ENERGY TRANSFORMED: SUSTAINABLE ENERGY SOLUTIONS

AUSTRALIAN UNIVERSITY SURVEY

SUMMARY OF QUESTIONNAIRE RESULTS

WHAT IS THE STATE OF EDUCATION FOR ENERGY EFFICIENCY IN AUSTRALIAN ENGINEERING EDUCATION?

PREPARED BY:

The Natural Edge
PROJECT

Attribution

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The Natural Edge Project (TNEP) is an independent non-profit Sustainability Think-Tank based in Australia. TNEP operates as a partnership for education, research and policy development on innovation for sustainable development. TNEP's mission is to contribute to, and succinctly communicate, leading research, case studies, tools, policies and strategies for achieving sustainable development across government, business and civil society. Driven by a team of early career Australians, the Project receives mentoring and support from a range of experts and leading organisations in Australia and internationally, through a generational exchange model.

EXECUTIVE SUMMARY

In 2007 the National Framework for Energy Efficiency provided funding for the first survey of energy efficiency education across all Australian universities teaching engineering education. The survey asked the question, '*What is the state of education for energy efficiency in Australian engineering education?*'. There was an excellent response to the survey, with 48 course responses from lecturers across 27 universities from every state and territory in Australia, and 260 student responses from 18 courses across 8 universities from all 6 states.

It is concluded from the survey findings that the state of education for energy efficiency in Australian engineering education is currently highly variable and *ad hoc* across universities and engineering disciplines. This Executive Summary highlights the survey's key findings:

1) Location of Content in Engineering Programs

a) The data suggests that energy efficiency education is not embedded across all engineering disciplines. Mechanical and electrical engineering students appear more likely to be taught energy efficiency content in their degree programs, followed by environmental, civil and chemical engineering students. Energy efficiency education across other discipline areas appears to be based on the individual interests and research pursuits of the lecturers involved rather than strategic integration across universities that is based on the needs of each discipline.

b) The inclusion of energy efficiency content in any course containing energy efficiency content appears to be driven by formal program requirements and the personal and research motivations of the individual lecturers.

c) Energy efficiency appears to be taught largely within well established courses (also called units or subjects depending on the university) that have been run by experienced lecturers for more than five years. Energy efficiency content appears to be mostly taught as part of a broader content area to second and third year undergraduate students. In addition there are a number of courses on more targeted energy efficiency topics in fourth year undergraduate, and postgraduate studies.

d) It appears that most students are not aware of how energy efficiency education is different at different universities, indicating that this is not a strong motivator for choosing to study at a certain university. Students do not appear to be clear on where in their degree program energy efficiency is taught. Students also appear unsure about what amount of such content should be in their degree.

2) Level of Integration of Topical Issues in Energy Efficiency

a) The level of integration of topical energy efficiency issues into courses appears to be very low. Even mainstream topics like 'the link between greenhouse gas emissions and global temperature change' and 'carbon dioxide and other greenhouse gas emissions from energy generation' were covered in detail by less than a third of those courses surveyed, and mentioned by less than half.

b) The survey suggests that students across undergraduate and postgraduate levels think they understand the terms 'sustainable development' and 'energy efficiency' very well, and are making some connection to issues in the media. However students appear to have a low to moderate appreciation of how 'energy efficiency' might be directly related to their future careers.

3) Level of Student Exposure to Content: Theory, Knowledge and Application

'Energy efficiency content' is a broad term that covers many aspects of curriculum. Hence, this survey separated energy efficiency content into energy efficiency 'fundamental principles and base theory', 'knowledge/ information' (for example demonstrating how principles and theory behave and why this knowledge is useful to engineer energy efficiency solutions and systems), and 'application' of the principles, theory, and knowledge/ information (for example through case studies and worked examples).

Within 'fundamental principles and base theory', the survey further distinguished between 'general design theory' (for example addressing concepts such as *embedded energy*, *resource productivity*, *life cycle assessment*, and *demand side management*); and 'technical design theory' (for example addressing concepts such as the *whole system design* methodology for calculations).

a) Despite the students' perception of how well they understand the term 'energy efficiency' and the extent of energy efficiency education, the data suggests that most did not have an in-depth understanding of the surveyed principles and theory.

b) While lecturers appear to be engaging with energy efficiency knowledge/information, there appears to be a low level of student exposure to energy efficiency theory. In particular, the extent to which energy efficiency concepts and principles are included in courses appears to be low to very low. Three areas of content that are highlighted by the survey as not being taught in detail and not understood by students include: 1) Product Stewardship & Responsibility; 2) Decoupling energy utility profits from kilowatt-hours sold; and 3) Incremental Efficiency versus Whole System Design.

c) Student exposure to energy efficiency information and knowledge appears to be moderate. However, the extent to which energy efficiency and productivity content is taught in engineering programs appears to be low. The extent to which courses address roles and responsibilities in energy efficiency is very low. This also aligns with the observed low level of course content about product stewardship and responsibilities.

d) Student exposure to applying energy efficiency principles and theory and information/knowledge to worked examples appears to be generally low to moderate. The data suggests that quite a number of courses may not be using case studies. Case studies appear to be less likely to go beyond the traditional sectors of industry and energy utilities. Popular case studies include motor systems, boilers, air-conditioning systems, lighting, and energy efficiency gains in appliances and equipment.

e) Many courses that include some energy efficiency content in their courses do not appear to include energy efficiency related reading resources for students. Together with results regarding content coverage, the survey indicates a general shortfall in the inclusion of energy efficiency theory, knowledge and application in Australian engineering education.

4) Energy Efficiency Education: Curriculum Renewal

a) Although lecturers are uncertain as to whether they are meeting expectations with regard to the type of energy efficiency content in their courses, they clearly value: 1) the inclusion of good content within their course; 2) the inclusion of team project work and practical and industry relevant material; and 3) a problem-based learning approach to learning. This list is important in suggesting that curriculum renewal strategies should aim to benefit courses in these areas.

b) For more than half of the surveyed courses, lecturers report that their course could include more (in-depth) energy efficiency content, particularly in: 1) applying energy efficiency theory and knowledge; and 2) including knowledge and information on the topic. There appears to be more hesitancy with regard to energy efficiency theory and principles, perhaps due to lecturers not being aware of content, or because of competing content areas.

c) Of those courses where lecturers said more could be done, lecturers are keen to receive assistance, particularly through accessing case studies on energy efficiency examples in engineering (i.e. worked real-life examples that show how the theory and knowledge is applied). They are also keen to access lists of good material (for example audio-visual materials, text books and other references), and are keen to have access to a customised set of readings on energy efficiency for engineers generally. Lecturers do not appear keen to receive professional development (i.e. additional training) on energy efficiency.

d) Almost all of the lecturers wanting assistance with accessing content about energy efficiency prefer the resources to be available through open access, online learning modules, rather than restricted access online modules, or intensive short courses .

e) Key perceived challenges for lecturers in improving their course content, are: 1) the potential for course content overload; and 2) having insufficient time to prepare new materials. In addition some lecturers do not appear to be aware of content that is beyond 'introductory'.

f) Some lecturers indicated preference for third party endorsement of materials, but comments indicated that the reason and messaging of the endorsement needs to be clear. These lecturers preferred Engineers Australia and the (former) Department of Environment and Water Resources as endorsers to stimulate the curriculum renewal process in energy efficiency education. Some lecturers also indicated they would look to other universities to lead through developing and/or using materials and endorsing them.

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1 Introduction

1.1 Background

Engineers have a major role to play in assisting society to make a transition to a sustainable form of development - 'sustainable development'. This will involve finding new ways to design our human environments, systems, and products so they no longer degrade the quality of the Earth's air, water, soil and the ecosystems. Sustainable development requires multi-disciplinary efforts across society.

In October 2006 The Natural Edge Project (TNEP), Griffith University, and the Australian National University were awarded a research grant by the federally funded 'CSIRO Energy Transformed Flagship' program, to develop an online textbook on energy efficiency. The aim of the grant was to empower design professionals (including engineers, technicians, facilities managers, architects etc.) with a toolkit to identify and implement energy efficiency opportunities throughout their studies and professional life. This was in accordance with the CSIRO Energy Transformed Flagship Program aim of, '*facilitating the development and implementation of stationary and transport technologies to halve greenhouse gas emissions, double the efficiency of the nation's new energy generation, supply and end use, and to position Australia for a future hydrogen economy'.*[1]

The grant deliverable is an online textbook (620 pages) called the '*Energy Transformed: Sustainable Energy Solutions for Climate Change Mitigation*' program, which is now freely available and online, at www.naturaledgeproject.net/Sustainable_Energy_Solutions_Portfolio.aspx. This new textbook addresses the following three themes:

- Module 1: Identifying, quantifying and implementing energy efficiency opportunities for Industrial/Commercial users (content arranged by Technology type).
- Module 2: Integrated systems based approaches to realising energy efficiency opportunities for Industrial/Commercial users (content arranged by Industry Sector type).
- Module 3: Integrated approaches to energy efficiency and low emissions electricity, transport and distributed energy.

These CSIRO project outcomes also address Australia's National Framework for Energy Efficiency (NFEE) call for capacity-building programs in energy efficiency, specifically for engineers and designers. During the project a significant opportunity was identified, to further inform the development of the modules with a formal survey of 'end-users': lecturers teaching energy efficiency content within engineering degree programs.

In March 2007, Sustainability Victoria, Chair of the NFEE Trades and Professions Training and Accreditation Working Group on behalf of the Commonwealth, State and Territory Governments provided funding for The Natural Edge Project to facilitate a formal consultation with Australian universities about the state of education for energy efficiency in engineering schools. The intention was to identify what gaps require filling, and to identify the best ways to embed courses (or course materials) on energy efficiency into university engineering programs.

It is intended that this study will assist in providing insight into the state of education for energy efficiency in Australia. Results of the university consultation informed the finalisation of the CSIRO education modules and will be made publicly available in summary form.

[1] For further information please refer to the Energy Transformed Flagship Program website at www.csiro.au/csiro/channel/ppch1d.html.

1.2 Scope

This study focuses on a key consideration in sustainable development: that of providing sustainable energy solutions. It asks the question '*What is the state of education for energy efficiency in Australian engineering education?*' This report provides a summary of the formal consultation with Australian universities about the state of education for energy efficiency in engineering schools, using results from a Lecturer and Student Questionnaire. Results are discussed in the context of what gaps were identified in engineering education for energy efficiency, and ways to embed courses (or course materials) on energy efficiency into university engineering programs in Australia. Results of the university consultation process will be used to inform the CSIRO Energy Transformed Flagship education modules and may also contribute to the creation of academically reviewed and publicly available reports, research papers and theses relating to education for sustainable development.

1.3 Limitations

The summary provided in this report is based on data gathered from questionnaires and through follow-up interviews with participants and colleagues in the field. Unless specific permission has been obtained from individuals, data presented in this summary report maintains individual and university anonymity. A copy of the survey consent summaries is provided in **Appendix 1**. While lecturing staff within all universities offering engineering education were invited to participate, this report does not necessarily represent the views of their universities.

The research team used a number of mechanisms to identify lecturers teaching energy efficiency within their courses in Australian universities. This relied on each Head of School/Faculty identifying those who taught energy efficiency education within their programs and giving them the questionnaire (either electronically or in hard copy). In addition, the project team used their existing network of colleagues to also assist in identifying individuals and encouraging them to participate. A number of email-lists were also used to promote the survey to audiences which were likely to include university academics. Participant and mentor feedback during the data collection phase indicates that the survey has reached the majority of the targeted audience.

Lecturer questionnaire responses have been obtained from 44 individuals, spread across 27 of the 33 universities teaching engineering education in Australia. This includes universities in every state and territory, spanning small to large engineering departments and programs. While this survey does not claim to cover every course teaching energy efficiency to engineers in Australia or every lecturer teaching such content, there is nothing to suggest that the data does not represent the composition of such courses and lecturer perspectives in Australia.

Each lecturer who was invited to complete the Lecturer Questionnaire was also invited to survey their students with a Student Questionnaire. Student questionnaire responses have been obtained from 18 courses, comprising 260 students across 8 universities in states and territories, except the Northern Territory and the ACT. This includes 8 undergraduate courses, 2 postgraduate courses and 4 mixed courses. Given there is a growing tendency within Australian universities to be wary of surveying students - for a number of reasons including student perception they are being 'over-surveyed', and staff pre-occupation with course and teaching evaluation surveys towards the end of the semester - all lecturers were advised on invitation, that student involvement was not compulsory for their participation and that the survey comprised one double-sided sheet. This may account for the reduced number of student data sets (i.e. 18, or 38%) obtained from the 48 courses for which a lecturer response was received. However, there is nothing to suggest that the data obtained from the courses does not represent the perceptions of engineering undergraduate and postgraduate students with regard to energy efficiency education in Australia.

1.4 Clarifying Definitions

In order to minimise confusion, the following definitions were derived for the purpose of this study:

- **School/ Department/ Faculty:** The level of coordination within a university context, where engineering programs are coordinated, and to which lecturers belong.
- **Program:** The award that a student works towards, and which is made up of a certain number of approved courses. This is sometimes referred to by universities as a 'Course'.
- **Course:** A unit of work undertaken, which is part of the overall *Program* of study (i.e. 1/8 of a nominal full study year). It may be referred to as having anything from 3 to 12 'Credit Points' of value. This is also commonly referred to by universities as a 'Unit' or 'Subject'.

'Energy efficiency content' is a very broad term, covering many aspects of curriculum. Hence for some questions, this survey separated energy efficiency content into the following:

- **Fundamental principles and base theory:** i.e. those principles and the theory underpinning the study of energy efficiency;
- **Knowledge/ information:** for example demonstrating how principles and theory behave and why this knowledge is useful to engineer energy efficiency solutions and systems; and
- **Application:** i.e. applying the principles, theory, and knowledge/ information through case studies and worked examples.

Within the area of 'fundamental principles and base theory', the survey further distinguished between:

- **General design theory:** for example addressing concepts such as *embedded energy*, *resource productivity*, *life cycle assessment*, and *demand side management*; and
- **Technical design theory:** for example addressing concepts such as the *whole system design* methodology for calculations.

1.5 Method Summary

The study method and timeframes of the survey are summarised in **Table 1**.

Table 1: Method Summary & Timeframes

Task	Key Personnel & Milestones	Completion
1. Ethics approval	– Approval obtained, no amendments required.	September 2007
2. Questionnaire Review	– External bodies review (NFEE, CSIRO, Engineers Australia) – Internal review: Griffith University & ANU – Grant provider review – Student & lecture questionnaire pilot	September 2007 – October 2007
3. Questionnaire Distribution	– Survey completion window: 1 – 26 October 2007 (to align with the end of teaching semester, before exams) – Follow-up contact (email, phone)	September 2007 – October 2007
4. Questionnaire - Collection	– Hard copies & electronic copies received – Individual follow-up to increase response rate.	October 2007 – November 2007
5. Questionnaire – Analysis	– Spreadsheet development for data entry – Data entry	November 2007 – December 2007
6. Report Writing	– Production of draft summary report – Internal Review – Grant provider review & comments – Final report production.	December 2007 – January 2008

The survey included two components (see **Appendix 2** and **Appendix 3**):

1. Lecturer Questionnaire: (40 questions, 16 pages, completion time: approximately 30 minutes) This was issued in hard copy and electronic format, to the Head of School/ Department/ Faculty of every Australian university providing engineering undergraduate and/or post-graduate programs. It included an invitation for completion by every lecturer teaching energy efficiency within engineering education (referred to in this report as 'engineering education for energy efficiency'). Lecturers receiving the questionnaire were also invited to forward it to colleagues responsible for course/s on energy efficiency who may also be interested in participating. This invitation was followed up by one or more phone calls to provide support and clarification.
2. Student Questionnaire: (10 questions, 2 pages, completion time: approximately 5 minutes) This was provided to all lecturers who received the Lecturer Questionnaire, to distribute and collect in one or more of their classes where energy efficiency is taught. Lecturers were reassured through email and follow-up correspondence that student responses were not a requirement for their participation in the survey.

Results of the two questionnaires were cross-checked for additional context and validity of interpretation, through semi-structured telephone interviews with a subset of Australian academic colleagues experienced in engineering education for energy efficiency (these participants had already indicated their availability for comment through the CSIRO project).

Key considerations in undertaking the study included the following:

1. Individual and University Anonymity: Given the sensitivity of the information being obtained with regard to potential commercial-in-confidence content and methods, any reporting of data from this study will ensure anonymity unless permission has been obtained from the individual concerned.
2. Inclusiveness (Stakeholder Engagement): Given the aim of the study to find the state of Australian engineering education with regard to energy efficiency, it was very important that this study be as inclusive as possible. The research team have liaised with representatives within Engineers Australia (EA), the Australian Council of Engineering Deans and the Australian Association of Engineering Education to ensure that the survey reached a wide range of academics within the survey timeframe.
3. Flexibility: Given the number of responsibilities carried by lecturers towards the end of the academic year, there were a number of lecturers who could not contribute within the original questionnaire submission deadline. On a case by case basis the deadlines were extended to ensure the maximum number of universities could be represented in the study.
4. Awareness Raising: Given the association of this survey with the CSIRO Energy Transformed Flagship project, it was important to use this survey as an opportunity to also raise awareness about the availability of educational content on energy efficiency, and its relevance across all engineering discipline areas.

