

Course Staff

Course Convener: Prof. Gavin Conibeer, TETB, g.conibeer@unsw.edu.au

Lecturers: Prof. Gavin Conibeer, Prof. Alistair Sproul, Dr. Mehrdad Farshchimofared

Consultations: For all enquiries about the course please contact the course convener. For all other questions or enquiries you are encouraged to ask the lecturer after class or post your question on the Discussion Forum 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. Email contact via UNSW student email will also be used at times.

Course Details

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.

Credits

This is a 6 UoC course and the expected workload is 13–16 hours per week throughout the 10 week term.

Pre-requisites and Assumed Knowledge

It is assumed that you can competently use Microsoft Excel (or equivalent software) for data manipulation and graphing. A background in Mathematics and Physics is assumed and preferably also an introductory level knowledge of Electrical energy and power, Heat Transfer, Fluid Mechanics and Thermodynamics.

Following Courses

The course is a suggested pre-requisite for SOLA3010/SOLA9009 and GSOE9122.

Relationship to Other Courses

SOLA5057 is a 3rd or 4th year course in the School of Photovoltaic and Renewable Energy Engineering. It is a compulsory course for the Renewable Energy Engineering (BE Hons) program and a “Disciplinary and Professional Elective” for the Photovoltaics and Solar Energy (BE Hons) program.

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).

Context and 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.

Learning outcomes

After successful completion of this course, you should be able to:

1. Identify and quantify energy efficiency opportunities across a range of energy consuming end use applications.
2. Analyse the economic potential of various energy efficiency options.
3. Carry out effective energy audits.
4. Communicate the results of such audits.

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

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 energy usage; 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 cost of energy in Australia are examined.

Indicative Lecture Schedule

Period	Summary of Lecture Program
Week 1	Introduction; <i>Case study – the Tyree Energy Technologies Building (TETB)</i> Economic Terms and Energy Policy <i>Case studies on economic assessment</i>
Week 2	Residential Energy, Hot Water, Energy Management <i>Case study: The Power factor Virtual Laboratory part 1</i>
Week 3	Lighting, MEPS, Energy Audits, Design Rating Schemes <i>Case study: The Power factor Virtual Laboratory part 2</i>
Week 4	Transport Efficiency <i>Guest lecture TBA</i>
Week 5	Commercial, HVAC, Co-Generation, Coefficient of Performance, Energy management control systems <i>Case studies on energy efficient commercial buildings</i>
Week 6	Industrial Energy Efficiency 1: Electric motors, Electric motor systems, pumps and fans <i>Guest lecture: Dr Jose Bilbao – TETB trigeneration system</i>
Week 7	Industrial Energy Efficiency 2: Furnaces, Heat recovery, Distributed generation, Combined cycle generation <i>Guest lecture TBA</i>
Week 8	Cogeneration, Absorption cooling, Production & distribution of process steam and compressed air <i>Case studies on industrial energy efficiency</i>
Week 9	Guest lectures: <i>Dr Mehrdad Farshchimonfared – HVAC: reduced energy use;</i> <i>Prof Alistair Sproul – A systems approach to energy efficiency</i>
Week 10 (to be held Tuesday of week 11)	Review of course Discussion of Digital Exam and example questions

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

Indicative Tutorial Schedule

Period	Summary of Tutorial Program
Week 2 -10	Tutorials will cover material from the previous week's Lecture

Contact Hours

The course consists of a 2.5 hour lecture and a 2 hour tutorial session each week as listed below. NOTE Lectures will run from week 1 until week 11 (with no lecture in week 10, ANZAC day public holiday). Tutorials will run from week 2 until week 10.

	Day	Time	Location
Lectures	Thursday Weeks 1-9	9 – 11.30 am	Law Theatre G04 (K-F8-G04)
Final lecture	Tuesday Wk11	9 – 11.30 am	Law Theatre G04 (K-F8-G04)
Tutorials	10 tutorial classes throughout each week, as assigned and timetabled Weeks 2-10		

Assessment

Assessment	Percentage of Total Mark	Date Due
Assignment 1: Energy Audit	20%	Friday Week 4
Assignment 2: Co-generation	20%	Friday Week 7
Laboratory Classes	6%	Completion of lab sessions
Online Quizzes 1 for each of weeks 2-10	1% each = 9%	Before the lecture each week
Final Digital Exam	45%	UNSW exam period

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

Assignment 1 (Total 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. In addition students will identify different ways these impacts could be minimized.

The report must be submitted on-line via Moodle in pdf form. *Late reports will attract a penalty of 10% per day* (including weekends). Reports submitted after results have been released will incur the maximum penalty.

Assignment 2 (Total 20%)

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

The report must be submitted on-line via Moodle in pdf form. *Late reports will attract a penalty of 10% per day* (including weekends). Reports submitted after results have been released will incur the maximum penalty.

