TEACHERS NOTES (TECHNOLOGY UNITS)

INTRODUCTION

The three units contained within this module represent a comprehensive resource aimed at enabling students, either individually or in groups, to carry out a feasibility study on the potential of renewable energy to meet a small scale identified need for energy, within the student's own school.

Having identified the potential for either wind or solar power the resources enable the students to go through the process of designing and making:

- *An anemometer or a solarimeter if required for data collection*
- *A wind turbine*
- *A solar hot water panel*

The resource is comprehensive and in places goes into more detail than might be required with some students. However this ensures that all the information that might be required within the project is there to hand. Some approaches to the project will not require all the information provided, this will be up to the teacher and in some cases the student to manage effectively.

CURRICULUM TARGETS

The structure of this unit lends itself to its completion as a minor project within many ‘A’ level Design and Technology schemes. It is also intended that it should be suitable for use within the developing GNVQ manufacturing and engineering courses. In addition it could with more teacher input, form the basis for interesting BTEC projects.

A geography focused resource is also published by TEP that provides more detail on assessing school based renewable energy developments. This additional resource could be of benefit to technology students undertaking the design and make project outlined here. Ideally if the technology and geography departments could work together on the two projects the students would certainly benefit, together with the school.

UNIT 1 - DESIGN AND MAKE AN ANEMOMETER OR SOLARIMETER

Unit Aim
To produce either an anemometer or solarimeter to enable the collection of micro-climate data around the school. This data can then be used within later units to assess the potential to meet identified energy needs within the school from renewable energy.

Timing
Minimum of 10-12 hours direct contact time with up to 20 hours of self directed study.

Process
Students should be provided with the task sheet and supporting information to initiate their investigation. The briefing sheets can then be used to support student study as required. The onus should be on the student in the first instance, with the sheets used by the teacher to resource students only when necessary to overcome problems. The briefing sheets are not intended to provide all the answers, but rather to initiate further student research. The students need to take responsibility for the development of the project, particularly at ‘A’ level and the higher level GNVQ.

It is possible to take a more prescriptive approach to this unit with the briefing sheets providing the framework for teacher-led sessions covering the necessary theory.

The briefing sheets consist of a mixture of technical or process ‘how to’ briefings, and background information.

It is important to emphasise at the beginning of the project the context within which this project is taking place, to encourage a sense of purpose with the students.

Student Outcomes
It is possible to encourage a range of student outcomes to fit in with student interests and abilities. For example the anemometer can be designed to a high specification to provide accurate readings and provide data logging capability, or can be based around a mechanical assessment of wind movement. It will be important in this context for the students to assess the level of accuracy required for the data analysis. The solarimeter is a more straightforward design task, however the emphasis here might be placed on packaging, data display and graphical presentation of designs. In all cases there are a number of opportunities for utilising found materials that should be encouraged where appropriate.

Resources
As well as the examples of anemometers listed in Briefing Sheet 1, anemometers can be obtained from Technology Teaching Systems, Maplins, Commotion and the Sheffield Purchasing Organisation.

The Wind & Sun Catalogue (£5) also has a lot of useful information in it. Wind & Sun, The Howe, Wellington, Oxford, OX9 5EX.

The Meteorological Office, London Road, Bracknell, Berks, RG12 2SZ for windspeed and solar radiation data.

Assessing Renewable Energy Developments. Published by TEP and aimed at post-16 geography students. The resource provides more detailed information on evaluating sites and assessing potential developments. As such the information could be of great help to technology students working on the design and make tasks outlined within this unit.

UNIT 2 AND 3 - DESIGN AND MAKE A SMALL SCALE WIND TURBINE OR SOLAR HOT WATER PANEL

Unit Aim
Both units enable students to design and make either a solar hot water panel or small scale wind turbine to meet a small localised need for energy within the school. The products might either be fixed or portable depending on the nature of the need identified.

Background
Designing a wind generator or solar panel is a complex process. Designing and making something that will turn and produce some measurable power or heat up a bit of water is not too difficult. In those terms your students should certainly achieve success from this project. Designing a very efficient machine is another matter.

One of the most demanding things for the students to cope with is that within this type of design project so many things are interdependent. The design process cannot be linear. Before they can design any one part in any detail they need to have made many design decisions about virtually all the different elements in the system. Each of these decisions is dependent upon various factors such as availability, cost of parts, materials as well as technical considerations.

This means that the first step is a considerable amount of research and investigation. However, some experimenting would make students' learning easier and more enjoyable.

When it comes to understanding the theory and principles involved, there are many concepts which are inter-related. So the theory back-up in this pack is designed to make it easy for teachers and students to refer back and forth to the different bits. There is a flow chart of a suggested design process for the wind turbine to make life a bit easier.

