COURSE HANDBOOK

2021/2022

MSc Energy Systems

This handbook applies to students starting the MSc Energy Systems in October 2021.

The Examination Regulations relating to this course are available at:

http://www.admin.ox.ac.uk/examregs/information/contents/

MSc in Energy Systems (full-time):

https://examregs.admin.ox.ac.uk/Regulation?code=mosbcinenersyst&srchYear=2020&srchTerm=1&year=2019&term=1

MSc in Energy Systems (part-time):

https://examregs.admin.ox.ac.uk/Regulation?code=mosbcienersyst-p-t&srchYear=2020&srchTerm=1&year=2019&term=1

If there is a conflict between information in this handbook and the Examination Regulations then you should follow the Examination Regulations. If you have any concerns, please contact:

mscprogrammes@eng.ox.ac.uk

The information in this handbook is accurate as at 24th May 2022; however, it may be necessary for changes to be made in certain circumstances, as explained at:

http://www.ox.ac.uk/admissions/graduate/courses/changes-to-courses

Summary of Changes

pp. 5 & 6	Amended dissertation deadlines, as per Examination Regulations.	24 May 2022
p. 6	Updated course teaching location.	24 May 2022
p. 7	Updated office location for Course Director and Deputy Course Director.	24 May 2022
p. 7	Removed reference to Print Room, Thom Building. Service is no longer available.	24 May 2022
p. 14	Removed reference to weighting of Small Group Case Study being subject to amendment of Examination Conventions. The Conventions have now been approved.	16 November 2021
p. 15	Removed reference to weighting of Whole Cohort Exercise being subject to amendment of Examination Conventions. The Conventions have now been approved.	16 November 2021

MSc Energy Systems
2022: version 1.4
For the latest version of this handbook please see
https://www.eng.ox.ac.uk/mscenergy/

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1. Introduction

1.1 Welcome

We are delighted to welcome you onto the MSc in Energy Systems.

Transitioning worldwide energy systems towards cleaner sources, while providing energy to over 1.3 billion people currently without access to electricity, is one of the biggest challenges of the 21st century. We aim to equip you with the best possible appreciation of complex interdisciplinary challenges for energy system development to ensure that industry and government policies can address these challenges effectively.

No other UK University matches Oxford's strengths across physical and social sciences in this area, and is recognised as a leader in interdisciplinary energy research nationally and globally. The creation of the Oxford Energy Network (www.energy.ox.ac.uk) has brought together some 200 energy researchers from 19 departments and institutions (nine in MPLS, nine in Social Sciences and one in Humanities).

In this multi-disciplinary course, you will be taught by energy researchers from across Oxford, including academics in the departments of Engineering Science (which is hosting the course), Physics, Materials Science, Chemistry, Economics, International Development, and the School of Geography and the Environment. Together these departments have formed the Oxford Energy Network to address the major technical, social, economic and policy challenges of providing secure, affordable and sustainable energy for all. We engage with small and large energy companies, and governments, government agencies and NGOs around the world. Major industrial collaborators include BBOXX, Bosch, BP, British Gas, EDF, E.ON, Jaguar Land Rover, Johnson Matthey, KETEP, Mitsubishi Heavy Industries, National Grid, Nissan, Rolls-Royce, Samsung, Shell, Siemens, SSE, Statoil, and UK Power Networks.

I hope that you will be very happy at the University of Oxford and that you will flourish academically and personally during your time here. The collegiate University provides a diverse and enriching series of opportunities to learn new skills, and I encourage you to make the most of what is on offer. I trust that you will become active participants and engage with the many events and activities that we host.

Professor David Wallom

Course director

Dr Sarah Sparrow

Deputy Course Director

1.2 Important dates

2021-2022 Academic Year (1-year, 2-year, & 3-year students)

Monday 4 October 2021	Departmental Induction
Sunday 10 October	Start of Michaelmas Term
Friday 26 November	R1. Energy Sources assignment deadline (All)
Saturday 4 December	End of Michaelmas Term
Friday 17 December	Sy1. Energy Infrastructure assignment deadline (FT, 2-year PT)
Friday 31 December	Se1. Energy Demand assignment deadline (FT)
Friday 7 January 2022	R2. Energy Conversion 1 assignment deadline (All)
Sunday 16 January	Start of Hilary Term
Friday 25 February	Sy2. Energy for Development assignment deadline (FT, 2-year PT)
Friday 4 March	Se2. Energy and Society assignment deadline (FT)
Saturday 12 March	End of Hilary Term
Friday 18 March	R3. Energy Conversion 2 assignment deadline (All)
Friday 25 March	Sy3. Digitization, Smart Energy and Communication assignment deadline (FT, 2-year PT)
Friday 8 April	Sy4. Energy Systems: Economics and Markets assignment deadline (FT, 2-year PT)
Friday 15 April	Se3. Energy Policy and Governance assignment deadline (FT)
Sunday 24 April	Start of Trinity Term
Friday 29 April	Whole Cohort Exercise presentation and event (FT, with 2-year PT 20/21 cohort and3-year PT 19/20 cohort)
Friday 13 May	Small Group Case Study report deadline and presentation (FT, 3-year PT)
Saturday 18 June	End of Trinity Term
Monday 5 September	Dissertation deadline (FT, 3-year PT 19/20 cohort)

2022-2023 Academic Year (2-year and 3-year students)

Sunday 9 October 2022	Start of Michaelmas Term
Saturday 3 December	End of Michaelmas Term
Friday 16 December	Sy1. Energy Infrastructure assignment deadline (3-year PT)
Friday 30 December	Se1. Energy Demand assignment deadline (2-year PT)
Sunday 15 January 2023	Start of Hilary Term
Friday 24 February	Sy2. Energy for Development assignment deadline (3-year PT)

Friday 3 March	Se2. Energy and Society assignment deadline (2-year PT)
Saturday 11 March	End of Hilary Term
Friday 24 March	Sy3. Digitization, Smart Energy, and Communication assignment deadline (3-year PT)
Friday 7 April	Sy4. Energy Systems: Economics and Markets assignment deadline (3-year PT)
Friday 14 April	Se3. Energy Policy and Governance assignment deadline (2-year PT)
Sunday 23 April	Start of Trinity Term
Friday 28 April	Whole Cohort Exercise, including presentation and event (3-year PT, with 2-year PT & FT 2021-2022 cohort)
Saturday 17 June	End of Trinity Term
Monday 4 September	Dissertation deadline (2-year PT)

2023-2024 Academic Year (Provisional Term Dates - 3-year students)

Sunday 8 October 2022	Start of Michaelmas Term
Saturday 2 December	End of Michaelmas Term
Friday 29 December	Se1. Energy Demand assignment deadline (3-year PT)
Sunday 14 January 2022	Start of Hilary Term
Saturday 10 March	End of Hilary Term
Friday 1 March	Se2. Energy and Society assignment deadline (3-year PT)
Friday 12 April	Se3. Energy Policy and Governance assignment deadline (3-year PT)
Sunday 21 April	Start of Trinity Term
Saturday 15 June	End of Trinity Term
Monday 2 September	Dissertation deadline (3-year PT)

1.3 Key contacts

Please note that the details given below relate to normal operating circumstances. COVID-19 related closures and limitations may mean they are not always accurate. COVID-19 specific alterations are indicated in green.

The Department of Engineering Science is the administrative base for the course, and a significant proportion of your teaching will be delivered here. Space for independent study and collaborative working in groups is also provided in the Department. Due to distancing requirements, we anticipate that all Michaelmas Term teaching will take place in LR7, Department of Engineering Science, Information Engineering Building.

From Hilary Term 2022 onward, the course will be based out of Holywell House, Osney Mead.

The course administrator, Dr Erin Nyborg, can be found in the Student Administration Office (8th floor, Thom Building).

The course director is Professor David Wallom (david.wallom@oerc.ox.ac.uk, Ground Floor, Holywell House) and the deputy course director is Dr Sarah Sparrow (sarah.sparrow@oerc.ox.ac.uk, Ground Floor, Holywell House)

Other useful general contact email addresses:

Student Administration Office – for all general queries relating to course administration and teaching
mscprogrammes@eng.ox.ac.uk
Tel: 01865 283254

Engineering Science IT Helpdesk – for help with IT
https://thehub.eng.ox.ac.uk
Tel: 01865 273069

1.4 Disability

If you have any form of disability, we strongly encourage you to disclose this to the Head of Student Administration in Engineering Science, Jo Valentine (jo.valentine@eng.ox.ac.uk), in order that we can make provision for you. Furthermore, your college will advise you of your Disability Contact who will be pleased to talk to you in the strictest confidence.

Students with a disability may also find useful advice and guidance on the University of Oxford Disability Office web page at www.ox.ac.uk/students/welfare/disability.

1.5 Virtual Learning Environment

This course uses a Virtual Learning Environment (VLE), which is a web-based application using Canvas.

https://canvas.ox.ac.uk/

Access to the course VLE is via an internet browser and using your Single Sign-On (SSO) account. When the course has started and you have activated your SSO, you will have access to module materials, the student forum, and information about student support. If you are unable to access Canvas please email the Student Administration Office with details of your SSO (msprogrammes@eng.ox.ac.uk).

Canvas will be used to house:

- Induction materials
- Pre-module reading and reading lists for each module
- Hand-outs and presentations from modules
- Links to resources on academic good practice and study skills
- Forums: for tutor-student and student-student interaction

Throughout the course you will also be required to submit work through a secure submission portal based on Inspera, which you can access using your SSO: https://oxford.inspera.com/

1.5 Online Presence, virtual meetings and video conferencing

Due to the COVID-19 pandemic we will still be operating the 2020/2021 academic year differently to both the last academic year and somewhat to how we envisaged the course would be run.

We anticipate that all taught sessions in Michaelmas Term will be given in person, in LR7 of the IEB. If necessary, we are also able to teach remotely (though we do not envisage this capability being utilised this academic year for the whole class). We will use either the Microsoft Teams or Zoom video conferencing systems depending on Module Leader preference. Remote participation is available for those who due to COVID-related restrictions must quarantine or self-isolate. Further details and information on the use of MS Teams is available from IT Services here: https://help.it.ox.ac.uk/nexus365/teams-how-do-i.

1.6 Sources of information

The University Student Handbook provides general information and guidance you may need to help you to make the most of the opportunities on offer at the University of Oxford. It also gives you formal notification and explanation of the University's codes, regulations, policies and procedures. It is available to download at

https://www.ox.ac.uk/students/academic/student-handbook?wssl=1

The student portal at www.ox.ac.uk/students provides a single point of access to information, services and resources for students.

The University has a wide range of **policies and regulations** that apply to students. These are easily accessible through the A-Z of University regulations, codes of conduct and policies available on the Oxford Students website at www.ox.ac.uk/students/academic/regulations?wssl=1.

Annual Registration

You can access the Student Self Service port at the link below:

https://www.ox.ac.uk/students/selfservice?wssl=1

You will be able to register, view and update your personal and academic information throughout your studies at Oxford. You must register at the start of the course and each successive year.

Graduate Supervision Reporting

The Graduate Supervision Reporting system allows you and your supervisor to record and review your progress. You can access the GSR system via the Student Self Service portal as well: https://www.ox.ac.uk/students/selfservice?wssl=1.

