# GSOE9017, SOLA5057

Energy Efficiency

Term 2, 2022

# Course Overview

## Staff Contact Details

### Convenors

| Name | Email | Availability | Location | Phone |
|---|---|---|---|---|
| Gavin Conibeer | g.conibeer@unsw.edu.au | Please contact via email | Room 245 TETB | |

## School Contact Information

For current students, all enquiries for The School of Photovoltaics and Renewable Energy are managed by The Nucleus:

Engineering Student Support Services – The Nucleus - enrolment, progression checks, clash requests, course issues or program-related queries

**Phone:** (+61 2) 9385 8500 – Nucleus Student Hub

For future students, all enquiries for The School of Photovoltaics and Renewable Energy are managed by the Future Student Team:

UNSW Future Students – potential student enquiries e.g. admissions, fees, programs, credit transfer

**Phone:** (+61 2) 9385 1844 – Future Students

# Course Details

## Units of Credit 6

## Summary of the Course

This course focuses on the efficient use of energy, predominantly in residential, commercial, and industrial settings. Transport, water and energy efficiency policy in Australia will also be covered. An understanding of the technical and economic possibilities of energy efficiency in the area of energy systems is vital for all engineers, and especially those involved in management of energy costs and environmental performance of a wide range of organisations, e.g. businesses, government organisations and public institutions.

GSOE9017 is an elective course (Advanced Disciplinary Knowledge) for the Photovoltaic and Solar Energy (SOLAES5341**)** and Masters of Engineering Science in Photovoltaic and Solar Energy (SOLACS8338). SOLA5057 is an elective course (Disciplinary Knowledge) for the Masters of Engineering Science in Renewable Energy (SOLADS8338).

If Australia and the world are to reduce emissions of greenhouse gases, both renewable energy and more efficient use of that energy will be required. Energy efficiency is the cheapest, fastest, safest and simplest way to reduce emissions. This course covers the various methodologies, technologies and policies that can be used to reduce energy use, while still producing what that energy is needed for - heat, light and movement.Topics covered include current and predicted energy use and associated GHG emissions; residential and commercial passive solar design; energy management programs; building management systems; heating, ventilation and air conditioning; and consumer products and office equipment. The impacts of transport are also covered, together with opportunities to reduce transport energy requirements through more efficient engines, public transport, and urban design. Industrial systems examined include heat recovery; cogeneration; compressed air and steam distribution; and motor systems, pumps and fans. Efficient use of water, and increased efficiency of water supply can also significantly reduce energy use. Various government policy measures at the local, state, commonwealth and international level are covered in terms of their effectiveness and relevance in Australia. Finally, barriers to improved energy efficiency such as up-front cost, lack of information, and the low cost of energy in Australia are examined.Assignments focus on energy use and emissions produced at your home and by your transport to and from the UNSW, and will also analyse current energy practices at the UNSW.

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## Course Aims

The emphasis in this course is on a “whole of system” engineering approach to end use energy. Traditional engineering focuses on small components of a total system. Opportunities to use energy most efficiently are possible only once the whole system is considered. This approach can allow much larger energy reductions of end use energy consumption to be achieved (in some cases as much as 95% energy reductions can be achieved whilst still delivering the same service). Assignments based on energy audits of a student’s own energy usage in transportation and household energy usage allow

students to gain hands on experience of how to reduce energy consumption.  Analysis of energy systems will focus on understanding the basic physical processes involved, identifying and quantifying the minimum energy requirements of energy consuming processes.

