

RENEWABLE ENERGY

*A RESOURCE
PACK FOR
TERTIARY
EDUCATION*



RENEWABLE ENERGY

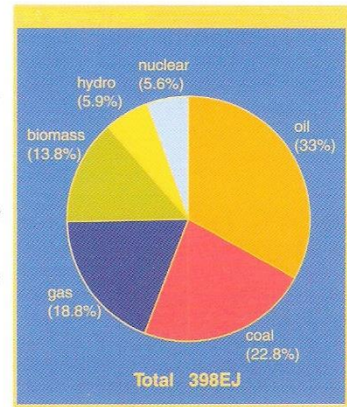
An increasingly important contributor to world energy supplies

Renewable energy sources – the sun, the wind, the flow of water, biomass, wastes and hot springs – have been harnessed for the benefit of humanity for thousands of years. Despite the enormous increase in use of fossil and nuclear fuels during the 20th century, renewables, in the form of hydroelectricity and traditional wood fuel, still meet between 16% and 20% of the world's primary energy requirements.

The potential for using renewables is enormous. For example, the sun continually supplies the earth with energy at a rate more than 15,000 times current consumption of conventional fossil and nuclear fuels. Currently, only a tiny fraction of this potential is harnessed.

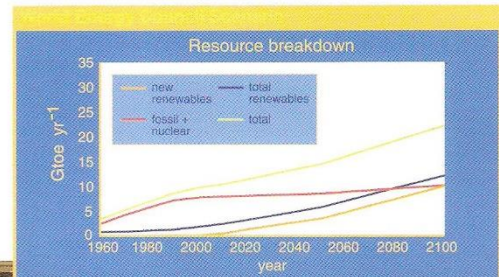
Renewables have long been recognised as clean, safe and non-depleting sources of energy. However, where alternative conventional energy sources have been available, the costs of renewable energy sources have generally not been competitive. But in recent years, as a result of technological developments, their cost-effectiveness has improved markedly. As recognition grows of the environmental and social costs associated with conventional energy sources, the renewables look increasingly attractive and viable. Most expert studies now predict that they will play an increasing role in contributing to the world's energy supplies during the remainder of the decade and into the 21st century.

Estimated annual world primary energy consumption by source, 1992. The primary energy contributions of nuclear and hydro electricity are calculated on a fuel substitution basis.



A projection of world energy demand to 2100, and the estimated contributions of renewables and conventional fuels.

World Energy Council (1993), Long-Range Ecologically Driven Scenario



A RESOURCE PACK FOR TERTIARY EDUCATION

This exciting new Pack on renewable energy from the Open University provides a *multi-media resource* for lecturers and professors in the tertiary education sector. It has been designed to support the *extension of existing teaching programmes to cover the topical and interesting subject of renewable energy.*

The Pack features:

- detailed user guides to all components
- 550 A4 pages of original text, fully illustrated in two colours
- 35 minute video
- 80 full-colour slides
- 6 disks of software and data
- 19 useful leaflets, booklets and brochures
- 40 reprints of articles and conference papers
- 100 pages of exercises, questions and answers, and seminar topics
- lists of useful addresses.

It is presented in a slip case containing two large ring binders.

The Pack is intended for use *across a wide range of academic disciplines* and can support teaching from *introductory to advanced level*. Renewable energy, as an inter-disciplinary topic, can be particularly valuable in *encouraging students to take a broader perspective of their chosen field of study.*

The Pack covers the principal renewable energy sources:

- wind
- hydro
- biomass
- solar thermal
- photovoltaics
- tidal
- wave
- geothermal.

