School of Photovoltaic and Renewable Energy Engineering

SOLA1070 Sustainable Energy Course Outline

Version Date

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Introduction

Course Staff

Course Convener:	Dr Murad Tayebjee, m.tayebjee@unsw.edu.au
PlayEnergy Team:	A/Prof Alison Lennon
	Dr Jessie Copper
	Dr Merlinde Kay
	Dr Murad Tayebjee
	In association with Lionsheart Studios
Lecturers:	Dr Murad Tayebjee
	Guest lecturers from SPREE & CCRC
Demonstrators:	Dr Dimitri Lazos (Head Demonstrator)
	Mr Bruno Stefani

Consultations

For all enquiries about the course please contact the course convener. For all questions or enquiries you are encouraged to ask the convener/lecturer after class or post your question on the Discussion Board on Moodle.

https://moodle.telt.unsw.edu.au/login/index.php

Keeping Informed:

All course material and announcements will be posted on Moodle. Please note that you will be deemed to have received this information, so you should take careful note of all announcements.

Course Summary

Contact Hours

The course consists of 4 hours per week, two one-hour lectures and a two-hour tutorial sessions as listed in the schedule below. This course requires you to use the on-line teaching resource in each tutorial. You will be required to perform exercises and quizzes in the tutorials so you should bring a laptop with internet access to your allocated tutorial time.

	Day	Time	Location
Lecture	Tuesday	10am – 11am	Colombo Theatre A (K-B16-LG03)
Lecture	Wednesday	9am – 10am	Colombo Theatre A (K-B16-LG03)
Tutorial	Thursday	1pm – 3pm	Science & Engineering B26 (K-E8-B26)
Tutorial	Thursday	3pm – 5pm	Science & Engineering B26 (K-E8-B26)

Context and Aims

The course aims to introduce:

- The concept of sustainability and increase awareness of the different sustainability indicators and the challenges imposed by climate change and natural resource reserves.
- The concept of energy, energy conversion, and energy efficiency.
- A range of renewable energy technologies and develop an understanding in students of how these technologies can be used to improve the sustainability of electrical power systems.
- Expose students to the challenges involved in balancing between energy security (ability to meet demand), energy equity (affordability) and environmental sustainability in the design of an energy infrastructure for a community.

Material will be learnt through:

- Lectures
- Tutorial exercises
- PlayEnergy Game and Textbook
- Quizzes
- Forum participation

Course Details

Credits

This is a 6 UoC course and the expected workload is approximately 25 hours per credit point per term.

Relationship to Other Courses

SOLA1070 is a 1st year course in the School of Photovoltaic and Renewable Energy Engineering. It is a recommended elective for the Photovoltaics & Solar Energy and Renewable Energy Streams.

This course is an introductory course. More details on the topics covered are given in SOLA2450, SOLA5053, SOLA5057, SOLA3010, and MECH9720

Assumed Knowledge

PHYS1121 Physics 1A or 2-unit Physics at HSC level or equivalent. It is assumed that you can competently use Microsoft Excel (or equivalent software) for data manipulation and graphing.

Learning outcomes

General - Renewable Energy & Energy Trilemma

- Make decisions based on an understanding of renewable energy resource characteristics.
- Balance between energy security (ability to meet demand), energy equity (affordability) and environmental sustainability in the design of an energy infrastructure for a community.

Climate Change & Sustainability

- Identify key economic and environmental sustainability indicators.
- Describe the potential impacts of CO_2 emissions, and define and calculate related parameters such as CO_2 emission intensity.
- Identify strengths and weaknesses in public and academic debate about climate change.

