Course Syllabus

This six-week course for engineering students explores energy and sustainability, with a focus on new developments in energy efficiency and renewable energy technologies. The program is based on a ninety-hour combination of lectures, tutorials, laboratory work, demonstrations, site visits, computer simulations, assignments and discussion periods.

Course Outline

The University of New South Wales is recognized as the top university for energy R&D in Australia with many of the research groups among the world leaders in their field. Professors from several of these research groups present the course content in their particular area of expertise. They include

1. World Energy

This unit examines the international outlook for both traditional and renewable energy sources; energy, economic growth and the environment, implications of the Kyoto Protocol; and structural change in the electricity supply industry. A primary focus of the unit is the comparative economics of sustainable energy systems. A detailed analysis of projected US energy requirements through 2020, and their related environmental implications, will be based upon recent US Energy Information Administration estimates.

2. Energy and Environmental Implications

This unit will consider: - The sources of the critical pollutants as defined by the EPA together with control strategies and forms of regulation; The concept of the environment as a closed system (i.e. spaceship earth) and the optimal level of pollution; The concept of environmental externalities and the use of market instruments to ensure that the

polluter pays. Climate change and the Kyoto Protocol: science, economics, and politics will be considered in overlap with section 1. The impact of each of the renewable technology areas on environmental factors will be discussed in the appropriate unit of the course.

3. Energy and Sustainable Development

Our society's energy systems have a critical role to play in driving sustainable development. Key sustainability drivers are energy poverty in the developing world and the environmental harms of present energy systems. This unit presents an 'energy services' model for designing sustainable energy systems that are highly energy efficient and use renewable energy sources.

4. Energy and the Built Environment

Energy use in buildings, domestic and commercial; sustainable architecture; thermal comfort; passive design; energy performance modelling; building systems; HVAC and lighting in buildings. The use of computer simulations to show effects of various design techniques on energy usage – glazing of windows, thermal storage, insulation, and ventilation.

5. Emerging Energy Technologies

There are a number of highly promising but, as yet, commercially unproven energy technologies which may play a very important role in our future energy systems over the longer term. We focus, in particular, on some emerging Carbon Capture and Storage (CCS) and hydrogen technologies.

6. Energy Storage

Energy storage systems include electrochemical, chemical and thermal. The principles of electrochemical energy systems and fundamentals of electrochemistry, secondary batteries and fuel cells are considered. The latest advanced batteries for stationary and mobile applications, including the vanadium redox flow battery, sodium sulphur, zinc-bromine, sodium metal chloride and nickel-hydride are discussed. Laboratory work includes battery design, testing and performance calculations.

7. Energy and the Process Industries

Process industries form the basis of modern society and will continue to play a major role. Research initiatives worldwide have paved the way for advancing the development of sustainable processes. Energy efficiency and waste utilisation are some of the key features of many of the sustainable processes that will be discussed.

8. Renewable Energy

This unit will cover the key renewable energy sources for sustainable energy systems:

(a) Biomass

This unit reviews the use of agricultural crops and biomass wastes in the production of alternative fuels. Ethanol production technology, from both yeasts and bacteria including genetically engineered micro-organisms (GMOs) and all the issues that this raises for large-scale ethanol production are considered as well as methane via biogas technology.

(b) Photovoltaic Devices and Systems

This unit examines the basics of converting sunlight into electricity; the behaviour of solar cells; cell properties; system components; applications; grid connection; system design, including for RAPS (remote area power supply) applications. Experimental work will be carried out at the Photovoltaic Centre teaching laboratories where there are operating PV systems connected to the grid, solar pumping systems and where development work has taken place on the solar powered car.

(c) Wind Energy

This unit outlines the components of a wind turbine; examines the interaction of wind and rotor; consider fatigue; and reviews the process of electricity generation and supply to the grid (wind farms).

(d) Solar Thermal Applications

This component reviews the applications of solar thermal energy collectors for water heating, steam generation and solar thermal-electricity.