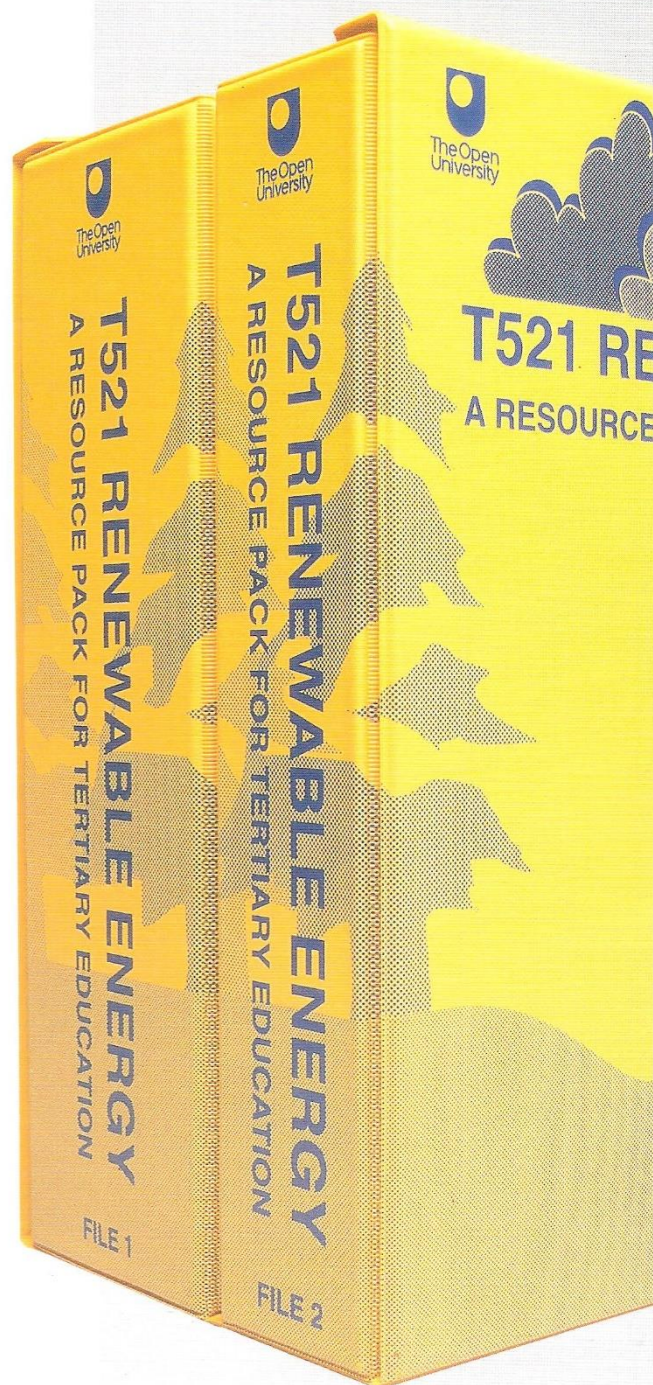
With the aid of more than 350 illustrations, it explains the *physical and engineering principles* underlying each source and discusses its *future prospects*. Also included are sections on *economics, resource assessment and integration*, a detailed *index*, and an extensive selection of *exercises and seminar topics*. The Pack focuses on deployment of renewables in the UK, but also covers developments in other parts of Europe and the rest of the world.

The Pack has been developed by a team of academics and support staff at the Open University Energy and Environment Research Unit, assisted by consultants and assessors from other UK universities. The coverage throughout is detailed, authoritative and up-to-date.

Funding for development of the Pack was provided by the UK Department of Trade and Industry through ETSU, a division of AEA Technology at Harwell, Oxfordshire.

*Whether you already lecture in the area of renewable energy or are considering introducing teaching modules in this fast-developing field, we are confident that you will find **Renewable Energy: A Resource Pack for Tertiary Education** extremely useful and exceptional value for money.*

Place your order now by completing the enclosed order form.



WHAT'S IN THE PACK?

User guides

The teaching resources within the Pack can be used in many different ways. They can provide the basis for an entire course on renewable energy, or enable selected aspects of renewables to be covered within courses on a wide range of other subjects. To help lecturers make the most of the Pack's resources, *User Guides* have been provided for all components, outlining their contents and suggesting ways in which they can be used in teaching. The *User Guides* comprise:

- Guide to the Pack
- Guide to the Slides
- Guide to the Video
- Guide to the Software
- Guide to the Reprints
- Guide to the Leaflets
- Guide to the Exercises

The main text

550 pages of two-colour text with the following chapter headings:

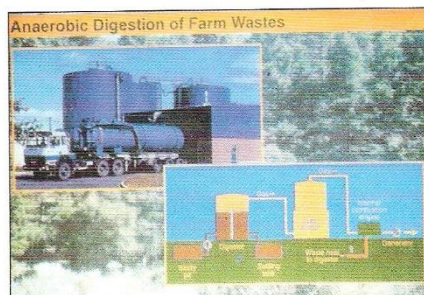
- The Context of Renewable Energies
- Cost and Resource Assessment
- Solar Thermal Energy
- Solar Photovoltaics
- Energy from Biomass
- Hydroelectricity
- Tidal Power
- Wind Energy
- Wave Energy
- Geothermal Energy
- Integration of Renewable Energy Sources.