2. Course content and structure

2.1 Course aims and learning outcomes

The course is designed to be accessible to those who have a first degree in engineering, the physical sciences or geography. Due to the programme's interdisciplinary nature, introductory material on thermodynamics, climate change, and the history of energy transition will be provided in the first module to enable all students to fully access the course material.

At the end of the course you will have acquired:

- A fundamental understanding of the interdependencies in energy systems;
- A substantial base of knowledge in the processes involved from energy conversion to delivery;
- A broad knowledge of technical and societal options that could contribute towards future systems and an understanding of where more detail may be obtained;
- Economic, legal and scientific tools to weigh up and compare the relative merits and limitations of system options;
- Knowledge of key authoritative sources of information to inform decision making and the ability to question these;
- Methods to critically assess the validity and merit of energy policies and strategies;
- An ability to communicate complex energy issues across disciplines and publics;
- Experience of professionally presenting possible solutions to complex problems within energy.

2.2 Course structure

The MSc in Energy Systems can be studied full time, or part time over two or three years.

Candidates will complete and be assessed on the following parts:

1. Submission of written assignments in each of the following foundation modules:
    a. Energy Sources
    b. Energy Demand
    c. Energy Infrastructure
2. Submission of written assignments corresponding to a minimum of six and a maximum of seven further taught modules chosen from those listed in the Course Handbook
3. A group case study project
4. The whole cohort industrial case study
5. A dissertation of not more than 15,000 words and/or 75 pages on a topic selected by the candidate in consultation with the supervisor and approved by the Standing Committee.

The programme is at level 7 in the Framework for Higher Education Qualifications (England, Wales and Northern Ireland)[1], which means it is equivalent to Masters Level. It meets the subject benchmark statement for Engineering at Masters Level, published by the Quality Assurance agency.[2]

[1] https://www.qaa.ac.uk/docs/qaa/quality-code/qualifications-frameworks.pdf
[2] https://www.qaa.ac.uk/docs/qaa/subject-benchmark-statements/subject-benchmark-statement-engineering.pdf

3. Taught modules

3.1 Teaching and Learning

The course is split into three core themes:

- Resources – How is energy produced, converted and, traded? What energy technologies are available, what energy differences are there between different parts of the world?
- Systems – How is energy distributed so that it is usable and what are the considerations that need to be made for bridging between producers and consumers?
- Services – What, why and how is energy provided or made available to society and how may it change or be changed by society? This theme concentrates on the interface between people and energy, and considers the consumptive end of the energy chain.

Within each of these themes will be a set of taught modules as listed below. Four of the units are taught in the first term (Michaelmas term, or MT), including the three foundation modules (shown by a star) and six are taught in the second term (Hilary term or HT). Each module is either two weeks long in the case of the three, mandatory foundation modules and one week in all other cases. These will be delivered with lectures for five hours of each day with two hours of each day available for cohort discussion, exercises or seminar from a relevant external speaker.

Students on the full-time course will take all taught and non-taught elements over the course of one year.

Students in Year 1 of the part-time, 24-month course will take the Resources theme modules (elements indicated in red) and Systems theme modules (elements indicated in blue) **but not the Small Group Case Study or Whole Cohort Exercise**. In the second year, students on the 24-month programme will complete the Services theme modules and the dissertation (elements indicated in green), **as well the Whole Cohort Exercise and Small Group Case study**. The two skills training weeks (indicated in orange) can be taken in either year of the course.

Students on the part-time, 36-month course will complete the Resources theme modules and Small Group Case study during their first year (elements indicated in red). In the second year, part-time students (36 months) will take the Systems theme modules and will complete the Whole Cohort Exercise (elements indicated in blue). In the final year, part-time students (36 months) will complete the Services theme modules and the dissertation (elements indicated in green). The two skills training weeks (indicated in orange) can be completed at any stage of the course.

	Resources	Systems	Services	Non-Taught
Michaelmas Term	R1. Energy Sources* (Weeks 1-2) R2. Energy Conversion 1, Fixed Generation sources (Week 8)	Sy1. Energy Infrastructure* (Weeks 3 & 5)	Se1. Energy Demand* (Weeks 6-7)	I1 Induction & Research Challenge (Week 0) Skills (Week 4)
Hilary Term	R3. Energy Conversion 2, distributed and renewable generation (Week 4)	Sy2. Energy for Development (Week 1) Sy3. Digitization, Smart Energy and communication (Week 5) Sy4. Energy Systems: Economics and Markets (Week 7)	Se2. Energy and Society (Week 2) Se3. Energy Policy and Governance (Week 8)	Dissertation project Planning 1 (Week 0) Whole Cohort Exercise Planning (Week 0) Skills (Week 3) Small Group case study Preparation, Week 6
Trinity Term				Dissertation project Planning 2 (Week 0) Whole Cohort Exercise preparation, presentations and event (Weeks -1 to 1) Small Group case study, including report presentation (Weeks 2-3) Dissertation (Weeks 4-16)

Further detail on each of these is provided in Appendix 1.

During the first term, you will be put into groups of five or six and asked to address a small research challenge which covers the disciplinary breadth of the course. In each group there will be at least one student who has particular strength in each of the subject areas and is able to explain concepts to fellow students where needed. This is not assessed but will give you an initial appreciation of the domain and build community with your fellow students.

3.2 Assessment of taught modules

The assessment tasks from the taught modules are together worth 50% of the overall marks for your MSc.

You must attend and submit written assessments for all taught modules. Of these, the three foundation modules and the best six results from the remaining modules will be taken by the Board of Examiners to contribute towards your overall MSc result.

Each taught module will have an assessment at the end. These may take a number of different forms from extended essay type questions through to specific worked problems given as take-away papers. The assessment of the foundation modules will be approximately twice the length and expected depth of the remaining seven single week modules.

For each module, the assessment will be distributed at midday of the penultimate day of the teaching of that module. You will then have five weeks to complete the exercise and submit it electronically through Inspera (a link to the secure submissions portal will be provided via Canvas).

Online submission

You must submit your assignments online using Inspera by the date specified on the assessment task. Through this process you will also be asked to attest that the work you are submitting is your own work ('declaration of authorship'). You should keep copies of all submitted work. There are penalties for work submitted late without prior agreement, and these are set out in the Examination Conventions.

If you are unsure about any element of the procedure for submitting your work, or are encountering difficulty submitting your work, please contact the Student Administration Office.

There is provision for students to make a case for mitigating circumstances for late submission. Students are permitted to apply for mitigating circumstances from five calendar days before the deadline up to seven calendar days after the date of submission. Work submitted late without an approved extension will be subject to mark deductions as set out in the draft Examination Conventions.

Feedback

When marking, each assessor is asked to provide an appropriate level of feedback to contextalise marks given. This will be returned to you to understand performance in that assessment.

Re-takes

Please see the Examination Conventions.

3.3 Programming and data skills

During one week in Michaelmas term and one week in Hilary term there will be skills teaching sessions on topics not directly aligned to energy but of general benefit. These are not assessed.

Michaelmas Term, Week 4	Topic
Day 1	Engineering Project Finance
Day 2	Scientific Programming in Python
Day 3	Scientific Programming in Python
Day 4	Scientific Programming in Python
Day 5	Communication

Hilary Term, Week 3	Topic
Day 1	Research Ethics
Day 2	Project Management
Day 3	Research Skills [online]
Day 4	Data Management
Day 5	Scientific Visualisation

4. Group work

4.1 Small Group Case study project

During Hilary term you will plan an energy transition case study project as part of a small group exercise that will occur in Trinity term. The content of lectures from all courses (including skills training) will provide important context for this.

Topics for these group work exercises will be made available at the beginning of the course to allow group members to collect relevant content throughout their period of study. Weeks 2 and 3 during Trinity term are dedicated time to allow you to work on this project in your groups. At the end of Week 3, you will give a presentation to the course examiners and director for assessment. You will be assigned your group membership to ensure balance between the different groups.

The output will constitute 15% of the marks for your MSc. The assessment of the output will be through a video presentation and accompanying report which are equally weighted.

Full details of the guidance given are in Appendix 3.

4.2 Whole Cohort Exercise

During Hilary term, the cohort will organise an industrial visit related to energy that will take place in Trinity term.

There will be a relevant team of academic supervisors available to the group, though the whole exercise will be overseen by the course director.

The exercise output will be a coherent set of presentations, posters and a multi-chapter report to which each member will have contributed through named authors per chapter. Weeks -1 to 1 during Trinity term are dedicated time to allow you to work on this.

The whole cohort exercise will be formally assessed as part of the final mark given to candidates, and is therefore a compulsory part of the course. The output will constitute 10% of the marks for your MSc. The entire cohort will receive the same mark from the academic panel that will be sitting as assessors. The industrial partner will provide informal input to the academic assessors. You will receive feedback from the problem-submitting organization and the academic supervisors as part of the dissemination event organized. You cannot pass the course without successfully completing this exercise.

5. Dissertation

5.1 Scope, topic selection and approval

Your dissertation topic must relate to energy systems as defined by the topics covered in the taught modules.

A list of potential dissertation projects with possible supervisors will be published at the end of Michaelmas term (Week 9). Alternatively, you can propose a dissertation topic, provided that it fits within the headings covered by the taught modules. However, the dissertation topic will need to be approved by the Course Director and Deputy Course Director and must be submitted by Tuesday of Trinity Term Week 1 to be finalised and approved by Friday of that week. Therefore, if you are considering proposing your own topic, we recommend that you start thinking about your dissertation topic as early as possible, as this will enable you to have fruitful discussions with your supervisor during and in-between the residential weeks.

A briefing on the dissertation will be provided at the beginning of Hilary term (Week 0) as the start of the process of choosing your topic, and you will have an opportunity to meet potential supervisors throughout Hilary term. For part-time students, this will be in the second or third year of your course. Having discussed the title with the supervisor, you must then submit the dissertation proposal form in *Appendix 4* by Trinity term Week 0 to the course administrator. The Course Director and Deputy Course Director will then consider your proposal and approve it, approve it subject to specific modifications, or reject the proposal. Their decision will be communicated to you by the end of Trinity term Week 0. If rejected, you must choose one of the topics proposed by the course tutors. All proposals must be finalised by Trinity term Week 3.

Notes

If you choose to be supervised by a researcher from the Oxford Institute for Energy Studies (OIES), you will also need a co-supervisor who is a member of the University of Oxford, as the OIES is an independent research institute external to the University.

If your dissertation is likely to require approval by a university ethics panel then it is essential to identify this quickly and if possible work with your supervisor to submit the required forms by Week 4 of Trinity term at the latest due to the time required for review.

5.2 IP and ownership of data

If you intend to base your dissertation on data collected at a company or other institution, it may be necessary to put in place an agreement to establish intellectual property and ownership of data and results. Please raise this with your dissertation supervisor if this is likely to be the case. In such circumstances, you will be required to sign a non-disclosure agreement and the project reports will be marked as confidential and not disclosed. External examiners might wish to see these reports, in which case a non-disclosure agreement can be signed if considered necessary. The reports will be reviewed very carefully by the company-based supervisor and anything sensitive can usually be identified in an early draft and dealt with.