## Course Learning Outcomes

After successfully completing this course, you should be able to:

| Learning Outcome | EA Stage 1 Competencies |
|---|---|
| 1. Explain the principles of energy efficiency, the contexts to which these apply and the importance of a systems level approach to reducing overall energy consumption. | PE1.1, PE1.3, PE1.5, PE1.6, PE2.1, PE2.2, PE2.3 |
| 2. Carry out cost analysis and comparison of the introduction of a new energy efficiency measure and assess its economic viability. | PE1.1, PE1.3, PE1.5, PE1.6, PE2.1, PE2.2, PE2.3 |
| 3. Carry out effective energy audits and demonstrate the importance of an energy systems approach. | PE1.5, PE1.6, PE2.4, PE3.2, PE3.4 |
| 4. Communicate the results of such audits and analyses. | PE1.5, PE1.6, PE2.4, PE3.2, PE3.4 |

This course is designed to address the learning outcomes above and the corresponding Engineers Australia Stage 1 Competency Standards for Professional Engineers as shown. The full list of Stage 1 Competency Standards may be found in Appendix A

## Teaching Strategies

The teaching strategy for this course comprises a series of adaptive learning packages (ALPs), lectures, projects, laboratories and workshop sessions.

All the knowledge content for the course is included in the Adaptive Learning Packages that will be released each week on Moodle. It is expected that students will work through these interactive packages before the lecture each week.

The short lectures on Tuesdays will summarise the key points of these ALPs and allow time for discussion of any points that are not clear.

The lecture each week will be followed by project work. The class will work on projects on a topic related to the topic of the week. The outputs from the projects will form the basis of the assignments 1 and 2 and the power factor assignment.

There will be laboratory classes arranged in the middle part of the course. These will an on-line laboratory that will investigate variable speed motors. It will include a brief assessment and will be available in an on-line environment.

Workshop classes will be held each week for small groups. Workshops will build on this knowledge by students undertaking more quantitative problem solving with an emphasis on a fundamental physical

understanding of the processes involved.  An understanding of first year university physics is sufficient. Weekly Problem Sets will cover all topics for this course. A demonstrator will be available to give assistance during each of the scheduled workshop sessions.

Guest lectures form an important part of the course, with academic experts giving their opinions on topics in energy efficiency.

## Assessment

Class participation Class and workshop attendance is expected. It is expected that you will attend all lecture and workshop sessions and participate in the project activities – class polls, quizzes etc. The guest lecture content may be assessed in the exam and/or the online quizzes.

On-line learning material The knowledge content for the course is delivered via the Adaptive Learning Packages (ALPs) on Moodle. These ALPs present the course content in an interactive learning format. Completion of the two or three ALPs for each week is required prior to the lecture for that week. The lectures will summarize material in the ALPs but not repeat all of it, so ALP completion is an essential part of the course.

Presentation All submissions are expected to be neat and clearly set out. Your results are the pinnacle of all your hard work and should be treated with due respect. Presenting results clearly gives the marker the best chance of understanding your method; even if the numerical results are incorrect.

Marking Marking guidelines for assignment submissions will be provided at the same time as assignment details to assist with meeting assessable requirements. Submissions will be marked according to the marking guidelines provided

Examinations You must be available for all quizzes, tests and examinations. Final examinations for each course are held during the University examination periods: August for T2 2022Please visit myUNSW for Provisional Examination timetable publish dates. For further information on exams, please see the Exams webpage.

| Assessment task | Weight | Due Date | Course Learning Outcomes Assessed |
|---|---|---|---|
| 1. Assignment 1 | 20% | 11.55pm Friday 17th June (week 3) via Moodle | 1, 2, 3, 4 |
| 2. Assignment 2 | 20% | 11.55pm Friday 22nd July (week 8) via Moodle | 1, 2, 3, 4 |
| 3. Lab work | 12% | On completion of the lab | 1, 2, 4 |
| 4. Quizzes | 8% | 11.55pm each Monday | 1, 2 |
| 5. Final Exam | 40% | Exam period, date TBC | 1, 2 |

### Assessment 1: Assignment 1

**Assessment length:** 20 Pages
**Due date:** 11.55pm Friday 17th June (week 3) via Moodle
**Marks returned:** Two weeks after submission

Assignment 1 Energy Audit 20%

Students will quantitatively assess the domestic energy consumption of a household and the impact of

travelling to and from university/work over a year (or an equivalent journey).
In addition students will identify different ways these impacts could be minimized.

This analysis will be carried out in project work during the classes of weeks 1,2,3.

