Juan Ordonez, Fundamentals of Renewable Energy Processes, 2021, Elsevier Academic Press, 4th edition