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

Module Leader

Professor M Pollitt [1]

Lecturer

Professor M Pollitt [1]

Professor Richard McMahon [2]

Mr Jim Platts [3]

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

- 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

<table>
<thead>
<tr>
<th>Format</th>
<th>Due date &amp; marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Individual report</td>
<td>20 March 2020</td>
</tr>
<tr>
<td>1500 words</td>
<td>50/100</td>
</tr>
</tbody>
</table>

First part of coursework

Use the UK 2050 calculator to generate own electricity related scenario.

Learning objectives:

- 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
### One piece of coursework in two parts

<table>
<thead>
<tr>
<th>Format</th>
<th>Due date &amp; marks</th>
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</thead>
<tbody>
<tr>
<td><strong>Second part of coursework</strong></td>
<td></td>
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<tr>
<td>Essay on the 2030 decarbonisation challenge facing the UK electricity system.</td>
<td>Individual Report, 1500 words, anonymously marked, 20 March 2020 [50/100]</td>
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</tbody>
</table>

**Learning objectives:**

- 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.

### Booklists

**Expected reading:**


**Recommended reading:**


### Examination Guidelines

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

### UK-SPEC

The UK Standard for Professional Engineering Competence (UK-SPEC) [7] 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 [8] which sets out the standard for degree accreditation.
The [Output Standards Matrices][9] 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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