5.3 Supervisor support

Over the period designated for the dissertation (see timeline), your supervisors will provide hour-long face-to-face or video conferencing meetings every two weeks. It is your responsibility to take the initiative to agree the dates for these meetings. You may also contact your supervisor by email to request advice.

Your supervisor will read one full draft of your dissertation and provide written feedback on it, providing it is sent to the supervisor by the Monday of 16th Week of Trinity Term.

5.4 Report design

The dissertation must be no more than 15,000 words. Bibliographies, tables, appendices and references are not included in the word count. Footnotes and endnotes are included in the word count. Your report should be in the normal format for academic publications and so include the following: abstract, introduction, methods, results, discussion, conclusions, references, and appendices.

Further guidance on the structure and production of your dissertation is given in Appendix 5.

5.5 Submission

Your dissertation must be electronically submitted by the deadline shown in section 1.2 (Important Dates). Submission will be via Inspera, which will be linked to from Canvas.

5.6 Assessment of your dissertation

Your dissertation will account for 25% of the overall marks for your MSc. The dissertation will be assessed according to the marking scheme in Appendix 6.

Candidates who fail to achieve an overall mark of 50% or over in the dissertation may resubmit the failed assessment(s) on one occasion only.

6. Good academic practice and avoiding plagiarism

Plagiarism is presenting someone else's work or ideas as your own, with or without their consent, by incorporating it into your work without full acknowledgement. All published and unpublished material, whether in manuscript, printed or electronic form, is covered under this definition. Plagiarism may be intentional or reckless, or unintentional. Under the regulations for examinations, intentional or reckless plagiarism is a disciplinary offence. Please review the Oxford Student's website guidance on plagiarism: www.ox.ac.uk/students/academic/guidance/skills/plagiarism

You are **required** to work through the following online courses on good citation practice and how to avoid plagiarism, and gain the associated certification:

https://weblearn.ox.ac.uk/portal/hierarchy/skills/generic/avoidplag

We will ask you to provide evidence to us of your having completed this online tutorial by sharing the certification with the course administrator.

All dissertations will be screened by Turnitin software which will compare them to a wide range of material (both published and unpublished) and to the work of other candidates. Written assignments from the taught modules may also be screened by Turnitin. The examiners will be notified of the extent of any textual matches discovered by Turnitin, and will consider, for instance, whether any text that a candidate has copied from elsewhere is properly identified and the source duly acknowledged.

The Examination Conventions set out the academic penalties for (a) intentional or reckless plagiarism and (b) poor academic practice.

Study skills

Guidance on time management, note-taking, referencing, research and library skills and information is available at www.ox.ac.uk/students/academic/guidance/skills

7. Feedback on your course

At the end of each taught module you will be asked to provide feedback on all aspects of the teaching you have received through an anonymous online survey. It is very important that you complete this survey as it is a key tool to help us monitor teaching quality and make necessary adjustments or improvements.

In December, you and all students at Oxford will also be asked to complete the Student Barometer, which is the University's key survey for collecting feedback from all students and monitoring the quality of all aspects of the student experience: induction, teaching and learning, assessment and feedback, and support services.

Concerns

If you have any issues with teaching or supervision, please raise these as soon as possible so that they can be addressed promptly. Details of who to contact are provided in Appendix 2 (complaints and appeals).

Student representation

Professor David Wallom and Dr Sarah Sparrow are the academic directors for the course and a Standing Committee, which meets three times a year, provides oversight of the course.

It is expected that there will be two student representatives selected by the cohort for each year (one male and one female) and that nominees will become members of the course standing committee. One representative should also attend the termly departmental Graduate Joint Consultative Committee.

8. Buildings and facilities

8.1 Engineering Science

All teaching during Michaelmas Term will take place in LR7, Information Engineering Building, Department of Engineering Science. The room will be open from 8.30am to 5.30pm, Monday to Friday.

We anticipate that teaching will take place in Holywell House, Osney Mead during Hilary and Trinity Terms.

Independent study space is also available for all students on the MSc in Energy Systems in the Student Study Area on the 8th floor of Engineering Science's Thom Building on Parks Road. The Study Area is open from 8.30 am to 7.00 pm, Monday to Friday.

You will be expected to have your own laptop. We recommend a minimum specification are follows that has been seen to be able to support the Python modelling activities within the course adequately;

- CPU – better than 2GHz processor (preferably multicore)
- Memory – 8GB or more
- Disk – more than 256GB
- Operating System – Windows (Windows 8 or later), Linux (CentOS or similar distribution), Mac (OSX 10.13 or later)

8.2 The Libraries

Radcliffe Science library

The Radcliffe Science Library (RSL) (www.bodleian.ox.ac.uk/science) is the main science research library at the university. The library holds copies of your reading list items, and most of your research will be done using this library's resources. The RSL is temporarily operating out of the Vere Harmsworth Library in the Rothermere American Institute, located a short walk away from the Engineering Science department on South Parks Road.

The Subject Librarian responsible for Engineering Science is Alessandra Vetrugno (alessandra.vetrugno@bodleian.ox.ac.uk) and she is based at the RSL.

Social Sciences Library

The Social Science Library (SSL) (www.bodleian.ox.ac.uk/ssl) is the main social science research library at the university and holds resources that may be relevant to some modules. The library is located less than 15 minutes away from the Engineering Science department, on Manor Road, just off South Parks Road, and opposite St Catherine's College.

The Subject Librarian responsible for relevant areas within the library is John Southall (john.southall@bodleian.ox.ac.uk) and he is based at the SSL.

Appendices

Appendix 1: Detailed syllabus

Resources Theme

How is energy produced, converted and traded? What energy technologies are available, what energy differences are there between different parts of the world and how have we arrived where we are with global energy systems?

R1. Energy Sources (Michaelmas Term Weeks 1-2)*

Professor David Wallom (Department of Engineering Science)

Course Context and Content

Energy, its production/transformation and consumption, are one of the key enablers for our current lifestyle and are about to undergo a huge transformation towards a low carbon future. As such it is essential that we understand energy itself from a theoretical and foundational basis, the primary sources of energy now and in the near past. This module is a foundational module and as such will describe the fundamentals of energy, including the different forms of energy when going beyond the fundamental of kinetic and potential towards those types of energy that can be exploited by society. We will discuss and understand the fundamental background of thermodynamics, conservation of energy and transformation of energy. We will discuss how we use energy at a high level to enable preparation for other modules within the course though topics such as energy for transport, energy for life and future energy sources for the masses. We will then consider the current global energy mix. The module will use lectures, group work, presentations, debates and project based learning to cover this broad and foundational topic to the whole course.

Lecturers

Prof David Wallom
Dr Masao Ashtine
Dr Sarah Sparrow
Prof Myles Allen
Prof Felix Leech
Prof Ben Williams

Course Content and Structure

The course will cover the following content in 30 1.5 hour sessions:

1. **Intro to the Energy System**

2. **The Energy System**

Discussion about the system and where there are key strengths and weaknesses laying the ground work for how we describe the Energy System within the course.

3. **Forms of Energy**
   i) What is energy
   ii) What is Work
   iii) What is Power
   iv) Units and Measurement

4. **Embodied or Embedded Energy**
   a. What is it and how important is it in current arguments about energy utilisation?
   b. Types of embodied energy
   c. Constraints
   d. Why?
   e. Definition
   f. Tracing the process
      i. Raw materials [extraction, transport, processing]
      ii. Construction [transport, assembly, waste]
      iii. Utilisation [operating]
      iv. Disposal [transport, waste]
   g. Example - buildings

5. **Energy System Behavioural Transition exercise**
   There are many energy transitions that are suggested as ways to reduce our environmental impact. We should think critically about these. Are the published studies credible? We should ensure they haven't made unfortunate assumptions.

6. **History of Energy and Global Energy usage**
   From the earliest times of almost prehistory to now energy has been a constant requirement of society, whether they realised it or not.

7. **Transformation and Transfer**
   As we must operate under the principle of conservation of energy we must understand the usable transformations between different types of energy.

8. **The Climate Change Challenge**
   Climate change is the single biggest challenge for society as it moves forward; as such it is an energy problem first and foremost and as such we must understand the mechanisms of climate change. We must do this whilst also realising that we do not have uniform availability of energy on the planet so we must understand the current limitations of energy availability around the world.

9. **Thermodynamics**

It will be necessary to have an understanding of the theoretical underpinnings of how we calculate energy within a system, in transformations and how energy may be distributed within a system and change during action or changes within that system.

10. The System

a. Current Energy sources and interconnection

What are the energy sources used in society now? What are the mechanisms used to transform their energy and make it usable? Resource location & distribution (local vs distributed)? Discussion on efficiency including full chain analysis.

b. Future Energy

What are the restrictions on current energy sources and what new sources are available? What are the future roles for current energy sources and how will new sources become widely adopted?

Course Text(s)

- Energy Science, Andrews and Jelley (OUP)
- Sustainable Energy –without the hot air, David J.C. MacKay
- Thermodynamics, A complete undergraduate course, Andrew M. Steane
- National Grid Future Energy Scenarios, National Grid PLC.
- Otto, F.E., 2017. Attribution of weather and climate events. *Annual Review of Environment and Resources*, *42*, pp.627-646.
- IPCC Special report on 1.5, https://www.ipcc.ch/sr15/
- Energy Systems: A Very Short Introduction, Nick Jenkins (OUP)
- BP Statistical review of world energy, BP.
- Applied Thermodynamics for Engineering Technologists, Eastop T.D. & McConkey A., Longman, 1993, Chaps 1-3, 6, 7-9, 13, 16
- Fundamentals of Engineering Thermodynamics , Moran M.J. & Shapiro H.N., Wiley, 2006, Chaps 1-4, 8-9, 11, 13
- Engineering Thermodynamics Work & Heat Transfer , Rogers G.F.C., Mayhew Y.R. Longman, 1993, Chaps 1-4, 7-12, 14-15, 17
- Basic Engineering Thermodynamics, Whalley, OUP, Chaps 1-7, 12-15, 17
- Four laws that drive the universe, Atkins, P. W. , Oxford University Press, 2007

R2. Energy Conversion 1 (Michaelmas Term Week 8)

Dr Anupama Sen (Oxford Institute for Energy Studies)

Course Context

Non-renewable energy (oil, gas, coal and nuclear) accounts for around ninety per cent of total global energy consumption. The current global energy system that we have today has been built around non-renewable energy sources, raising the question: *how did we get to where we are today?* This question can be considered in three connected parts.

The first and obvious part is the science of energy conversion, and the role of technology and technological advancements in facilitating newer and more efficient forms of non-renewable energy generation to meet society's needs. Technological advancement on its own is, however, insufficient in explaining the evolution of non-renewable energy systems and a deeper understanding requires going beyond the singular issue of technology to consider it in relation to wider socioeconomic factors.

The second part is therefore the role of economic growth and human development and their contribution to non-renewable energy use. As societies grow richer and incomes increase, energy use among consumers typically evolves from lower value-added fuels to higher-value added and 'cleaner' fuels (e.g. from wood, through to coal, oil and gas). As energy consumers around the world moved up the 'energy ladder' in this way, it also catalysed the construction and development of capital intensive infrastructure for the different fossil fuel types, that was necessary to support the use of these non-renewable fuels, in a centralised way.