Fully illustrated, with 78 half-tones and 278 line diagrams. Comprehensive 17-page Index.

Printed in A4 format, with each section tabbed and 4-hole punched for filing in the easy-to-use ring binder provided.

Slides

A set of 80 full-colour 35mm slides covering all major renewable energy sources, plus cost and resource assessment, integration and future prospects. Most slides include multiple images – text, graphics and photographs.



Example of slide

RENEWABLE ENERGY

3.2 CASE STUDY: SOLAR WATER HEATERS IN SOUTH LONDON

In 1978, the South London Consortium (SLC), a group offering energy design advice to a number of south London boroughs, suggested the installation of solar water heaters on 14 houses undergoing rehabilitation work in the borough of Southwark (Figure 3.1).

The details of a typical system are shown in Figure 3.2. It consists of the following three components:

1. A roof-mounted collector panel of 5 square metres area, covered with a single sheet of glass and tilted towards the sun. The actual panel is a steel plate bonded to copper tubing through which water circulates. It is painted with a special black paint to maximise solar absorption. The whole assembly is insulated on the back to cut heat losses.
2. A 440 litre storage tank, which also doubles as the normal domestic hot water cylinder, containing an electric immersion heater for winter use. The tank is insulated all round with 50 millimetre glass fibre. The hot water from the panel circulates through a heat exchanger at the bottom of the tank.
3. A pumped circulation system to transfer the heat from the panel to the store. An electric sensor detects when the collector is becoming hot and switches on an electric circulating pump. Since the collector has to be able to survive freezing temperatures, the circulating water contains an anti-freeze. Non-toxic propylene glycol is used instead of the poisonous ethylene glycol commonly used in car engines. The performance of the systems was monitored during 1982. On average, each house consumed water per day. Over that year, solar energy supplied over 40% of the domestic hot water needs. In the summer three months, the proportion was 60% and in the winter three months, 21%. Ten

LANDFILL GAS DEVELOPMENT

Although in the 4-sometimes upland quality methane is removed carbon dioxide applications work economic to burn. One use is to fire boilers nearby, but

plant together with coal. However, strict environmental standards on all forms of waste combustion in the UK have so far limited the size of the BDI market.

Figure 5.17 Incineration of solid wastes in some EU countries.

Country	total % incinerated	% incinerated with heat recovery
Belgium	25	15
Denmark	35	25
Western Germany	45	35
France	55	45
Italy	65	55
Netherlands	75	65
UK	85	75

Figure 5.22 MSW delivery, storage bunker, combustion of solids, slag removal, control room, steam to turbine, combust of volatil, bed hopper.

Figure 3.1 Solar water heaters in Southwark

Figure 3.2 Pumped active solar water heater

Figure 6.45 The first UK wind farm (at Cammish in Poyles) to utilise UK-manufactured wind turbines (4x WECS 1000 200 kW turbines) developed by National Wind Power Ltd

Sample of text

6-34

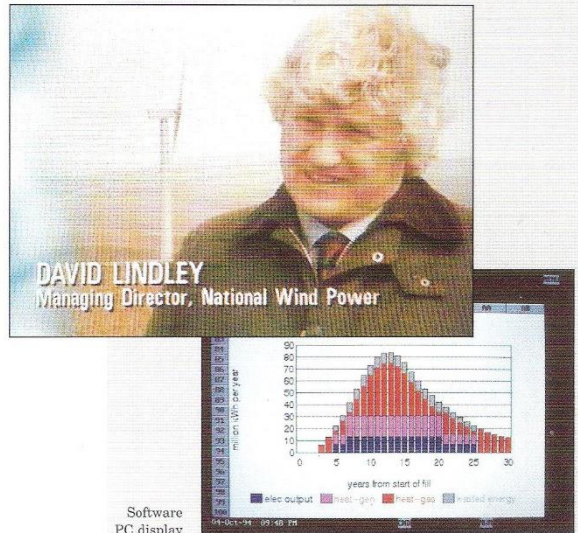
Pack contents

Still from video

Video

The Renewable Present, a 35-minute video covering:

- case studies of commercial projects: wind energy, biofuels and hydroelectricity
- animation sequence explaining the sun's role as the main source of renewable energy
- the developing renewables: solar thermal, photovoltaics, wave, tidal and geothermal
- overview of future prospects for renewables in the UK, Europe and the world.



Software

Six 3.5" disks providing models and examples of renewable energy systems in spreadsheet format (Lotus 123). Also included are files of solar, wind, temperature and tidal data.

Reprints

A collection of 40 reprints of authoritative journal and conference papers, book extracts and shorter articles for classroom discussion, designed to complement the main text and packed in a convenient wallet.

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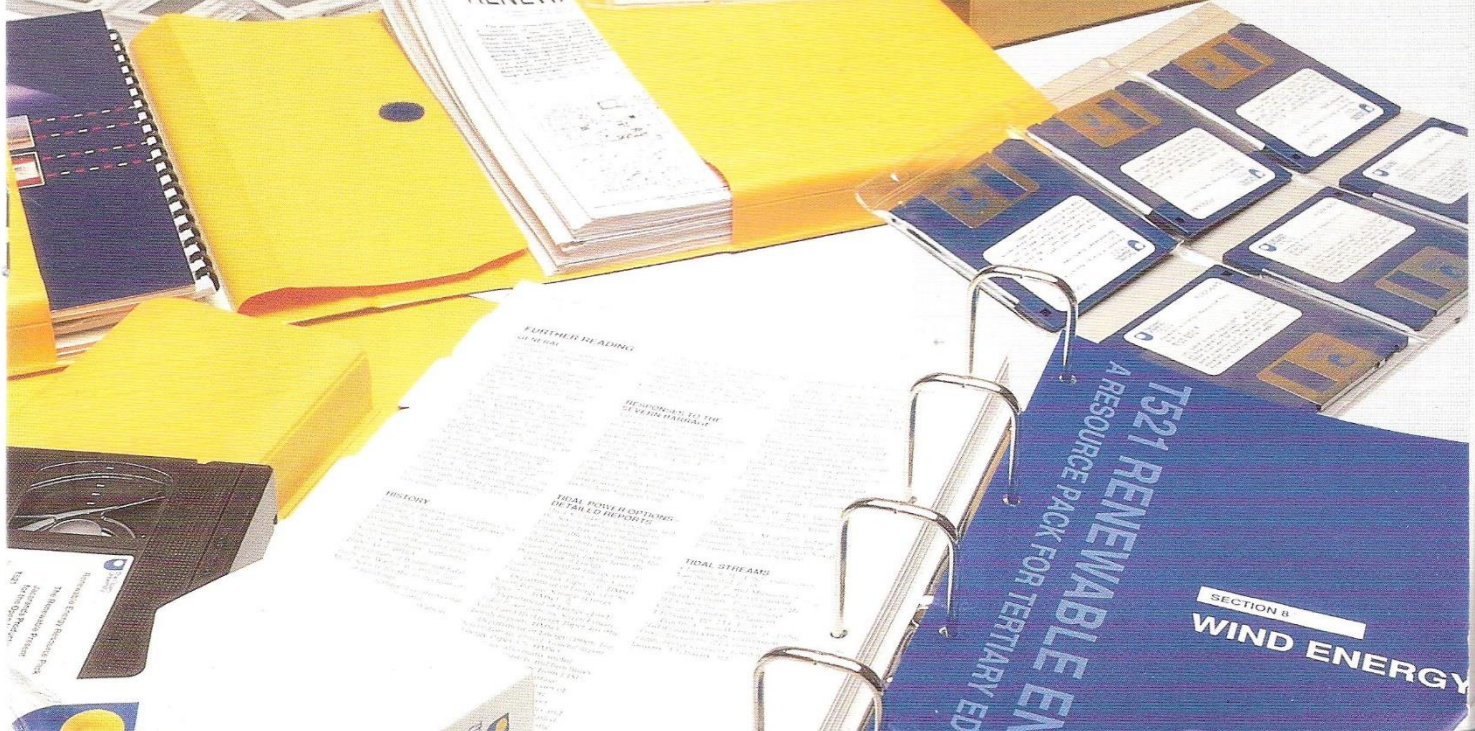
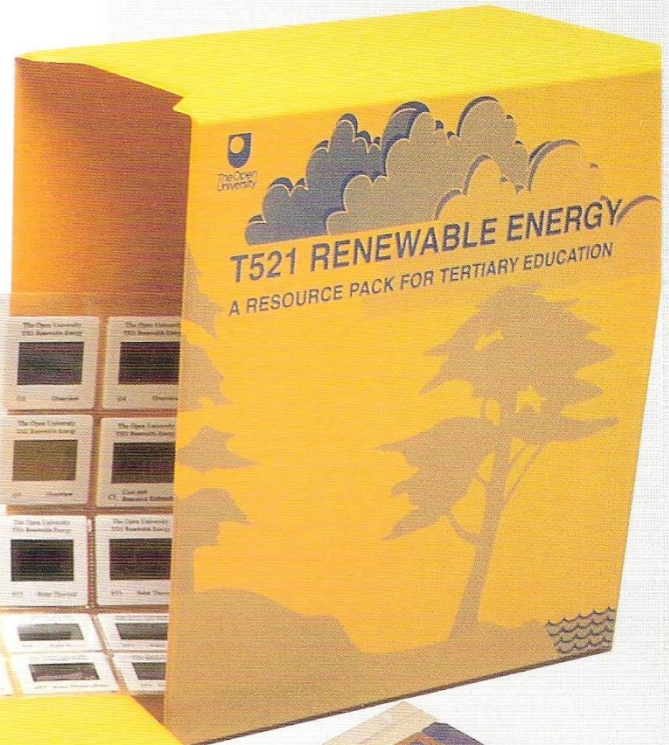
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Leaflets and useful addresses