Final Digital Exam

The exam in this course is a 2 hour digital examination which will be carried out on dedicated computer work stations. 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.

Weekly Online Quizzes

These will be available on Moodle for each week of the course.

Laboratory classes

Laboratory classes will be held in Weeks 5,6,7&8. Times will be advised. These may not be in your tutorial class times. Sessions will be available to be booked in at least 2 weeks prior. Attendance is required and marks will be given for successfully completing the laboratory task.

Class participation

Lecture attendance is expected. It is expected that you will attend all lecture sessions and participate in the lecture activities – class polls, quizzes etc. The guest lecture content may be assessed in the online quizzes.

On-line learning material

An essential part of the course is the Adaptive Learning Packages (ALPs). These ALPs present the majority of 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.

Relationship of Assessment Methods to Learning Outcomes

Assessment	Learning Outcomes			
	1	2	3	4
Assignment 1	✓	✓	✓	✓
Assignment 2	✓	✓	✓	✓
Final exam	✓	✓	-	-

Teaching Strategies

Delivery Mode

The teaching strategy for this course comprises a series of adaptive learning packages, lectures and tutorial sessions. The ALPs and lectures will present case studies and overview of a wide range of end use energy efficiency technologies and systems aimed at exploring the various topic areas. Tutorials 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 tutor will be available to give assistance during each of the scheduled tutorial sessions. Key topics will be reinforced in laboratory classes.

Learning in this course

This course is designed to provide an overview of energy efficiency across a broad range of end use applications and systems. The teaching approach used throughout the course encourages students to analyze energy usage through an analysis of the fundamental physical processes that occur. A whole of systems approach allows engineers to optimize the complete system for efficiency, not just one small part.

You are expected to attend all lectures, tutorials and labs and to complete all ALPs in order to maximize learning. You will need to complete some pre-work for each of your tutorial classes. In addition to the ALPs and 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

Attendance at the tutorial classes is compulsory from Week 2 to 10. There will be no tutorials in Week 1.

Tutorial Exemption

You must attend all tutorials. 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.

Course 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

Websites

Course website: <https://moodle.telt.unsw.edu.au/login/index.php>

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). Home page:
<https://research.qut.edu.au/tnep/>
 - 600 page online textbook on Energy Efficiency
<https://research.qut.edu.au/tnep/books/energy-transformed/>
 - Design Suite: <https://research.qut.edu.au/tnep/books/whole-system-design/>
- 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/>

- Australian Alliance for Energy Productivity (previously Australian Alliance to Save Energy) <https://a2se.org.au>
- Energy Efficiency Council (Australia) <http://www.eec.org.au/>
- Winning the Carbon War, Jeremy Leggett (2017) <http://jeremyleggett.net/online-version-winning-of-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/>
- For other sources see 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.

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 **13 to 16 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. UNSW regulations state that if students attend less than 80% of scheduled classes they may be refused final assessment.

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/electrical-engineering/policies-and-procedures>

<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:

- Developing scholars who have a deep understanding of their discipline, through lectures and solution of analytical problems in tutorials and assessed by assignments and written examinations.
- Developing rigorous analysis, critique, and reflection, and ability to apply knowledge and skills to solving problems. These will be achieved through students working through the Problem Sets and use of modelling software for the assignment.
- Developing independent, self-directed professionals who are enterprising, innovative, creative and responsive to change, through challenging design and project tasks.
- Developing citizens, who can apply their discipline in other contexts, are culturally aware and environmentally responsible.

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

	Program Intended Learning Outcomes		Relevant LO
PE1: Knowledge and Skill Base	PE1.1 Comprehensive, theory-based understanding of underpinning fundamentals	✓	LO1,LO2
	PE1.2 Conceptual understanding of underpinning maths, analysis, statistics, computing		
	PE1.3 In-depth understanding of specialist bodies of knowledge	✓	LO1,LO2
	PE1.4 Discernment of knowledge development and research directions		
	PE1.5 Knowledge of engineering design practice	✓	LO1 – LO4
	PE1.6 Understanding of scope, principles, norms, accountabilities of sustainable engineering practice	✓	LO1 – LO4
PE2: Engineering Application Ability	PE2.1 Application of established engineering methods to complex problem solving	✓	LO1,LO2
	PE2.2 Fluent application of engineering techniques, tools and resources	✓	LO1,LO2
	PE2.3 Application of systematic engineering synthesis and design processes	✓	LO1,LO2
	PE2.4 Application of systematic approaches to the conduct and management of engineering projects		LO3,LO4
PE3: Professional and Personal Attributes	PE3.1 Ethical conduct and professional accountability		
	PE3.2 Effective oral and written communication (professional and lay domains)	✓	LO3,LO4
	PE3.3 Creative, innovative and pro-active demeanour		
	PE3.4 Professional use and management of information	✓	LO3,LO4
	PE3.5 Orderly management of self, and professional conduct		
	PE3.6 Effective team membership and team leadership		