The third part is the dynamic nature of the process and the different speeds at which the non-renewable energy system has evolved in different countries around the world. Factors underpinning this 'differential development' of non-renewable energy systems include the speed of technology transfer, resource endowment, comparative advantage, and policies promoting inter-fuel substitution. For instance, many hydrocarbon-producing countries rely on the enormous rents generated by oil and gas production and export to support their societies and on cheap non-renewable energy to support their economies.

This module will explore the evolution and development of the main non-renewable energy sources within the current energy system against the context of the three parts above. It will draw from the experiences of different countries to show how differences in contexts have shaped the evolution of non-renewable energy alongside the 'locking in' of infrastructure created to support them. Using specific examples, it will look at the path dependencies created by incumbent non-renewable energy systems, and the role of policies in disrupting them and shaping the transition to decarbonised energy systems.

The course will draw on a mix of academic and industry expertise, giving students the opportunity to engage with guest lecturers as well as tackle practical exercises and thought experiments.

Course Content and Structure

The course will cover most of the following topics through lectures and/or readings:

1. **Global overview of non-renewable energy systems**

Looks at the global energy scene and sets out the main trends in non-renewable energy use in different world regions. Connects this with the historical evolution of these systems and questions why economies moved from renewables to fossil fuels in the first place, with the process still happening today e.g. developing economies moving from traditional biomass to fossil fuels constitutes an 'advance' in sustainability. Discusses the characteristics of past non-renewable energy transitions. Stresses that the drivers have been different in different countries. Covers key economic concepts including: sustainability, comparative advantage, scarcity rents, interfuel substitution, path dependency, environmental Kuznets curve, efficiency of energy use.

2. **Energy Conversion and Conventional Power Generation System**

Principles of energy conversion in conventional non-renewable energy systems. The laws of thermodynamics and heat-to-work conversion in different thermodynamic cycles. The efficiencies of power plants and heating devices. State-of-the-art and future developments of different technologies: Steam power plant; Open Gas Turbine (GT) plants; Combined Cycle Gas Turbine Plants (CCGT)s. Future flexible operation of conventional power generation systems (improved operating flexibility, biofuels) with increasing presence of renewable power. Hybrid conventional and renewable energy systems (CCGT and Concentrated Solar Power (CSP). Fuel cells. Combined Heat and Power (CHP) – Cogeneration plants. Types of CHP plants. Performance parameters for a CHP plant. Power plants for transport: The reciprocating internal combustion engine and its performance. Turbojet engines.

3. **Coal: persistence in the energy mix**

The early emergence of coal as a major non-renewable energy source; the development and organisation of infrastructure to support its use; coal production and consumption around the world; links between the coal sector and the wider economy including labour markets; environmental issues and the decline of coal; new 'clean coal' technologies; the future of coal – can we expect coal to 'disappear' from the energy mix?

4. **Oil: the world's dominant energy source**

Key drivers for the emergence and widespread use of oil across the world, including factors such as higher value-add, ease of transportation, and storage; the oil supply chain; the operation of world oil markets; the valuation of oil reserves and their contribution to path dependency; the macroeconomics of oil in major exporting countries; new oil production technologies; oil and the energy transition; adaptation strategies of oil producers.

5. **Gas's evolving role in the energy system**

Gas's evolution from a by-product of oil to a high value-added fuel; the development of capital intensive infrastructure to support its use; the gas supply chain; how gas is valued and traded globally; the drivers of gas demand in different regions; the future of gas in a decarbonising energy system.

6. **Nuclear Energy**

Fission and fusion technologies – the nature of energy release, and the challenges associated with controlling nuclear reactions. Energy density and fuel tolerance – the need for a nuclear fuel cycle – proliferation and security of supply. The role of nuclear energy in current power generation – national norms and historical perspectives. Modern fuel cycles from mining to reuse/ storage. Possibilities for future development.

7. **Decarbonisation of fossil fuels**

Carbon footprint of different power generation technologies. Carbon sequestration and storage (CCS). Although there are several recommended / researched techniques, it has not yet been implemented on a large scale. Carbon capture methods: Pre- and post-combustion, Oxy-Combustion systems. Coal gasification through Integrated Gasification Combined Cycle (IGCC) plants. Geological CO2 storage options and enhanced oil recovery. Reducing carbon emissions through further efficiency improvements: Ultra-high-efficiency Hybrid Combined Cycle Gas Turbine (CCGT) and Renewable Energy. The feasibility of implementation of different CCSs technologies depends on many factors, including economics (scale) and government policy. Clean coal initiatives – China and India cases. Thinking big – Climate Engineering: Direct CO2 Removal (DCR) and Solar Radiation Management. Why the energy shift towards renewables in Germany fails to cut the carbon emission?

8. **The transition away from the current non-renewable energy system**

Is technological change the only factor in transitioning from a predominantly non-renewable carbon emitting energy system to a decarbonised system; are there 'rigidities' or other characteristics of non-renewable energy systems that are unsuited (or suited) to a decarbonised future; how can the path dependency of non-renewable energy systems be disrupted or reshaped, and how can we begin thinking about this – i.e. which parts of the system need to be changed first; what are some of the difficult trade-offs involved and some of the uncertainties surrounding them; will renewables come to dominate energy systems and will they be centralised or decentralised; will we see increasing diversity or homogeneity between regions; what is the role of government policies vis-à-vis market instruments in catalysing change.

R3. Energy Conversion 2 (Hilary Term Week 4)

Professor Moritz Riede (Department of Physics)

Course Context and Content

This module expands on the energy sources available to use in the form of renewables but is then extended into the different additional infrastructure that is necessary when considering renewable energy to cope with its intermittent nature. This will include Wind, Solar, Marine (Wave and Tidal), Geothermal and Bioenergy as well as a specific strength of the university in batteries and energy storage technologies. Alongside studies on the different methods of converting energy into heat and electricity using the renewable technologies the module will discuss implications of different energy mixes available and how they could affect a final energy balance. The module will use both lectures and project based learning to ensure there is a full understanding of the implications.

Course Content and Structure

1. **The current capabilities of renewable energy**
What is the overall contributions that renewables make to the energy mix currently and what are the restrictions on current expansion? Comparison to RE1 energy conversion technologies.

2. Solar energy conversion
What are the current designs of electricity generating solar panels and what are the current leading edge areas of research? What are alternative ways of using the sun's energy to generate electricity and heat. How the sun can be used for solar cooling?

3. Harnessing the power of the wind
Where can Wind power (on and off shore) contribute, what are the limitations and what specific infrastructure is necessary for wind to provide input to the grid? What unconventional concepts are explored?

4. Power from biomass
Traditional biomass has been used for heating and cooking for millennia. How can this form of energy be used today, and what implications are there for land use and food supply?

5. Geothermal energy
What ways are there to convert the heat the earth produces (both surface and deep) into other usable forms.

6. Power from water
How will running water sources and developments continue to contribute to the available renewable energy mix? How will Marine energy sources and developments contribute to the available renewable energy mix and what are leading edge areas of wave and tidal energy capture?

7. Energy Storage technologies and keeping the lights on

Due to the intermittent nature of renewables it will be necessary to provide mechanisms for storing energy provided in times of plenty but required in times of famine. What technologies are available at the moment and how can we use those currently available without environmental damage or external dependency?

8. Energy Transport

In addition to temporal intermittency, renewable energy resources are – just as e.g. fossil ones – unequally distributed across the Earth. How can energy, and in what form, be transported over short and large distances in an effective and safe way?

Course Text(s)

- Energy Science, J. Andrews and N. Jelley; OUP (3^{rd} ed), 2017
- Renewable Energy: Power for a Sustainable Future, G. Boyle; OUP (3^{rd} ed), 2012
- Renewable Energy Resources, J. Twidell and T. Weir; Routledge (3^{rd} ed), 2015
- Elementary Climate Physics, F. W. Taylor; OUP, 2005
- Beyond Smoke and Mirrors, B. Richter; CUP, 2010
- IEA World Energy Outlook(s) (http://www.worldenergyoutlook.org/)
- Sustainable Energy- without hot air, David MacKay; UIT, 2009, (http://www.withouthotair.com/)

Systems Theme

How is energy distributed so that it is usable and what are the considerations that need to be made for bridging between the producers and consumers?

Sy1. Energy Infrastructure (Michaelmas Term Weeks 3 & 5)*

Professor Malcolm McCulloch (Department of Engineering Science)

Course Context and Content

Useful energy is often not available to the end user at the time or place that it is required. Therefore the right type of energy – the energy vector – needs to be brought through space and time, from the source of production to the point of consumption. This module considers the former challenge – that of distributing the energy to the end user, often over long distances (transmission) and over wide areas (distribution). However, there is often an overlap with moving energy through time – storage – and this will be developed when considered as part of the design of the spatial distribution system.

This module develops some key principles, and then applies them to case studies – that highlight the common themes and challenges for distributing many forms of energy. This module is designed to enable the student to deeply understand the following principles:

1. The implications of the choice of energy vector.
2. The underlying physics and technical models.
3. Operational methods to manage losses and faults.
4. The drivers of capital expenditure.
5. Identification of key risks, including obsolesce, social acceptability and financial viability.

By the end of the module you will be able to:

1. Critically assess an existing distribution system.
2. Develop a scoping study to develop an enhanced distribution system, considering multiple vectors.
3. Develop a scoping study for a new distribution system.

Course Content and Structure

1. Understanding the problem today and tomorrow.
    a. Basics.
    b. Energy density and timing of production and generation.
    c. Diversity.
    d. Moving energy through time and space: Storage, distribution and transmission.
2. Types, principles and characteristics of energy vectors.
    a. Types of energy vectors: Mechanical, Thermal, Chemical, Electrical
    b. Energy, power and ramping.

    c. Losses: Conversion, spatial, temporal
    d. Costs, capex and opex: Conversion, spatial, temporal
    e. Reliability and fault management. (Degradation and failure mechanisms, Identification and mitigation)
3. Low fidelity modelling
    a. First principles model
    b. Sankey diagram
    c. LCOE for energy vector
    d. Exercise 1 - Enhance an existing system
4. Detailed analysis of power grids
    a. Power, Reactive Power and Apparent power.
    b. DC and AC Single and Three phase analysis.
    c. Power through a resistor (DC) and an inductor (AC).
    d. Simple power flow analysis in Python
    e. Parameters: Transmission lines and transformers.
    f. Costings for different technologies (overhead lines, cables, transformers, switchgear)
    g. Exercise 2 - Analyse an existing system
5. Spatial analysis
    a. GIS systems: QGIS
    b. Analysis of existing transmission grids: UK and Africa
    c. Coupled with power flow analysis.
    d. Analysis of existing distribution grids.
    e. Spatial optimisation in Python.
6. Emerging grid topologies
    a. Fractal like grids.
    b. Space-time grids.
7. Module synthesis

Course Text(s)

https://open-power-system-data.org

https://www.elexon.co.uk/wp-content/uploads/2017/06/bmrs_api_data_push_user_guide_v1.1.pdf

https://www.qgis.org

Sy2. Energy for Development (Hilary Term Week 1)

Professor Malcolm McCulloch (Department of Engineering Science)

Course Context and Content

Modern energy is a necessary condition for development. This importance is recognised as it is a core Sustainable Development Goal: SDG7. Providing the energy needed at an acceptable cost to deliver appropriate services efficiently, while protecting the environment, is a significant challenge. New technologies are being developed and there is a growing appreciation that they need to be appropriately targeted. Furthermore the system has to be able to grow with the customer, possibly changing technologies and providers. This transition is complicated by the institutional and economic local, regional and in-country capacities.