2 Summary of Results – Lecturer Questionnaire

This section summarises results for the Lecturer Questionnaire. Aggregated results for each question are also provided in **Appendix 2**.

2.1 Who Responded to the Survey?

Summary information about those registered and who completed questionnaires are provided in **Table 2** below. Of the 33 Australian universities offering engineering education, 29 universities (88%) from all states and territories had lecturers who registered their interest in this study and provided contact details to receive further information. 27 of these universities had lecturers who submitted completed questionnaires. This response by Australian universities is considered excellent.

Through the invitation process, 59 lecturers registered their interest in the study (i.e. providing name and contact details to receive the questionnaire). 44 lecturers (75%) from 27 of these universities completed and returned questionnaires for one or more of their courses. Given that it is usually quite difficult to achieve a high response rate in surveys, these high response rates are perhaps an indication of a high level of university faculty interest in energy efficiency as a topic area.

Table 2. Lecturer Questionnaires – Summary of participation

State	University Participation Data			Lecturer Participation Data		
	Teaching Engineering Education^	Where Lecturers Expressed Interest	Where Lecturer/s Responded	Number of Lecturers who Registered Interest	Number of Lecturers who Responded	Number of Questionnaires Submitted**
ACT	3	2	2	3	3	3
NSW	6	6	5	11	7	7
NT	1	1	1	1	1	1
QLD	6	6	6	15	13	15
SA	3	2	2	5	2	2
TAS	2	2	2	5	3	5
VIC	8	7	6	12	8	8
WA	4	3	3	7	4	7
Total	**33**	**29**	**27**	**59***	**41**	**48**
%	**-**	**88%**	**82%**	**-**	**70%**	**-**

^ *This list was drawn from the university membership of the Australian Council of Engineering Deans.*
* *5 other lecturers expressed interest in the survey, but did not teach a course that could be counted in the questionnaire.*
** *Several lecturers in QLD, Tasmania and WA completed a questionnaire for more than one of their courses.*

Of the six universities who did not participate:

- Two did not respond to the invitation, follow-up calls and emails to participate.
- Two provided a statement by the Head of School/ Department/ Faculty that they did not teach energy efficiency in their engineering degree programs.
- One nominated a lecturer who could not complete the questionnaire within the study period due to other commitments.
- One was in the process of closing the engineering program at the end of 2007. In this case, the Head of School still provided general comments on energy efficiency education.

It is noted that several lecturers provided generalised responses in one questionnaire, that covered several courses, due to their curriculum structure (problem-based learning) where it is difficult to represent the range of energy efficiency education through responding on a single course. In these cases, the completed questionnaire was counted as one course.

In each sub-section, summary statements about the findings are italicised and bolded. The questions and results to the questions are then provided in bullet points, prefixed by '(LQX)' which denotes 'Lecturer Question X'. The questions are also bolded.

2.2 Energy Efficiency – Where is it Taught? (LQ1-LQ8)

2.2.1 Course and Program Details (LQ1 – LQ5)

Energy efficiency content appears to be most often taught as part of a broader discipline area to second and third year undergraduate students, in addition to focused courses on energy efficiency topics in fourth year undergraduate and postgraduate studies.

- **(LQ1-2) Please provide the Course Name/Code and details regarding the topic of the Course (if not clear in the Course Name).** Just under half of the courses (21) surveyed included the word 'Energy' in the course name. There was a variety of course names provided in the responses that did not contain the term.
- **(LQ3) What type of student enrols in this Course?** Almost half (48%) of the surveyed courses are available to third year undergraduate students, while just under one third (31%) are available to fourth year undergraduate students. Just over one quarter (27%) are available to postgraduate students.
- **(LQ4-5) Please list the program name/s for which this course is usually undertaken, and for whom is this Course is offered as compulsory and as an elective.** Three quarters (75%) of the surveyed courses are offered to undergraduate students only. Five courses (10%) are offered to both undergraduate and postgraduate students and six courses (15%) are offered to postgraduate students only.

2.2.2 Course Evolution – Energy Efficiency Content (LQ6)

Energy efficiency content appears to be taught largely within well established courses that have been running for more than 5 years. Further to discussions with respondents during the data collection, these are considered likely to be fundamental/ foundational courses within engineering education. The data also suggests that energy efficiency content has been taught within the surveyed courses as part of a more recent curriculum development. Lecturers teaching energy efficiency education appear to be experienced teachers, most of whom have been evolving their course materials for at least 5 years.

- **(LQ6a) How many years has this course been offered (i.e. with most content the same)?** Almost half (49%) of the surveyed courses have been offered for 5 years or longer. Just under one third of the courses (30%) have been offered between 2 – 3 years.
- **(LQ6b) How long have you been evolving this set of teaching material?** Just over half of the respondents (52%) have personally been evolving the course content for 5 years or more (mostly between 5 – 10 years, 27%) and over one third (36%) have been involved between 2 – 4 years.

2.2.3 Discipline Exposure to Energy Efficiency Content (LQ7 – LQ8)

From the courses surveyed, it appears that mechanical and electrical engineering students appear more likely to be taught energy efficiency content in their degree programs, followed by environmental, civil and chemical engineering students. From discussions with respondents during the data collection phase, energy efficiency education across other discipline areas appears to be based on the individual interests and research pursuits of the lecturers involved rather than consistent integration across universities based on the needs of each discipline.

- **(LQ7) Students of which engineering disciplines take this course?** Of the surveyed courses, two thirds (one third each) of the surveyed courses are taught to electrical (33%) and mechanical (33%) engineering students. Environmental (19%), civil (17%) and chemical (13%) engineering students are the next major subset of disciplines to whom the courses are taught. There was also an *ad hoc* scattering of other discipline areas.
- **(LQ7)** Although exposure to energy efficiency education by systems engineering students appears low (13%), from discussions during the data collection phase it is understood that this number reflects the low number of 'systems engineering' degree programs in Australia, rather than this discipline missing out on energy efficiency content.
- **(LQ8) Would you be willing to provide your course outline to the research team for this project?** Just under two thirds (65%) of respondents provided additional course information (in the form of course outlines and reading lists). Almost all of the other respondents (a further 29%) said they are willing to be approached about further information.

2.3 Energy Efficiency – What is Being Taught? (LQ9 – LQ28)

As noted in Section 1.4, 'energy efficiency content' is a very broad term, covering many aspects of curriculum, so this was further expanded to the following terms: 'fundamental principles and base theory' which refers to those principles and the theory underpinning the study of energy efficiency; 'Knowledge/ information' which refers to the explanation of how principles and theory behave and why this knowledge is useful to engineer energy efficiency solutions and systems; and 'Application' refers to how these principles, theory, and knowledge/ information are applied through case studies and worked examples. Within the area of 'fundamental principles and base theory', the questions also distinguish between 'general design theory' (for example addressing concepts such as *embedded energy*, *resource productivity*, *life cycle assessment*, and *demand side management*) and 'technical design theory' (for example addressing concepts such as the *whole system design* methodology for calculations).

2.3.1 Teaching Energy Efficiency - Expectations (LQ9 - LQ12)

In up to one third of the courses that include energy efficiency content, the data suggests that students may not be identifying the relevance of energy efficiency to the content. Rather than being driven by student expectations, the inclusion of energy efficiency content in courses appears to be driven by program requirements and the personal and research motivations of the individual lecturers. The data suggests that lecturers are uncertain as to whether they are meeting expectations with regard to the type of energy efficiency content in their courses. However, when considering the quality of their course with respect to energy efficiency education, lecturers appear to value: 1) how much key energy efficiency content is covered, 2) the inclusion of practical/ team project work/industry relevant material, and 3) the use of a problem-based learning approach.

- **(LQ9) Do you think that students who enrol in your course expect to learn about energy efficiency issues and solutions?** Just under two thirds (65%) of lecturers thought that students who enrol in their course expect to learn about energy efficiency.
- **(LQ10) Do you think that you are expected to teach about energy efficiency issues and solutions in your course?** Just over three quarters (77%) of lecturers thought that they were expected to teach about energy efficiency issues and solutions in their course. Nearly two thirds of the lecturers (60%) listed program requirements as a driver and just over one third (34%) identified personal motivations to teach such content. Just over one quarter of lecturers (28%) nominated research motivations.
- **(LQ10)** No respondent listed formal teaching performance indicators as a driver for teaching energy efficiency. Engineers Australia was listed twice under 'Other' as a driver, through accreditation and through the Generic Graduate Attributes.
- **(LQ11) Do you think your course is a good example/model of how to embed energy efficiency into engineering education?** Two thirds (67%) of the courses were perceived by lecturers as good examples/models of how to embed energy efficiency into engineering education. Just over one fifth (21%) of the responses were unsure.
- **(LQ11)** Lecturers provided a range of responses as to why they thought the course was a good example. These have been grouped by the research team under several headings (see Appendix 2). Just over a quarter nominated adequate coverage of key energy efficiency content (28%), followed by the provision of practical/ team project work/industry relevance (22%). Some examples of responses are listed here under the headings:
  - Good Coverage of Key Energy Efficiency Content:
    - *"Energy efficiency in real systems – a thermodynamic approach"*
    - *"Systems based approach, real world problems"*
    - *"The course material suits promotion of energy efficiency. We examine broader perspectives of energy generation and thermodynamic cycles (e.g. cost, energy)"*
  - Practical/Team Project Work/Industry Relevance:
    - *"Practical and industry led"*
    - *"Using a problem based learning approach, students begin their exposure in first year to real projects with local industry"*
  - A Foundation/Introductory Role:
    - *"It begins the first introduction into energy requirements within the sustainability 'umbrella'"*
    - *"It provides students with fundamental principles that empower them to tackle new and emerging problems creatively"*
  - A Flagship Course within the Program:
    - *"This is the one and only few courses covering this topic"*
    - *"Specific focus in one unit on energy efficiency"*
  - Level of Integration with Other Courses:
    - *"Would prefer to see it across more units"*
- **(LQ12) Does this course have any 'problem based learning' ('PBL') projects/assignments that apply energy efficiency content to 'real world' situations?** Almost three quarters (73%) of respondents said that their course includes 'problem based learning' (PBL) projects/ assignments that apply energy efficiency content to 'real world' situations. Just under two thirds

(60%) of the explanations provided discussed asking students to analyse a renewable energy system or part of a system. The responses were grouped into headings by the research team. The full list is provided in Appendix 2 and some examples of responses are listed here:

- Analysis of a Renewable Energy System/Part of the System:
  - *"The major course assignment requires efficiency calculations as part of the analysis of a renewable energy system (based on a practical situation)"*
  - *"They have to assess the feasibility of a renewable energy technology, and energy efficiency has to be considered"*
  - *"Each year we put a call out to local industry for student assignment topics (any type). This provides us with a great indicator of topical issues in the local context … energy efficiency is certainly becoming more topical"*
- Student Initiated Consideration of Energy Efficiency Issues/Audit:
  - *"Participants use own data and produce own organisation's 'energy footprint'"*
  - *"Major assignment of energy efficiency performance at students own home"*
  - *"Students conduct energy audit in industry"*
- Tutorial Questions:
  - *"Weekly tutorial comparing/examining energy related technologies, special tutes with more detailed presentation on distributed generation etc."*
- Engineers without Borders (EWB) Activity:
  - *"We used a reduced form of EWB Indian orphanage project for 3-4 weeks of a 13 week semester"*
- Industry Case Study:
  - *"Case study on VCM [Vinyl Chloride Monomer] manufacturing"*

2.3.2 Coverage of Theory, Knowledge and Application (LQ13 - LQ18)

While lecturers appear to be engaging with energy efficiency knowledge/information, the data suggests that there is a low frequency of teaching energy efficiency theory. Despite the apparent popularity of problem-based learning, there also appears to be a proportion of lecturers who do not apply energy efficiency content (theory and/or knowledge) to worked examples. This may be in part due to a lack of worked case studies to pick up and use in such a manner.

- **(LQ13-14) Does this course teach 'general design theory' and 'technical design theory' associated with energy efficiency?** Under half of courses do not teach either energy efficiency 'general design theory' (44%) or 'technical design theory' (42%).
- **(LQ15) How would you rank the importance of energy efficiency as a component of the course?** Almost half of respondents (48%) reported that energy efficiency content was a 'significant' (i.e. 15 – 30%) to 'major' (i.e. over 30%) component of the course.
- **(Q16) To what extent is energy efficiency taught, with regard to course 'fundamental principles and base theory'?** Just under a third (29%) of courses teach energy efficiency, but not as part of the course's base theory and principles.
- **(LQ17) To what extent is energy efficiency taught, with regard to course 'knowledge/ information'?** Just over half (58%) of the surveyed courses comprised some knowledge/ information about energy efficiency. Just under one fifth (17%) of the courses were entirely comprised of energy efficiency knowledge/information, including criteria for assessing some projects/assignments.

- **(LQ18) How well do you think this course includes examples of issues and innovations related to energy efficiency, to demonstrate the 'application of energy efficiency theory and knowledge' to engineering?** No course surveyed was entirely comprised of worked examples on issues and innovations relating to energy efficiency. Over three quarters (79%) of respondents thought that the course contains some (48% responses) or many (31% of responses) worked examples addressing issues and innovations related to energy efficiency.
- **(LQ18)** Of the responses 15% did not include any application (worked examples) of energy efficiency theory and knowledge within their course.

2.3.3 Coverage of Principles and Concepts (LQ19)

The data suggests that most energy efficiency concepts and principles are not taught in detail within engineering education. These results are quite surprising given the foundational role these concepts and principles play in understanding energy efficiency. The data suggests that the concept of decoupling energy utility profits from kilowatt-hours sold is not taught in detail in Australian engineering education, despite well-regarded research demonstrating its importance as a key mechanism.

- **(LQ19) Please select the type/s of energy efficiency concepts and principles that are included in the course, with regard to whether they are 'mentioned' or covered 'in detail'.** Of the 'Energy Efficiency Principles and Concepts' surveyed no more than 40% of courses covered any concept/principle 'in detail' and no more than 44% of courses 'mentioned' any concept/principle.
- **(LQ19)** The following were taught in detail in one third or more of the surveyed courses:
  - Efficiency, resource efficiency and energy efficiency 40%
  - Energy generation and transmission losses 33%
- **(LQ19)** The lowest ranked concept/principle was 'Decoupling energy utility profits from kilowatt-hours sold', with no courses covering it in detail' and 17% of courses mentioning it.
- **(LQ19)** Other principles and concepts which ranked very low (i.e. covered in detail by 10% or less of the surveyed courses) include:
  - Life Cycle Analysis/ Assessment 10%
  - Sustainable energy supply – standby energy 10%
  - Performance at part and full load 10%
  - Embedded (or embodied) energy of water distribution 9%
  - Energy management of electronic components and systems 6%
  - Embedded (or embodied) water in energy generation 6%
  - Embedded (or embodied) energy of materials 6%
  - Incremental efficiency versus whole system design 4%
  - Resource productivity 4%
  - Product stewardship and responsibility 4%

2.3.4 Topical Coverage of Energy Efficiency (LQ20 – LQ22)

The data suggests that the level of integration of topical energy efficiency issues into teaching is generally very low. Even mainstream topics like 'the link between greenhouse gas emissions and global temperature change' and 'carbon dioxide and other greenhouse gas emissions from energy generation' are being covered in detail by less than a third of

those lecturers surveyed, and mentioned by less than half. These results potentially have implications if students are not making the link between mainstream issues and opportunities to address them within their career path, leading to enhanced employment opportunities.

The data indicates that the frequency of, and depth to which energy efficiency and productivity content is taught in engineering programs is low. The data suggests that the depth and frequency of teaching about roles and responsibilities in energy efficiency is very low. This aligns with the observed low level of teaching about product stewardship and responsibilities identified in Question 19.

- **(LQ20) Please select the type/s of topical energy efficiency issues that are included in the course, with regard to whether they are mentioned or covered in detail.** Not more than one third (33%) of the courses covered any energy efficiency issue in detail. The issue covered in detail by 33% of courses is 'Carbon dioxide and other greenhouse gas emissions from energy generation'. One lecturer commented that, '*Broader issues are addressed by more zealous colleagues. I simply provide the students with the tools and understanding to solve the problems as they emerge.*'
- **(LQ20)** Not more than 42% of surveyed courses mentioned any of the listed energy efficiency issues. The issue mentioned by 42% of courses is 'The link between greenhouse gas emissions and global temperature change'.
- **(LQ21) Please select the type/s of energy efficiency and productivity content that are included in the course, with regard to whether they are mentioned or covered in detail.** The most popular 'efficiency and productivity' content taught by courses 'in detail' was 'undertaking energy auditing and energy assessment', although only 23% of courses did this.
- **(LQ21)** More courses 'mention' other 'efficiency and productivity' content, with topics mentioned by more than one third of the surveyed courses as follows:
  - Air pollution from combustion that can be reduced through energy efficiency 40%
  - The magnitude of reductions in fossil fuel consumption that can be achieved through the combined mechanisms of energy efficiency gains by the energy consumer, and the resultant reduced energy production and transmission demands 35%
- **(LQ22) Please select the type/s of energy efficiency content related to 'Roles and Responsibilities' that are included in the course, with regard to whether they are mentioned or covered in detail.** Just 8% of surveyed courses included the listed 'roles and responsibilities' topics 'in detail'.
- **(LQ22)** Approximately one third to a half of the courses 'mentioned' 4 of the 7 topics, with the exception of the following topics which ranked very low:
  - How to communicate energy efficiency opportunities to employers and clients in business and economic terms? 8% 'In Detail' 8% 'Mentioned'
  - How to identify the multiple benefits of energy efficiency and communicate these to employers and clients in business and economic terms? 8% 'In Detail' 15% 'Mentioned'
  - The role of business in improving the efficiency with which it uses energy 8% 'In Detail' 17% 'Mentioned'

2.3.5 Supporting Documentation – Case Studies and Readings (LQ23 - LQ28)

The survey results indicate that quite a number of lecturers may not be using case studies in their courses. Of those who are, they are generally less likely to go beyond the traditional sectors of industry and energy utilities, into transportation, built environment and business case studies. Popular case studies used by lecturers include motor systems, boilers, air-conditioning systems, lighting and case studies of energy efficiency gains in appliances and equipment. While lecturers are including some energy efficiency content into their courses, the survey suggests that they are not drawing upon established reading resources such as text books and articles. Together with results regarding content coverage, this indicates a possible shortfall in energy efficiency theory, knowledge and application.