Energy/Energy Efficiency

- Define the concepts of energy and power in terms of: (a) power applied over time; and (b) rate of energy flow.
- Perform calculations using dimensional analysis to verify the above concepts.
- Perform calculations based on energy conversion processes.
- Identify methods of reducing energy usage

Solar Photovoltaic Technology

- Explain why the entire solar spectrum cannot be harvested
- Describe the dependence of solar radiation intensity on: time of day; time of year; and location.
- Identify the energy conversion processes in a photovoltaic cell
- Calculate the power and energy generated by a photovoltaic array considering derating factors
- List the functions and desired properties of inverters

Solar thermal

- Compare solar thermal to solar photovoltaics in terms of key metrics and feasible applications
- Be able to explain and calculate the energy output of a solar thermal module as a function of direct and diffuse insolation, wind speed, ambient temperature, and operating temperature.
- Be able to distinguish between different solar thermal technologies and their suitability to different environments/applications.

Wind Power Generation

- Explain the basic underlying science of wind energy, and engineering aspects of wind turbines.
- Perform basic statistical analysis of wind data
- Perform calculations of annual energy output and determine the capacity factor of a wind turbine
- Have a good appreciation of some of the wider economic, social and environmental aspects of wind energy systems.

Storage

- Describe the current challenges facing energy storage technologies
- Calculate required battery capacities and charging times

Economics and Utility Scales

- Define, calculate and apply basic techno-economic parameters, including LCOE, the time value of money, and marginal cost of energy generation.
- Describe the relationships between energy efficiency and costs of electricity.
- Describe the implications of implementing large-scale renewable energy technologies on the electricity grid

<u>After successful completion of this course, you should be able to:</u>

1. Apply an understanding of science and engineering fundamentals related to energy conversion;
2. Have problem identification and solving skills;
3. Communicate an awareness of social, cultural, global and environmental responsibility.

This course is designed to achieve the above learning outcomes which address the specific UNSW and Faculty of Engineering graduate capabilities listed in ***Appendix A***. This course also addresses the Engineers Australia (National Accreditation Body) Stage I competency standard as outlined in ***Appendix B***.

Syllabus

Indicative Lecture Schedule

As this course has many guest lecturers who are leaders in their field there may be changes to the lecture schedule below during the session depending on their availability. Announcements will be made on Moodle and in the lectures if this occurs. Updated Course Outlines will also be put onto Moodle.

Wk	Date (Monday)	Lecture Tuesday 11am	Lecture Wednesday 9am	Tutorial	Assessment
1	16-Sep	L1. Introduction	L2. Sustainability	Sustainability	
2	23-Sep	L3. Climate Change (Jason Evans)	L4. Climate Change (Jason Evans)	Climate change & common myths	
3	30-Sep	L5. Energy Basics	L6. Buildings (Alistair Sproul)	Energy basics calculations Introduction to PlayEnergy	
4	7-Oct	L7. Energy Efficiency (Alistair Sproul)	L8. Thermodynamics	PE: energy efficiency scenario	Paper Assignment (20%)
5	14-Oct	L9. Security: Intermittent Resources, Capacities and Nameplates	L10. The Solar Resource	PE: building materials	
6	21-Oct	L11. Photovoltaic Systems	L12. Wind Energy (Kay)	PE: PV scenario + practice quiz	
7	28-Oct	L13. Wind Energy (Kay)	L14. Solar Thermal (Taylor)	PE/wind energy questions	PlayEnergy Result (10%) Moodle Quiz 1 (15%)
8	4-Nov	L15. Storage	L16. Economic considerations (global/general)	Energy equity	
9	11-Nov	L17. Utility Scale RE	L18. Equity	Utility scale	
10	18-Nov	L19. AEMO/NEM (Origin Energy representative)	L20. Summary	Course wrap-up	Moodle Quiz 2 (15%)
					Exam (40%)

Delivery Mode

The teaching strategy for this course comprises a series of lectures and tutorial sessions. The lecture series will present theory related to the different aspects of the energy trilemma. Assessments are based on the lecture content.