This module develops some key principles, and then applies them to case studies – that highlight the common themes and challenges for developing appropriate energy systems. This module is designed to enable the student to deeply understand the following principles:

- The end user is key in defining the service requirements and the finances available.
- The choice of distribution of energy is dependent on population density, effective load density and generation type.
- Key risks include social acceptability, obsolesce and financial viability.

By the end of the module you will be able to:

1. Deploy different methods to understand end user requirements and capabilities.
2. Critically assess an existing distribution system.
3. Develop a scoping study for a new distribution system, including costings.

Lecturers

Professor Malcolm McCulloch (Department of Engineering Science)
Dr John Rhys (Environmental Change Institute, School of Geography and the Environment)
Dr Avinash Vijay (Department of Engineering Science)
Dr Stephi Hirmer (Department of Engineering Science)

Course Content and Structure

1. Understanding the end user
    a. Energy Cultures as a framework of understanding the interplay of end-users and technology.
    b. Understanding norms and perceived value
    c. Social and productive uses: Information, motion, thermal
    d. Determining important energy services:
    e. Indicative load profiles and diversity.
    f. Willingness/ ability to pay
    g. Ethics
    h. Exercise 1: End users of West Ngosini

2. Spatial density
    a. Data sets
    b. Determining spatial density from discrete locations
        i. Nearest Neighbours
        ii. Kernal methods
        iii. Clustering techniques
    c. Exercise 2: Spatial analysis of West Ngosini

3. Grid topologies
    a. Spatial, temporal and energy resource as determinants.
    b. SHS, battery grid, Micro grid, Mini grid, grid, Fractal
    c. Exercise 3: Grid plan for Machakos County

4. Institutions
    a. Weberian vs Northian States
    b. Power sector organisation
        i. Vertically integrated
        ii. Unbundling
        iii. Private sector
        iv. Synergistic frameworks
    c. Exercise 4: Institutions

5. Module synthesis

Course Text(s)

Topic 1

1. https://doi.org/10.1016/j.enpol.2010.05.069
2. https://doi.org/10.1016/j.rser.2014.03.005

Topic 2

1. https://www.qgis.org

Topic 3

1. https://open-power-system-data.org

Topic 4

1. https://www.beloit.edu/upton/assets/North.pgs.vol.I.pdf

Sy3. Digitisation, Smart Energy and Communication (Hilary Term Week 5)

Professor David Wallom (Department of Engineering Science)

Course Context and Content

It is clear that as we approach an era where we are no longer living in energy abundance that we must increase the efficiency with which we use energy. As such it is important that we consider how we will make use of advanced communications tools and technologies. These will primarily be concerned with the mechanisms by which we improve the distribution and consumption of energy and as such this is where this module will concentrate. Outside of regular smart systems for electricity we will also look at other activities in this area including local heat networks, smart homes and their interfaces to energy, etc. As part of the critical national infrastructure we will also consider the cybersecurity aspects of smart systems.

Lecturers

Professor David Wallom (Department of Engineering Science)
Professor Alex Rogers (Department of Computer Science)
Dan Bentham (Ubitricity)
Ramon Granell (Department of Engineering Science)
Dr Masao Ashtine (Department of Engineering Science)

Course Content and Structure

The course will cover the following content:

Day 1

1. **The Power System, Dynamics, Stability and Control**
   How is the electrical system operated now, balancing demand and quality of supply?
2. **What is a smart grid?**
   a. International Definitions
   b. Generalised characteristics exercise to pull out key points from definitions
3. **Smartening the Energy system**
   a. Information and analytics in the electricity network
      i. Fixed point Generation
      ii. Transmission
         1. Operations
      iii. Distribution
         1. Network equipment
         2. Large Distributed generation connection points
      iv. Retail
         1. Metering
         2. Services
   b. Gas network

How do we **currently** make use of multiple types of input information to improve the efficiency of the electricity transmission network? What are the communications and control protocols and systems in use currently? What scope is there for smartening the gas network?

Day 2

1. **Smart grid concept and Reference model**
    a. NIST Smart Grid
    b. Smart Grid Architecture Model (SGAM)

2. **Creating tools and services to inform smart energy systems roll outs**

3. **Smart Meters and smart homes**
    a. Current situation (SMETS 1)
    b. Current Smart home solutions
    c. The national smart meter rollout, (SMETS 2) including the full system design as currently proposed.
    d. The DCC and access models
    e. The advantages and disadvantages of smart meters

Day 3

1. **How we can use Smart Meters and other enhanced data providers, Cornish Local Energy Market**
    a. **Demand Management, now and in the future**; How do you currently understand in depth the current state of the energy network, at all voltage levels? It is clear though that we will need to manage consumption in the future, from the management of large scale usage now to the domestic consumption in future.

    b. Enhancing data within the network through meter information; Upgrading of capabilities within the distribution network to match transmission
        i. System state estimation techniques have been used in the transmission and are now beginning to be seen in the distribution networks.
        ii. Voltage control

2. **Creating insights from big data**
   Utilising Machine Learning and AI to understand better the relationship between energy consumption and the physical activities that are drivers. Using these to also enable the provision of behavioural changes to reduce consumption.
    a. Energy theft
    b. Cross domain insights

3. **The use of Forecasting within the energy system**

Day 4

4. **Beyond just smart meters to an integrated communications and energy home, transport and lifestyle system**
    a. Integrating micro generation, home storage, transport infrastructure and the smart home. Include talking about market makers, new markets etc.
    b. Smart homes

5. **Security implications of energy systems**

    How as part of the critical national infrastructure should we be securing the communication channels, equipment and keeping data private in a new energy system where everything is 'smart'?

Day 5

6. **A global perspective on smart grids, where have we got to?**
7. **Summary, Synthetisation and conclusions**

Course Text(s)

https://ec.europa.eu/energy/sites/ener/files/documents/xpert_group1_reference_architecture.pdf

Sy4. Energy Systems; Economics and Markets (HT wk7)

Professor Cameron Hepburn

Couse Context and Content

Five of the seven largest companies in the world by revenue are in the energy sector, which is at the start of a remarkable, once-in-a-civilisation transition. Coal is under severe pressure and the oil and gas majors are rethinking their long-term strategies, given the transition towards greater electricity and renewable energy, driven by climate change and new technologies. After a brief background into the energy system, this course examines the shifts underway in technology, government energy and climate policy and economic and political issues across the energy supply chain. We examine the potential for value creation as the transition to zero-carbon energy, particularly solar and wind, occurs around the world, and the social scientific dimensions of integrating those technologies into energy systems.

Lecturer

Professor Cameron Hepburn – Smith School of Enterprise and the Environment and Institute for New Economic Thinking, email: cameron.hepburn@new.ox.ac.uk.

General information

Each of the eight session has 1-2 essential readings and several additional readings. Useful references and sources of data include the annual publications of the International Energy Agency (IEA) World Energy Outlook, BP Energy Outlook, and the United States Energy Information Agency (EIA) Annual Energy Outlook, although you should not necessarily take numbers and certainly forecasts at face value.

Two very readable books on energy are:

- Helm, D. (2017) Burn Out: The Endgame for Fossil Fuels
- Yergin, D. (2012) The Quest: Energy, Security, and the Remaking of the Modern World.

The Oxford Review of Economic Policy periodically has useful special issues on energy, including a 2016 issue on the Future of Fossil Fuels and an issue in 2019 on the Age of Electricity.

Those wanting a more academic input can peruse journals such as Nature Energy or Applied Energy. Basic facts and figures can be found at Our World in Data.

Almost every 3 hour session has at least an external speaker for some part of the session. Speakers tend to be distinguished leaders in the energy industry, and are noted below. The sessions also include a multi-player game and investment pitch exercise.

Outline of Course Structure

The course will cover the following content in eight 3-hour sessions:

1. Energy sector history and the coming transition. Concepts and definitions. Brief overview of energy system history. Trilemma (security, cost, environment). Introduction to the drivers of the coming transition (new technologies and climate change).

2. Energy technologies. Rates of progress, costs and wider implications of the following: Renewables (solar, wind, hydro), SMRs, CCS, Smart energy systems, demand side, grid.

3. Climate Change and the final 25%. Scientific basis of climate change. Political and policy response, including carbon markets. Non-fossil energy carriers and energy storage. Difficult to abate sectors.

4. Power markets. Challenge to power markets of very low marginal cost technologies. Balancing supply and demand. Functioning of wholesale power markets, balancing markets, capacity markets. Main approaches to regulation. Missing money problem.

5. Electricity Market Laboratory. The class will use Python to work out a model of a realistic electricity day-ahead wholesale market. Determine emerging electricity pricing using economic dispatch based on merit order considering network constraints.

6. Energy access. Energy markets in developing countries. SE4All and SDG 7: role of business in providing electricity for the 1 billion people without it. Grids vs distributed power generation.

7. Energy finance. Scale of the coming financing challenge. Financing of the energy supply chain. Finance in the context of political risk. Bankability of different energy revenue streams.

8. Future directions. Threats and opportunities are created by newer technologies (including blockchain smart grid and DSR) and policy responses to climate change. Shifts in value pools. Future role of the oil and gas majors.

About the Lecturer

The course is primarily taught by Professor Cameron Hepburn, whose positions and experience include:

- Professor of environmental economics at Oxford
- External Advisory Board, Royal Dutch Shell
- Advisory Panel, Sarasin & Partners LLP, Climate Active Fund
- Entrepreneur in energy / climate / economics
- Former McKinsey, Rhodes Scholar

Detailed Course Structure

Session 1: History of the energy sector, and the coming transition

Session content: Concepts and definitions. Brief overview of energy system history. Trilemma (security, cost, environment). Introduction to the drivers of the coming transition (new technologies and climate change).

Essential reading:
- Energy Transition Commission (2017) Better Energy, Greater Prosperity, Executive Summary.
- International Energy Agency (2016) World Energy Outlook, Executive Summary.

Additional reading:
- Fouquet, R. (2014). Long-run demand for energy services: Income and price elasticities over two hundred years. *Review of Environmental Economics and Policy*, 8(2): 186-207.
- Aurora Energy Research (2013) Predictable Surprises: Lessons from 30 Years of Energy Sector Forecasts, November.
- Segal, P. (2011). Oil price shocks and the macroeconomy, *Oxford Review of Economic*
- *Policy*, 27(1): 169-185.

Session 2: (New) Energy Technologies

Session content: Rates of progress, costs and wider implications of the following: Renewables (solar, wind, hydro), energy storage technologies, SMRs, CCS, Smart energy systems, demand side, grid.

Essential readings
- International Energy Agency (2017) Energy Technology Perspectives, Executive Summary
- Farmer, J. D. and Lafond, F. (2016), How predictable is technological progress? *Research Policy*, 45(3): 647-665.

Additional readings
- World Economic Forum (2017) The Future of Electricity: New Technologies Transforming the Grid Edge, March.