An assembly of 19 manufacturers' brochures, posters, charts, magazines and booklets on the renewable energy sources, plus compilations of UK and world energy data, and a list of useful addresses from which further information can be obtained.

Exercises

More than 100 pages of short exercises, solutions, essay and seminar topics and role-playing exercises.

Short Exercises

The short exercises are mainly numerical and relate closely to each of the 11 main text sections. They involve calculations designed to give students a feeling for the quantities involved and to provide practice for those less used to numerical work.

Solutions to Exercises

Solutions to the numerical exercises, together with comments on their role in the development of each topic.

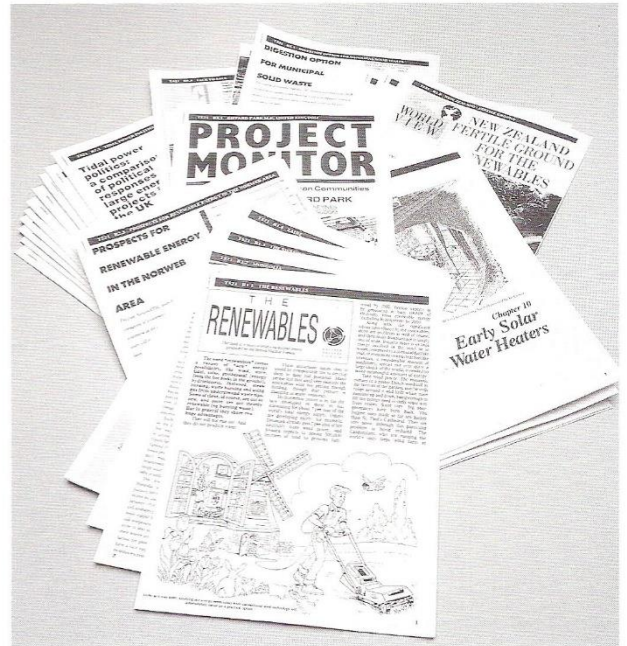
Essay and Seminar Topics

Suggestions for essays and seminars, ranging from simple essay titles to more detailed case study specifications.

Role-Playing Exercises

Explanatory material and documentation for three role-playing exercises, on wind farming, tidal energy and the use of renewables on an imaginary island.