- **(LQ23) Please select the type/s of case studies (listed by sector) on 'energy efficiency opportunities' that are included in the course (select all that apply).** 40% of the respondents (19 of the 48) did not answer this question on whether the course contained case studies (listed by sector). Of the 29 responses, case studies in the industry sector (55%) and energy utilities sector (45%) were the most popular in courses, followed by built environment (34%), transportation (31%), and business case studies (24%). Two other types noted in the questionnaire by respondents were, '*renewable energy sources*' and *'Loading level of diesel generators in hybrid renewable energy systems*'.
- **(LQ24) Please select the type/s of case studies (listed by technology) on 'energy efficiency opportunities' that are included in the course (select all that apply).** 31% of respondents (15 of the 48) also left this question blank, on the type/s of case studies (listed by technology) on 'energy efficiency opportunities' included in courses. Of the 33 responses, the most popular case studies for use were motor systems (45% of respondents using them) and boilers (45%), followed closely by air conditioning (HVAC) systems (39%), lighting (39%) and case studies of energy efficiency gains in appliances and equipment (36%).
- **(LQ25-26) Does the course contain required or optional reading on the topic of 'sustainable development'?** Just under half of the surveyed courses did *not* have required reading (48%) or optional reading (46%) for 'sustainable development'.
- **(LQ27-28) Does the course contain required or optional reading on the topic of 'energy efficiency'?** Just over half did *not* have required reading (54%) or optional reading (48%) for the topic of 'energy efficiency'.

2.4 Curriculum Renewal – Preferences? (LQ29 – LQ35)

2.4.1 Identified Content and Delivery Needs (LQ29 – LQ31)

It appears from the data that half of the courses surveyed could include more energy efficiency content, particularly in the area of applying energy efficiency theory and knowledge, and including more knowledge and information on the topic. There appears to be more hesitancy with regard to energy efficiency theory and principles. From discussions with respondents during the data collection phase, this could be due to lecturers not being aware of what content is available in this regard, or that there were other content areas competing for time (for example where energy efficiency is not the main focus of the course).

Where respondents considered their course could be improved, it appears they are keen to receive assistance with teaching content about energy efficiency, particularly through accessing case studies on energy efficiency examples in engineering. They appear keen to access lists of good material (for example audio-visual materials, text books and other

references). A subset of lecturers also appear keen to have access to a customised set of readings on energy efficiency for engineers generally. Lecturers do not appear keen to receive professional development (i.e. additional training) on energy efficiency. Almost all of these lecturers prefer the resources to be available through open access, online learning modules, rather than through restricted access online modules, or intensive short courses.

- **(LQ29) Please select the following area/s where you think this course could include more energy efficiency education.** According to the respondents, over half of the surveyed courses could be improved (56%). For just under three quarters (74%) of these courses respondents think this could be in the area of applying energy efficiency theory and knowledge. Respondents think that just over half (52%) of the courses could have more knowledge/information about energy efficiency and just under one third (30%) of the courses could include more on fundamental principles and base theory.
- **(LQ29)** Just over one third of courses were considered by respondents to have sufficient 'energy efficiency' education included. These respondents did not answer Q30 – Q34.
- **(LQ30) Please select resource/s that you think would assist in further including energy efficiency education in this course (select all that apply).** Of the respondents who thought their course could be improved, more than three quarters (77%) think that a set of case studies on energy efficiency in engineering would assist in further including energy efficiency education in their course.
- **(LQ30)** Approximately a third of lecturers identified the following resources that would also be beneficial to them in their teaching:
  - A list of related documentaries/TV episodes etc. and their sources 55%
  - A list of key energy efficiency textbooks and references for engineers 55%
  - A customised set of readings on energy efficiency for engineers generally 48%
- **(LQ30)** Comments in relation to teaching resources included the following:
  - *"Use DVD format for expert lecturers for example."*
  - *"We are looking for help with specifically designed projects (including the problem definition … we are happy to be involved in the design of such a resource) that brings out action-specific items for investigation and provides students opportunities to improve learning at various stages of the project … Generic projects that are real but constrained enough to be valuable learning tools."*
  - *"… I would still very much like to see more resources developed for Energy Efficiency. In particular information in the local context (i.e. Australian) is very patchy or increasingly dated. There are numerous reports from Europe, USA (esp. California) and elsewhere on energy efficiency, however, Australian data is less common, in part due to such programs as the "Energy Efficiency Best Practice", a federal program whose funding was concluded on 30 June, 2003."*
- **(LQ30)** '*Professional development in this field (i.e. in the form of intensive training)*' which was selected by only 2 respondents.
- **(LQ31) How would you prefer these resources to be presented (select all that apply)?** Almost all of the respondents (90%) nominated online learning modules – open access as a preferred mechanism for providing content resources to students. There was a large gap between this option and the remaining options which were selected by 6% to 13% of respondents. Comments from respondents included:
  - *"Time to include this in the course."*

- *"All of the above would be useful resources but something would need to be displaced from the syllabus to accommodate it."*
- *"The resources need to assist with the language of the area and point students in the right direction. There is a slight disconnect – we tend to teach more theoretically – there is a huge amount of mining energy with fairly detailed perspectives rather than choices. This is the problem with the energy sector – fairly obvious – not much choice at the moment."*
- *"Important to make it clear that energy efficiency starts at home."*
- *"Just in Time Format – possibility for staff to be involved and taught."*

2.4.2 Identified Challenges to Implementation (LQ32)

Where respondents considered their course could be improved, key perceived challenges in improving their course content are: 1) the potential for course content overload; and 2) having insufficient time to prepare new materials. From respondents comments to this question, it also appears that lack of knowledge about the available content could be an issue – lecturers are not aware of content that is beyond 'introductory'. It is essential to address these barriers, by ensuring that lecturers are aware of emerging content, and ensuring that any modular content can be integrated and substituted into existing curriculum, rather than having to be an additional 'add on'.

- **(LQ32) If the resources in Q28 were easily accessible and freely available, what other challenge/s do you think might limit their use (select all that apply)?** Of those respondents who consider that their course could be improved, more than half nominated the following two challenges as an important consideration in limiting the use of materials provided:
  - A potential for course content 'overload' 58%
  - Insufficient time to include the materials (i.e. not enough time to modify course notes, lectures, course outlines, assessment etc.) 52%

  One lecturer commented that, '*One issue with this material is possibly low technical content; the 'fit' in highly technical subjects can be difficult when discussing some more general concepts.'*
- **(LQ32)** There were a number of comments relating to the problem of trying to fit the modules into full courses, including the following:
  - *"Needs to spread appropriately and progressively through the years of the course i.e. through theory and application in case studies."*
  - *"Some Faculty staff may resist but most see need."*
  - *"… resourcing issues."*

2.4.3 Identified Role for Third Party Endorsement (LQ33 – LQ34)

There appears to be a demand from some lectures for third party endorsement of materials, but the reason and messaging of the endorsement needs to be clear. There appears to be an opportunity for both Engineers Australia (as the chief accrediting body for engineering education in Australia) and the (Former) Australian Federal Department of Environment and Water Resources, to play a key role for a substantial group of lecturers around the country who are looking for their endorsement to stimulate the curriculum renewal process in energy efficiency education. There also appears to be a role for other universities to lead by developing and/or using materials and endorsing them.

- **(LQ33) Would endorsement by a third party increase the likelihood of the use of content developed on energy efficiency?** Just under one half of respondents (45%) thought that endorsement by a third party would increase the likelihood of using materials provided. One fifth (21%) were unsure, indicating some confusion about what this might mean as an incentive.
- **(LQ34) If you answered 'Yes' or 'Under Some Circumstances' to Q33, what third party endorsement would increase the likelihood that the material is used (select and comment where relevant)?** The following third party endorsements were most popular to those 45% of lecturers nominating it as a positive driver for curriculum renewal:
    - Engineers Australia 81%
    - (*Former*) Australian Federal Department of Environment and Water Resources 44%
    - (Other) Australian Universities 31%

2.4.4 Respondent Interest in Survey Findings (LQ35)

- **(LQ35) Would you like to be kept informed of project progress?** Just under two thirds (63%) of respondents wanted to be kept informed of this project's progress, while 19% did not. The 19% who left this field blank were contacted by the research team and all confirmed that they did want to receive the study findings.

2.5 University Context: Education for Sustainable Development (LQ36 – LQ40)

From the number of blank responses to this section, it could be suggested that either some lecturers did not think this section was important, or they may have felt less qualified to respond to questions about the university in general. From the responses obtained from this section, it appears that few universities are being seen by the lecturing staff within engineering to be promoting education for sustainable development. From discussions with respondents during the data collection phase, this could perhaps have some influence on some staff enthusiasm for engaging in curriculum renewal.

The data suggests lecturers perceive this to be the same at the School/ Department/ Faculty level, where there appear to be few Heads of School/ Faculty/ Department (i.e. the level responsible for all engineering education offered by the university) who have made a public commitment to integrate sustainability into engineering education. There also appears to be some confusion as to whether their School/ Faculty/ Department supports education for sustainable development. Despite respondents not seeing their university marketing the importance of education for sustainable development, the data suggests a generally positive outlook regarding the level of commitment by engineering schools/ faculties/ departments in teaching education for sustainable development, within the university context.

- **(LQ36-40)** This section required completing once per lecturer (rather than once per course as for all the other sections); 9 of the 41 lecturers (22%) left this section blank.
- **(LQ36) Has University senior management (i.e. at the level of the Vice Chancellor or equivalent) made a commitment to integrate 'sustainability' or similar concepts into the curriculum?** 23% of the responses agreed that University senior management had made a commitment to integrate sustainability or similar concepts into curriculum.
- **(LQ37) If yes to the previous question (Q36), is this an internal undertaking and/or a public commitment?** Most of those who agreed with Q36 thought it to be an 'internal undertaking' (73%) and almost half (45%) thought it to be a 'formal/public commitment'. This data could be suggesting there is confusion from faculty as to whether their institutions support

education for sustainable development. Indeed, this would indicate an area for improvement at an institutional level.

- **(LQ38) Has your Head of School/ Faculty/ Department (i.e. the level responsible for all engineering education offered by the university) made a public commitment to integrate sustainability into engineering education?** Just over half (53%) of the responses were 'No' (13%) or 'Unsure' (40%) as to whether their Head of School/ Faculty/ Department made a public commitment to integrate sustainability into engineering education.
- **(LQ39a) How would you describe your University's marketing of its commitment to integrating 'sustainability' or similar concepts into education, with regard to the level of commitment?** 6% of responses saw the level of university marketing of its commitment to integrating sustainability or similar concepts into education as 'high/consistent'.
- **(LQ39b) How would you describe your University's marketing of its commitment to integrating 'sustainability' or similar concepts into education, with regard to the depth of commitment?** 20 responses were blank for the university 'depth of commitment' question. Just over one quarter (27%) thought that the university's commitment was across the university, while just over one eighth (13%) thought it was in engineering only.
- **(LQ40) Do you have any other comments about University education for sustainable development?** Respondents provided additional comments about university engineering education for sustainable development, including the following:
  - *"It is critical for the country and the world, but very difficult … but things are changing – but fast enough??"*
  - *"Universities should offer alternatives and train people to think critically. People will ultimately make their own decision."*
  - *"This should be embedded in relevant courses/units rather than creating an important unit/course."*
  - *"We don't teach our students how to overcome resistance to implementation in the workplace."*
  - *"University is resistant to adopt sustainable practice for running the University e.g. building management, air con, recycling etc."*

3 Summary of Results – Student Questionnaire

This section summarises results for the Student Questionnaire. Aggregated results for each question are also provided in **Appendix 3**.

3.1 Who Responded to the Survey? (SQ1-2)

(LQ1 – LQ2) What is the name of this course, where is it taught and what year are you currently enrolled in at university?

Courses from which the students' responses were obtained are listed in **Table 3** below (actual course names may have been changed to protect the anonymity of respondents). Of the 48 courses covered by the lecturer questionnaires, 14 courses from 8 universities also obtained student responses. These comprised 8 undergraduate, 2 postgraduate and 4 mixed courses.

Table 3. Student Questionnaires – List of Course Topics

State	Course Topic/ Discipline Area	Student Enrolment		Number of Respondents^
		Undergrad	Postgrad	
NSW	Eng. Geology & Concrete Materials	✓	-	26
NSW	Energy Systems	✓	✓	[3,26] 29
QLD	Energy Conversion and Utilisation	✓	✓	[11,17] 28
QLD	Renewable Energy Systems	✓	✓	[8,8] 16
QLD	Power System Reliability & Planning	-	✓	16
QLD	Energy and the Environment	✓	-	9
QLD	Advanced Industrial Economics	✓	-	1*
SA	Electric Energy Systems	✓	✓	[1,22] 23
TAS	Thermal Engineering	✓	-	17
VIC	Architectural Engineering	✓	-	23
VIC	Civil Engineering	✓	-	5
VIC	Civil Engineering	✓	-	34
WA	Engineering Sustainable Development	✓	-	30
WA	Sustainable Energy	-	✓	3
			Total Student Responses	**260**

** Given to a student to represent the class of approximately 20 students*
^ Split between undergraduate and postgraduate students shown in square brackets

Student response data is summarised in **Table 4** below, where two thirds (67%) of undergraduate respondents were in their final two years of undergraduate studies (i.e. 3rd or 4th year). Most postgraduate responses were from students in their first 2 years of study.

Table 4. Student Questionnaires – Student Response Data

Level:	Year 1	Year 2	Year 3	Year 4	Other	Sub-Total	%
Undergraduate	13	58	94	48	6	**219**	**84%**
(%)	6%	26%	43%	22%	3%		

Level:	Year 1	Year 2	Year 3	Year 4	Other	Sub-Total	%
Postgraduate	34	6	0	1	0	**41**	**16%**
(%)	83%	15%	0%	2%	0%		
						Data Set Total:	**260**

In each sub-section, summary statements about the findings are italicised and bolded. The questions and results to the questions are then provided in bullet points, prefixed by '(SQX)' which denotes 'Student Question X'. The questions are also bolded.

3.2 Appreciation of Terms and Relevance to Career Paths (SQ3 - SQ7)

Students across undergraduate and postgraduate levels appear to think that they understand the terms 'sustainable development' and 'energy efficiency' very well, and are making the connection to issues in the media. However the data suggests there is a lower appreciation of how 'energy efficiency' might be directly related to their future careers.

- **(SQ3) Do you think you understand the term 'sustainable development'?** There was a high level of perceived student understanding of the term 'sustainable development' (77% undergraduate; 63% postgraduate) and an even higher perceived understanding of the term 'energy efficiency' (87% undergraduate; 88% postgraduate).
- **(SQ4) How relevant do you think 'sustainable development' will be to your career?** There was a lower understanding of the relevance of 'sustainable development' to careers reflected in both undergraduate and postgraduate responses. Half of the students thought it was highly relevant (undergraduate 57%; postgraduate 46%) and one third thought it was of medium relevance (undergraduate 32%; postgraduate 37%).
- **(SQ5) Do you think you understand the term 'energy efficiency'?** Responses to understanding the term 'energy efficiency' were almost identical for undergraduate and postgraduate students, with the majority of students thinking that they do (87% undergraduate, 88% postgraduate) and almost all of the remaining students thinking they might (10% undergraduate, 10% postgraduate).
- **(SQ6) How relevant do you think 'energy efficiency' will be to your career?** Students believe they slightly better understand the relevance of 'energy efficiency' to their careers, with between half to two thirds of respondents rating it as 'high' (63% undergraduate; 56% postgraduate), and less than a third rating it of 'medium' significance (27% undergraduate; 29% postgraduate).
- **(SQ7) Do you remember seeing energy efficiency issues in the news, within the last six months?** More than two thirds of undergraduate students (68%) responded that they could recall seeing energy efficiency issues in the news within the last 6 months. Almost half (49%) of postgraduate students also responded they had seen energy efficiency issues in the news.

3.3 Appreciation of Importance to Education (SQ8 – SQ9)

Most students are not aware of how energy efficiency education is different among different universities, indicating that this is not a strong motivator for choosing to study at a certain university. Indeed, students do not appear to be clear on where energy efficiency is taught within their own discipline areas.

