School of
Engineering and Computer Science
Te Kura Mātai Pūkaha, Pūrorohiko

Prescription

This course will provide an overview of the role of energy systems in sustainability, and the development trends, past and future, of different technologies. The ways in which the technologies influence industry, government, and society will be examined from a range of different perspectives. Students will also gain practical skills in energy generation and utilisation through a range of experiments, as well as skills in modelling renewable energy systems for different contexts.

Course learning objectives

Students who pass this course will be able to:

1. Identify a broad range of renewable energy interventions to address specific energy requirements, particularly related to solar and wind resources.
2. Determine the sustainability challenges of different renewable energy interventions.
3. Identify key scientific principles affecting renewable energy generation and utilisation.
4. Utilise an industry standard modelling package to compile basic renewable energy systems.

Course content

The course comprises of three components. First, it is intended to give students a broad understanding of the accepted principles of sustainable development, and how the related goals manifest on a global scale and influence the energy sector specifically at different levels; from the macro-economy, to local communities. Second, it is intended for students to gain the necessary insight to critique the sustainability of a variety of renewable energy technology systems that aim to address equitable energy access, and a just transition to a low-carbon economy. Third, it is intended for students to gain experience with energy generation and utilisation from renewable resources, and especially solar photovoltaic and wind, through experimentation, basic calculations, and software modelling; to understand the key scientific principles that underpin different renewable energy technology systems.

Required Academic Background

Mathematics and physics at NCEA level 3 are recommended, but not essential to take this course.

Withdrawal from Course

Withdrawal dates and process:
https://www.wgtn.ac.nz/students/study/course-additions-withdrawals

Alan Brent (Coordinator)

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413 Alan MacDiarmid Building, Kelburn

Dr James (Jim) Hinkley
Dr Daniel Burmester

Teaching Format

There are weekly lectures, tutorials, and laboratory sessions, supported by online materials and discussion. The practical work in the labs involves experimentation on energy generation, and utilisation. An individual project will involve modelling a renewable energy system for a specific context. Students are also required to enrol and complete (demonstrated by a certificate of proficiency) "How to Achieve the SDGs" - an online, on-demand course of the SDG Academy.

Student feedback

Student feedback on University courses may be found at: http://www.cad.vuw.ac.nz/feedback/feedback_display.php

Dates (trimester, teaching & break dates)

- Teaching: 13 July 2020 - 18 October 2020
- Break: 17 August 2020 - 30 August 2020
- Exam period: 19 October 2020 - 25 October 2020

Class Times and Room Numbers

13 July 2020 - 16 August 2020

- **Monday** 14:10 - 15:00 – 106, Alan MacDiarmid Building, Kelburn
- **Wednesday** 14:10 - 15:00 – 120, Easterfield, Kelburn
- **Friday** 14:10 - 15:00 – 120, Easterfield, Kelburn

31 August 2020 - 18 October 2020

- **Monday** 14:10 - 15:00 – 106, Alan MacDiarmid Building, Kelburn
- **Wednesday** 14:10 - 15:00 – 120, Easterfield, Kelburn
- **Friday** 14:10 - 15:00 – 120, Easterfield, Kelburn

Other Classes

Laboratory sessions will be for less than 2 hours, but are available over 4 hours from 12h00 to 16h00 on Thursdays in AM407.
Students are also required to enrol for, and complete, the SDG Academy online course: "How to Achieve the SDGs". The enrolment details will be communicated via Blackboard in the first week of the trimester.

Set Texts and Recommended Readings

Required

The course will use the set text below, available at Vic Books and as an e-book.

Additional material is made available online, via Blackboard, to assist with understanding the various concepts and the current debate around the renewable energy technology systems, which include: webinars, explanation videos, and other resources. Journal papers are made available via Talis Aspire with specific case studies and academic literature that are discussed and/or from part of the tutorials. In some weeks students are required to identify relevant literature, as part of online discussions, through the University library.

- Buchla D, Kissell T, Floyd T, 2015, *Renewable Energy Systems*. Pearson.
  Available through the University library:
  https://www.pearson.com/us/higher-education/program/Buchla-Renewable-Energy-Systems/PGM143285.html

Mandatory Course Requirements

There are no mandatory course requirements for this course.

