



ELEC9714

Electricity Industry Planning & Economics

Course Outline – Semester 1, 2015

Never Stand Still

Faculty of Engineering

School of Electrical Engineering and Telecommunications

Course Staff

The course coordinator and lecturer is:

Dr Iain MacGill

Joint Director (Engineering), Centre for Energy and Environmental Markets (CEEM)

Associate Professor, School of Electrical Engineering and Telecommunications.

Room TETB316 (Tyree Energy Technology Building), i.macgill@unsw.edu.au

Iain will be assisted this year by two colleagues; Dr Jenny Riesz and Dr Peerapat Vithayasrichareon who are both Post-Doctoral Researchers in EE&T and CEEM. Peerapat's research is focused on electricity industry investment and evaluating possible future electricity generation portfolios. Jenny's focus is on electricity market design for high renewable energy penetrations. It is intended that a number of guest lectures will also be arranged with research and industry experts during the semester.

Consultations: You are, of course, encouraged to ask questions on the course material during the lectures. Iain will be available for additional consultation on the lectures, assignments and projects before, during and after lectures, or by appointment (arranged at lectures or by email). Please note that he is unlikely to be available for consultations in his office without an appointment.

Scheduled lecturer consultation times for the assignments and projects will be advised during lectures, and on the course *Moodle*. Note that ALL email enquiries should be made from your student email address with ELEC9715 mentioned in the subject line.

Course Details

Credits

This is a 6 UoC course and the expected workload is 10–12 hours per week throughout the 13 week semester. As noted below, most of this time must be self-directed learning.

Contact Hours

As a post-graduate offering, the course consists of 3 hours of lectures each week from weeks 1 to 13. The last two to three weeks will involve student seminar presentations in the same room. It is possible that there will be a one week in this period where no lecture will be held subject to travel commitments of the lecturer – note, however, that at a minimum there will be 12 weeks of class in total. There are no tutorials or laboratories. Consultation periods prior to the submission of assignments will be offered – further details will be provided over the semester. The provisional syllabus of these weekly lectures is outlined below.

Lectures	Day	Time	Location
	Tuesday	6-9pm	Electrical Eng 224 (K-G17-224).

Context and Aims

The purpose of this course is to introduce students to the main issues involved in electricity industry planning and economics – that is, decision making approaches and methods to meet longer-term industry objectives. Industry planning and economics, with a particular focus on investment, will be considered in the context of both traditional monopoly utility run power systems, and the restructured market-based industries now becoming more common worldwide. Thus the course will explore the broader issue of electricity industry planning, economics and investment, rather than the narrower traditional power system focus. Furthermore, it will also explore the challenges and opportunities that distributed energy resources – generation, storage and demand-side participation – bring to these issues. The subject should also provide a basis for further study of this field.

The course gives an Australian perspective, considering issues including:

- the nature of the electricity industry
- objectives and options for restructuring
- insights from electricity pricing theory
- Australia's restructured electricity industry
- National Electricity Market design and performance
- the role of electricity networks in a restructured electricity industry including market representation, network pricing and network regulation
- design and implementation of retail electricity markets
- climate change and the electricity industry

Considerable attention is given to practical implementation and experience to date in Australia, with comments on other countries when appropriate. Students taking this course will therefore gain a critical appreciation of economics, planning and investment within Australia's restructured industry, and the emerging opportunities and challenges that the industry faces in these regards.

Relationship to Other Courses

This is a postgraduate course in the School of Electrical Engineering and Telecommunications. The course is available in the following programs: Master of Engineering Science; Doctor of Philosophy in Engineering, Master of Engineering and Bachelor of Engineering (4th Year Elective substitution). Students undertaking other courses may also be permitted subject to agreement with the School of Electrical Engineering and Telecommunications, and the Course Coordinator.

The companion course, *ELEC9715 Electricity Industry Operation and Control* explores presents decision making approaches and methods to meet shorter-term industry objectives through appropriate operation and control of existing, in place, power system equipment. These courses can be taken separately, or in either sequence. This course replaces the old *ELEC9201 Power System Planning and Economics*.