3.3.1 Awareness of Energy Efficiency Education (SQ8 – SQ9b)

- **(SQ8) Do you know of energy efficiency being taught at other universities in Australia?** One quarter (undergraduate, 25%) to just under one third (postgraduate, 29%) of respondents had knowledge of other energy efficiency education opportunities.
- **(SQ9a) Do you think energy efficiency has been taught to you at this university?** This question attracted the highest blank response rate, with just under one quarter (undergraduate

18%; postgraduate 20%) of the students choosing not to respond to the question of whether they thought energy efficiency has been taught to them at their university.

- **(SQ9a)** Almost three quarters (72%) of undergrad students who answered the question thought they had been taught energy efficiency in their university, while the percentage for postgraduate students is slightly less (59%).
- **(SQ9b) If YES to (a), when has it been taught?** 18% of undergraduate students and 20% of postgraduate students did not provide a response to this question. Of those who did, there was a difference of perception in when energy efficiency was taught, between undergraduate and postgraduate respondents:
  - More than three quarters of undergraduate respondents (80%) thought it was taught in their final two years of study, whereas less than an eighth (13%) of postgraduate students thought that energy efficiency was taught in undergraduate programs.
  - Almost no undergraduate respondents thought it was taught at postgraduate level (3%), while all postgraduate students thought that it was taught at postgraduate level.

3.3.2 Extent of Energy Efficiency Education (SQ9c)

Less than half of the students surveyed appear to think that there is the right amount of energy efficiency education in their degree programs, with approximately one quarter thinking there is too little and the remainder being unsure.

- **(SQ9c) If YES to (a), How much energy efficiency content do you think has been taught?** More students responded to this question than actually ticked 'YES' in Question 9a. Notwithstanding this anomaly in the number of responses, approximately one third to just under half of student respondents (undergraduate 36%; postgraduate 45%) believed that the amount of energy efficiency education taught to them was 'Just Right'.
- **(SQ9c)** Less than one quarter (undergraduate 23%; postgraduate 13%) believed that there was 'Too Little'. Only 1 of the 219 undergraduate students (in fourth year) and 1 of the 46 postgraduate student respondents believed that there was 'Too Much' energy efficiency education.

3.4 Understanding Energy Efficiency Principles and Concepts (SQ10)

The data suggests that postgraduate students generally have a higher regard for their understanding of the concepts and principles than the undergraduate students. It appears that postgraduate students also think they understood a number of principles/concepts very well, although it is not necessarily taught in detail. This may be an indication that postgraduate students feel more confident about energy efficiency as a field, although it could potentially be an issue if they do not possess the knowledge and skills to match their perceived level of competency in the field.

Despite the students' perception of how well they understand the term 'energy efficiency' and the extent of energy efficiency education, the data suggests that most did not have a very high level of understanding of the principles and concepts surveyed.

- **(SQ10) Please indicate how well you think you understand and can apply (where appropriate) the following principles.** On average, one quarter to one third (undergraduate 24%; postgraduate 33%) thought they had a 'Very High' level of understanding of the principles and concepts surveyed.

- **(SQ10)** Half of the surveyed students understood the terms 'Somewhat' (undergraduate 50%; postgraduate 47%) and up to a quarter (undergraduate 23%; postgraduate 15%) did not think they understand the terms at all.

– **(SQ10)** The following were understood very well by one third or more of the surveyed undergraduate students:

  - o Link between friction losses and energy consumption 39%
  - o Energy generation and transmission losses 38%
  - o Efficiency, resource efficiency and energy efficiency 35%

– **(SQ10)** The following were understood very well by one third or more of the surveyed postgraduate students:

  - o Efficiency, resource efficiency and energy efficiency' 55%
  - o Energy generation and transmission losses 48%
  - o Distributed generation (reducing transmission losses) 48%
  - o Decoupling energy utility profits from kilowatt-hours sold 39%
  - o Sustainable energy supply – energy storage 39%
  - o Sustainable energy supply – standby energy 42%
  - o Performance at part and full load 45%
  - o System design (for energy efficiency) 35%

– **(SQ10)** Content areas that one third or more of undergraduate students thought they did not understand at all include:

  - o Product stewardship and responsibility 45%
  - o Decoupling energy utility profits from kilowatt-hours sold 41%
  - o Incremental efficiency versus whole system design 34%
  - o Embedded (or embodied) energy of materials 33%

– **(SQ10)** The only content area not understand by more than one third of postgraduate students was product stewardship and responsibility (35%).

4 Discussion – Lecturer and Student Questionnaires

Two areas of content that are highlighted by the survey as being taught in detail and understood well by students include:

1) Efficiency, resource efficiency and energy efficiency; and
2) Energy generation and transmission losses.

Three areas of content that are highlighted by the survey as not being taught in detail by lecturers or understood well by students include:

1) Incremental Efficiency Versus Whole System Design;
2) Decoupling energy utility profits from kilowatt-hours sold; and
3) Product Stewardship & Responsibility.

- **(LQ19 & SQ10)** Content areas that both undergraduate and postgraduate students thought they understood very well and Lecturers thought was taught in detail or mentioned include (highest to lowest):
  - Energy generation and transmission losses
  - Efficiency, resource efficiency and energy efficiency

- **(LQ19 & SQ10)** Content areas that both undergraduate students thought they did not understand at all and lecturers thought was not mentioned or taught in detail include (highest to lowest):
  - Product stewardship and responsibility
  - Decoupling energy utility profits from kilowatt-hours sold
  - Incremental efficiency versus whole system design
  - Embedded (or embodied) energy of materials
  - Energy management of electronic components and systems
  - Embedded (or embodied) energy of water distribution

- **(LQ19 & SQ10)** Content areas that both postgraduate students thought they did not understand at all and lecturers thought was not mentioned or taught in detail include (highest to lowest):
  - Product stewardship and responsibility
  - Embedded (or embodied) energy of water distribution
  - Embedded (or embodied) energy of materials

5 Conclusions

It is concluded from the survey findings that the state of education for energy efficiency in Australian engineering education is currently highly variable and *ad hoc* across universities and engineering disciplines.

5.1 Location of Content in Engineering Programs

The survey suggests that energy efficiency education is not embedded across all engineering disciplines. Mechanical and electrical engineering students appear more likely to be taught energy efficiency content in their degree programs, followed by environmental, civil and chemical engineering students. Energy efficiency education across other discipline areas appears to be based on the individual interests and research pursuits of the lecturers involved rather than strategic integration across universities that is based on the needs of each discipline. The inclusion of energy efficiency content in any course appears to be driven by formal program requirements and the personal and research motivations of the individual lecturers.

Energy efficiency appears to be taught largely within well established courses that have been run by experienced lecturers for more than five years. It appears to be mostly taught as part of a broader content area to second and third year undergraduate students. In addition there are a number of courses on more targeted energy efficiency topics in fourth year undergraduate, and postgraduate studies.

It appears that most students are not aware of how energy efficiency education is different at different universities, indicating that this is not a strong motivator for choosing to study at a certain university. Students do not appear to be clear on where in their degree program energy efficiency is taught. Students also appear unsure about what is the right amount of energy efficiency content should be in their degree programs.

5.2 Level of Integration of Topical Issues in Energy Efficiency

The level of integration of topical energy efficiency issues into courses appears to be very low. Even mainstream topics like ‘the link between greenhouse gas emissions and global temperature change’ and ‘carbon dioxide and other greenhouse gas emissions from energy generation’ were covered in detail by less than a third of those courses surveyed, and mentioned by less than half.

The survey suggests that students across undergraduate and postgraduate levels think they understand the terms ‘sustainable development’ and ‘energy efficiency’ very well, and are making some connection to issues in the media. However students appear to have a low to moderate appreciation of how ‘energy efficiency’ might be directly related to their future careers.

5.3 Level of Student Exposure to Content

Despite the students’ perception of how well they understand the term ‘energy efficiency’ and the extent of energy efficiency education, the data suggests that most did not have an in-depth understanding of the surveyed principles and theory.

While lecturers appear to be engaging with energy efficiency knowledge/information, there appears to be a low level of student exposure to energy efficiency theory. In particular, the extent to which energy efficiency concepts and principles are included in courses appears to be low to very low. Three areas of content highlighted by the survey as not being taught in detail and not understood by students include:

1) Product Stewardship & Responsibility;
2) Decoupling energy utility profits from kilowatt-hours sold; and
3) Incremental Efficiency versus Whole System Design.

Student exposure to energy efficiency information and knowledge appears to be moderate. However, the extent to which energy efficiency and productivity content is taught in engineering programs appears to be low. The extent to which courses address roles and responsibilities in energy efficiency is very low. This also aligns with the observed low level of course content about product stewardship and responsibilities.

Student exposure to applying energy efficiency principles and theory and information/knowledge to worked examples appears to be generally low to moderate. The data suggests that quite a number of courses may not be using case studies. Case studies appear to be less likely to go beyond the traditional sectors of industry and energy utilities. Popular case studies include motor systems, boilers, air-conditioning systems, lighting, and energy efficiency gains in appliances and equipment.

Many courses that include some energy efficiency content in their courses do not appear to include energy efficiency related reading resources for students. Together with results regarding content coverage, the survey indicates a general shortfall in the inclusion of energy efficiency theory, knowledge and application in Australian engineering education.

5.4 Energy Efficiency Education: Curriculum Renewal

Although lecturers are uncertain as to whether they are meeting expectations with regard to the type of energy efficiency content in their courses, they clearly value:

1) the inclusion of good content within their course;
2) the inclusion of team project work and practical and industry relevant material; and
3) a problem-based learning approach to learning.

This list is important in suggesting that curriculum renewal strategies should aim to benefit courses in these areas. For more than half of the surveyed courses, lecturers report that their course could include more (in-depth) energy efficiency content, particularly in applying energy efficiency theory and knowledge, and including knowledge and information on the topic. There appears to be more hesitancy with regard to energy efficiency theory and principles, perhaps due to lecturers not being aware of content, or because of competing content areas.

Of those courses where lecturers said more could be done, lecturers are keen to receive assistance, particularly through accessing case studies on energy efficiency examples in engineering (i.e. worked real-life examples that show how the theory and knowledge is applied). They are also keen to access lists of good material (for example audio-visual materials, text books and other references), and are keen to have access to a customised set of readings on energy efficiency for engineers generally. Lecturers do not appear keen to receive professional development (i.e. additional training) on energy efficiency.

Key perceived challenges for lecturers in improving their course content, are:

1) the potential for course content overload; and
2) having insufficient time to prepare new materials. In addition some lecturers do not appear to be aware of content that is beyond ‘introductory’.

Almost all of the lecturers wanting assistance with accessing content about energy efficiency prefer the resources to be available through open access, online learning modules, rather than restricted access online modules, or intensive short courses. Some lecturers indicated preference for third party endorsement of materials, but comments indicated that the reason and messaging of the endorsement needs to be clear. These lecturers preferred Engineers Australia and the (former) Department of Environment and Water Resources as endorsers to stimulate the curriculum renewal process in energy efficiency education. Some lecturers also indicated they would look to other universities to lead through developing and/or using materials and endorsing them.

Appendix 1:

Survey Informed Consent Summaries

(Extracts from the Lecturer & Student Questionnaires)

SUSTAINABLE ENERGY SOLUTIONS
UNIVERSITY STUDENT QUESTIONNAIRE

This study focuses on a key consideration in sustainable development: providing sustainable energy solutions. It asks the question 'What is the state of education for energy efficiency in Australian engineering education?' Your lecturer will give you the context for this questionnaire and you can access the following websites for additional research context: (www.csiro.au/csiro/channel/ppch1d.html and www.naturaledgeproject.net). The completed questionnaires will be collated, analysed and presented in a public summary of results. Results will inform the production of education modules on energy efficiency and may also contribute to the creation of academically reviewed and publicly available reports, research papers, and theses relating to education for sustainable development.

Agreement: ***This questionnaire in non-compulsory and anonymous. It will not be used to contribute to the grade for this course. By completing and returning this questionnaire I agree that I have read these two paragraphs and have listened to my lecturer about the survey context. I permit the information that I provide to be used to inform the production of education modules and contribute to the creation of academically reviewed and publicly available reports, papers, and theses relating to education for sustainable development.***

Q1. What is the name of this course and where is it taught?

Course Name: _____ _____ University: _____

Q2. What year are you currently enrolled in at university?

☐ Undergraduate: Year _____ OR ☐ Postgraduate: Year _____

Q3. Do you think you understand the term 'sustainable development'?

☐ Yes ☐ No ☐ Maybe

Q4. How relevant do you think 'sustainable development' will be to your career?

☐ High ☐ Medium ☐ Low ☐ Unsure

Q5. Do you think you understand the term 'energy efficiency'?

☐ Yes ☐ No ☐ Maybe

Q6. How relevant do you think 'energy efficiency' will be to your career?

☐ High ☐ Medium ☐ Low ☐ Unsure

Q7. Do you remember seeing energy efficiency issues in the news, within the last six months?

☐ Yes ☐ No ☐ Unsure

Q8. Do you know of energy efficiency being taught at other universities in Australia?

☐ Yes ☐ No ☐ Unsure

SUSTAINABLE ENERGY SOLUTIONS PROGRAM

WHAT IS THE STATE OF EDUCATION FOR ENERGY EFFICIENCY IN AUSTRALIAN ENGINEERING EDUCATION?

UNIVERSITY LECTURER QUESTIONNAIRE

Engineers have a major role to play in assisting society to make a transition to a sustainable form of development, known as 'sustainable development'. This will involve finding new ways to design our human environments, systems, and products so that they no longer degrade the quality of earth's air, water, soil and the ecosystems. Sustainable development requires multi-disciplinary efforts across society.

This study focuses on a key consideration in sustainable development: providing sustainable energy solutions. It asks the question 'What is the state of education for energy efficiency in Australian engineering education?'

Three open-source education modules are currently being developed under a federally funded 'CSIRO Energy Transformed Flagship' program. The modules address the National Framework for Energy Efficiency (NFEE) call for capacity-building programs in energy efficiency, specifically for engineers and designers. NFEE has provided funding for The Natural Edge Project (TNEP) to facilitate formal consultation with Australian universities about the state of education for energy efficiency, in engineering education. Results of the university consultation will be used to finalise the education modules and will be made publicly available in summary form.

Questionnaire responses must be received by Friday 26 October 2007

Email: info@naturaledgeproject.net

Post: NFEE Survey, Room 0.28F, Building N55, Nathan Campus, Griffith University, QLD 4111

The Natural Edge PROJECT

Hosted by Griffith University's Centre for Environmental Systems Research &
the Australian National University, Fenner School of Environment and Society.

INFORMED CONSENT FORM

Title of Research: Sustainable Energy Solutions Program: "What is the state of education for energy efficiency in Australian Engineering Schools?"

Research Aim: The aim of the study is to assess the state of education for energy efficiency in engineering departments/ schools/ faculties of Australian higher education institutions. It also aims to understand how energy efficiency information can be embedded (integrated) into engineering education.

Research Details: The following two pages provide information about 'Background to the Research', 'Questionnaire Definitions', 'Survey Method Summary'. It explains how the questionnaire has been distributed and what you will be asked to do (including instructions for questionnaire completion and return). It describes how results will be fed back to you.

Investigator: The Natural Edge Project (hosted in-kind by Griffith University and the Australian National University) on behalf of the National Framework for Energy Efficiency (NFEE). NFEE is a joint initiative of Federal, State and Territory Government Agencies. It aims to unlock the significant but un-tapped economic potential associated with the increased uptake of energy efficient technologies and processes across the Australian economy. The Principal Investigator is Mr Charlie Hargroves (TNEP Project Coordinator). Additional key research team members (TNEP staff) include Ms Cheryl Desha, Mr Michael Smith, Ms Renee Stephens and Mr Peter Stasinopoulos.

Contact Details (Questions/ Further Information): Please direct any questions to Mr Charlie Hargroves (TNEP Project Coordinator): charlie@naturaledgeproject.net; Phone: +61 7 3735 5062; Room 0.28F, Building N55, Nathan Campus, Griffith University,170 Kessels Road, QLD 4111.

Risks to you: The research team has identified the only potential risk for participants, as the release of personal details, confidential comments, anonymous comments or information provided in the questionnaire, beyond the research team. An appropriate management strategy of secure paper storage, password-protected electronic storage, internal peer review and quality control is in place to ensure that information will be kept strictly secure during and after the research project, by the research team.

Your Confidentiality: All information gathered from the study will be treated as confidential. The identity of participants will not be disclosed to any unauthorised persons; only direct members of the research team will have access to the data collected as part of the study. Any information that may compromise the anonymity or cause risk to professional reputation of participants will not be disclosed. *Persons will only be personally identifiable if prior consent is sought and granted.*

Your Participation is Voluntary: Undertaking this questionnaire is voluntary and the decision not to participate will in no way upon your relationship with the university or with the research project or research team.

The Ethical Conduct of this Research: This is in accordance with Griffith University's research commitment to the *National Statement on Ethical Conduct in Research Involving Humans*. If you have any concerns or complaints about the ethical conduct of this research project please contact the Manager, Research Ethics on (07) 3735 5585 or research-ethics@griffith.edu.au.

Privacy Statement: The conduct of this research involves the collection, access and / or use of your identified personal information. The information collected is confidential and will not be disclosed to third parties without your consent, except to meet government, legal or other regulatory authority requirements. A de-identified copy of this data may be used for other research purposes. However, your anonymity will at all times be safeguarded. For further information consult the University's Privacy Plan at www.griffith.edu.au/ua/aa/vc/pp or telephone (07) 3735 5585.