If you believe that exceptional circumstances may prevent you from meeting the mandatory course requirements, contact the Course Coordinator for advice as soon as possible.

Assessment

Assessment Item	Due Date or Test Date	CLO(s)	Percentage
How to Achieve the SDGs certificate of proficiency (7 hours)	31 August 2020	CLO: 1,2	15%
Six laboratory exercises with a report on their learning (9 hours)	16 October 2020	CLO: 3	15%
Test 1 (1 hr)	30 July 2020	CLO: 1,2,3	10%
Test 2 (1 hr)	3 September 2020	CLO: 1,2,3	10%
Test 3 (1 hr)	24 September 2020	CLO: 1,2,3	10%
Test 4 (1 hr)	15 October 2020	CLO: 1,2,3	10%
Individual modelling project (simulation model & 2-4 page report) (20 hrs)	23 October 2020	CLO: 3,4	30%

Penalties

Work submitted late will be subject to a penalty of 10% of the total mark per day.

Extensions

Individual extensions will only be granted in exceptional personal circumstances, and should be negotiated with the course coordinator before the deadline whenever possible. Documentation (eg, medical certificate) may be required.

Submission & Return

All work must be submitted through the Blackboard submission system. Marks and comments will also be returned through the Blackboard marking system.

Workload

Although the workload varies from week to week, students should expect to spend approximately 10 hours per week on the course, to give a total of 150 hours study time. A plausible and approximate breakdown for these hours would be: lectures (2 hours); tutorials (1 hour); laboratories (2 hours); SDG online course (1 hour); reading, review and online discussions (1 hours); and modelling and written assignments (3 hours).

Teaching Plan

The intended lectures and other activities over the learning period are outlined in the Teaching Plan, which may be updated as the Trimester progresses.

Week 1

Lecture	▪ Sustainability perspectives, SDGs and the role of energy, and global and local energy trends. ▪ Energy and climate protection calculations, energy efficiency and losses basics, with an overview of RE conversion options. ▪ Online lectures. ▪ Work through sections 2-1 to 2-10 of the textbook.
Tutorial	▪ Carbon footprint analyses in various economies/energy systems. ▪ Online lecture and discussion.
Laboratory	▪ Health and Safety induction. ▪ Electrical basics. ▪ The laboratory sessions will be in AM407 of the Alan MacDiarmid building on the Kelburn Campus.

Week 2

Lecture	▪ Renewable energy resources. ▪ The basics of solar irradiance (direct and diffuse), solar position and angle of incidence, and why these parameters are important for solar technologies. ▪ Contact lecture (also available online). ▪ Work through sections 1-3 to 1-7 of the textbook.
Tutorial	▪ Solar position and angle of incidence calculations for Wellington. ▪ Contact session (also available online).
Laboratory	▪ SolarView analysis. ▪ Contact session (also available online).

Week 3

Lecture	▪ Overview of how a PV cell works, the cell configurations, and how the technology is applied in different contexts. ▪ PV system configurations and sustainability. ▪ Contact lecture (also available online). ▪ Work through sections 3-1 to 4-3 of the textbook.
Tutorial	▪ PV generation and load calculation. ▪ Contact session (also available online).
Laboratory	▪ Test 1. ▪ Online, but can be done in AM407.

Week 4

Lecture	▪ Solar tracking. ▪ Concentration and optimisation. ▪ Contact lecture (also available online). ▪ Work through sections 5-1 to 5-5 of the textbook.
Tutorial	▪ Tracking cost-benefit calculations. ▪ Contact session (also available online).
Laboratory	▪ Solar PV characteristics using Ohm's law and power equations. ▪ Contact session.

Week 5

Lecture	▪ Charge controlling with batteries. ▪ Maximum power point tracking and control. ▪ Contact lecture (also available online). ▪ Work through sections 6-1 to 6-7 of the textbook.
Tutorial	▪ Maximum power point tracking calculations. ▪ Contact session (aslo available online).
Laboratory	▪ PV configurations experimentation and the implications for power output. ▪ Contact session.

Week 6

Lecture	▪ Solar thermal systems. ▪ Fundamentals of heat pumps. ▪ Contact lecture (also available online). ▪ Work through section 4-5 of the textbook. ▪ Additional material provided online.
Tutorial	▪ Heat transfer calculations. ▪ Contact session (also available online).
Laboratory	▪ Test 2. ▪ Online, but can be done in AM407.