Session 3: Climate change and the final 25%

Session content: Science of climate change. Political response. Carbon prices, carbon markets. Impact on energy markets. Physical impacts of changing climate on energy assets.

Essential readings
- IPCC (2014) Synthesis Report: Summary for Policy Makers
- World Bank (2016), State and trends of carbon pricing, September.

Additional readings
- Ellerman et al (2016), The European Union Emissions Trading System: Ten Years and Counting
- World Bank (2016), Emissions trading in practice, March.
- Pfeiffer et al (2016), The 2°C capital stock for electricity generation, *Applied Energy*, 179: 1395-1408.

Session 4: Power Markets

Session content: Challenge to power markets of very low marginal cost technologies. Balancing supply and demand. Functioning of wholesale power markets, balancing markets, capacity markets. Missing money problem. European day-ahead market orders. Uniform pricing vs pay-as-bid. Pool markets vs continuous trading. Introduction to the nodal pricing framework.

Essential readings

- Green, R. (2005) Electricity and markets, *Oxford Review of Economic Policy*, 21(1): 67-87.

Additional readings

- Fundamentals of Power System Economics, D. Kirschen, G. Strbac, 2004
- Litvinov, E. (2010). Design and operation of the locational marginal prices-based electricity markets. IET generation, transmission & distribution, 4(2), 315-323.
- Joskow, P. L. (2008). Capacity payments in imperfect electricity markets: Need and design. Utilities Policy, 16(3), 159-170.
- Imran, K. and Kockar, I., 2014. A technical comparison of wholesale electricity markets in North America and Europe. *Electric Power Systems Research*, 108, pp.59-67.
- Farrell, N. et al (2017) Is this the end of conventional wholesale electricity markets? in preparation.

Session 5: Electricity Market Laboratory

Session content: The class will use Python to work out a model of a realistic electricity day-ahead wholesale market. Determine emerging electricity pricing using economic dispatch based on merit order considering network constraints.

Essential readings

- Pyomo Documentation

Additional readings

- Biggar, D. R., & Hesamzadeh, M. R. (2014). *The economics of electricity markets*. John Wiley & Sons

Session 6: Energy Access

Session content: Scale of the coming financing challenge. Financing of the energy supply chain. Finance in the context of political risk. Bankability of different energy revenue streams.

Essential readings

- Se4All (2017) Global Tracking Framework 2017: Progress towards sustainable energy.
- Shen, W. and Power, M (2017) Africa and the export of China's clean energy revolution, *Third World Quarterly*, 38:3, 678-697.

Additional readings

- M-KOPA (2015) Affordable, clean energy: A pathway to new consumer choices.
- World Bank Programme: http://www.scalingsolar.org
- Gies, E. (2016) Can wind and solar fuel Africa's future? *Nature*, 539: 20-22
- Quansah et al (2016) Solar PV in Sub-Saharan Africa – Addressing Barriers, Unlocking Potential, *Energy Procedia*, 106: 97-110.

Session 7: Energy Finance

Session content: Scale of the coming financing challenge. Financing of the energy supply chain. Finance in the context of political risk. Bankability of different energy revenue streams. Group finance exercise on financing batteries in the UK.

Essential reading

- International Energy Agency (2016), World Energy Investment Outlook, Executive Summary.
- Renton, A. (2016) The role of energy storage in the UK electricity system, Bird&Bird.

Additional reading

- Covington et al (2016), Global warming: Shareholders must vote for climate-change mitigation, 530(7589) *Nature*, 156.
- Milken Institute (2015) Innovative Financing Models for Energy Infrastructure in Africa.

Session 8: Future directions

Session content: Threats and opportunities are created by new technologies (including smart grid and DSR) and policy responses to climate change. Shifts in value pools. Future role of the oil and gas majors.

Essential readings

- Miller, D. (2013) Why the oil companies lost solar, *Energy Policy*, 60: 52-60.
- Kammen, D (2014) Solar energy innovation and Silicon Valley, Bulletin of the Atomic Scientists, 70(5): 45-53.

Additional readings

- Helm, D. (2017) Burn Out: The Endgame for Fossil Fuels
- Lovins, A. (2013) Reinventing Fire: Bold Business Solutions for the New Energy Era

Services Theme

What is energy for? Why and how is energy provided to society and how can the energy system change – or be changed by – demand for services? How might social and economic goals be met in future? This theme concentrates on the interface between people (individuals and organisations) and energy, considering the role of demand for energy and energy services in the broader energy system.

Se1. Energy Demand (Michaelmas Term Weeks 6-7)*

Dr Gavin Killip (Environmental Change Institute, School of Geography and the Environment)

Course Context and Content

The Energy Demand module introduces students to the end uses of energy, how they differ between and within societies (>Sy 4) and geographies. We will explore demand as a socio-technical evolutionary process driven by progress in technology (>Se 2), development (>Sy 2) and society (Se4/Sy4).

Students will gain a foundation and understanding of the underlying service demands and units of energy used in different domains, framed by the Sustainable Development Goals of the United Nations. Key concepts include: socio-technical systems, energy services, energy efficiency, demand reduction, flexibility, and links beyond the energy system. Key skills developed include: critical evaluation and analysis, synthesis and presentation of data from diverse sources, reflexivity about studying complex systems using imperfect and incomplete data.

Assumptions: EVs and electrified heating are covered in Se2. Demand side policies are covered in Se4/Sy4.

Lecturers

Dr Gavin Killip (Environmental Change Institute, School of Geography and the Environment)
Dr Sarah Darby (Environmental Change Institute, SoGE)
Dr James Dixon (Environmental Change Institute, SoGE)
Professor Nick Eyre (Environmental Change Institute, SoGE)
Dr Tina Fawcett (Environmental Change Institute, SoGE)
Dr Debbie Hopkins (Transport Studies Unit, SoGE)

Course Content and Structure

The course will cover the following content in 30 ***1.5***-hour session*s:*

1. Energy and energy services. People and organisations use energy for a wide variety of purposes, but rarely ever consume energy for its own sake. The difference between the services we seek and the ways in which we achieve them have far-reaching implications for what we mean by energy demand and possible energy futures.

2. **Energy in relation to other Sustainable Development Goals.** Affordable and clean energy is one of 17 SDGs adopted by world leaders in 2015. The SDGs provide a framework for thinking about complexity, diversity, equity and human well-being in relation to environmental impacts.

3. **Energy demand as a socio-technical system.** Human activity, energy demand and energy services do not arise independently of technology. Instead, social processes and technological change can be considered as inter-dependent parts of a system which is therefore 'socio-technical' in nature.

4. **Energy demand in buildings.** Buildings account for a large and diverse share of energy demand worldwide. Innovations in technologies, processes and practices can all have an effect on energy demand. In theory, the demand reduction potential is large, but it remains difficult to achieve in practice.

5. **Energy demand in transport.** Transport energy demand is also large and varied. Mobility has links to different fuels and technologies, but also to patterns of social and economic activity, and to land-use and land-use planning.

6. **Energy demand in industry.** Goods and services provided by different kinds of industry account for a large share of energy use worldwide. This energy use can be analysed 'upstream' at the point of production but also 'downstream' at the point of consumption.

7. **Energy efficiency and demand reduction.** Energy efficiency has historically contributed to energy policy goals, and has the potential to continue to do so. Other routes to energy demand reduction (eg sufficiency) are also possible.

8. **Understanding and comparing data for energy demand.** Energy demand typically occurs in a highly distributed way, being made up of countless routine and strategic decisions by billions of people worldwide. This highly fragmented picture leads to numerous metrics and uses of energy data, which need to be analysed carefully if misleading conclusions are to be avoided.

9. **Timing and flexibility of energy demand.** With the rise of variable renewable energy supply and internet-enabled technologies, there is more potential than ever before to pay attention to the timing and flexibility of energy demand, which has the potential to contribute benefits to the wider energy system.

10. **Thinking about future energy demand.** Models and scenarios are widely used in strategic and policy debates about the future. Socio-technical systems thinking is useful when evaluating scenarios and the underlying assumptions about energy demand in relation to technology deployment

Course Text(s)

IEA (2018) Energy Efficiency 2018: Analysis and outlooks to 2040
https://www.iea.org/reports/energy-efficiency-2018 (NB registration required on IEA website for free access)

Unruh, G. C. (2000) Understanding carbon lock-in, Energy Policy 28(12): 817-830 https://doi.org/10.1016/S0301-4215(00)00070-7

Unruh, G. C. (2002) Escaping carbon lock-in, Energy Policy 30(4): 317-325 https://doi.org/10.1016/S0301-4215(01)00098-2

Boardman, B. (2015) Low-energy lights will keep the lights on. Carbon Management, 5(4): 361-371 https://doi.org/10.1080/17583004.2015.1006020

Energy and Society (Hilary Term Week 2)

Dr Nick Banks & Dr Colin Nolden (Environmental Change Institute, School of Geography and the Environment)

Course Context and Content

Energy systems exist to provide energy services to people, and they are designed, operated, developed and (occasionally) sabotaged by people. It is reasonable to describe and analyse them as socio-technical systems, but the social dimension of energy systems is often missed or treated as an optional extra consideration.

This module aims to develop students' understanding of how energy systems rely on interactions between technologies and people. It also examines how they evolve in response to changes in human activities, actors, skills and governance arrangements.

Students will learn how to analyse energy transitions in terms of

- actors, their knowledge and skills
- stakeholder priorities and interactions
- local and more general influences on energy use patterns and system configuration
- technology adoption and adaptation in real-life conditions.

The teaching will build on material on demand in Se 1, in particular. It emphasises social considerations in analysis, design and operation of energy systems at different scales and in a range of contexts.

Lecturers

Dr Nick Banks and Dr Colin Nolden will lead the module with contributions from colleagues at the Environmental Change Institute and beyond. The details of guest speakers may vary, depending on their availability.

Dr Jake Barnes, ECI
Dr Maximus Byamukama, Dept of Engineering
Dr Philipp Grunewald, Dept of Engineering
Dr Stefanie Reiss, Oxford University Sustainability team
Sarah Rosenberg-Jansen, consultant, humanitarian energy policy and practice
Alexandra Schneiders, UCL Energy Institute

Course Content and Structure

The course will cover the content set out below. The plan is for two sessions in the morning and one in the afternoon, with time in the second half of the afternoon for further discussion and one-to-one guidance. However, there may be alterations depending on teaching conditions at the time.

Monday: *systems, concepts and theory*

- Energy systems as social systems, and vice versa. Energy services, infrastructures of demand and supply and how we engage with them.
- Energy transition – the global challenge.
- Actors in energy systems.
- Methods for analysing socio-technical systems and system change. Metrics, indicators and scales of operation.
- Communicating about energy – exercise based on learning from the course to date.

Tuesday: *Energy demand in relation to system development*

- Report back from homework exercise (Grunewald and Diakonova). Changing household practices and implications for demand and supply, UK and worldwide.
- Peer to peer electricity trading, with game if possible.
- Aiming for a zero-carbon University: the challenge of making Oxford University more sustainable.

Wednesday: *Energy transition, local*

- Energy and geography.
- Business models for local energy transition
- Implementing change in a local energy system: Project LEO as a local, low-carbon demonstrator project built on social capital, using market mechanisms and smart technology, and led by the network operator.
- Communicating energy – practical exercise.