Expressing Consent: By completing and returning this questionnaire I agree that I have read and understood the Informed Consent information. I permit the information that I provide to be used to inform the production of three education modules and contribute to the creation of academically reviewed and publicly available reports, research papers, and theses relating to education for sustainable development.

[Please detach/ copy this sheet and retain it for your later reference]

BACKGROUND TO THE RESEARCH

In October 2006 The Natural Edge Project (TNEP), Griffith University, and the Australian National University were awarded a research grant by the federally funded 'CSIRO Energy Transformed Flagship' program, to develop three education modules and a supporting trainers' guide on energy efficiency. The aim of the grant is to empower built environment professionals (including engineers, technicians, facilities managers, architects etc) with a toolkit to identify and implement energy efficiency opportunities throughout their studies and professional life. This is in accordance with the CSIRO Energy Transformed Flagship Program aim of, '*facilitating the development and implementation of stationary and transport technologies to halve greenhouse gas emissions, double the efficiency of the nation's new energy generation, supply and end use, and to position Australia for a future hydrogen economy*'[1].

The grant deliverable is an online publication of three education modules called the '*Engineering Sustainable Energy Solutions*' program. It will address the following themes:

- Module 1: Identifying, quantifying and implementing energy efficiency opportunities for Industrial/Commercial users (content presented by Technology type).
- Module 2: Integrated systems based approaches to realising energy efficiency opportunities for Industrial/Commercial users (content presented by Industry Sector type).
- Module 3: Integrated approaches to energy efficiency and low emissions electricity, transport and distributed energy.

The CSIRO grant also addresses the National Framework for Energy Efficiency (NFEE) call for capacity-building programs in energy efficiency, specifically for engineers and designers. In March 2007, Sustainability Victoria, Chair of the NFEE Trades and Professions Training and Accreditation Working Group on behalf of the Commonwealth, State and Territory Governments provided funding for The Natural Edge Project to facilitate a formal consultation with Australian universities about the state of education for energy efficiency in engineering schools. The intention is to identify what gaps require filling, and to identify the best ways to embed courses (or course materials) on energy efficiency into university engineering programs. The research will assist in providing insight into the state of education for energy efficiency. Results of the university consultation will be used to finalise the education modules and will be made publicly available in summary form.

QUESTIONNAIRE DEFINITIONS

School/ Department/ Faculty: The level of coordination within a university context, where engineering programs are coordinated, and to which lecturers belong.

Program: The award that a student works towards, which is made up a certain number of approved courses. This is sometimes referred to by universities as a "Course".

Course: A unit of work undertaken, which is part of the overall ***Program*** of study (ie 1/8 of a nominal full study year). It may be referred to as having anything from 3 to 12 'Credit Points' of value. This is also commonly referred to by universities as a "Unit" or "Subject".

[1] For further information please refer to the Energy Transformed Flagship Program website (http://www.csiro.au/csiro/channel/ppch1d.html).

SURVEY METHOD SUMMARY:

There are two key components to this survey:

1. Lecturer Questionnaire: This will be issued in October 2007 on behalf of CSIRO and NFEE to the Head of School/ Department/ Faculty of every Australian university providing engineering undergraduate and/ or post-graduate programs, with an invitation for completion by every lecturer teaching engineering education for energy efficiency. Lecturers receiving the questionnaire are invited to forward it to colleagues who may also be interested in participating. This will be followed up by phone to provide support and clarification if required. The questionnaire is designed to take approximately 30 minutes to complete.
2. Student Questionnaire: This will be provided to lecturers who complete the Lecturer Questionnaire, to distribute and collect in one or more of their classes where energy efficiency is taught. This questionnaire is designed to take approximately 5 minutes to complete.

Results of the two questionnaires will be cross-checked for additional context and validity of interpretation, through semi-structured telephone interviews with a subset of Australian academic colleagues experienced in engineering education for energy efficiency. These participants have already indicated their availability for comment through the CSIRO project.

The completed questionnaires will be collated, analysed and presented in a public aggregated summary of results. Results will be used to inform the production of education modules and may also contribute to the creation of academically reviewed and publicly available reports, research papers, and theses relating to education for sustainable development.

QUESTIONNAIRE INSTRUCTIONS:

1. **Please fill out a copy of this questionnaire for each engineering course in which you are the primary lecturer and/or convener.**
2. **Please attach additional sheets of information if this helps to answer the questions. In particular, please consider attaching your Course Outline to provide greater context for the interpretation of results. It will be kept confidential along with the survey data.**
3. **Please consider distributing and collecting the Student Questionnaire to one or more of your courses where you teach energy efficiency.**

RETURNING THE QUESTIONNAIRES:

- ☐ **Please return one completed questionnaire for each engineering course in which you are the primary lecturer and/or convener.**
- ☐ **Attach your course outline and any other supporting material to the relevant completed questionnaire.**
- ☐ **Attach any completed student questionnaires, noting the name of the course and the number of students enrolled.**
- ☐ **Use the pre-addressed enveloped that was enclosed in your questionnaire pack to send your completed questionnaire. Alternatively please use the following return details: info@naturaledgeproject.net; or post to The Natural Edge Project, Room 0.28F, N55, Nathan Campus, Griffith University, QLD 4111.**
- ☐ **Questionnaire responses must be received by Friday 26 October 2007**

Appendix 2:

Lecturer Questionnaire

Aggregated Results Summary

ENGINEERING SUSTAINABLE ENERGY SOLUTIONS

UNIVERSITY LECTURER QUESTIONNAIRE

AGGREGATE DATA SUMMARY

Section 1: Program and Course Details

Q1. Please provide the Course Name/Code:

[Confidential]

Q2. Please provide details regarding the topic of the Course (if not clear in the Course Name):

See Table 1 for Key Words

Q3. What type of student enrols in this Course *(select all that apply)*: [Ordered]

☐ 3rd year undergraduate	23	48%
☐ 4th year undergraduate	15	31%
☐ Postgraduate	13	27%
☐ 2nd year undergraduate	10	21%
☐ 1st year undergraduate	6	13%
☐ Professional development	1	2%
☐ Other Comments: ***See Table 1***		
Blanks	2	4%
Percentages given out of the total number of respondents:	***48***	***-***

Q4. This Course is offered as:

☐ A compulsory Course
For whom is it compulsory?: ***See Table 1***

☐ An elective Course
For whom is it an elective?: ***See Table 1***

Q5. Please list the program name/s for which this course is usually undertaken, e.g. Bachelor of Engineering/Master of Project Management. (Include majors where appropriate):

See Table 1

Table 1: Summary of written comments from Q1 – Q5

Course Name (Q1) - Key Words -	Enrolment (Q3)		Program in which Course is Undertaken? (Q5)	Compulsory/ Elective? (Q4)	Other Comments (Q2/Q3)
	Undergrad	Postgrad			
Sustainable **Energy** Technologies	✓		• Bachelor of Engineering/Master of Engineering	• Compulsory: Environmental Engineering Undergraduates • Elective: Mechanical and Mechatronic Engineering Students	-
Energy Systems	✓		• Bachelor of Engineering (Electrical)	• Compulsory: Bachelor of Engineering (Elect) • Elective: Other Bachelor of Engineering programs	-
Engineering Profession	✓		• Bachelor of Engineering (Architectural, Civil, etc)	• Compulsory: All 1st year Architectural, Civil, Building and Mechanical Engineering students	-
Environmentally Sustainable Design	✓		• Bachelor of Engineering (Architectural)	• Elective: Architectural Engineering students	One component of a three component subject. Each subject offered sequentially across semesters. This particular module focuses on fundamentals of heat transfer fluid flow as they relate to buildings.
Mechanical Engineering	✓		• Bachelor of Engineering	• Compulsory: Bachelor of Mechanical Engineering students	-
Process Analysis	✓		• Bachelor of Engineering (Chemical)	• Compulsory: Bachelor of Chemical Engineering students	Course of system analysis, energy balances, process design
Urban Infrastructure and Pollution	✓		• Bachelor of Engineering (Environmental Engineering)	• Compulsory: Bachelor of Engineering students • Elective: Bachelor of Environmental Science./ Bachelor of Engineering Planning	Wide range of infrastructure & associated pollution management strategies for urban systems
Chemical and Biochemical processes	✓		• Bachelor of Engineering (Environmental Engineering)	• Compulsory: Bachelor o f Engineering; Bachelor of Environmental Engineering	-
Engineering geology and concrete materials	✓		• Bachelor of Engineering	-	Bachelor of Engineering
Energy Conversion and Utilisation	✓		• Bachelor of Engineering	• Elective: Bachelor of Engineering	-
Marine and Offshore Systems	✓		• Bachelor of Engineering	• Compulsory: Bachelor of Engineering (Naval Arch); Ocean	Energy Management

Course Name (Q1) - Key Words -	Enrolment (Q3)		Program in which Course is Undertaken? (Q5)	Compulsory/ Elective? (Q4)	Other Comments (Q2/Q3)
	Undergrad	Postgrad			
				Engineering, marine and off-shore systems	
Electric **Energy** Systems	✓		• Bachelor of Engineering (Electrical & Electronic; Mechanical)	• Compulsory: Mechanical Engineering students and Electrical Engineering students	Electric machines and intro to power systems
Engineering Thermodynamics	✓		• Bachelor of Engineering	• Mechanical Engineering students	-
Energy and Environment	✓		• Bachelor of Engineering	• Elective: Year 3 and Year 4 undergraduate engineering students	Energy production and associate environmental issues.
Advanced Power Electronics Design	✓		• Bachelor of Engineering (Majors)	• Elective: Undergraduate Electrical Engineering; Computer Systems Engineering and Mechatronics Eng.	-
Introduction to Professional Engineering	✓		• Bachelor of Engineering	• Compulsory: All Bachelor of Engineering students	General 1st year introductory course including ethics, graphics excel. I teach the sustainability component called “Engineering problem solving..”
Heat and Mass Transfer	✓		• Bachelor of Engineering (Chem; Env; Chem-Met); Chem Bio)	• Compulsory: Chemical, chem-bio environmental and chem.-metallurgical engineering students.	-
Environmental Engineering Practice	✓		• Bachelor of Engineering (Civil)	• Compulsory: Civil Engineering Students	-
Efficient **Energy** Systems	✓		• Bachelor of Engineering	-	-
Combustion and Emissions Engineering	✓		• Bachelor of Engineering	• Compulsory: Bachelor of Engineering (Marine and Offshore Systems)	-
Marine Thermal **Energy** Systems	✓		• Bachelor of Engineering	• Compulsory: Bachelor of Engineering (Marine and Offshore Systems)	-
Thermal Engineering	✓		• Bachelor of Engineering (Naval Architecture; Ocean Engineering; Marine and Offshore Systems)	• Compulsory: All Bachelor of Engineering students	Introductory Thermodynamics
Engineering for Sustainable	✓		• Bachelor of Engineering	• Compulsory: All engineering	-

Course Name (Q1) - Key Words -	Enrolment (Q3)		Program in which Course is Undertaken? (Q5)	Compulsory/ Elective? (Q4)	Other Comments (Q2/Q3)
	Undergrad	Postgrad			
Development				students	
Renewable **Energy** Systems	✓		• Bachelor of Engineering, Bachelor of Arts (Environ.) • Bachelor of Engineering in Environmental Engineering • Bachelor of Science	-	Refer to attached course outline
Energy Systems	✓		• Bachelor of Engineering (majors as shown)	• Elective: Mechanical / Manufacturing major. Sustainable Energy major	-
Advanced Industrial Electronics (Alternative **Energy** & Hybrid Electric Vehicles)	✓		• Bachelor of Engineering	• Compulsory: Electrical Engineering students • Elective: Electrical Engineering students	Will be 'Industrial Electronics' in 2009
Energy Management	✓		• Bachelor of Engineering • Masters Engineering Management	• Elective: Bachelor of Engineering students	-
Engineering and Industrial Design Practice	✓		• Bachelor of Engineering • Bachelor of Industrial Design • Bachelor of Construction Management • Bachelor of Housing	• Compulsory: All 1st year students in the School of Engineering, including Construction Engineering and Industrial design students	Intro to profession ETHICS teamwork, project work, research processes and communication skills
Thermal Engineering	✓		• Bachelor of Engineering (Mech.)	• Compulsory: Mechanical Engineering students	Thermodynamics relating to power generation
Thermofluids 3	✓		• Bachelor of Engineering (Mech.) students	• Compulsory: Bachelor of Engineering (Mech.) students • Elective: Bachelor of Engineering./Bachelor of Science (Mechatronic) students	Analysis of major thermodynamic cycles
Electrical **Energy** Generation & Supply; Power Engineering; Electrical Power Engineering; Optimal Estimate & Numeric Methods	✓		• Bachelor of Electrical Engineering	-	-

Course Name (Q1) - Key Words -	Enrolment (Q3)		Program in which Course is Undertaken? (Q5)	Compulsory/ Elective? (Q4)	Other Comments (Q2/Q3)
	Undergrad	Postgrad			
Bachelor of Engineering (Program)	✓		• Bachelor of Engineering	-	• Teaching method different from the traditional model of education. • Problem based learning approach to engineering education • Based around E.A. Graduate Attributes ("Course Learning Outcomes" and "Program Graduate Attributes")
Electrical Plant	✓		• Bachelor of Engineering (Elect; Power Engineering) • Bachelor of Technology (Elect)	• Compulsory for these programs	Energy Audit on existing organisation and energy losses in diesel/generator set
Engineering for Sustainable Development	✓		• Bachelor of Engineering	• All students (mechanical, environmental, petroleum, oil and gas, materials, mechatronics, electrical, electronic engineering) except Civil.	It is a choice between this unit and the unit on project management. Approximately two thirds of the students choose this unit.
Sustainable **Energy** System Design	✓		• Bachelor of Engineering (Mechanical and Manufacturing Engineering)	• Compulsory: all Bachelor of Engineering students.	-
Thermal **Energy** System	✓		• Bachelor of Engineering	• Elective: All engineering students	-
Environmental Awareness and Sustainability	✓	✓	• Bachelor of Engineering • Master of Engineering Management	• Compulsory: Bachelor of Engineering students, civil and mechanical streams. • Elective: Bachelor of Engineering electrical stream, Master of Engineering Management; Master of Engineering	-
Energy Efficiency	✓	✓	• Bachelor of Engineering in Photovoltaic Engineering • Bachelor of Engineering in Renewable Energy Engineering • Masters of Engineering (coursework) Photovoltaic &	-	-

Course Name (Q1) - Key Words -	Enrolment (Q3)		Program in which Course is Undertaken? (Q5)	Compulsory/ Elective? (Q4)	Other Comments (Q2/Q3)
	Undergrad	Postgrad			
			Renewable Energy Engineering		
Environmental Engineering (Program)	✓	✓	Bachelor of Engineering (Environmental)	-	No specific courses in Environmental Engineering or Sustainable Energy Solutions
Various components and Models of Renewable **Energy** Sources	✓	✓	• Bachelor of Engineering (Electrical Power Engineering) • Masters of Environmental Science (Renewable Energy Electrical Power Systems).	• Compulsory: Third year electrical engineering and masters course on Renewable power systems • Elective: For Electronic and Communication Engineering students.	-
Sustainable Design	✓	✓	• Bachelor of Engineering; • Master of Project Management	•	
Power System Reliability and Planning		✓	• Masters of Engineering (Electrical Engineering; Elec. Market; Power Generation)	• Compulsory: Master of Engineering in electricity market • Elective: Master Engineering (Electrical; Power Generation)	-
Energy Efficiency (Systems Analysis and Auditing)		✓	• Master of Science in Renewable Energy	• Elective: Students in Master of Renewable Energy Technology	Offered thru another international university
Energy Efficiency (Industrial and Commercial Technology)		✓	• Master of Science in Renewable Energy	• Elective: Students in Masters of Science in Renewable Energy	-
Energy Management		✓	• Postgraduate Diploma in Energy Studies	• Compulsory: Students in post-grad diploma	-
Sustainable **Energy**		✓	• Masters in Cleaner Production in Renewable Power Systems.	• Elective: Masters in Cleaner Production in Renewable Energy Power System	-
Renewable **Energy** Systems		✓	• Master of Environmental Engineering • Graduate Diploma of Environmental Engineering • Master of Environmental Engineering (Honours)	• Elective: Postgraduate students in programs below	Also refer to the attached Course Outline
Triple Bottom Line: Theory into Practice		✓	-	-	See attached

Table 2: Summary of data by State (from Q1 – Q5)

State	Lecturer Participation Data			University Participation Data		
	Number Registered Interest	Number of Lecturers Responded	Number of Questionnaire Submissions	Teaching Engineering Education	With Lecturer/s registered interest	With Lecturer/s Responded
ACT	3	3	3	3	2	2
NSW	11	7	7	6	6	5
NT	1	1	1	1	1	1
QLD	15	13	15	6	6	6
SA	5	2	2	3	2	2
TAS	5	3	5	2	2	2
VIC	12	8	8	8	7	6
WA	7	4	7	4	3	3
Total	**59****	**41**	**48**	**33**	**29**	**27**
%	**-**	**70%**	**-**	**-**	**88%**	**82%**

** Where not all universities offering engineering education participated in the survey, the total number of universities offering engineering education in the state is shown in brackets*

*** 4 other lecturers expressed interest in the survey, but did not teach a course that could be counted in the questionnaire.*

Q6. **a)** How many years has this course been offered (*i.e. most content the same*)? [Ordered]

☐ More than 15 years	5	10%
☐ More than 10, up to and including 15 years	2	4%
☐ More than 5, up to and including 10 years	14	29%
☐ 5 years	3	6%
☐ 4 years	0	0%
☐ 3 years	7	15%
☐ 2 years	7	15%
☐ 1 year	2	4%
☐ This is its first year	3	6%
Blank	5	10%
Total =	***48***	***100%***

b) How long have you evolving this set of teaching material? *This may have been in previous courses that are no longer offered for example.* [Ordered]

☐ More than 15 years	**3**	**6%**
☐ More than 10, up to and including 15 years	**3**	**6%**
☐ More than 5, up to and including 10 years	**13**	**27%**
☐ 5 years	**6**	**13%**
☐ 4 years	**4**	**8%**
☐ 3 years	**7**	**15%**
☐ 2 years	**6**	**13%**
☐ 1 year	**1**	**2%**
Blank	**5**	**10%**
Total =	***48***	***100%***

Q7. Students of which engineering disciplines take this course *(select all that apply)*: [Ordered]

☐ Electrical Engineering	**16**	**33%**
☐ Mechanical Engineering	**16**	**33%**
☐ Environmental Engineering	**9**	**19%**
☐ Civil Engineering	**8**	**17%**
☐ Chemical Engineering	**6**	**13%**
☐ Systems Engineering	**6**	**13%**
☐ Structural Engineering	**4**	**8%**
☐ Software Engineering	**4**	**8%**
☐ Other (please list) [responses typed as written]:	**10**	**21%**

- *Mechatronics Engineering*
- *Architectural and Building Engineering*
- *Building and Architectural Engineering*
- *Industry Chemistry*
- *Naval Architecture: ocean engineering; marine and offshore*
- *Mechatronics Engineering*
- *Computer Systems Engineering and Mechatronics Engineering*
- *Metallurgical and Chem-Biological Engineering*

Blank	**8**	**17%**
Percentages given out of the total number of respondents:	***48***	**-**

Q8. Would you be willing to provide your course outline to the research team for this project? *Note that this material will be kept in confidence by the research team*.