The full text of the exercises is also provided on one of the software disks described above, to allow lecturers to adapt the exercises for their own purposes.



Reprints



Leaflets

SOME COMMENTS FROM PACK USERS AND ASSESSORS:

FINISHABLE PLOTS: take advantage of the WYSIWYG system, using colour to distinguish different elements and draw attention to particular cells and to improve the appearance of graphs. The 20 x 80 screen and non-proportional font are strongly recommended in this case. In detail, however, to ensure that neither colour nor the other aspects of WYSIWYG are essential in order to use these exercises, Figure G51 shows the screen appearance in plain and WYSIWYG modes.

NAMED BLOCKS: The material in each exercise is organized into named blocks although the contents of some blocks may vary in detail with the topic. In general, they are as follows:

INTRO: A single-screen introduction.

USE: A description of the methods for moving about the spreadsheet in the various modes. This section, which is essentially the same in all cases, also invites users to control whether or not their spreadsheet system can display embedded graphics (see 'Graphics below').

LISTS: Lists of the named blocks and named graphs, with their location and brief indications of their contents. Effectively a table of contents, this could naturally be printed out as a working guide to the exercise.

TEXT: A longer account (typically 500 words) of the background, purpose and functions of the exercise. The amount of detail varies. (We assume throughout that students are using the software in the context of a lecture course.)

3.3 USING THE SPREADSHEET EXERCISES: The short exercises have been designed to a common worksheet pattern - as far as their differing contents and functions allow (see Figure G52 opposite). The following account may help reviewers to negotiate the worksheets and display the graphs. It also includes suggested methods once the set of slides has been set up satisfactorily for use by students.

WELCOME TO "RENEWABLE ENERGY"

This sheet should be the first to introduce the fact that high displacement rates do not favour schemes with low financing costs and relatively high capital costs - a matter of some significance for renewable energy. Four types of energy situation are compared:

- Wind turbine
- Tidal barrage
- Nuclear plant
- Coal plant

Extensive algebra models are used for their estimation of costs and output, which you can view as graphs. For any element make within the energy use table, showing how the results change as the rate rises. There is also an indication for extra data for another plant of your choice.

Page down for more. Tab right for TEXT.

RENEWABLE ENERGY

The spreadsheet contains the following eight slides relating to REPEAT PLANTS. They are:

- WINDT which summarizes the effects of different positions of output from a tidal power plant.
- TIDAL which models the financial implications for a proposed tidal plant.

The slides are designed to help others, with other opportunities for you to enter data, and in both cases you can hold for graphs.

Page down for more. Tab right for TEXT.

Figure G51 Screen appearance in plain and WYSIWYG mode

SECTION 3 WIND ENERGY

8.1 Calculate the average wind speed for the site whose annual wind speed distribution is shown in Figure E8.1.

Figure E8.1

8.2

(a) Plot a graph showing how the power delivered by the wind, in watts per square metre, varies with wind speed over a speed range from 1 to 20 metres per second. (Assume the density of air at normal pressure to be 1.23 kg per cubic metre.)

(b) Construct a bar diagram showing the annual energy delivered at each speed in kilowatt-hours per square metre per year, for a site with the speed distribution of Figure E8.1. Find the total annual energy per square metre.

8.3 Figure E8.2 shows the general form of the annual wind speed distribution at a site where the mean wind speed is 5 metres a second. (This idealised curve is known as the Rayleigh distribution.)

Figure E8.2

Sample of exercises

“... an excellent product which presents a balanced view of renewable energy in all its forms, including their advantages and problems. The Team have successfully covered the material at the higher education level and I certainly will use it in my undergraduate ‘Energy and Environment’ course and probably also at the MSc level.”

Prof. David Hall

King's College, London. External Assessor.

“The Open University Renewable Energy Pack will be a valuable resource for use in lecturing and tutoring to many groups of students ranging from architects and engineers to those with a less technical background. The range of materials included in the pack is excellent and will certainly be widely used at the University.”

Dr Adrian Pitts

University of Sheffield.

“... wonderful pack, logical, well laid out, just the right degree of environmental, technical and economic content.”