The report must be submitted on-line via Moodle in pdf form. *Late reports will attract a penalty of 5% per day* (including weekends) up to 5 days after which the assignment cannot be submitted. Reports submitted after results have been released will incur the maximum penalty

**Assessment criteria**

ALP and lecture material from weeks 1-3

Energy system analysis skills

Report writing skills

## Assessment 2: Assignment 2

**Assessment length:** 18 Pages
**Due date:** 11.55pm Friday 22nd July (week 8) via Moodle
**Marks returned:** Two weeks after submission

## Students will undertake a range of end use energy efficiency assessments and calculations and submit a report. Data will be provided.

This analysis will be carried out in project work during the classes of weeks 5,7&8.

The report must be submitted on-line via Moodle in pdf form. *Late reports will attract a penalty of 5% per day* (including weekends) up to 5 days after which the assignment cannot be submitted. Reports submitted after results have been released will incur the maximum penalty.

**Assessment criteria**

ALP and lecture material from weeks 5-8

Analysis skills for energy and generation systems

Report writing skills

## Assessment 3: Lab work

**Due date:** On completion of the lab

Labs on power factor correction and variable speed drives.

Laboratory classes will be held in Weeks 4-8. Times will be advised. These may not be in your usual class times. Attendance on-line is required and marks will be given for successfully completing the laboratory task.

**Assessment criteria**

Lab 1: *Power Factor Laboratory:* Material from weeks 2 & 3

Lab 2:  Variable Speed Drive Laboratory: Material from week 7

## Assessment 4: Quizzes

**Due date:** 11.55pm each Monday

Weekly quiz based on the course content. These will be available on Moodle for each week of the course.

Multiple choice and simple answers

1% for each of 8 quizzes= 8%

**Assessment criteria**

Each week's quiz will test material from the previous week.

## Assessment 5: Final Exam

**Assessment length:** 2 hours
**Due date:** Exam period, date TBC
**Marks returned:**  Upon release of final results

Final Exam Individual

**Assessment criteria**

All course content from weeks 1-10 inclusive.

## Attendance Requirements

Students are strongly encouraged to attend all classes and review lecture recordings.

## Course Schedule

The course consists of a 2.5 hour lecture and project session and a 2 hour workshop session each week as listed below. NOTE Lectures will run from week 1 until week 10 (with no lecture in week 6, flexible study week). Workshops will run from week 2 until week 10 (with no workshop in week 6, flexible study week).

| | Day | Time | Location |
|---|---|---|---|
| **Lecture and projects** | Tuesday Weeks 1-5 | 10am – 12.30pm | On-line on MS Teams |
| **Lecture and projects** | Tuesday Weeks 7-10 | 10am – 12.30pm | On-line on MS Teams |
| **Workshops** | 3 workshop classes throughout each week, as assigned and timetabled<br><br>Weeks 2-5 & 7-10 | | |

Please refer to your class timetable for the learning activities you are enrolled in and attend only those classes.

| Week | Class Schedule (subject to small changes) |
|---|---|
| Week 1 | Introduction to course<br><br>*Case study – the Tyree Energy Technologies Building (TETB)*<br><br>Economic Terms and Energy Policy<br><br>*Project: Transport to/from UNSW or place of study* |
| Week 2 | Residential Energy, Hot Water, Energy Management<br><br>*Project: Household energy usage* |
| Week 3 | Lighting, MEPS, Energy Audits, Design Rating Schemes<br><br>*Project: Deliverable on personal energy usage* |
| Week 4 | Transport Efficiency<br><br>*Project: The Power Factor Virtual Laboratory* |
| Week 5 | Commercial, HVAC, Co-Generation, Coefficient of Performance,<br><br>Energy management control systems |

| | |
|---|---|
| | *Project: Computer energy usage* |
| Week 6 | Flexible study week - no lecture |
| Week 7 | Industrial Energy Efficiency 1: Electric motors, Electric motor systems, pumps and fans<br><br>*Extra lecture: TETB trigeneration system* |
| Week 8 | Industrial Energy Efficiency 2: Furnaces, Heat recovery, Distributed generation, Combined cycle generation<br><br>*Project: Co-generation* |
| Week 9 | Absorption cooling, Production & distribution of process steam and compressed air<br><br>Review of course |
| Week10 | Guest lecture: *A systems approach to energy efficiency*<br><br>Discussion of Digital Exam |

