Engineering Tripos Part IIB, 4I7: Electricity & Environment, 2019-20

Module Leader

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Lecturer

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Lecturer

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Lecturer

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Timing and Structure

Lent term. 2 hour sessions. 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 develops frameworks by which progress against policy goals may be achieved.

Objectives

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

- generate scenarios for the future UK electricity system out to 2050
- evaluate and compare the efficacy of different electricity generation technologies
- critique current and future electricity policy
- 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.

Overview - Class Introduction - Michael Pollitt

Lecture 1

- History of Electrical Power and Energy Policy.
- Fundamentals of the UK and USA Electricity System.
- UK Energy Policy and Politics.
- Principles of good energy policy.
- Recent UK Energy White Papers.

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

Wind Energy (Jim Platts)

Lecture 4

- Attributes of wind power
- Technology and history
- Wind resources and grid integration
- UK and EU wind policy
- Wind turbine manufacture

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

Lecture 5

- 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 6

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

Electricity Networks (Richard McMahon)

Lecture 7

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

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

Lecture 8

- The economics of Nuclear Power
- Energy Security
- EU Energy Policy
  - EU 2030 Targets
  - Roadmap 2050
- Good electricity policy?

Coursework

One piece of coursework in two parts	Format	Due date & marks
First part of coursework Use the UK 2050 calculator to generate own electricity related scenario. <u>Learning objectives:</u> • To develop an internally consistent quantified energy scenario for a real economy • To get a sense of the scale of the difficulty of the energy transition challenges for electricity	Individual report 1500 words anonymously marked	20 March 202 [50/100]

One piece of coursework in two parts	Format	Due date & marks
Second part of coursework Essay on the 2030 decarbonisation challenge facing the UK electricity system. <u>Learning objectives:</u> • To discuss the challenge of decarbonising the UK electricity system by 2030. • To cover both the economic and engineering challenges facing the UK electricity system.	Individual Report 1500 words anonymously marked	20 March 202 [50/100]

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 withouthotair http://www.withouthotair.com/download.html [4] Printed book at: Engineering: DE.164

HM Government 2050 Pathways analysis Report via DECC Publications http://www.decc.gov.uk/en/content/cms/tackling/2050/2050.aspx [5]

Examination Guidelines

Please refer to Form & conduct of the examinations [6].

UK-SPEC

This syllabus contributes to the following areas of the UK-SPEC [7] standard:

Toggle display of UK-SPEC areas.

GT1

Develop transferable skills that will be of value in a wide range of situations. These are exemplified by the Qualifications and Curriculum Authority Higher Level Key Skills and include problem solving, communication, and working with others, as well as the effective use of general IT facilities and information retrieval skills. They also include planning self-learning and improving performance, as the foundation for lifelong learning/CPD.

IA1

Apply appropriate quantitative science and engineering tools to the analysis of problems.

IA2

Demonstrate creative and innovative ability in the synthesis of solutions and in formulating designs.

KU1

Demonstrate knowledge and understanding of essential facts, concepts, theories and principles of their engineering discipline, and its underpinning science and mathematics.

KU2

Have an appreciation of the wider multidisciplinary engineering context and its underlying principles.

S1

The ability to make general evaluations of commercial risks through some understanding of the basis of such risks.

S3

Understanding of the requirement for engineering activities to promote sustainable development.

S4

Awareness of the framework of relevant legal requirements governing engineering activities, including personnel, health, safety, and risk (including environmental risk) issues.

E1

Ability to use fundamental knowledge to investigate new and emerging technologies.

E4

Understanding of and ability to apply a systems approach to engineering problems.

P1

A thorough understanding of current practice and its limitations and some appreciation of likely new developments.

P3

Understanding of contexts in which engineering knowledge can be applied (e.g. operations and management, technology, development, etc).

US1

A comprehensive understanding of the scientific principles of own specialisation and related disciplines.

US3

An understanding of concepts from a range of areas including some outside engineering, and the ability to apply them effectively in engineering projects.

US4

An awareness of developing technologies related to own specialisation.

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