In week 3 there will be an introduction to a game simulation PlayEnergy2 which brings together some of the content learnt in the lectures/tutorials. The objective of the **Play Energy Project** is to develop a Renewable Energy Engineering gamified course in partnership with Lionheart Studios. Centrally, this journey involves the development of an energy infrastructure that fulfils the three-fold goals of energy security (ability to meet demand), energy equity (affordability) and environmental sustainability. The third stage of development this year will have students experience learning quests and quizzes within the game. Students' progress in the game will form a part of their assessment.

Learning in this course

You are expected to attend all lectures and tutorials in order to maximise learning. You will need to complete some pre-work for some of your tutorial classes. In addition to the lecture notes, you will be expected to read relevant papers and texts as required. Group learning is also encouraged. UNSW *assumes* that self-directed study of this kind is undertaken in addition to attending face-to-face classes throughout the course.

Tutorial classes

Tutorial classes will be where students reinforce the ideas taught in the lectures. They will work through questions related to lectures that have been taught and also from week 4 start exploring PlayEnergy. If, for any reason you cannot attend your tutorial please contact the course convener and check whether it would be possible to attend another tutorial class.

Assessment

The assessment scheme in this course reflects the intention to assess your learning progress through the semester.

Assessment	% of Final Mark	Due
Paper Assignment	20%	Friday week 4 11th October by 11pm
PlayEnergy	10%	Results released after end of simulation 1st November
Moodle Quiz 1	15%	Friday week 7 1st November by 11pm
Moodle Quiz 2	15%	Monday week 11 25th November by 11pm
Final Exam	40%	TBD
TOTAL	**100%**	

Assignment 1 (Total 20%)

Assignment 1 will comprise a number of questions about energy basics and will cover material covered in lectures up to week 3. You will need to research the questions and provide short-answers or calculations showing all working to each question. The assignment **must be typed** and completed individually and submitted electronically via Moodle. Marks will be assigned according to how completely and correctly the problems have been addressed.

The assignment questions will be available in week 1 and due at 11pm on Friday of Week 4. *Late reports will attract a penalty of 20% per day, calculated hourly.*

Moodle Quizzes (Total 30%)

There will be two Moodle quizzes due in Weeks 7 and 10. The first quiz will cover material based on building efficiency, solar energy, photovoltaics and solar thermal energy. The second quiz will cover wind energy, utility scale and economic considerations. *Late quiz submissions are not allowed.*

PlayEnergy Result (Total 10%)

PlayEnergy will run from week 4 to week 7. The game will track the amount of CO_2, money, and comfort of your home and your rank in your climate region will be used to calculate 5% of your total mark. The remaining 5% will be calculated by your participation in the game and how many in-game questions you answer. Details of this will be provided before the game commences in week 4.

Final Exam (Total 40%)

The exam in this course is a standard closed-book 2 hour written examination. University approved calculators are allowed. The examination tests analytical and critical thinking and general understanding of the course material in a controlled fashion. Questions may be drawn from any aspect of the course, unless specifically indicated otherwise by the lecturer. Marks will be assigned according to the correctness of the responses.

Course Resources

An online companion textbook will be provided for PlayEnergy.

On-line Resources

Moodle

As a part of the teaching component, Moodle will be used to disseminate teaching materials, and host forums. Assessments and assessment marks will also be made available via Moodle: https://moodle.telt.unsw.edu.au/login/index.php.

Announcements and Discussion Board

Announcements concerning course information will be given in the lectures and/or on Moodle. A Discussion Board will also be established on the Moodle course page for you to post questions or initiate course-related discussions.

Recommended Reading

Further topical reading recommendations will be provided at the end of each lecture and in the PlayEnergy textbook.

Other Matters

Academic Honesty and Plagiarism

Plagiarism is the unacknowledged use of other people's work, including the copying of assignment works and laboratory results from other students. Plagiarism is considered a form of academic misconduct, and the University has very strict rules that include some severe penalties. For UNSW policies, penalties and information to help you avoid plagiarism, see https://student.unsw.edu.au/plagiarism. To find out if you understand plagiarism correctly, try this short quiz: https://student.unsw.edu.au/plagiarism-quiz.