- The course structure is subject to small changes during the term. In particular, the projects and guest lectures in *italics* may move weeks and change slightly in content or presenter.

| **Week** | **Summary of Workshop Program** |
|---|---|
| 2 - 5<br><br>7-10 | Workshops will cover material from the previous week's Activities |

# Resources

## Recommended Resources

### Reference Books

- Energy Efficiency Manual: for everyone who uses energy, pays for utilities, designs and builds, is interested in energy conservation and the environment by Donald R. Wulfinghoff
- Energy Management Handbook (8th Edition) by Wayne C. Turner and Steve Doty
  *Both are available online via UNSW Library.*
- Heat Transfer: A Practical Approach by Yunus A. Cengel
- Thermodynamics: An Engineering Approach by Yunus A. Cengel, Michael A. Boles.
- Fluid Mechanics – Fundamentals and Applications by Yunus A. Cengel and John M. Cimbala
- Factor Five: Transforming the Global Economy through 80% Improvements in Resource Productivity, Ernst von Weizsäcker, Karlson 'Charlie' Hargroves, Michael H. Smith, Cheryl Desha and Peter Stasinopoulos
- Factor 4: Doubling Wealth – Halving Resource Use by E. Weizaecker, A. Lovins and L.H. Lovins
- Natural Capitalism – Creating the Next Industrial Revolution by P. Hawken, A. Lovins and L.H. Lovins
- Cents and Sustainability Securing Our Common Future by Decoupling Economic Growth from Environmental Pressures, Michael H. Smith, Karlson 'Charlie' Hargroves and Cheryl Desha
- Rocky Mountain Institute: http://www.rmi.org/
- AS/NZS 3598:2014 Australian/New Zealand Standard™ Energy audits (currently under revision) – Access via UNSW Library website

### On-line Resources

- Stanford Energy Lectures by Amory Lovins, (2009)
  https://www.youtube.com/watch?v=O5txQIEI7bc&t=1596s
- Natural Edge Project (Australian project (2002-2015) looking at ways to tackle climate change. Good sections on Energy Efficiency, useful books)
  https://en.wikipedia.org/wiki/The_Natural_Edge_Project
- Factor 10- Engineering: https://www.rmi.org/our-work/areas-of-innovation/office-chief-scientist/10xe-factor-ten-engineering/
- Alliance to Save Energy (USA) http://www.ase.org/
- Energy Efficiency Council (Australia) http://www.eec.org.au/
- Winning the Carbon War, Jeremy Leggett (2017) https://jeremyleggett.net/the-carbon-war/
- American Council for an Energy Efficient Economy http://aceee.org/
- German Initiative for Energy Efficiency (Deutschen Unternehmensinitiative Energieeffizienz) http://www.deneff.org/
- Energy Savings Trust (UK) http://www.energysavingtrust.org.uk/
- California Energy Commission http://www.energy.ca.gov/

*UNSW Library website:* https://www.library.unsw.edu.au/

### Moodle

As a part of the teaching component, Moodle will be used to disseminate teaching materials. Assessment marks will also be made available via Moodle:

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

## Announcements and Discussion Forum

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

## Submission of Assessment Tasks

Work submitted late without an approved special consideration or extension by the course coordinator or delegated authority is subject to a late penalty of 5% mark reduction per day, capped at five days (120 hours) from the assessment deadline, after which a student cannot submit an assessment, consistent with UNSW Assessment Implementation Procedure.

The late penalty is applied per calendar day (including weekends and public holidays) that the assessment is overdue. There is no pro-rata of the late penalty for submissions made part way through a day.

Work submitted after the 'deadline for absolute fail' is not accepted and a mark of zero will be awarded for that assessment item.