Thursday: *Socio-technical system change – practical examples*

- Implementing smart metering – an exercise in socio-technical change.
- Setting up nanogrids in East Africa.
- Implementing smart storage heating – lessons from a European demonstrator project.
- Energy services for displaced people.
- Introducing assessment exercise.

Friday: *synthesis day*

- What are the main takeaways and how are they relevant to the rest of the course? Any unresolved issues?

- Preparation for assignment.

Reading list

Systems, concepts, theory

Eyre, N., Darby, S.J., Grünewald, P., McKenna, E. and Ford, R., (2018) Reaching a 1.5C target: Socio-technical challenges for a rapid transition to low carbon electricity systems. *Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences* 376:20160462

Stephenson, J., Hopkins, J. and Doering, A. (2014) Conceptualizing transport transitions: Energy Cultures as an organizing framework. *Energy and Environment* 4 (4), 354-364

Wilhite, H. (2008) New thinking on the agentive relationship between end-use technologies and energy-using practices. *Energy Efficiency* 1, 121-130.

Personal energy use in relation to system development

Khalid, R., Sunikka-Blank, M. (2018) Evolving houses, demanding practices: A case of rising electricity consumption of the middle class in Pakistan. *Building and Environment* 143, 293-305

Darby, S.J. and McKenna, E. (2012) Social implications of residential demand response in cool temperate climates. *Energy Policy*, 49: 759-769

Grunewald, P. and Diakonova, M. (2018) Flexibility, dynamism and diversity in energy supply and demand: A critical review. *Energy Research and Social Science*, 38: 58-66

Hargreaves, T., Wilson, C. and Hauxwell-Baldwin, R. (2017) Learning to live in a smart home. *Building Research and Information* 46 (1), pp.127-139

Energy system change as a social process

Boamah, F. and Rothfuss, E. (2018) From technical innovations towards social practices and socio-technical transition? Re-thinking the transition to decentralised solar PV electrification in Africa. *Energy Research & Social Science* 42, 1-10

BSECC: Bristol Smart Energy City Collaboration. Taking action to realise the benefits of smart energy data. https://www.cse.org.uk/projects/view/1296

Executive Summary of Darby, S.J., Liddell, C., Hills, D. and Drabble, D. (2015) Smart Metering Early Learning Project: synthesis report. For the Department of Energy and Climate Change, London https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/407568/8_Synthesis_FINAL_25feb15.pdf

Nolden, C., Barnes, J. and Nicholls, J. (2020) Community energy business model evolution: A review of solar photovoltaic developments in England. Renewable and Sustainable Energy Reviews 122, 109772. https://www.sciencedirect.com/science/article/pii/S1364032120300198

Parag, Y. and Janda, K.B. (2014) More than filler: Middle actors and socio-technical change in the energy system from the “middle-out”. *Energy Research & Social Science* 3, 102-112

Se3. Energy Policy and Governance (Hilary Term Week 8)

Dr Tina Fawcett (Environmental Change Institute, School of Geography and the Environment)

Course Context and Content

This module introduces energy policy and governance. It will provide an understanding of the social, economic, technical and political contexts in which policies are formed and implemented. Theories of policy making will be introduced. Students will learn about the different policy instruments and policy mixes used in various countries and contexts. Most focus will be on policies related to the energy transition – policy on energy efficiency / energy demand reduction and renewable energy. Throughout the module there will be examples of successful and unsuccessful policies from across the world. By the end of the module the students should understand how to critically analyse current and proposed policies against a range of criteria.

The teaching will build on introductory material on policy in Se 1, and relies on the strong socio-technical understanding of the energy system delivered by earlier modules.

Lecturers

Dr Tina Fawcett will lead the module with contributions from colleagues at the Environmental Change Institute and beyond. The details of guest speakers may vary, depending on their availability.

Dr Jan Rosenow, European Director, Regulatory Assistance Project
Dr Colin Nolden, Environmental Change Institute, University of Oxford
Dr Radhika Khosla, Smith School of Enterprise and Environment, University of Oxford
Dr Paula Hansen, Environmental Change Institute, University of Oxford

Course Content and Structure

The structure this year will depend somewhat on teaching conditions, as some interactive teaching elements may be harder to deliver.

Monday: Purpose of energy policy
A brief history of energy policy. Introduction to the energy trilemma. Interactive exercise about different priorities in policy making. Contrasts in policy for people / organisations / technologies / markets. Introduction to student exercise to find out about energy policies in home / another country

Tuesday: Current policy
Student report-back – policies in home countries (or another country). Different types of policy and policy mixes. An overview of European energy policy. Examples of successful and unsuccessful policies, e.g. the ‘Cash for Ash’ scandal in Northern Ireland, the successful introduction of condensing gas boilers in the EU.

Wednesday: Policy making processes and evaluation
Processes and theory of policy-making. Understanding multi-level governance and roles of non-government actors. Choices and trade-offs in policy design and implementation. Evaluation – how do we decide whether a policy has been a success?

Thursday: Politics and policy making
The links between politics, policy and power. Geo-politics of energy. The role of elected politicians. The role of other stakeholders. Governance of policy making, including examples of new initiatives e.g. Climate Assemblies in the UK & France. The politics of carbon taxes in various countries. Introduction to student exercise on policy evaluation.

Friday: Policies for the future
New challenges for policy – market structures, new technologies, new business models, peer-to-peer trading, 'smart' everything, decentralisation. New approaches to policy making. Examples of new policy models including community sharing of renewable energy. Ways of meeting the 1.5C challenge. The limits of policy. Student presentations/ feedback on policy evaluation exercise.

Reading list
Some of these papers / information sources would fit under more than one heading. It is not necessary to read them all, but worthwhile looking at one source from each category.

Energy policy: overview and aims of policy
World Energy Trilemma Index – this ranks countries on their ability to provide sustainable energy through 3 dimensions: Energy security, Energy equity (accessibility and affordability), Environmental sustainability. Use the 'Trilemma Tool' to explore different countries:
https://www.worldenergy.org/publications/entry/world-energy-trilemma-index-2019

Sterner, B. et al (2019) Policy design for the Anthropocene. *Nature Sustainability* 2:14-21 (Goes beyond energy – broad overview of policy options and key considerations in design.)

Current policy
Rosenow, J., Cowart, R., Thomas, S. (2019): Market-based instruments for energy efficiency: a global review. Energy Efficiency 12(5), pp. 1379–1398

Databases for policy measures:
MURE (Mesures d'Utilisation Rationnelle de l'Energie) provides information on energy efficiency policies and measures that have been carried out in the Member States of the European Union.
http://www.measures-odyssee-mure.eu/
International Energy Agency database: https://www.iea.org/policies - for global coverage

Policy making processes and evaluation
Obeng-Darko, N.A. (2018) Why Ghana will not achieve its renewable energy target for electricity. Policy, legal and regulatory implications. *Energy Policy* 128:75-83

EPATEE European project on evaluation – includes case studies from EU and USA:
https://epatee.eu/case-studies

Politics and policy
Cairney, Paul (2015) 12 Things to know about studying public policy.
https://paulcairney.wordpress.com/2015/10/29/12-things-to-know-about-studying-public-policy/

Mallaburn, P. and Eyre, N. (2014) Lessons from energy efficiency policy and programmes in the UK from 1973 to 2013. *Energy Efficiency* **7:** 23–41

Lamb, W., Mattioli, G., Levi, S., Roberts, J., Capstick, S., Creutzig, F., . . . Steinberger, J. (2020). Discourses of climate delay. *Global Sustainability, 3*, E17. doi:10.1017/sus.2020.13

Policies for a better future
ECEEE, AEEE, ACEEE (2019) 12 strategies to step up global energy efficiency: Advice from three expert NGOs to IEA's High Level Commission on Energy Efficiency. Available:
https://www.eceee.org/all-news/news/12-strategies-to-step-up-global-energy-efficiency/

UNEP (2019) Cooling in a warming world: Opportunities for delivering efficient and climate friendly cooling for all/ https://www.k-cep.org/insights/resources/

Executive summary of: IRENA (2018) Renewable energy policies in a time of transition.
https://www.irena.org/publications/2018/Apr/Renewable-energy-policies-in-a-time-of-transition

Bruun, E. and Givoni, M. (2015) Sustainable mobility: Six research routes to steer transport policy. *Nature* 523:29-31

Green Alliance and CREDS (2020) Balancing the energy equation: Three steps to cutting UK demand
https://www.green-alliance.org.uk/Balancing_the_energy_equation.php

Appendix 2: Complaints and appeals

The University, the MPLS Division and the Department of Engineering Science hope that provision made for students at all stages of their course of study will make the need for complaints (about that provision) or appeals (against the outcomes of any form of assessment) infrequent.

Nothing in the University's complaints procedure precludes an informal discussion with the person immediately responsible for the issue that you wish to complain about (and who may not be one of the individuals identified below). This is often the simplest way to achieve a satisfactory resolution.

Many sources of advice are available within colleges, within faculties/departments and from bodies like the Student Advice Service provided by OUSU or the Counselling Service, which have extensive experience in advising students. You may wish to take advice from one of these sources before pursuing your complaint.

General areas of concern about provision affecting students should be raised through Joint Consultative Committees or via student representation on the faculty/department's committees.

Complaints

If your concern or complaint relates to teaching or other provision made by the faculty/department, then you should raise it with the Course Director (Professor David Wallom), Deputy Course Director (Dr Sarah Sparrow) or Director of Graduate Studies (Professor Robin Cleveland) as appropriate. Within the faculty/department, the officer concerned will attempt to resolve your concern/complaint informally.

If you are dissatisfied with the outcome, then you may take your concern further by making a formal complaint to the University Proctors. The procedures adopted by the Proctors for the consideration of complaints and appeals are described on the Proctors' webpage (https://academic.web.ox.ac.uk/academic-appeals-complaints-and-conduct), the Student Handbook (https://www.ox.ac.uk/students/academic/student-handbook?wssl=1) and the relevant Council regulations (www.admin.ox.ac.uk/statutes/regulations/247-062.shtml)

If your concern or complaint relates to teaching or other provision made by your college, you should raise it either with your tutor or with one of the college officers, Senior Tutor, Tutor for Graduates (as appropriate). Your college will also be able to explain how to take your complaint further if you are dissatisfied with the outcome of its consideration.

Academic appeals

An academic appeal is defined as a formal questioning of a decision on an academic matter made by the responsible academic body.

A concern which might lead to an appeal should be raised with your college authorities and the individual responsible for overseeing your work. It must not be raised directly with examiners or assessors. If it is not possible to clear up your concern in this way, you may put your concern in writing and submit it to the Proctors via the Senior Tutor of your college.

As noted above, the procedures adopted by the Proctors in relation to complaints and appeals are described on:

- the Proctors' webpage (https://academic.web.ox.ac.uk/academic-appeals-complaints-and-conduct)
- the Student Handbook (https://www.ox.ac.uk/students/academic/student-handbook?wssl=1)
- the relevant Council regulations (www.admin.ox.ac.uk/statutes/regulations/247-062.shtml).