Week 7

Lecture	▪ Fundamentals of airflow and the basic principles that affect a wind generator. ▪ Different wind energy technology configurations and appropriateness for different contexts/applications. ▪ Contact lecture (also available online). ▪ Work through sections 7-1 to 7-7 of the textbook.
Tutorial	▪ Theoretical power from a wind turbine. ▪ Contact session (also available online).
Laboratory	▪ Wind turbine characteristics analyses. ▪ Contact session.

Week 8

Lecture	▪ Wind turbine control. ▪ Wind farm management. ▪ Contact lecture (also available online). ▪ Work through sections 8-1 to 8-5 of the textbook.
Tutorial	▪ Electricity supply from a small wind farm. ▪ Contact session (also available online).
Laboratory	▪ Wind turbine configurations experimentation and the implications for power output. ▪ Contact session.

Week 9

Lecture	▪ Fundamental principles of hydropower and marine energy, and technology configurations. ▪ Applications and related sustainability issues. ▪ Contact lecture (also available online). ▪ Work through sections 11-1 to 11-5 of the textbook.
Tutorial	▪ Hydro and ocean current and power potential calculations. ▪ Contact session (also available online).
Laboratory	▪ Test 3. ▪ Online, but can be done in AM407.

Week 10

Lecture	▪ Sustainability aspects related to hybrid systems with storage, including fuel cells. ▪ An overview of different storage options, and the sustainability thereof. ▪ Online lecture (also available online). ▪ Work through sections 12-1 to 12-4 of the textbook.
Tutorial	▪ Introduction to the HOMER software package. ▪ Contact session (also available online).
Laboratory	▪ HOMER modelling experimentation. ▪ Contact session (also available online).

Week 11

Lecture	▪ Fundamentals and scientific principles of electrical machines, their categorization, and related concepts. ▪ Overview of different system components/configurations, and their applications. ▪ Contact lecture (also available online). ▪ Work through sections 13-1 to 13-4 of the textbook.
Tutorial	▪ Synchronous and asynchronous generators calculations. ▪ Contact session (also available online).
Laboratory	▪ HOMER modelling for individual project. ▪ Contact session (also available online).

Week 12

Lecture	▪ Overview of the electrical power grid, and three-phase systems. ▪ Smart grids, and connecting to the grid. ▪ Contact lecture (also available online). ▪ Work through sections 14-1 to 14-6 of the textbook.
Tutorial	▪ EV projections and implications. ▪ Contact session (also available online).
Laboratory	▪ Test 4. ▪ Online, but can be done in AM407.

Communication of Additional Information

All online material for this course will be made available via Blackboard, which will also be used to facilitate discussions every week.

Links to General Course Information

- Academic Integrity and Plagiarism: https://www.wgtn.ac.nz/students/study/exams/integrity-plagiarism
- Academic Progress: https://www.wgtn.ac.nz/students/study/progress/academic-progess (including restrictions and non-engagement)
- Dates and deadlines: https://www.wgtn.ac.nz/students/study/dates
- Grades: https://www.wgtn.ac.nz/students/study/progress/grades
- Special passes: Refer to the Assessment Handbook, at https://www.wgtn.ac.nz/documents/policy/staff-policy/assessment-handbook.pdf
- Statutes and policies, e.g. Student Conduct Statute: https://www.wgtn.ac.nz/about/governance/strategy
- Student support: https://www.wgtn.ac.nz/students/support
- Students with disabilities: https://www.wgtn.ac.nz/st_services/disability/
- Student Charter: https://www.wgtn.ac.nz/learning-teaching/learning-partnerships/student-charter
- Terms and Conditions: https://www.wgtn.ac.nz/study/apply-enrol/terms-conditions/student-contract
- Turnitin: http://www.cad.vuw.ac.nz/wiki/index.php/Turnitin
- University structure: https://www.wgtn.ac.nz/about/governance/structure
- VUWSA: http://www.vuwsa.org.nz

Offering CRN: 30093

Points: 15
Restrictions: ENGR 110 from 2019
Duration: 13 July 2020 - 25 October 2020
Starts: Trimester 2
Campus: Kelburn