

## Engineering Tripos Part IB, Sustainable Engineering, 2019-20

### Lecturers

[Dr Claire Barlow and others](#) [1]

### Timing and Structure

5 lectures in Michaelmas Term.

### Objectives

As specific objectives, by the end of the course students should be able to:

- Appreciate the scale of the global challenges in energy production and control of climate change, and the importance of identifying, quantifying and pursuing the developments which will have significant impact.
- Understand a range of opportunities to reduce energy consumption and to implement lower carbon technologies, in different sectors of engineering, in both developed and developing economies.
- Complete a technical investigation into an aspect of Sustainable Engineering of their own choice.

### Content

The need to move rapidly toward a lower carbon economy is widely accepted in the Engineering community, to mitigate against climate change, to improve future energy security, and to assist the developing economies of the world. This course will illustrate some of the current issues and applied developments relating to sustainability, in all areas of Engineering. Students follow up the lecture course with their own short research project over the Christmas vacation, submitted as a poster.

#### **1. 31 October. Professor Julian Allwood. Use Less.**

In this talk, we'll take a look at how humans are getting on in managing (or not) their impacts on the natural environment, and focus particularly on climate change. The sad reality is that while we talk more and more about global warming, the rate at which our emissions are increasing is itself increasing, and this comes down to the fact that rich countries want to keep continuing getting richer. As a result, while we're happy to talk about relative reductions in environmental impact, our absolute impacts are still rising. The solution is pretty straightforward - we have to use less; less energy, water, material and meat. Doing so wouldn't be that painful if we made the choice to do so, so we'll look at how it might happen, how engineers can contribute, and how we can be part of the very broad public debate that's required to imagine a future in which we aim to grow our well-being more than our incomes.

#### **2. 7 November. Dr Michael Ramage (Architecture). Natural structure: materials, form and force.**

The relationship between structural form and natural force allowed medieval master builders to construct spaces that still inspire awe today, many of which would be difficult to recreate. But with an understanding of antique knowledge, traditional construction, and contemporary computation we can once again explore the form and structure of centuries ago in contemporary architecture and engineering. Combining historic wisdom with the latest natural material technology offers the promise of novel and sustainable building solutions. Michael Ramage will discuss new developments from his research at Cambridge that draws on learning from ancient traditions for contemporary sustainable architecture and engineering.

### **3. 14 November. Dr Adam Boies. Wait - Could Carbon be beneficial for climate?**

*Carbon emissions to the atmosphere are the largest pollutant worldwide and among the most pressing challenges for engineers and society to solve. Carbon also provides unique structures that offer superior material properties for technology, infrastructure and energy storage – if only they could be produced efficiently at scale. We will explore how material and energy use can be improved by eliminating carbon emissions and producing hydrogen fuel from natural gas. We should be sceptical of claims that offer easy solutions to intractable problems, and will therefore examine the opportunities and costs of transforming carbon from an energy source to material. This talk will examine the carbon atom at the centre climate change and advanced materials to explore the future of carbon as we strive to maintain our economy and climate.*

### **4. 21 November. Dr Claire Barlow. Plastic packaging: challenges, problems and solutions.**

David Attenborough's Blue Planet documentaries have highlighted the devastating effect that waste plastic is having on our environment, particularly focusing on the marine environment. Plastic packaging is seen as iconic of our wasteful throwaway society: should it just be banned? But if we look more closely at the whole system we see that there are other sides to the story: packaging can save huge amounts of resources if used and disposed of wisely. In this lecture we will look at the big picture around the use of plastics for packaging, and examine the alternatives.

### **5. 28 November. Dr Teng Long. Edison Redux - Greening of electrical power systems using power electronics technologies**

120 years ago, Edison and Westinghouse publicly battled over DC (Direct Current) versus AC (Alternating Current) in the War of Currents. Fixed frequency AC won the battle at that time, and became the dominant form of the electric power thanks to its ease and efficiency for high voltage electricity transmission with low losses. Since that time, however, DC technology has been improved significantly. Transformative semiconductor technologies in electric power applications, known as Power Electronics, enables efficient and controllable conversion between different forms of power: DC, AC, electromagnetic and electromechanical. The advantages offered by Power Electronics have been driving a revolution of greener and more sustainable transport and energy. In this Lecture, state-of-the-art Power Electronics technologies will be introduced, and illustrated with emerging applications of power conversion for intelligent and efficient generation, transfer, storage and consumption of electrical energy. Engineering challenges and future career opportunities in transport electrification and sustainable energy will be briefly discussed, in order to give an overview of the contribution Power Electronics Engineers can make to move and power the world by more sustainable means.

## **Coursework**

Coursework, in the form of a small independent research project, will be conducted over the Christmas vacation, leading to preparation of a poster summarising the key findings. The expected time to be spent on the research project and poster is 12-15 hours.

You will present your poster to a small group of students in a timetabled lab session in the Lent Term.

Deadline for poster submission (in electronic format as PDF): Friday January 17th 2020, 4pm (via Moodle: details to follow).

Standard credit: 10 marks (from maximum of 14); penalty of 1 mark per day poster is late.

## **Booklists**

I have listed here some books, e-resources and documents that you may find interesting. All the books are readable rather than being textbooks!

- *Sustainable Materials: with both eyes open*, Julian Allwood and Jonathan Cullen ([www.withbotheyesopen.com](http://www.withbotheyesopen.com) [2])
- *Sustainable Energy: without the hot air*, David Mackay ([www.withouthotair.com](http://www.withouthotair.com) [3])

- *Materials and the Environment*, Michael Ashby, Butterworth-Heinemann, 2012 (e-book available)
- Paul Hawken, Amory B Lovins, L. Hunter Lovins. *Natural Capitalism: The Next Industrial Revolution* (2010).
- Michael Braungart, William McDonough. *Cradle to Cradle. Remaking the Way We Make Things* (2009)
- Mike Berners-Lee. *How Bad are Bananas?: The Carbon Footprint of Everything* (2010)
  
- Rethinking Single-use plastics. Report from Citi GPS, download from <https://www.citivelocity.com/citigps/rethinking-plastics/> [4]
- You may like to look at the latest report from the Intergovernmental Panel on Climate Change, <http://www.ipcc.ch/> [5]

See [Part IB Booklist](#) [6]

### Examination Guidelines

Please refer to [Form & conduct of the examinations](#) [7].

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### Links

[1] <mailto:cyb1@cam.ac.uk>

[2] <http://www.withbotheyesopen.com>

[3] <http://www.withouthotair.com>

[4] <https://www.citivelocity.com/citigps/rethinking-plastics/>

[5] <http://www.ipcc.ch/>

[6] <https://www.vle.cam.ac.uk/mod/book/view.php?id=364081&chapterid=44291>

[7] <https://teaching19-20.eng.cam.ac.uk/content/form-conduct-examinations>