☐ Yes (please attach)	**31**	**65%**
☐ Unsure – please approach me if you would like me to consider further	**14**	**29%**
☐ No	**1**	**2%**
Blank	**2**	**4%**
Total =	***48***	***100%***

ENGINEERING SUSTAINABLE ENERGY SOLUTIONS

Section 2: Course Content - Energy Efficiency

Q9. Do you think that students who enrol in your course expect to learn about energy efficiency issues and solutions?

☐ Yes	**31**	**65%**
☐ No	**8**	**17%**
☐ Unsure	**4**	**8%**
Blank	**5**	**10%**
Total =	***48***	***100%***

Additional Comments made by Respondents to this Question [typed as received]:

- *Particularly Electrical/ Mechanical students. Civil students perhaps a bit surprised.*

Q10. Do you think that you are expected to teach about energy efficiency issues and solutions in your course?

☐ Yes	**37**	**77%**
☐ No	**6**	**13%**
☐ Unsure	**2**	**4%**
Blank	**3**	**6%**
Total =	***48***	***100%***

If 'Yes', is this because of (*select all that apply*): [Ordered]

☐ Program requirements (ie the course and its content have been pre-determined)?	**28**	**76%**
☐ Personal motivations? Please describe *[no comments]*	**17**	**46%**
☐ Research motivations (ie research led teaching)?	**14**	**38%**
☐ Other (please describe)? *[responses typed as written]:*	**6**	**16%**

- *Energy sessions done by another lecturer. Energy efficiency briefly touched on.*
- *As a part of students motivation to renewable energy and energy conservations*
- *Engineers Australia Accreditation requires courses to teach about "sustainability"*
- *Engineers Australia – Generic Graduate Attributes*
- *It's a core part of systems engineering although not explicitly in my syllabus. I encourage students to examine problems from not cause.*
- *It is becoming more inculcated across the College, mirroring student expectations.*

Results for this question are continued next page …

☐ Head of School/Faculty/Group expectations?	**3**	**8%**
☐ Formal teaching performance indicators? Please describe: *[no comments]*	**0**	**0%**
Blank	**1**	**3%**
Out of total number of respondents to Q10 'YES' as noted:	***37***	***-***

Q11. Do you think your course is a good example/ model of how to embed energy efficiency into engineering education? [Ordered]

☐ Yes	**32**	**67%**
☐ Unsure	**10**	**21%**
☐ No	**4**	**8%**
Blank	**2**	**4%**
Total =	***48***	***100%***

Additional comments made by respondents to this question [typed as written]:

- *Working towards this.*

If 'Yes', what is the key reason for this?

[Grouped under aggregated headings & ordered by percentage. Comments typed as written – one bullet-pointed comment per respondent]

Good coverage of key Energy Efficiency content:	**9**	**28%**

- *Material, if mentioned, but not strictly "embedded in the course*
- *Understanding heat transfer is a key part of energy efficiency – as the students learn the fundamentals of heat transfer and practice, interpreting and applying results, energy efficiency is a great example.*
- *Topic[al] material*
- *Energy efficiency in real systems – a thermodynamic approach*
- *Thermodynamics forms the basis of energy efficiencies*
- *Conservation of resources for future generations & mitigation of CO2 emission to combat Climate Change*
- *Since the course is a study of Renewable Energy Systems, energy efficiency must be included.*
- *The course material suits promotion of energy efficiency. We examine broader perspectives of energy generation and thermodynamic cycles (e.g. cost, energy)*
- *Systems approach can be adopted.*
- *Systems based approach, real world problems*

Practical/ Team Project Work/ Industry Relevance:	**7**	**22%**
– *Practical and industry led*		
– *Final year placement have all pre-requisite material.*		
– *Because it is attached to team project work as a theme/topic*		
– *Postgraduate opportunities in Environmental Engineering are very important*		
– *Postgraduate opportunities in Environmental Engineering are very important*		
– *Using a problem based learning approach, students begin their exposure in first year to real projects with local industry.*		
– *Energy efficiency is an integral part of photovoltaic and renewable energy engineering*		
– *It offers practical design solutions for energy efficiency and renewable energy*		
A Foundation/ introductory role:	**3**	**9%**
– *It begins the first introduction into energy requirements within the sustainability 'umbrella'*		
– *It provides students with fundamental principles that empower them to tackle new and emerging problems creatively.*		
– *In the study of energy systems, efficiency is a vital concept.*		
A Flagship course within the program:	**3**	**9%**
– *This is the one and only few courses covering this topic.*		
– *Energy efficiency is important to electrical machine design and selection*		
– *Specific focus in one unit on energy efficiency*		
Level of integration with other courses:	**2**	**6%**
– *It is appropriate to other [ ] content*		
– *Would prefer to see it across more units*		
Blank	**7**	**22%**
Out of total number of respondents to Q11 'YES' as noted:	***32***	***100%***

Q12. Does this course have any 'problem based learning' ('PBL') projects/ assignments that apply energy efficiency content to 'real world' situations? [Ordered]

☐ Yes	**35**	**73%**
☐ No	**6**	**13%**
☐ Unsure	**5**	**10%**
Blank	**2**	**4%**
Total =	***48***	***100%***

If 'Yes', please describe:

[Grouped under aggregated headings & ordered by percentage. Comments typed as written – one bullet-pointed comment per respondent]:

Results for this question are continued next page …

Analysis of a Renewable Energy System/ Part of the system: **21** **60%**

- *Students carry out an assignment on a renewable energy system that they must analyse.*
- *Energy Assignment – done by about 15/20 percent of students. Topic relates to real life energy issues.*
- *machine practical problems*
- *Assignment (study) of transport in 2050*
- *They have to assess the feasibility of a renewable energy technology, and energy efficiency has to be considered.*
- *(a) exam question on passive thermal building design (calculation of heat transfer to building (b) interpretation of heat exchanger questions on assignment and exams, including use of low-grade waste heat and reducing losses from heat exchangers.*
- *Assignment*
- *Calculations on efficiency of combustion processes*
- *Performance calculations on real systems*
- *Calculation of efficiency for basic systems*
- *Please see the attached sheet*
- *Students do an assignment (2,000 words) requiring the analysis of a renewable energy system adapted from a practical situation (see 'Assessment' in Course Outline)*
- *The major course assignment requires efficiency calculations as part of the analysis of a renewable energy system (based on a practical situation).*
- *Real systems design and costing assignment*
- *Efficiency analysis of compressor and engine.*
- *In recent years we have run assignments on optimising hybrid GT/SOFC cycles, turbo jets, steam turbines etc.*
- *Looking at …. .dimensions, provisioning and proving of alt. energy sources and looking at impact on reliability and availability.*
- *Most problems based on real world situations.*
- *Most problems are based on real world situations*
- *Each year we put a call out to local industry for student assignment topics (any type). This provides us with a great indicator of topical issues in the local context … energy efficiency is certainly becoming more topical.*
- *Three assignments: students audit 1) their travel to and from [the university] 2) home energy & water usage and 3) energy/water in a commercial organization (eg small business, school etc.)*
- *Sustainable energy system design project*

Student initiated consideration of energy efficiency issues/ Audit: **6** **17%**

- *Depends on the definition of problem based learning. The students analyse and discuss source materials and this helps them to form them as critical scholars.*
- *There are opportunities for students to suggest energy efficiency solutions in the assignment but open-ended, so they may choose different solutions.*
- *Participants use own data and produce own organisation's 'energy footprint'*
- *Students conduct energy audit in industry*
- *Major assignment – personal energy audit – applying principles in their own environment. Assignment questions based on real problems.*
- *Major assignment of energy efficiency performance at students own home.*

Tutorial Problems: **2** **6%**

- *Just a few tute problems, but energy efficiency is not central.*
- *Weekly tutorial comparing/examining energy related technologies, special tutes with more detailed presentation on distributed generation etc..*

Results for this question are continued next page …

Engineers without Borders (EWB) Activity:	**2**	**6%**
– *We used a reduced form of EWB Indian orphanage project for 3-4 weeks of a 13 week semester*		
– *EWB Project brief provides the assessment structure (attached). NB inf of sustainability*		
Industry Case Study:	**1**	**3%**
– *Case study on VCM [Vinyl Chloride Monomer] manufacturing*		
Blank	**3**	**9%**
Out of total number of respondents to Q12 'YES' as noted:	***35***	***100%***

Q13. Does this course teach 'general design theory' associated with energy efficiency? *This could include concepts such as: embedded energy; cradle to cradle philosophy; resource productivity; life cycle assessment; and demand side management etc.* [Ordered]

☐ No	**21**	**44%**
☐ Yes	**20**	**42%**
☐ Unsure	**4**	**8%**
Blank	**3**	**6%**
Total =	***48***	***100%***

Q14. Does this course teach 'technical design theory' associated with energy efficiency? *This could include for example, whole system design calculations for residential home insulation or industrial processes.* [Ordered]

☐ No	**21**	**44%**
☐ Yes	**21**	**44%**
☐ Unsure	**2**	**4%**
Blank	**4**	**8%**
Total =	***48***	***100%***

Q15. How would you rank the importance of energy efficiency as a component of the course?

☐ A major component (e.g. over 30%)	**16**	**33%**
☐ A significant component (e.g. 15-30%)	**7**	**15%**
☐ A moderate component (e.g. 5-15%)	**7**	**15%**
☐ A minor component (e.g. less than 5%)	**14**	**29%**
Blank	**4**	**8%**
Total =	***48***	***100%***

Additional comments made by respondents to this question [typed as written]:

– *Difficult to estimate – Not sure – Everything down to the proper design of roads needs to consider energy efficiency*

Q16. To what extent is energy efficiency taught, with regard to course 'fundamental principles and base theory'?

☐ Energy efficiency forms a significant component of the course's theory and principles	**16**	**33%**
☐ Energy efficiency forms a part of the course's theory and principles	**11**	**23%**
☐ Energy efficiency is taught, but not part of the course's base theory and principles	**14**	**29%**
☐ Energy efficiency does not form part of the course's principles and theory	**4**	**8%**
Blank	**3**	**6%**
Total =	***48***	***100%***

Additional comments made by respondents to this question [typed as written]:

- *Not sure (program level)*

Q17. To what extent is energy efficiency taught, with regard to course 'knowledge/ information'?
This could include for example, demonstrating how theory and principles behave and how the students can use this knowledge to engineer energy efficiency solutions and systems.

☐ Knowledge/ information about energy efficiency comprises the whole course, and energy efficiency forms a key criteria for assessing of all projects/ assignments.	**8**	**17%**
☐ Knowledge/ information about energy efficiency forms part of the course, and is well integrated across learning and assessment.	**14**	**29%**
☐ Knowledge/ information about energy efficiency is provided in some parts of the course, with some level of assessment.	**14**	**29%**
☐ Knowledge/ information about energy efficiency is included in some parts of the course and is not assessed.	**6**	**13%**
☐ Knowledge/ information about energy efficiency is not taught or assessed in this course.	**3**	**6%**
Blank	**3**	**6%**
Total =	***48***	***100%***

Additional comments made by respondents to this question [typed as written]:

- *Not sure (program level)*

Q18. How well do you think this course includes examples of issues and innovations related to energy efficiency, to demonstrate the 'application of energy efficiency theory and knowledge' to engineering?

Note that energy efficiency may be focus of the example, or may be one aspect of a worked example. For example the criteria might be to optimise capital cost, operating costs (including energy) and productivity, or achieve multiple objectives such as water quality and energy efficiency.

☐ The course is based entirely on worked examples that address issues and innovations related to energy efficiency.	**0**	**0%**
☐ The course contains many worked examples that address issues and innovations related to energy efficiency (in addition to a few examples of current or past inefficient practices)	**15**	**31%**
☐ The course contains some worked examples that address issues and innovations related to energy efficiency (in addition to some examples of current or past inefficient practices).	**23**	**48%**
☐ The course does not contain worked examples that address issues and innovations related to energy efficiency.	**7**	**15%**
Blank	**3**	**6%**
Total =	***48***	***100%***

Q19. Please select the type/s of *energy efficiency concepts and principles* that are included in the course, with regard to whether they are 'mentioned' or covered 'in detail': [Ordered, and shaded to assist reading data, table breaks added to highlight grouping of results]

Concept/ Principle	In Detail		Mentioned		Blank		Total
	Number	Percent	Number	Percent	Number	Percent	
c) Efficiency, resource efficiency, and energy efficiency	19	40%	21	44%	8	17%	48
b) Energy generation and transmission losses	16	33%	13	27%	19	40%	48
t) Energy efficiency & low carbon technologies (renewable energy)	14	29%	16	33%	18	38%	48
a) Fundamentals of Thermodynamics	13	27%	12	25%	23	48%	48
u) Energy efficiency and low carbon technologies (fuels)	12	25%	13	27%	23	48%	48
d) Heat transfer management (particularly insulation and thermal capacity)	11	23%	10	21%	27	56%	48
n) Climate neutrality or emission mitigation	9	19%	17	35%	22	46%	48
p) Sustainable energy supply - energy storage	8	17%	15	31%	25	52%	48
o) Distributed generation of electricity (reducing transmission losses)	8	17%	13	27%	27	56%	48
f) Life Cycle Analysis/ Assessment	5	10%	16	33%	27	56%	48
q) Sustainable energy supply - standby energy	5	10%	12	25%	31	65%	48
s) Performance at part and full load	5	10%	11	23%	32	67%	48
k) Link between friction losses and energy consumption	4	9%	9	20%	32	71%	45
i) Embedded energy of water distribution	4	8%	4	8%	40	83%	48
h) Embedded energy of materials	3	6%	13	27%	32	67%	48
g) Energy management of electronic components and systems	3	6%	7	15%	38	79%	48
j) Embedded water in energy generation	3	6%	6	13%	39	81%	48
r) Incremental efficiency versus whole system design (for overall efficiency gains)	2	4%	13	27%	33	69%	48
e) Resource productivity	2	4%	11	23%	35	73%	48
l) Product stewardship and responsibility	2	4%	8	17%	38	79%	48
m) Decoupling energy utility profits from kilowatt-hours sold	0	0%	8	17%	40	83%	48

☐ Other: *[Typed as written]*

- *Civil Engineers have much less exposure than Electrical or Mechanical Engineers. Largely dependent on the individual experience.*

Q20. Please select the type/s of *topical energy efficiency issues* that are included in the course, with regard to whether they are 'mentioned' or covered 'in detail': [Ordered, and shaded to assist reading data]

Concept/ Principle	In Detail		Mentioned		Blank		Total
	Number	Percent	Number	Percent	Number	Percent	
- Carbon dioxide and other greenhouse gas emissions from energy generation	16	33%	18	38%	14	29%	48
- The link between energy and greenhouse gas emissions	15	31%	18	38%	15	31%	48
- The link between greenhouse gas emissions and global temperature change	11	23%	20	42%	17	35%	48
- The contribution to climate change/global warming from energy generation	11	23%	16	33%	21	44%	48
- The link between energy efficiency and peak energy demand (for a process and larger scale – implications for investment in plant and infrastructure size)	10	21%	11	23%	27	56%	48
- The effects of climate change/global warming	9	19%	12	25%	27	56%	48
- Peak oil and managing demand for oil	8	17%	14	29%	26	54%	48
- Synergies between energy efficiency and other aspects of environmental performance (eg water, waste, material usage)	8	17%	12	25%	28	58%	48

