

## **Engineering Tripos Part IIB, 4M23: Electricity and Environment, 2021-22**

### **Module Leader**

[Prof M Pollitt](#) [1]

### **Lecturers**

[Professor M Pollitt](#) [1]

### **Lecturer**

[Dr Teng Long](#) [2]

### **Timing and Structure**

Lent term. 2 hour sessions delivered in person. Assessment: 100% coursework.

### **Prerequisites**

A basic engineering knowledge of electricity (first year undergraduate) and a familiarity with the units and notation associated with energy science and engineering is an advantage, but not essential. Assessment will be structured so as to be accessible to students from a range of backgrounds.

### **Aims**

The aims of the course are to:

- provide students with a firm foundation in modern electricity policy with an emphasis on the UK.
- introduce students to a wide a variety of mature and emergent electricity generation and demand side technologies.
- expose students to the local, regional and global environmental effects of energy use.
- introduce the key considerations of energy policy and develop frameworks by which progress against policy goals may be achieved.
- discuss issues with electrification of heating and transport.

### **Objectives**

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

- critique scenarios for the future UK electricity system out to 2050
- evaluate and compare the efficacy of different electricity generation technologies
- understand current and future electricity policy options
- appreciate how economics and engineering interact in a sustainable electricity system

### **Content**

This module is a postgraduate module of Cambridge Judge Business School. It has its origins as an elective course of the MPhil in Technology Policy and the MPhil in Engineering for Sustainable Development. The module is

of the standard size adopted in the Engineering Department and the Judge Business School, i.e. a nominal 16 hours. The course is delivered via one two-hour lecture each week for eight weeks.

We take the UK electricity system as a working example which we will refer to throughout the course.

### **Overview - Class Introduction (Michael Pollitt)**

#### Lecture 1

- History of Electrical Power and Energy Policy
- Fundamentals of the UK and USA Electricity System
- The nature of the current UK electricity bill and electricity market
- UK Energy Policy and Politics
- Principles of good energy policy

### **Environmental Effects of Fossil Fuel Use and what to do about them (Michael Pollitt)**

#### Lecture 2

- Local Emissions and Impacts
- Putting a Price on Damages?
- Economic approaches to externalities
- Pricing carbon
- Experiences of the EU Emissions Trading System and carbon pricing in Australia

### **Electricity Demand (Michael Pollitt)**

#### Lecture 3

- Economics of Electricity Demand
- The economics of smart energy services
- Technological aspects of electricity demand
- Social aspects of electricity demand
- Demand side policy

### **Fossil fuel generation, storage and future electricity markets (Michael Pollitt)**

#### Lecture 4

- Current status of fossil-fuel power generation
- Economics of Carbon Capture and Storage
- The economics of electricity storage
- Business models for the internet of energy
- Future electricity market design

### **Renewables and the Electricity System (Michael Pollitt)**

#### Lecture 5

- Renewables context
- Potential for renewables in the UK
- Place of renewables in electricity system
- How to subsidise renewables
- Lessons from around the world

### Electrification of heating and transport? Electricity in Net Zero (Michael Pollitt)

#### Lecture 6

- Electrification of everything?
- Decarbonising heating with electricity
- Decarbonising transport with electricity
- ??Sector coupling and modelling Net Zero
- Policy recommendations for Net Zero

### Electricity Networks (Teng Long)

#### Lecture 7

- Transmission and distribution system engineering considerations
- Design and operation
- History of the grid and transport electrification
- Distributed Generation
- High voltage DC and interconnection

### Nuclear Power, Electricity Security and EU Policy (Michael Pollitt)

#### Lecture 8

- Nuclear Power Technology
- History and Economics of Nuclear Power
- EU and UK energy security
- National security of electricity supply
- Meeting UK targets by Electricity Market Reform
- Good electricity policy?

### Coursework

| Coursework   | Format   | Due date & marks                      |
|--|--|---------------------------------------|
| <p>Essay on the 2030 decarbonisation challenge facing the UK electricity system.</p> <p><u>Learning objectives:</u></p> <ul style="list-style-type: none"><li>• To discuss the challenge of decarbonising the UK electricity system by 2030.</li><li>• To cover both the economic and engineering challenges facing the UK electricity system.</li></ul> | <p>Individual Report</p> <p>2000 words</p> <p>anonymously marked</p> | <p>25 March 2022</p> <p>[100/100]</p> |

### Booklists

Expected reading:

Grubb, M., Jamasb, T., and Pollitt, M.G. (eds.) (2008) Delivering a low-carbon electricity system. Cambridge: Cambridge University Press Printed book at: JBS: TD195.E4 G72 2008 Engineering: DE.166

Ozawa, M., Chaplin, J., Pollitt, M., Reiner, D. and Warde, P. (eds.) (2019) In Search of Good Energy Policy. Cambridge: Cambridge University Press.

Recommended reading:

Taylor, S. (2016) The Fall and Rise of Nuclear Power in Britain Cambridge: UIT Printed book at: JBS: HD9698.G72 T39 F3 2016 UL: C212.c.2239

Jamasb, T. and Pollitt, M. (eds.) (2011) The Future of Electricity Demand Cambridge: Cambridge University Press Printed book at: JBS: HD9685.G72 J35 2011 Engineering: DE.190 UL: 235.c.201.356 (South Front 6)

MacKay, D.J.C. (2009) Sustainable energy without the hot air. Cambridge: UIT E-book via withoutotair <http://www.withouthotair.com/download.html> [3] Printed book at: Engineering: DE.164

## Examination Guidelines

Please refer to [Form & conduct of the examinations](#) [4].

## UK-SPEC

The [UK Standard for Professional Engineering Competence \(UK-SPEC\)](#) [5] describes the requirements that have to be met in order to become a Chartered Engineer, and gives examples of ways of doing this.

UK-SPEC is published by the Engineering Council on behalf of the UK engineering profession. The standard has been developed, and is regularly updated, by panels representing professional engineering institutions, employers and engineering educators. Of particular relevance here is the '[Accreditation of Higher Education Programmes \(AHEP\) document](#) [6] which sets out the standard for degree accreditation.

The [Output Standards Matrices](#) [7] indicate where each of the Output Criteria as specified in the AHEP 3rd edition document is addressed within the Engineering and Manufacturing Engineering Triposes.

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## Links

[1] <mailto:mgp20@cam.ac.uk>

[2] <mailto:tl322@cam.ac.uk>

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

[4] <http://teaching.eng.cam.ac.uk/content/form-conduct-examinations>

[5] <http://www.engc.org.uk/ukspec.aspx>

[6] <http://www.engc.org.uk/standards-guidance/standards/accreditation-of-higher-education-programmes-ahp/>

[7] <http://teaching.eng.cam.ac.uk/content/output-standards-matrices>