Pre-requisites and Assumed Knowledge

Although this subject has no formal prerequisites, it is assumed that each student has a basic working knowledge of power systems, and the electricity industry more generally. A number of texts are available for students whose undergraduate training did not include this type of material, or who feel that they require revision. Please contact the lecturer to discuss if you have questions regarding this matter. It is further assumed that students are familiar with Standard Office software tools including Excel, Word and Powerpoint (or equivalents).

Following Courses

The course is not a pre-requisite for other courses at UNSW. However, it does have close links to its companion course, *ELEC9715 Electricity Industry Operation and Control*. There is some cross-over between the two courses but they are also carefully designed to complement each other whilst not requiring that you take them in sequence, or take both of them.

Learning outcomes

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

1. Understand the fundamental objectives, constraints and concepts of electricity industry planning, economics and investment.
2. apply basic conventional 'optimal generation mix' planning techniques to simple electricity industry investment problems
3. describe the implementation of electricity industry planning and investment in a restructured industry context including the role of energy spot and derivative markets
4. apply basic models of electricity markets to simple restructured electricity industry problems involving operation and investment.
5. appreciate how electricity industry restructuring, technology development and environmental concerns are changing the way in which electricity industry planning, economics and investment is defined and undertaken
6. describe the opportunities and challenges that emerging distributed energy resources pose for future electricity industry planning, economics and investment.

This course is designed to provide the above learning outcomes which arise from targeted graduate capabilities listed in **Appendix A**. The targeted graduate capabilities broadly support the UNSW and Faculty of Engineering graduate attributes (listed in **Appendix B**). This course also addresses the Engineers Australia (National Accreditation Body) Stage I competency standard as outlined in **Appendix C**.

Syllabus

The nature of the electricity & gas industries; climate change and the electricity industry; objectives & options for restructuring; insights from electricity pricing theory; wholesale electricity market design; Australia's restructured electricity industry; National Electricity Market design & performance; the role of electricity networks in a restructured electricity industry including market representation, network pricing and network regulation; ancillary services; design & implementation of retail electricity markets; electricity industry regulation.

Teaching Strategies

Delivery Mode

The teaching in this course aims at establishing a good fundamental understanding of the areas covered using:

- Formal face-to-face lectures, which provide you with a focus on the core analytical material in the course, together with qualitative, alternative explanations to aid your understanding;
- A number of guest lectures from industry and research experts
- Small periodic quizzes (non-assessed)

Learning in this course

You are expected to attend all lectures in order to maximise learning. In addition to the lecture notes, you should read relevant sections of any recommended texts. Reading additional texts and reports will further enhance your learning experience. 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.

Lectures will make extensive use of PowerPoint slides and white board work. Summary PowerPoint printouts will be provided at the start of lectures if and when possible, and placed on the course Moodle website. Additional information and reading materials will also be progressively made available on *Moodle*, but they are no substitute for accurate notes, and active student participation through questions and informal exercises during the lectures. It is also intended that you will be provided with access to a number of on-line data sources for the Australian National Electricity Market including a powerful market tool - *NEMSight*.

Indicative Lecture Schedule

Note that this schedule is provisional at this stage and may be updated during the session. You should attend lectures and regularly check the course *Moodle* website for possible updates. Note that there may be tasks (non-assessable) to undertake on *Moodle* each week as well – be sure to keep up to date with developments. A number of guest lectures are also intended to be included in the second half of semester.

WEEK	LECTURE	Class tasks	
1	Introduction to the electricity industry and electricity industry restructuring		
2	Introduction to economic, commercial and regulatory perspectives Conceptual model for a restructured electricity industry. Some international experience to date	[out] Assignment 1	
3	Centralised and decentralised decision making frameworks – Techniques for integrated resource planning, price setting	[out] information on projects and topics	
4	Market prices and financial instruments – their role in the electricity industry for investment	[in] Assignment 1 [out] Assignment 2 Group project discussions	
5	Australia's restructured electricity industry National Electricity Market (NEM) design	Group project discussions	
6	Australia's National Electricity Market performance	[in] Assignment 2 Group project topics finalized by end week 6	
7	Network services and investment	[out] Assignment 3	
8	Retail market design and end-use decision making in the electricity industry. What role for smart grids?	Mid semester quiz	