Dr Kathy Langley

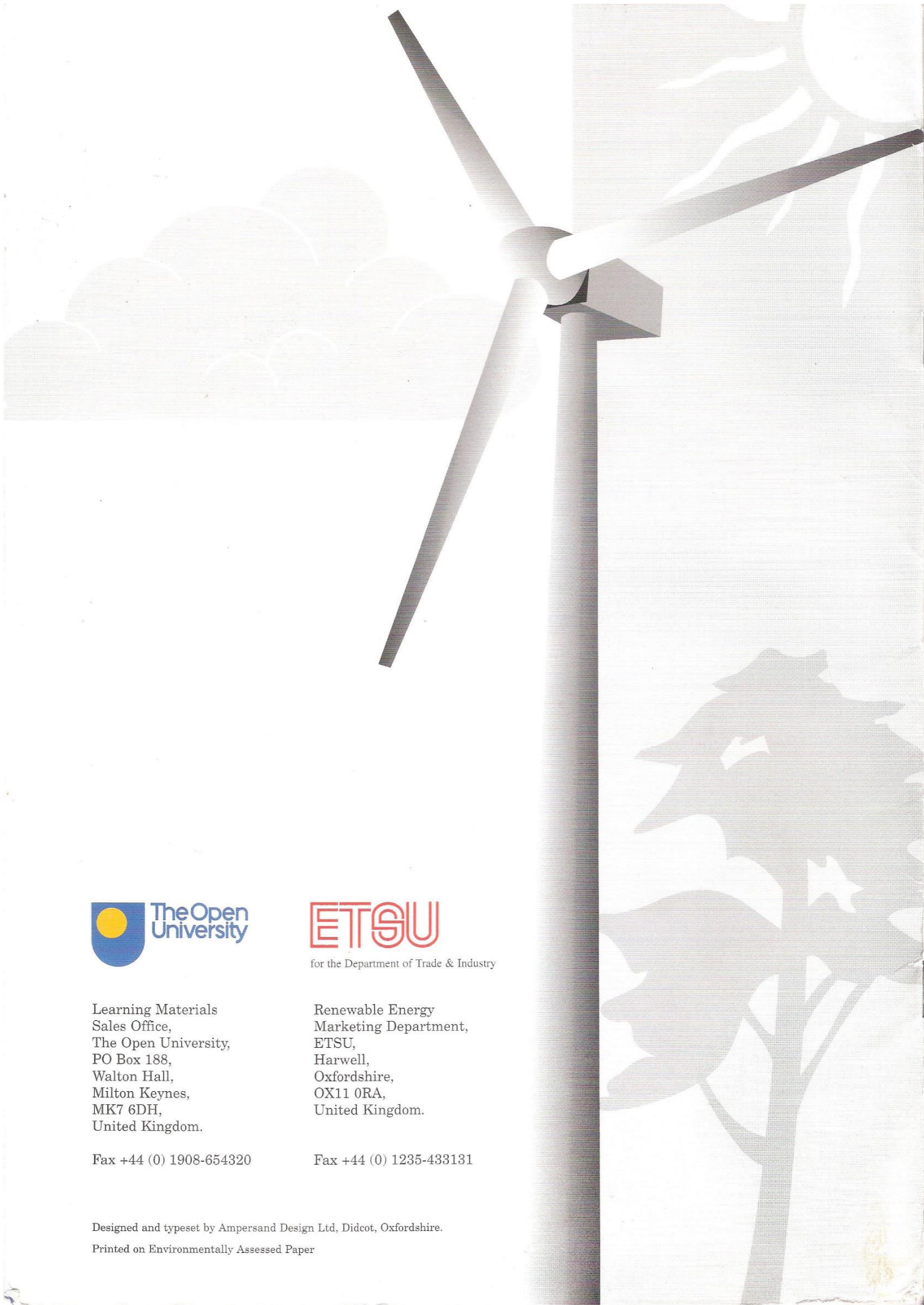
Nene College, Northampton.

“... I greatly welcome the production of the Renewable Energy Resource Pack for Tertiary Education. It will help meet a real need. ... It should be of value not only for those engaged in education but for all concerned with future energy policy.”

Sir Crispin Tickell

Warden of Green College, Oxford University and former UK Ambassador to the United Nations





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