Student Responsibilities and Conduct

Students are expected to be familiar with and adhere to all UNSW policies (see https://student.unsw.edu.au/guide), and particular attention is drawn to the following:

Workload

It is expected that you will spend at least **twelve to fourteen hours per week** studying a 6 UoC course, from Week 1 until the final assessment, including both face-to-face classes and *independent, self-directed study*. In periods where you need to complete assignments or prepare for examinations, the workload may be greater. Over-commitment has been a common source of failure for many students. You should take the required workload into account when planning how to balance study with employment and other activities.

Attendance

Regular and punctual attendance at all classes is expected.

General Conduct and Behaviour

Consideration and respect for the needs of your fellow students and teaching staff is an expectation. Conduct which unduly disrupts or interferes with a class is not acceptable and students may be asked to leave the class.

Work Health and Safety

UNSW policy requires each person to work safely and responsibly, in order to avoid personal injury and to protect the safety of others.

Special Consideration and Supplementary Examinations

You must submit all assignments and attend all examinations scheduled for your course. You should seek assistance early if you suffer illness or misadventure which affects your course progress. All applications for special consideration must be **lodged online through myUNSW within 3 working days of the assessment**, not to course or school staff. For more detail, consult https://student.unsw.edu.au/special-consideration.

Continual Course Improvement

This course is under constant revision in order to improve the learning outcomes for all students. Please forward any feedback (positive or negative) on the course to the course convener or via the

Course and Teaching Evaluation and Improvement Process. You can also provide feedback to RESOC who will raise your concerns at student focus group meetings. As a result of previous feedback obtained for this course and in our efforts to provide a rich and meaningful learning experience, we have continued to evaluate and modify our delivery and assessment methods.

Administrative Matters

On issues and procedures regarding such matters as special needs, equity and diversity, occupational health and safety, enrolment, rights, and general expectations of students, please refer to the School and UNSW policies:

http://www.engineering.unsw.edu.au/energy-engineering/forms

https://my.unsw.edu.au/student/atoz/ABC.html

Appendix A: UNSW Graduate Capabilities

The course delivery methods and course content directly or indirectly addresses a number of core UNSW graduate capabilities, as follows

1. **Scholars** capable of independent and collaborative enquiry, rigorous in their analysis, critique and reflection, and able to innovate by applying their knowledge and skills to the solution of novel as well as routine problems;
2. **Entrepreneurial leaders** capable of initiating and embracing innovation and change, as well as engaging and enabling others to contribute to change;
3. **Global citizens** who are culturally adept and capable of respecting diversity and acting in a socially just and responsible way

Appendix B: Engineers Australia (EA) Professional Engineer Competency Standard

	Program Intended Learning Outcomes	
PE1: Knowledge and Skill Base	PE1.1 Comprehensive, theory-based understanding of underpinning fundamentals	✓
	PE1.2 Conceptual understanding of underpinning maths, analysis, statistics, computing	✓
	PE1.3 In-depth understanding of specialist bodies of knowledge	✓
	PE1.4 Discernment of knowledge development and research directions	
	PE1.5 Knowledge of engineering design practice	
	PE1.6 Understanding of scope, principles, norms, accountabilities of sustainable engineering practice	
PE2: Engineering Application Ability	PE2.1 Application of established engineering methods to complex problem solving	
	PE2.2 Fluent application of engineering techniques, tools and resources	✓
	PE2.3 Application of systematic engineering synthesis and design processes	
	PE2.4 Application of systematic approaches to the conduct and management of engineering projects	
PE3: Professional and Personal Attributes	PE3.1 Ethical conduct and professional accountability	
	PE3.2 Effective oral and written communication (professional and lay domains)	✓
	PE3.3 Creative, innovative and pro-active demeanour	
	PE3.4 Professional use and management of information	
	PE3.5 Orderly management of self, and professional conduct	✓
	PE3.6 Effective team membership and team leadership	