☐ Other: *[Typed as written]*

- *Broader issues are addressed by more zealous colleagues. I simply provide the students with the tools and understanding to solve the problems as they emerge.*
- *Details of Renewable Energy Generation techniques*
- *Heat Pumps/CFCs, Carbon sequestration (fringe)*
- *Quite a number on energy efficiently currently*

Q21. Please select the type/s of *efficiency and productivity* content that are included in the course, with regard to whether they are 'mentioned' or covered 'in detail': [Ordered, and shaded to assist reading data]

Concept/ Principle	In Detail		Mentioned		Blank		Total
	Number	Percent	Number	Percent	Number	Percent	
- Undertaking energy auditing and energy assessment	12	25%	12	25%	24	50%	48
- The magnitude of reductions in fossil fuel consumption that can be achieved through the combined mechanisms of energy efficiency gains by the energy consumer, and the resultant reduced energy production, and transmission demands	9	19%	17	35%	22	46%	48
- Peak load demand versus base load and average demand to understand the benefit of energy efficiency at different times of the day	8	17%	10	21%	30	63%	48
- The link between financial savings and improvements in energy efficiency to enable a profitable transition to low carbon and renewable fuels	9	19%	14	29%	25	52%	48
- Factors affecting peak load demand and options for management	7	15%	12	25%	29	60%	48
- Economic benefits of energy efficiency (including offsets of other costs, timescales and certainty of benefits?)	7	15%	15	31%	26	54%	48
- Air pollution from combustion that can be reduced through energy efficiency	5	10%	19	40%	24	50%	48

☐ Other: *[Typed as written]*

- *Students study a range of solar cooling systems and the energy consumption of archetypal building forms i.e. courtyards, pavilions, terraces and so on.*
- *Any or all of these can be covered in participant discussion – depends on the group.*

Q22. Please select the type/s of energy efficiency content related to *'Roles and Responsibilities'* that are included in the course, with regard to whether they are 'mentioned' or covered 'in detail': [Ordered, and shaded to assist reading data]

Concept/ Principle	In Detail		Mentioned		Blank		Total
	Number	Percent	Number	Percent	Number	Percent	
- The role of industry in improving the efficiency with which it uses energy	4	8%	19	40%	25	52%	48
- The role of government in providing clear frameworks and incentives to improve the efficiency with which nations use energy.	4	8%	18	38%	26	54%	48
- The role of the community in improving the efficiency with which it uses energy	4	8%	14	29%	30	63%	48
- The role of universities and research organisations in increasing education and capacity building in energy efficiency	4	8%	12	25%	32	67%	48
- How to identify the multiple benefits of energy efficiency and communicate these to employers and clients in business and economic terms?	4	8%	7	15%	37	77%	48
- How to communicate energy efficiency opportunities to employers and clients in business and economic terms?	4	8%	4	8%	40	83%	48
- The role of business in improving the efficiency with which it uses energy	4	8%	8	17%	36	75%	48

☐ Other: *[Typed as written]*

- *I do not attempt to influence the zeitgeist: the market and other modes will define the future.*
- *These are all part of the course but emphasis will depend on interest*

Q23. Please select the type/s of case studies (listed by sector) on *'energy efficiency opportunities'* that are included in the course (*select all that apply*): [Ordered]

☐ Case studies of energy efficiency opportunities in the industry sector	**16**	**55%**
☐ Case studies of energy efficiency gains in the energy utilities sector	**13**	**45%**
☐ Case studies of energy efficiency gains in the transportation sector	**9**	**34%**
☐ Case studies of energy efficiency gains in the built environment sector	**10**	**31%**
☐ Case studies of energy efficiency gains in the business sector	**7**	**24%**
☐ Other: Please specify	**4**	**14%**

- *Renewable Energy Sources*
- *Loading level of diesel generators in hybrid renewable energy systems*
- *Indirectly related, some of these issues appear when they do LCA and cleaner production strategies.*
- *Provided by the participants as relevant to them.*

Blank	**19**	**-**
Percentages given out of the total number of responses to this question ('total respondents – blank responses'):	***29***	**-**

Q24. Please select the type/s of case studies (listed by technology) on *'energy efficiency opportunities'* that are included in the course (*select all that apply*): [Ordered]

☐ Case studies of energy efficiency opportunities in motor systems	**15**	**31%**
☐ Case studies of energy efficiency gains in boilers	**15**	**31%**
☐ Case studies of energy efficiency gains in HVAC systems	**13**	**27%**
☐ Case studies of energy efficiency gains in lighting	**13**	**27%**
☐ Case studies of energy efficiency gains in appliances and equipment	**12**	**25%**
☐ Other: Please specify	**7**	**15%**

- *Lecture Notes and on-line reading lists*
- *'The Natural Wealth of Nations – 'you know the rest'. and excerpts relating to energy, consumption alternatives.*
- *Industrial reactors and separators (distillation) equipment*
- *Engine efficiency*
- *See Reference List in attached course outline*
- *As in (Q23) above.*
- *Touches on all but not formal case studies as such.*

Blank	**15**	**-**
Percentages given out of the total number of respondents:	***48***	**-**

Q25. Does the course contain <u>required reading</u> about the topic of 'sustainable development'? *For example books/ text excepts/papers/online resources.* [Ordered]

☐ No	**23**	**48%**
☐ Yes	**20**	**42%**
Blank	**5**	**10%**
Total =	***48***	***100%***

If 'Yes', please list them (author, date, title) *[typed as written]:*

- *Renewable Energy: editor Boyle, Oxford Uni Press*
- *Knowles, R.L. The Solar Envelope: Its meaning for energy and building. Energy and Buildings 35: pp15-25 (2003), Ratte, Rayden and Steemes – Building Form and environmental performance: archetypes, analysis and an arid climate. Energy and Buildings 35 pp47-57 (2003)*
- *Course Reader*
- *Lecture notes*
- *Renewable Energy Electric Power Systems*
- *Ribin 2001, "Introduction to Engineering and the Environment"*
- *Eng. Aust - Code of Ethics*
- *See attached*
- *Implicity in Chapter 4 of the textbook. Quaschong, V. "Understanding Renewable Energy System" 2005.*
- *Sustainable development is implicit in the first chapter of the textbook used for the course. Quaschung, v. (2005) "Understanding Renewable Energy Systems"*
- *Suggested readings and same readings provided in hard book (emailed separately)*
- *General Reading: Renewable Energy, Boyle, Oxford Uni Press and Energy Systems and Sustainability, Boyle, Oxford Uni Press*
- *See attached.*
- *A selection of textbook chapters and online information.*
- *Various extracts in course notes.*

Q26. Does the course contain <u>optional reading</u> about the topic of 'sustainable development'? *For example books/ text excepts/papers/online resources.* [Ordered]

☐ No	**22**	**46%**
☐ Yes	**20**	**42%**
Blank	**6**	**13%**
Total =	***48***	***100%***

If 'Yes', please list them (author, date, title): *[typed as written]:*

- *'As Above Q25' (Lecture Notes and on-line reading lists)*
- *M.Achour-et al: Chemical Engineering and Processing 44 (2005) 901-909*

Results for this question are continued next page …

- *Sustainable Development in Practice: Case Studies for Engineers and Scientists: Appendix A: LCA, Ed. A. Azapagic, s. Perdan et al J. Wiley & Sons. 2004*
- *Students encouraged to read widely*
- *Industrial and government documents*
- *About "Entropy"*
- *Azapagic, et al (Ed) 'Sustainable Development in Practice', Wiley, 2004*
- *See attached. No specific textbook for this unit. But we provide all relevant reading materials including required and additional resources.*
- *PPP based on Carbon-neutral paper.* www.isa.org.asyd.edu.au/publication/CarbonNeutral.pdf.
- *Same as for (Q25) above.*
- *In "Skills" – selection of required reading resources = All related to S.D.*

Q27. Does the course contain required reading on the topic of 'energy efficiency'? *For example books/ text excepts/papers/online resources.* [Ordered]

☐ No	**26**	**54%**
☐ Yes	**16**	**33%**
Blank	**6**	**13%**
Total =	***48***	***100%***

If 'Yes', please list them (author, date, title) or alternatively attach list to this questionnaire *[typed as written]:*

- *"As above Q26" (Renewable Energy: editor Boyle; Oxford Uni Press)*
- *"As above" Q25*
- *Course Notes*
- *Please see the attached list for Q25.*
- *The energy efficiency of each of the renewable energy technologies covered in the course is investigated. Quaschung V, 2005 "Understanding Renewable Energy System" is the main text for the course.*
- *Please see the attached list*
- *Same as for Q25 above.*
- *Crude – ABC*
- *Detailed course notes provided*
- *Detailed Course Notes provided*
- *Old DPIE booklets; CADDET publications (unrealistic question!)*
- *(i) Natural Capitalism (ii) Natural Advantage of Nations*
- *As above*
- *Moran and Shapiro – Thermodynamics; Holman – Heat Transfer.*

Q28. Does the course contain optional reading on the topic of 'energy efficiency'? *For example books/ text excepts/papers/online resources.* [Ordered]

☐ No	**23**	**48%**
☐ Yes	**17**	**35%**
Blank	**8**	**17%**
Total =	***48***	***100%***

If 'Yes', please list them (author, date, title) *[typed as written]:*

- *"As above Q26".*
- *See Reference Texts in attached course outline*
- *See Reference List in attached course outline*
- *See Reference Tests in attached course outline*
- *Sheet is attached.*
- *Attached list*
- *See list attached*
- *Same as for Q25 above.*
- *Turner – Energy Management Handbook*

ENGINEERING SUSTAINABLE ENERGY SOLUTIONS

Section 3: Curriculum Renewal - Energy Efficiency Education

Q29. Please select the following area/s where you think this course could include more energy efficiency education: [Ordered]

☐	This course could include more on *(select all that apply)*:	**27**	**55%**
	Of the number of respondents to this option, the break-up is:		
	☐ Applying energy efficiency theory and knowledge	*20*	*74%*
	☐ Knowledge/ Information about energy efficiency	*14*	*52%*
	☐ Fundamental principles and base theory on energy efficiency	*8*	*30%*
☐	This course has sufficient 'energy efficiency' education included: (***If this option is selected, please go directly to Q35***)	**17**	**35%**
Blank		**4**	**9%**
Total =		***48***	***100%***

Additional comments made by respondents to this question [typed as written]:

- *But could be more specifically integrated.*
- *From an industrial perspective, through reflection of cost and energy efficiency measures is important e.g. Energy efficiency, [state agency] … boxes with no eaves.*

Q30. Please select resource/s that you think would assist in further including energy efficiency education in this course (*select all that apply*)? [Ordered]

☐	A set of case studies on energy efficiency examples in engineering	**24**	**77%**
☐	List of related documentaries/TV episodes etc. and their sources	**17**	**55%**
☐	A list of key energy efficiency textbooks and references for engineers	**17**	**55%**
☐	A customised set of readings on energy efficiency for engineers generally	**15**	**48%**
☐	Lecture notes on key energy efficiency issues & solutions for engineers	**14**	**45%**
☐	A set of mini-lectures (i.e. lecture guides and study materials) on various energy efficiency topics	**12**	**39%**
☐	Special guest/ expert lectures on energy efficiency	**13**	**42%**
☐	Lecture notes on energy efficiency opportunities, specifically by technology	**12**	**39%**
☐	Lecture notes on energy efficiency opportunities, specifically by sector	**9**	**29%**
☐	A customised set of readings on energy efficiency, relevant to engineering discipline/s	**10**	**32%**

Results for this question are continued next page …

☐ Other (please specify):	**4**	**13%**

- *More of government policy: 2nd prize in Future Energy Comp. (Dallas). Power Conditioning Equipment … problem based learning environment – here is a system – how would you make it more energy efficiency and design it. Not a broad/brush experience … "#1 factor is X". All software includes that now.*
- *Use DVD format for expert lecturers for example.*
- *We are looking for help with specifically designed projects (including the problem definition- NB we are happy to be involved in the design of such a resource) that brings out action-specific items for investigation and provides students opportunities to improve learning at various stages of the project. (General skills & technical skills) = Generic projects that are real but constrained enough to be valuable learning tools.*
- *Despite my answer to Q.29, I would still very much like to see more resources developed for Energy Efficiency. In particular information in the local context (i.e. Australian) is very patchy or increasingly dated. There are numerous reports from Europe, USA (esp. California) and elsewhere on energy efficiency, however, Australian data is less common, in part due to such programs as the "Energy Efficiency Best Practice", a federal program whose funding was concluded on 30 June, 2003.*

☐ Professional development in this field (i.e. in the form of intensive training)	**2**	**6%**
Blank	**2**	**6%**
Percentages out of [total respondents minus Q29 'Sufficient']:	***31***	***-***

Q31. How would you prefer these resources to be presented (*select all that apply*)? [Ordered]

☐ Online learning modules – open access	**28**	**90%**
☐ Intensive short course, taught and undertaken in person	**4**	**13%**
☐ Intensive short course, taught and undertaken remotely	**3**	**10%**
☐ Online learning modules – restricted access (eg through payment/ registration)	**2**	**6%**
☐ Other (please specify):	**4**	**13%**

- *Time to include this in the course*
- *All of the above would be useful resources but something would need to be displaced from the syllabus to accommodate it.*
- *The resources need to assist with the language of the area and point students in right direction. There is a slight disconnect – we tend to teach more theoretically – there is a huge amount of mining energy with fairly detailed perspectives rather than choices. This is the problem with the energy sector – fairly obvious – not much choice at the moment.*
- *Important to make it clear that energy efficiency starts at home.*
- *Just in Time Format – possibility for staff to be involved and taught*

Blank:	**0**	**0%**
Percentages out of [total respondents minus Q29 'Sufficient']:	***31***	***100%***

Q32. If the resources in Q28 (previous page) were easily accessible and freely available, what other challenge/s do you think might limit their use (*select all that apply*)? [Ordered]

☐ A potential for course content 'overload' *	**18**	**58%**
☐ Insufficient time to include the materials (ie not enough time to modify course notes, lectures, course outlines, assessment etc)	**16**	**52%**
☐ Insufficient resources to include the materials (i.e. not enough funding to spend time or employ someone to renew the course)	**7**	**23%**
☐ Lack of understanding that employment opportunities are linked to energy efficiency expertise/qualifications	**5**	**16%**
☐ Lack of support regarding curriculum renewal by University/ colleagues**	**4**	**13%**
☐ Lack of a streamlined approach to managing renewal of course content	**2**	**6%**
☐ Other (please specify):	**5**	**16%**

- *I am not sure that optional reading would be done.*
- *None applies.*
- *Make materials easily compatible with on-line teaching such as Black Board*
- *One issue with this material is possibly low technical content; the 'fit' in highly technical subjects can be difficult when discussing some more general concepts.*
- *(i) smaller: can react faster; (ii) cope with fluctuations in the market, but (iii) resourcing issues*

Blank	**0**	**0%**
Percentages out of [total respondents minus Q29 'Sufficient']:	***31***	***-***

Additional comments made by respondents to this question [typed as written]:

- ** Needs to spread appropriately and progressively through the years of the course i.e. through theory and application in case studies.*
- *** Some Faculty staff may resist but most see need.*

Q33. Would endorsement by a third party increase the likelihood of the use of content developed on energy efficiency? *This could include for example Engineers Australia, the National Framework for Energy Efficiency, the federal Department of Environment, Water and Resources.* [Ordered]

☐ Yes	**15**	**45%**
☐ No	**10**	**30%**
☐ Unsure	**7**	**21%**
☐ Under some circumstances: (Please specify)	**1**	**3%**

- *Endorsement by Architects association would help because they strongly influence engineering courses at [this university].*

Blank	**0**	**0%**
Percentages out of [total respondents minus Q29 'Sufficient']*:	***32***	***100%***

**** Note: 2 extra respondents answered this question.***

Additional comments made by respondents to this question [typed as written]:

- *This would have significant impact on staff. Greater authority/argument to pick it up.*

– *As Program Director, I can say to staff, 'this is something EA wants us/requires us to do'. It would also help in relation to evidence during the accreditation process.*

Q34. If you answered 'Yes' or 'Under Some Circumstances' to the previous question (**Q33**), what third party endorsement would increase the likelihood that the material is used (select and comment where relevant) (*select all that apply*)? [Ordered]

Government: ***[responses typed and bolded where given]***

☐ Australian Federal Department of Environment and Water Resources	**7**	**44%**
☐ Australian Federal Department of Industry Tourism and Resources	**1**	**6%**
☐ Australian Federal Other: ***Australian Greenhouse office***	**1**	**6%**
☐ State Government (please describe): ***WA Sustainable Energy SED6***	**1**	**6%**
☐ Federal Government (another country):	**0**	**0%**
Blank	**6**	**38%**
Out of total number of respondents to Q33 as noted:	***16***	**-**

Academia/ Research: ***[responses typed and bolded where given]***

☐ Australian Universities: ***UNSW, Murdoch, ANU***	**5**	**31%**
☐ International universities: ***University of California, Barkley***	**3**	**19%**
☐ CSIRO	**2**	**13%**
☐ A United Nations Agency or Group:	**0**	**0%**
Blank	**6**	**38%**
Out of total number of respondents to Q33 as noted:	***16***	**-**

Professional and Industry Organisations: ***[responses typed and bolded where given]***

☐ Engineers Australia	**13**	**81%**
☐ Australasian Association of Engineering Education	**3**	**19%**
☐ Energy or industry agencies:	**3**	**19%**
☐ The World Federation of Engineering Organizations	**1**	**6%**
Blank	**0**	**0%**
Out of total number of respondents to Q33 as noted:	***16***	**-**

Q35. Would you like to be kept informed of project progress?