For some assessment items, a late penalty may not be appropriate. These are clearly indicated in the course outline, and such assessments receive a mark of zero if not completed by the specified date. Examples include:

a. Weekly online tests or laboratory work worth a small proportion of the subject mark, or

b. Online quizzes where answers are released to students on completion, or

c. Professional assessment tasks, where the intention is to create an authentic assessment that has an absolute submission date, or

d. Pass/Fail assessment tasks.

## Academic Honesty and Plagiarism

UNSW has an ongoing commitment to fostering a culture of learning informed by academic integrity. All UNSW students have a responsibility to adhere to this principle of academic integrity. Plagiarism undermines academic integrity and is not tolerated at UNSW. *Plagiarism at UNSW is defined as using the words or ideas of others and passing them off as your own.*

Plagiarism is a type of intellectual theft. It can take many forms, from deliberate cheating to accidentally copying from a source without acknowledgement. UNSW has produced a website with a wealth of resources to support students to understand and avoid plagiarism, visit: student.unsw.edu.au/plagiarism. The Learning Centre assists students with understanding academic integrity and how not to plagiarise. They also hold workshops and can help students one-on-one.

You are also reminded that careful time management is an important part of study and one of the identified causes of plagiarism is poor time management. Students should allow sufficient time for research, drafting and the proper referencing of sources in preparing all assessment tasks.

If plagiarism is found in your work when you are in first year, your lecturer will offer you assistance to improve your academic skills. They may ask you to look at some online resources, attend the Learning Centre, or sometimes resubmit your work with the problem fixed. However more serious instances in first year, such as stealing another student's work or paying someone to do your work, may be investigated under the Student Misconduct Procedures.

Repeated plagiarism (even in first year), plagiarism after first year, or serious instances, may also be investigated under the Student Misconduct Procedures. The penalties under the procedures can include a reduction in marks, failing a course or for the most serious matters (like plagiarism in an honours thesis) even suspension from the university. The Student Misconduct Procedures are available here:

www.gs.unsw.edu.au/policy/documents/studentmisconductprocedures.pdf

# Academic Information

### Course Evaluation and Development

Feedback on the course is gathered periodically using various means, including the UNSW myExperience process, informal discussion in the final class for the course, and the School's Student/Staff meetings. Your feedback is taken seriously, and continual improvements are made to the course based, in part, on such feedback.

# Important Links

All students are expected to read and be familiar with UNSW Guidelines and Polices. In particular, students should be familiar with the following:

· Attendance ·

· Special Consideration

· Equitable Learning Services

· Exams

· Approved Calculators

· UNSW Email Address

# Disclaimer

*This course outline sets out description of classes at the date the Course Outline is published. The nature of classes may change during the Term after the Course Outline is published. Moodle should be consulted for the up to date class descriptions. If there is any inconsistency in the description of activities between the University timetable and the Course Outline (as updated in Moodle), the description in the Course Outline/Moodle applies.*

## CRICOS

CRICOS Provider Code: 00098G

## Acknowledgement of Country

We acknowledge the Bedegal people who are the traditional custodians of the lands on which UNSW Kensington campus is located.

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

| **Program Intended Learning Outcomes** | |
|---|---|
| Knowledge and skill base | |
| PE1.1 Comprehensive, theory based understanding of the underpinning natural and physical sciences and the engineering fundamentals applicable to the engineering discipline | ✓ |
| PE1.2 Conceptual understanding of the mathematics, numerical analysis, statistics, and computer and information sciences which underpin the engineering discipline | |
| PE1.3 In-depth understanding of specialist bodies of knowledge within the engineering discipline | ✓ |
| PE1.4 Discernment of knowledge development and research directions within the engineering discipline | |
| PE1.5 Knowledge of engineering design practice and contextual factors impacting the engineering discipline | ✓ |
| PE1.6 Understanding of the scope, principles, norms, accountabilities and bounds of sustainable engineering practice in the specific discipline | ✓ |
| Engineering application ability | |
| PE2.1 Application of established engineering methods to complex engineering 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 | ✓ |
| Professional and personal attributes | |
| PE3.1 Ethical conduct and professional accountability | |
| PE3.2 Effective oral and written communication in 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 | |