9	Renewable energy economics and investment	Group progress reviews [in] Assignment 3	
10	Sustainable energy futures – climate change, the role of technology assessment		
11	Discussion on future challenges and options for the NEM and electricity industries around the world. Course review.		
12	Student group presentations	Seminar ppt to be uploaded into Moodle by 6pm on evening of presentation	
13	Student group presentations	Seminar ppt to be uploaded into Moodle by 6pm on evening of presentation Group reports due end week 13	

Assessment

The assessment scheme in this course reflects the intention to assess your learning progress through the semester. Assessment will consist of a group report on an agreed topic related to material covered in the course; a group oral presentation to the class of the major points in the report, class assignments taken individually, a mid-semester quiz and the final exam. Satisfactory performance in both the class based assessment and examination is required to pass this course. The assigned marks for each assessment component are as follows:

Assessment activity	Assesst (%)
Group student project reports on a topic agreed with the course coordinator by week 6 lecture (submission prior to the end of week 13)	20
Group student presentations on their report topics (over final 2 -3 weeks in a student order determined by the course coordinator)	10
Mid semester quiz (1 hour)	5
Individual student assignments during the semester (number and submission dates to be confirmed within the course lectures).	15
Final exam (2 hours)	50

Assignment

The assignment allows self-directed study leading to the solution of partly structured problems. Marks will be assigned according to how completely and correctly the problems have been addressed and the understanding of the course material demonstrated by the report.

These assignments must be undertaken by students individually. It is expected that there will be three such assignments during the semester. Provisional dates for assignment distribution and submission are provided in the course syllabus.

Project report and seminar

The project will involve students in an activity suited to their interests and skills in the area of electricity industry planning, economics and investment. Groups of four students are very strongly preferred although smaller groups may also be permitted if and as appropriate – groups and topics must be approved by the course coordinator. In particular, students undertaking a fourth year engineering thesis or post-graduate research thesis should not choose an elec9714 project topic that closely relates to their other thesis research. Similarly, students are strongly encouraged not to choose a project that closely relates to any other projects that they have undertaken – for example, in elec9715 or other electricity industry related courses. The intent of these group elec9714 projects is to expose you to electricity industry planning and economics issues other than those you might already have already worked on, or are currently working on. Note also that the large student numbers this year will make smaller groups than 4 students particularly challenging to manage.

Projects will either focus on

- development and testing of a simple software, spreadsheet or Matlab power system modelling and optimisation tool, or
- an in-depth literature survey of some aspect of electricity industry planning, economics and investment (around 5000 words plus tables, diagrams, references etc.).

More information on these projects and suitable topics will be distributed in week 3 and project topics are to be negotiated and finalised by week 6. Details on the formal requirements for the project reports will also be provided at this time. It should contain a significant review of the literature relevant to the topic and a comprehensive bibliography. All source material must be adequately referenced in the body of the report and it is expected that there will be 25 or more scholarly references in a literature survey. It is also expected that the project will include some analysis of actual electricity industry economic and/or market data.

The group presentations will take place during class time in the last two to three weeks of semester. Presentations will be a maximum 8 minutes with 5 minutes for questions and should make extensive use of visual aids. A computer and projector for PowerPoint presentations will be available. You will also be able to run the presentation from your own laptop if that is preferred. It is envisaged that all presentations will be made available on *Moodle* prior to the seminars. Assessment will be based on the structure, content and clarity of the presentation and how well they answer questions. Note that students will participate in the assessment through a peer review process. More details will be provided during classes closer to the time of the seminar presentations.

For all of the non-exam assessment tasks in this course, it is essential that you have a complete understanding of the UNSW official position on 'In-class assessment and plagiarism' as outlined below. Please note that there are severe penalties associated with plagiarism offences.

Mid-Semester Exam

The mid-session examination tests your general understanding of the course material, and is designed to give you feedback on your progress through the analytical components of the course. Questions may be drawn from any course material up to the end of week 7.