☐ Yes	**30**	**63%**
☐ No	**9**	**19%**
Blank	**9**	**19%**
Total =	***48***	***100%***

ENGINEERING SUSTAINABLE ENERGY SOLUTIONS

Section 4: University Context

Q36. Has University senior management (i.e. at the level of the Vice Chancellor or equivalent) made a commitment to integrate 'sustainability' or similar concepts into the curriculum? [Ordered]s

☐ Unsure	**14**	**29%**
☐ Yes	**11**	**23%**
☐ No (Go to **Q38**)	**11**	**23%**
Blank	**12**	**25%**
Total =	***48***	***100%***

Q37. If yes to the previous question (**Q36**), is this *(select all that apply)*: [Ordered]

☐ An internal undertaking	**8**	**73%**
☐ A formal/public commitment	**5**	**45%**
Blank	**0**	**0%**
Out of total number of respondents to Q36 as noted:	***11***	***-***

Q38. Has your Head of School/ Faculty/ Department (i.e. the level responsible for all engineering education offered by the university) made a public commitment to integrate sustainability into engineering education? *(e.g. through advertisements, statements etc.)* [Ordered]

☐ Unsure	**19**	**40%**
☐ Yes	**12**	**25%**
☐ No	**6**	**13%**
Blank	**11**	**23%**
Total =	***48***	***100%***

Additional Comments made by Respondents to this Question [typed as received]:

- *(Implicitly)*

Q39. How would you describe your University's marketing of its commitment to integrating 'sustainability' or similar concepts into education?

Results for this question are continued next page …

a) Level of commitment:

☐ Medium / intermittent	**13**	**27%**
☐ Unsure	**9**	**19%**
☐ Low / infrequent	**8**	**17%**
☐ Not evident	**3**	**6%**
☐ High / consistent	**3**	**6%**
Blank	**12**	**25%**
Total =	***47***	***100%***

b) Depth of commitment:

☐ Across the University: *Pockets – Geography, Engineering*	**13**	**27%**
☐ In Engineering only	**6**	**13%**
☐ Only within specific disciplines (list):	**8**	**17%**
– *Don't know*		
– *Engineering, Marine Environment*		
– *Engineering, Environmental Science, Environmental Planning*		
– *Environmental Science, Some engineering*		
– *Energy Studies, Environmental Science, Institute for Sustainability Technology Policy. Other Individuals are undertaking PhD waste and sustainability in their areas i.e. sport in a carbon constrained world.*		
– *Institute for [a research centre within the university].*		
– *Patchy, also depends on individuals.*		
☐ Other:	**1**	**2%**
– *but there is a Centre for Sustainable Tourism.*		
Blank	**20**	**42%**
Total =	***48***	***100%***

Q40. Do you have any other comment about University education for sustainable development?

- *It is critical for the country and the world, but very difficult - see Rolf Juehers work at Swansea Uni, UK. – but things are changing – but fast enough??*
- *Universities should offer alternatives and train people to think critically. People will ultimately make their own decision.*
- *This should be embedded in relevant courses/units rather than creating an important unit/course*
- *We don't teach our students how to overcome resistance to implementation in the workplace.*
- *University is resistant to adopt sustainable practice for running the University e.g. building management, air con, recycling etc.*
- *See notes to questions in this questionnaire.*
- *Often difficult to get everyone involved seeing "sustainable development" as an important tissue or to see if from a common perspective (e.g. University facilities managers and Engineering Schools such as Mining and Petroleum tend to have a different perspective to me on "sustainable development").*
- *These days everything is funding driven!!*

Appendix 3:

Student Questionnaire

Aggregated Results Summary

SUSTAINABLE ENERGY SOLUTIONS

UNIVERSITY STUDENT QUESTIONNAIRE

AGGREGATE DATA SUMMARY

Q1. What is the name of this course and where is it taught?

Detail	Student Questionnaire Responses	Lecturer Questionnaire Responses*	Percentage
Universities:	8	27	30%
Data Sets:	14	48	30%
Undergraduate Courses:	8	36	22%
Postgraduate Courses:	2	5	40%
Mixed Courses:	4	6	67%

* Where for each course, the lecturer was invited to survey the students

State	Course Topic/ Discipline Area	Student Enrolment		Number of Respondents^
		Undergrad	Postgrad	
NSW	Eng. Geology & Concrete Materials	✓	-	26
NSW	Energy Systems	✓	✓	[3,26] 29
QLD	Energy Conversion and Utilisation	✓	✓	[11,17] 28
QLD	Renewable Energy Systems	✓	✓	[8,8] 16
QLD	Power System Reliability & Planning	-	✓	16
QLD	Energy and the Environment	✓	-	9
QLD	Advanced Industrial Economics	✓	-	1*
SA	Electric Energy Systems	✓	✓	[1,22] 23
TAS	Thermal Engineering	✓	-	17
VIC	Architectural Engineering	✓	-	23
VIC	Civil Engineering	✓	-	5
VIC	Civil Engineering	✓	-	34
WA	Engineering Sustainable Development	✓	-	30
WA	Sustainable Energy	-	✓	3
		Total Student Responses		**260**

** Given to a student to represent the class of approximately 20 students*

^ Split between undergraduate and postgraduate students shown in square brackets

Q2. What year are you currently enrolled in at university?

Level:	Year 1	Year 2	Year 3	Year 4	Other	Sub-Total	Percent
Undergraduate	13	58	94	48	6	**219**	**84%**
(Percent)	6%	26%	43%	22%	3%		

Level:	Year 1	Year 2	Year 3	Year 4	Other	Sub-Total	Percent
Postgraduate	34	6	0	1	0	**41**	**16%**
(Percent)	83%	15%	0%	2%	0%		
						Data Set Total:	**260**

Q3. Do you think you understand the term 'sustainable development'?

UNDERGRADUATE	Year 1	Year 2	Year 3	Year 4	Other	Sub-Total	Percent
Yes	9	47	73	38	2	169	**77%**
No	0	1	3	2	0	6	**3%**
Maybe	3	9	18	7	3	40	**18%**
Blank	1	1	0	1	1	4	**2%**
Check - Total	13	58	94	48	6	**219**	**100%**

POSTGRADUATE	Year 1	Year 2	Year 3	Year 4	Other	Sub-Total	Percent
Yes	22	4	0	0	0	26	**63%**
No	2	0	0	0	0	2	**5%**
Maybe	10	2	0	1	0	13	**32%**
Blank	0	0	0	0	0	0	**0%**
Check - Total	34	6	0	1	0	**41**	**100%**

Q4. How relevant do you think 'sustainable development' will be to your career?

UNDERGRADUATE	Year 1	Year 2	Year 3	Year 4	Other	Sub-Total	Percent
High	6	40	51	26	2	125	**57%**
Medium	3	14	34	16	4	71	**32%**
Low	0	1	6	4	0	11	**5%**
Unsure	3	3	2	2	0	10	**5%**
Blank	1	0	1	0	0	2	**1%**
Check - Total	13	58	94	48	6	**219**	**100%**

POSTGRADUATE	Year 1	Year 2	Year 3	Year 4	Other	Sub-Total	Percent
High	17	2	0	0	0	19	**46%**
Medium	11	3	0	1	0	15	**37%**
Low	4	0	0	0	0	4	**10%**
Unsure	2	1	0	0	0	3	**7%**
Blank	0	0	0	0	0	0	**0%**
Check - Total	34	6	0	1	0	**41**	**100%**

Q5. Do you think you understand the term 'energy efficiency'?

UNDERGRADUATE	Year 1	Year 2	Year 3	Year 4	Other	Sub-Total	Percent
Yes	9	48	83	45	6	191	87%
No	1	0	2	2	0	5	2%
Maybe	2	10	9	1	0	22	10%
Blank	1	0	0	0	0	1	0%
Check - Total	13	58	94	48	6	219	100%

POSTGRADUATE	Year 1	Year 2	Year 3	Year 4	Other	Sub-Total	Percent
Yes	29	6	0	1	0	36	88%
No	1	0	0	0	0	1	2%
Maybe	4	0	0	0	0	4	10%
Blank	0	0	0	0	0	0	0%
Check - Total	34	6	0	1	0	41	100%

Q6. How relevant do you think 'energy efficiency' will be to your career?

UNDERGRADUATE	Year 1	Year 2	Year 3	Year 4	Other	Sub-Total	Percent
High	6	32	68	29	4	139	63%
Medium	3	20	19	16	2	60	27%
Low	0	3	5	3	0	11	5%
Unsure	3	3	2	0	0	8	4%
Blank	1	0	0	0	0	1	0%
Check - Total	13	58	94	48	6	219	100%

POSTGRADUATE	Year 1	Year 2	Year 3	Year 4	Other	Sub-Total	Percent
High	19	3	0	1	0	23	56%
Medium	9	3	0	0	0	12	29%
Low	3	0	0	0	0	3	7%
Unsure	3	0	0	0	0	3	7%
Blank	0	0	0	0	0	0	0%
Check - Total	34	6	0	1	0	41	100%

Q7. Do you remember seeing energy efficiency issues in the news, within the last six months?

UNDERGRADUATE	Year 1	Year 2	Year 3	Year 4	Other	Sub-Total	Percent
Yes	8	42	54	39	6	149	68%
No	2	5	18	4	0	29	13%
Unsure	2	11	22	5	0	40	18%
Blank	1	0	0	0	0	1	0%
Check - Total	13	58	94	48	6	219	100%

POSTGRADUATE	Year 1	Year 2	Year 3	Year 4	Other	Sub-Total	Percent
Yes	18	2	0	0	0	20	49%
No	7	2	0	0	0	9	22%
Unsure	8	2	0	0	0	10	24%
Blank	1	0	0	1	0	2	5%
Check - Total	34	6	0	1	0	41	100%

Q8. Do you know of energy efficiency being taught at other universities in Australia?

UNDERGRADUATE	Year 1	Year 2	Year 3	Year 4	Other	Sub-Total	Percent
Yes	4	15	21	14	0	54	25%
No	3	15	28	13	4	63	29%
Unsure	5	28	45	21	2	101	46%
Blank	1	0	0	0	0	1	0%
Check - Total	13	58	94	48	6	219	100%

POSTGRADUATE	Year 1	Year 2	Year 3	Year 4	Other	Sub-Total	Percent
Yes	10	2	0	0	0	12	29%
No	11	2	0	0	0	13	32%
Unsure	11	1	0	1	0	13	32%
Blank	2	1	0	0	0	3	7%
Check - Total	34	6	0	1	0	41	100%

Q9. **a)** Do you think energy efficiency has been taught to you at this university?

UNDERGRADUATE	Year 1	Year 2	Year 3	Year 4	Other	Sub-Total	Percent
Yes	8	36	70	40	3	157	72%
No	2	12	12	5	0	31	14%
Unsure	2	10	12	3	3	30	14%
Blank	1	0	0	0	0	1	0%
Check - Total	13	58	94	48	6	219	100%

POSTGRADUATE	Year 1	Year 2	Year 3	Year 4	Other	Sub-Total	Percent
Yes	20	4	0	0	0	24	59%
No	4	1	0	1	0	6	15%
Unsure	10	1	0	0	0	11	27%
Blank	0	0	0	0	0	0	0%
Check - Total	34	6	0	1	0	41	100%

b) If YES to (a), when has it been taught? (please select one or more boxes)

UNDERGRADUATE	Year 1	Year 2	Year 3	Year 4	Other	Sub-Total	Percent
1st - 2nd Yr U/Grad	4	32	18	11	0	65	41%
3rd - 4th Yr U/Grad	5	13	67	39	1	125	80%
Post-graduate	1	3	0	0	0	4	3%
Percentages given out of the total to 'YES' in Q9a):						157	-

POSTGRADUATE	Year 1	Year 2	Year 3	Year 4	Other	Sub-Total	Percent
1st - 2nd Yr U/Grad	3	1	0	0	0	4	17%
3rd - 4th Yr U/Grad	3	0	0	0	0	3	13%
Post-graduate	20	4	0	0	0	24	100%
Percentages given out of the total to 'YES' in Q9a):						24	-

c) If YES to (a), How much energy efficiency content do you think has been taught?

UNDERGRADUATE	Year 1	Year 2	Year 3	Year 4	Other	Sub-Total	Percent
Too Much	0	0	0	1	0	1	1%
Too Little	2	10	26	12	1	51	32%
Just Right	5	17	34	21	2	79	49%
Unsure	1	10	12	5	1	29	18%
Blank	0	0	0	0	0	0	0%
Check - Total	8	37	72	39	4	**160**	**100%**

POSTGRADUATE	Year 1	Year 2	Year 3	Year 4	Other	Sub-Total	Percent
Too Much	1	0	0	0	0	1	3%
Too Little	4	1	0	0	0	5	17%
Just Right	15	3	0	0	0	18	60%
Unsure	3	2	0	0	0	5	17%
Blank	0	0	0	1	0	1	3%
Check - Total	23	6	0	1	0	**30**	**100%**

Q10. Please indicate how well you think you understand and can apply (where appropriate) the following principles: (Please use a tick " ✓ " in the centre of each chosen box)

UNDERGRADUATE:				
Energy Efficiency Principles and Concepts	**Very Well**	**Somewhat**	**Not at all**	**Blank**
a) Fundamentals of Thermodynamics	27%	54%	17%	1%
b) Energy generation and transmission losses	38%	50%	10%	2%
c) Efficiency, resource efficiency and energy efficiency	35%	53%	8%	3%
d) Heat transfer management (insulation and thermal capacity)	22%	55%	22%	1%
e) Resource productivity	15%	59%	24%	2%
f) Life Cycle Analysis/Assessment	23%	52%	23%	2%
g) Energy management of electronic components and systems	20%	46%	32%	2%
h) Embedded (or embodied) energy of materials	15%	51%	33%	2%
i) Embedded (or embodied) energy of water distribution	17%	50%	32%	2%
j) Embedded (or embodied) water in energy generation	22%	50%	25%	3%
k) Link between friction losses and energy consumption	39%	46%	12%	3%
l) Product stewardship and responsibility	9%	44%	45%	3%
m) Decoupling energy utility profits from kilowatt-hours sold	12%	45%	41%	3%
n) Climate neutrality or emission mitigation	21%	49%	27%	3%
o) Distributed generation (reducing transmission losses)	21%	52%	24%	4%
p) Sustainable energy supply - energy storage	30%	50%	17%	3%
q) Sustainable energy supply - standby energy	29%	45%	23%	3%
r) Incremental efficiency versus whole system design	14%	49%	34%	3%
s) Performance at part and full load	28%	47%	22%	3%
t) Energy Efficiency and low carbon technologies (renewable energy)	32%	52%	13%	3%
u) Energy efficiency and low carbon technologies (fuels)	27%	54%	17%	3%
v) Energy efficiency improvement opportunities	30%	53%	15%	3%
w) Energy auditing and energy assessment	19%	49%	29%	3%
x) Systems design (for energy efficiency)	24%	55%	17%	3%
Average:	24%	50%	23%	2%

Results for this question are continued next page …

POSTGRADUATE:				
Energy Efficiency Principles and Concepts	**Very Well**	**Somewhat**	**Not at all**	**Blank**
a) Fundamentals of Thermodynamics	29%	55%	13%	3%
b) Energy generation and transmission losses	48%	48%	0%	3%
c) Efficiency, resource efficiency and energy efficiency	55%	39%	3%	3%
d) Heat transfer management (insulation and thermal capacity)	26%	52%	19%	3%
e) Resource productivity	23%	58%	16%	3%
f) Life Cycle Analysis/Assessment	26%	48%	23%	3%
g) Energy management of electronic components and systems	32%	45%	19%	3%
h) Embedded (or embodied) energy of materials	32%	32%	32%	3%
i) Embedded (or embodied) energy of water distribution	23%	42%	32%	3%
j) Embedded (or embodied) water in energy generation	32%	35%	29%	3%
k) Link between friction losses and energy consumption	32%	61%	3%	3%
l) Product stewardship and responsibility	23%	39%	35%	3%
m) Decoupling energy utility profits from kilowatt-hours sold	39%	42%	16%	3%
n) Climate neutrality or emission mitigation	29%	45%	23%	3%
o) Distributed generation (reducing transmission losses)	48%	45%	3%	3%
p) Sustainable energy supply - energy storage	39%	52%	6%	3%
q) Sustainable energy supply - standby energy	42%	48%	6%	3%
r) Incremental efficiency versus whole system design	32%	48%	16%	3%
s) Performance at part and full load	45%	42%	10%	3%
t) Energy Efficiency and low carbon technologies (renewable energy)	26%	58%	13%	3%
u) Energy efficiency and low carbon technologies (fuels)	29%	55%	13%	3%
v) Energy efficiency improvement opportunities	29%	61%	6%	3%
w) Energy auditing and energy assessment	29%	52%	13%	6%
x) Systems design (for energy efficiency)	35%	42%	16%	6%
Average:	33%	48%	15%	3%

The end of Survey Results