Please remember in connection with all the academic appeals that:

- The Proctors are not empowered to challenge the academic judgement of examiners or academic bodies.
- The Proctors can consider whether the procedures for reaching an academic decision were properly followed; i.e. whether there was a significant procedural administrative error; whether there is evidence of bias or inadequate assessment; whether the examiners failed to take into account special factors affecting a candidate's performance.
- On no account should you contact your examiners or assessors directly.

Harassment

The University condemns harassment as an unacceptable form of behaviour, and has an advisory system to help people who think they are being harassed. Harassment includes any unwarranted behaviour directed towards another person which disrupts that person's work or reduces their quality of life. Further information and guidance is available at:

www.admin.ox.ac.uk/eop/harassmentadvice

http://www.admin.ox.ac.uk/eop/harassmentadvice/policyandprocedure/

The Department of Engineering Science has two confidential advisors. At present these are Ms Jo Valentine, Head of Student Administration, and Ms Helen Burton, HR Manager, either of whom may be consulted in relation to matters of harassment.

Appendix 3: Small Group Case Study Guidance

You are a small but innovative energy consultancy that has been engaged by the *Ministry for Energy* for the country to which your group has been assigned to develop a national energy transition strategy. That country has made commitments to NetZero by 2050 and signed up to the 'Paris agreement', whilst it must also aim to at least maintain GDP per head and economic growth. By this latter point it, is meant that the transition should be economically positive.

You are asked to deliver a 50-page report[*] and a video presentation on your strategy to accompany the report. This video should be no shorter than 30 minutes and no longer than 45 minutes. The minimum requirement is for a voice over slides though improvements in presentation style are welcome.

The report should be structured in the normal way for academic publication. There should be a clear breakdown of the contributions to both report and presentation by all members of the group.

[*] Not including references and appendices though the total submitted report should not exceed 75 pages.

Appendix 4: Dissertation proposal form

Student Name & # (if student initiated)

Supervisor (Name, Department and email)

Title

External Involvement (Name and contribution)

Project Category (Open to all or for specific student)

Description *(Max 15 lines)*

Suggested preparatory work/reading *(Max 10 lines)*

Objectives (1 line per)

- Easily Attainable;
- Medium Attainable;
- Advanced;

Dissertation classification (% of each must add to 100)

- Literature
- Theoretical
- Experimental
- Numerical/computational

Primary location

External Resources required (e.g. Consumables, travel, technical workshops, IT support etc.)

Health & Safety Considerations

- Computer use: Y/N
- Using hazardous substances: Y/N
- Using nanomaterials: Y/N
- Using biological substances: Y/N
- Using lasers or high power LEDs: Y/N
- Using components or systems pressurized with gases or compressed air: Y/N
- Using liquefied gases e.g. liquid nitrogen: Y/N
- Other Hazard:

Safety Notes: None

Appendix 5: Dissertation Report Guidance

Planning

Examination Regulations require each MSc candidate to submit a dissertation of not more than 15,000 words on a topic selected by the candidate in consultation with the supervisor and approved by the Standing Committee.

The report must not exceed 75 pages (including all diagrams, photographs, references and appendices). All pages should be numbered, have margins of not less than 20 mm all round, and type face not less than 11 point font with line spacing of no less than 8 mm.

Before starting to write, be clear what is the purpose of the report and who will read it. The principal readers will be one or more examiners or assessors. However, subsequent readers may include students, technical staff and academics.

Structure

A report should have:

- Cover and Title Page: the project title, the author and their college affiliation should be prominently displayed, both on the front cover and on the first page. Your candidate number must not be included.
- Acknowledgements should be made of sources of help and finance. Helpful people appreciate gratitude.
- Abstract: a summary of the project, not longer than one page in length. This is best written last.
- Contents page giving page numbers of the main sections and sub-sections of the report.
- Sectional structure: for example

    1. Introduction
    1.1 What the project is about
    1.2 How the report is organised
    2. Literature Review
    3. Methodology
    4. Results
    4.1 Presentation of collected data or input
    5. Discussion
    5.1 Analysis of results
    5.2 Presentation of findings from analysis

    6. Conclusions

    6.1 Summary, recapitulating what was achieved

    7 Recommendations for future work

    n+1. References Appendices

All projects should include a review of appropriate research literature.

The two Sections 'Introduction' and 'Conclusions' should make sense if read together without the intervening sections.

- References are an essential part of any technical report because credibility depends not only on a clear explanation of what has been done but also on showing how it relates to, or builds on prior knowledge. References to other work, whenever it is used, should be included in a way that clearly distinguishes between the work of the report and the work of others. Refer also to the source of any quoted text or diagrams or other graphics. (See section 3 on the style of references).
- Appendices should record information that is likely to be of use to the reader who seeks detailed information, but which is not essential to an understanding of the report. For example: tables of numerical data, computer source-code, details of electronic circuits (if incidental to the main body of the text). Appendices are included in the page count.

Style

- Authors should concentrate on communicating with readers. For engineering projects, readers may be assumed to understand engineering language but not to know anything about the subject of the project. A report suitable for a reasonably competent contemporary engineering student would be at about the right level.
- For formal reports, such as these are, use the third person passive. For example 'In Section 2 it is shown that . .' rather than 'I found that . .'.
- Avoid jargon. Define any unusual terms or acronyms wherever they first appear.
- Spelling and grammar are important.
- Reports should be presented so as to give a good impression.
- Reports should be bound so that pages do not easily become detached; advice on binding can be obtained from the Print Room (Ground floor Thom Building).
- Guidance can also be found in the books listed in the bibliography of Section 5 below.

Figures, tables and equations

Every figure and table should have a caption and should be explicitly referred to in the text, using a numbering system that identifies the object within its section of the report. For example, Figure 3.4 would be the fourth figure in Section 3. Place the figure or table near the text that refers to it; but not necessarily embedded within word-processed text.

Diagrams in the main text of a report should be simple and clear. Detailed material, such as engineering drawing or computer source code, is often better placed in an appendix. Tabulated data can sometimes be represented in graphical form in the main text. Large sets of numbers, if they must be included, should be placed in an appendix.

Equations should in general be numbered either sequentially or using a numbering system as for figures.

References

There are two main styles for references:

- A numerical system with a number in square brackets in the text after each reference, the numbers running in sequence starting at the beginning of the report, with a numbered list of references in the same order at the end of the report.
- Reference by author name(s) and date of publication in the text with the list of references at the end of the report arranged in alphabetical order according to the surname of the first author. This second method is recommended because it more easily accommodates changes during composition.

Examples of referencing systems can be found in most periodicals in the departmental Library, and in some of the books mentioned in Section 5. Where quoting web pages the full description of the document (including its electronic source data) has to be given using the following format: Creator's surname, creator's first name. Title. Date of publication. Name of Institution associated with site. View date. <http://address/filename>.

Practical advice

- Writing a report is not a trivial task, so allow plenty of time: weeks not days.
- Plan the structure as early as possible. In consultation with your supervisor, decide what will be the main technical sections of the report. The structure is not developed to show the chronology of the work, but rather to help communicate the nature of the work done (hindsight is very useful!).
- Agree with the supervisor a schedule which exploits the full time available and allows time to receive sufficient guidance on writing your report. Note that supervisors are expected to:
    - Discuss in detail the student's outline for the report.
    - Look carefully at the early drafts of chapters, making reasonably detailed comments and constructive suggestions on both the content and style (including grammar).
    - Give a quick overview of later drafts, but not the finished report, and point out any major problems.
- Before submitting a final version, ask a friend to read the report and comment on it. Or have it read aloud. Failing these, re-read the report a few days after completing it. Residual errors can be detected by this procedure.

Bibliography

Strunk W & White E B, 'The Elements of Style', MacMillan 1995 Gowers E, 'The Complete Plain Words', Penguin 1987

Fowler H W, 'The new Fowler's modern English usage', Clarendon, 1996 Davies J W, 'Communication for Engineering Students', Longman, 1996 Turk C and Kirkman J, 'Effective Writing', Chapman and Hall 1989

Sharp J A & Howard K, 'The Management of a Student Research Project', Gower 1996

Appendix 6: Dissertation Marking Scheme

Introduction (/10)

- Has the topic of study been introduced, stating clearly its relevance using a set of well described aims and objectives?
- Does the introduction make clear for the reader how the candidate has approached the problem?

Literature Review (/15)

- Is the review well-ordered showing a clear logical structure displaying an understanding of relevant literature that is used to form the basis for the investigation?
- Are the sources used timely and academically qualified to provide justification in their usage?
- Are sources correctly referenced in a consistent/appropriate manner?

Methodology (/25)

- Is the research methodology appropriate to the objectives of the study being conducted? Are there clear rationales for the methods chosen that are well described?
- Has the methodology been evaluated against other possible methods or structures to show that there is justification for that chosen?

Results & Discussion (/25)

- Is the data collected during the study relevant to the objectives and aims of the study?
- Are appropriate data visualisation tools and techniques utilised where insights are presented or claimed to be shown by the data?
- Are appropriate considerations of uncertainty, errors and or omissions made by the student wrt the data collected, i.e. are there improvements they could make with hindsight?
- Are the results discussed appropriately such that they are compared to available research elsewhere?

Conclusion (/20)

- [Note: Students are given the option of using their conclusion section as a draft publication to showcase their results. Therefore, alongside this will be a brief Summary conclusions section.]
- Have the research aims and objectives, the research question, been evaluated in light of the results and discussion?
- Does the study show that by building on results and discussion that appropriate conclusions can be made?
- Can the conclusions have been made more generally applicable beyond any specific use cases or examples?
- Has the student outlined possible future work that could be conducted in light of their research outputs?

Report Structure and presentation (/5)

- Is the report correctly structured following guidelines originally given to the students?
- Is there correct labelling of figures/tables in a manner such that it is consistent throughout and able to be followed?
- Is the text free of grammatical errors to a level that would be expected of a professional document?
- Are all external sources correctly cited within the text with references recorded in a consistent manner?

Appendix 7: Guidance in the event of an attack by an armed person or persons

1. Be prepared and stay calm

The purpose of this guidance is to alert and not to alarm – it is not being provided in response to any specific information. Although students are asked to be mindful and alert, please do not be overly concerned. You are asked to carry on with your day-to-day life as normal.
In the event of an incident, quickly determine the best way to protect yourself.

2. Evacuate

- If it is possible to do so safely, exit the building or area immediately
- Have an escape route in mind (Fire Exit signs are a good point of reference)
- Evacuate regardless of whether others agree to follow
- Help others, if possible
- Prevent others from entering the area of danger
- Do not attempt to move wounded people
- When you are safe, call 999 and ask for the police

3. Hide

- If evacuation is not possible, find a place to hide where the offender is less likely to find you
- If you are in a room/office, stay there
- If you are in a corridor, get into a room/office
- Lock the door and blockade it with furniture
- Silence your mobile phone and remain quiet
- Turn off the lights and draw any blinds
- Hide out of view and behind something solid (desk or cabinet)
- If it is possible to do so safely, call 999 and ask for the police

4. Inform

If you contact the police, provide the following information:

- Location of and the number of offenders
- Any physical descriptions of the offenders
- Number and type of weapons used by the offenders
- Number and potential victims at the location
- Your location

STAY SAFE

Further information and advice is available from Oxford University Security Services on 01865 (2) 72944 or security.control@admin.ox.ac.uk