Final Exam

The exam in this course is a standard closed-book 2 hour written examination, comprising four compulsory questions. University approved calculators are allowed. The examination tests analytical and critical thinking and general understanding of the course material. Questions may be drawn from any aspect of the course unless specifically indicated otherwise by the lecturer..

Relationship of Assessment Methods to Learning Outcomes

Assessment	Learning outcomes					
	1	2	3	4	5	6
Assignments	✓	✓	✓	✓	✓	✓
Group project and seminar	✓	✓	✓	✓	✓	✓
Mid-semester exam	✓	✓	✓	✓	✓	✓
Final exam	✓	✓	✓	✓	✓	✓

Course Resources

Textbooks

There is no assigned textbook for this subject. The more recent concepts relevant to electricity industry planning and economics in restructured industries are not easily found in textbooks. The UNSW library has a number of power system planning books dating from the 1960s to 1990s. Some of these have useful descriptions of traditional optimal generation mix techniques. However, they generally have very little to say about planning, economics and investment in restructured industries. There are several more recent books on electricity industry economics and markets including, notably, Stoft, 2002. Unfortunately there is only a single copy of this book in the Library. It is also rather US centric, as are several of the other books. The right text book remains to be written.

On-line resources

Instead of an assigned text book, regular updates and course materials will be added to the course Moodle website. You should check this site frequently. Materials will include summary pdf versions of the lecture PowerPoints (also provided as printouts prior to each lecture). A range of reports, papers and websites will be uploaded throughout the semester to provide more background on electricity industry planning, economics and investment within the restructured Australian electricity industry, as well as internationally.

Another useful website is that of the UNSW Centre for Energy and Environmental Markets (CEEM) found at www.ceem.unsw.edu.au. It contains useful papers and presentations covering many of the topics that are explored during the course.

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 <http://www.lc.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://my.unsw.edu.au/student/atoz/ABC.html>), and particular attention is drawn to the following:

Workload

It is expected that you will spend at least **ten to twelve 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 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.

Keeping Informed

Announcements may be made during classes, via email (to your student email address) or via online learning and teaching platforms like *Moodle*. From time to time, UNSW will send important announcements via these media without providing any paper copy. Please note that you will be deemed to have received this information, so you should take careful note of all announcements.

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://my.unsw.edu.au/student/atoz/SpecialConsideration.html>.

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 ELSOC 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, more generally, UNSW policies:

<http://www.engineering.unsw.edu.au/electrical-engineering/policies-and-procedures>

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

Appendix A: Targeted Graduate Capabilities

Electrical Engineering and Telecommunications programs are designed to address the following targeted capabilities which were developed by the school in conjunction with the requirements of professional and industry bodies:

- The ability to apply knowledge of basic science and fundamental technologies;
- The skills to communicate effectively, not only with engineers but also with the wider community;
- The capability to undertake challenging analysis and design problems and find optimal solutions;
- Expertise in decomposing a problem into its constituent parts, and in defining the scope of each part;
- A working knowledge of how to locate required information and use information resources to their maximum advantage;
- Proficiency in developing and implementing project plans, investigating alternative solutions, and critically evaluating differing strategies;
- An understanding of the social, cultural and global responsibilities of the professional engineer;
- The ability to work effectively as an individual or in a team;
- An understanding of professional and ethical responsibilities;
- The ability to engage in lifelong independent and reflective learning.

Appendix B: UNSW Graduate Attributes

The course delivery methods and course content addresses a number of core UNSW graduate attributes, as follows:

UNSW graduates will be -

Scholars who are:

- understanding of their discipline in its interdisciplinary context
- capable of independent and collaborative enquiry
- rigorous in their analysis, critique, and reflection
- able to apply their knowledge and skills to solving problems
- ethical practitioners
- capable of effective communication
- information literate
- digitally literate

Leaders who are:

- enterprising, innovative and creative
- capable of initiating as well as embracing change
- collaborative team workers



Professionals who are:

- capable of independent, self-directed practice
- capable of lifelong learning
- capable of operating within an agreed Code of Practice

Global Citizens who are:

- capable of applying their discipline in local, national and international contexts
- culturally aware and capable of respecting diversity and acting in socially just/responsible ways
- capable of environmental responsibility

Appendix C: 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