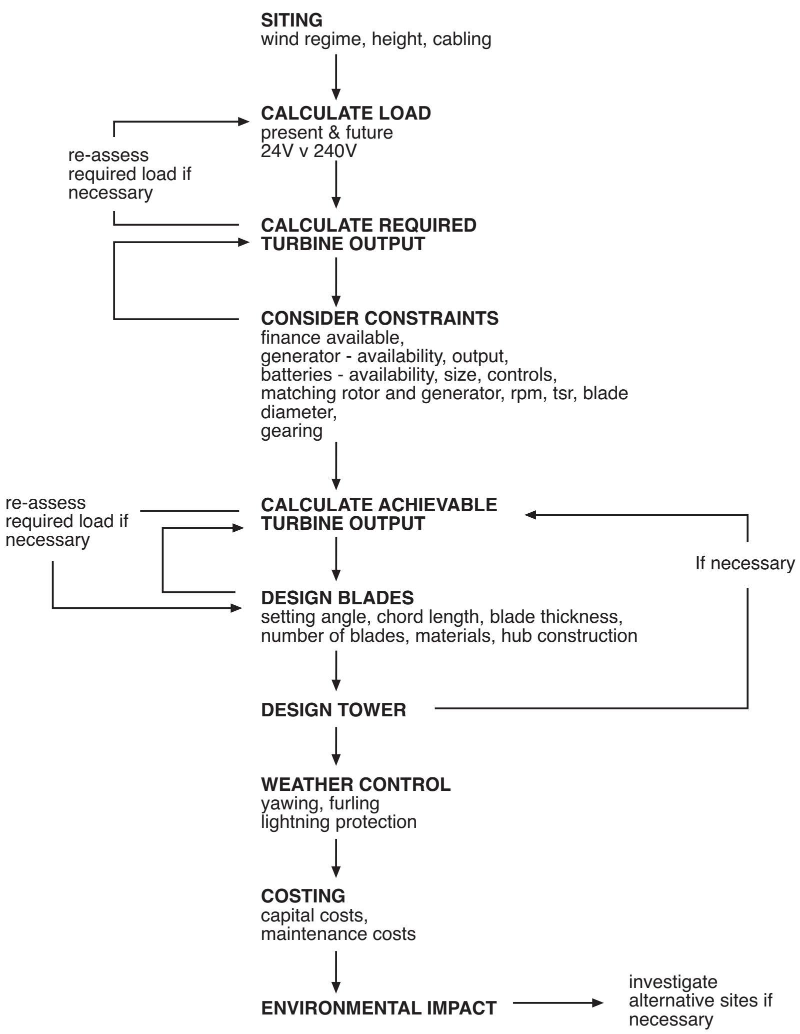
Some elements of the system will be more of a limiting factor than others, because of their cost and availability. The most problematic is likely to be the generator, but energy storage (if batteries) might be expensive for the wind turbine. For the solar panel the storage tank and the collector are the key elements.

Some elements could be limiting factors for other reasons. Students might design a system that depends on having a high tower in a spot that is unacceptable for a variety of reasons, or that depends on laying a cable underground across the middle of the cricket pitch. Continuous reassessment will be required until you can see that all the different bits can happily live together, and be within your budget.

This process of continually reassessing decisions in the light of others reflects the demands of the real world and offers the students the opportunity to display a high level of design skills. The solar panel is less dependent on a complicated design process to maximise efficiency, and might therefore be more appropriate for less able students. However with both the solar panel and the wind turbine it is possible to design and make the product without so much emphasis on the design process. The sacrifice in terms of efficiency of operation of the final product will be necessary to make the project accessible to lower ability students, particularly with the wind turbine. The resources are structured in such a way as to make this possible. Sections can be used or ignored as required.

The involvement of the geography department in the identification of appropriate sites and their evaluation might be beneficial to the students and the project as a whole. A framework for their involvement is outlined in a separate resource published by TEP.

Wind Turbine Design Process Flow Chart



Timing

Designing and making every element of the wind turbine or solar panel will be very time consuming, so using 'found' or bought parts for some elements might be absolutely necessary in order to get the project finished within the time constraints allowed. This could not really be described as an easy option. Students will need to acquire a considerable level of knowledge in order to be able to select the appropriate 'found' parts and integrate them successfully with other parts which they might make.

A variety of approaches are possible. It might be possible for one student, working alone, to build each part of the wind turbine and energy storage system, but it is unlikely that any one student could devote the time necessary to design and make blades, generator, bearings, perhaps gearing, tail mechanism, tower, control mechanisms etc. for a machine of any size or degree of efficiency.

The solar panel is not so complex, however the project would also benefit from group working.

With either project the group could pool their ideas to develop the overall design and then divide up in any way that seemed appropriate to design the details of the various parts before making them. This should provide a valuable way of developing teamwork skills, as close co-ordination would be essential with many of the individual elements offering a sufficiently demanding challenge for the individual student to be able to produce work of a sufficiently high standard. Even discrete elements, such as how to erect the tower, offer the opportunity for high quality design work.

There is also scope for the delivery of discrete projects within both units that might be carried out by students as smaller projects. For example, the generator investigations as a physics project, or the temperature control unit for the solar panel.

Projects could therefore involve between 10 and 35-40 hours or longer of student contact time, depending on the nature of the task undertaken, plus students self directed study time.

Costs

This project could prove very expensive. The best way to keep the costs down is to use as many cheap components as possible. Making every part totally from scratch might be an answer, although there would still be considerable costs involved (e.g. for magnets for a generator) but, in practice, using scrap or re-used parts is likely to be the cheapest and easiest way forward, particularly for things like the generator. This means that one of the design constraints will be what you can get hold of. This is in fact a constraint that reflects the situation you often find in the 'real world' (apart from in large commercial firms) an important part of their learning experience.

Depending on the use of materials and size of turbine or panel it should be possible to construct the wind turbine for between £50 and £100 and the solar panel for less.

Safety

Safety is an extremely important aspect. Students will need to consider this carefully not only because of the real risks that could be involved at certain stages of building a wind turbine or solar panel, but also because it is an extremely important aspect of designing in the 'real world'. They will need to consider all aspects of safety very carefully before constructing any parts of their final design.

Stimulus

If a visit to a wind power site can possibly be arranged this would greatly help students. Some windfarm sites welcome visitors (who should always make arrangements and ask permission before visiting). The windfarm at Blyth in Northumberland or Cold Northcott in North Devon are two examples of accessible windfarms, close to public roads. The Centre for Alternative Technology displays a variety of wind turbines, is open to the public virtually all year round, has Education Officers and is visited by thousands of school and College students.

If it proves impossible to see a wind generator in action then a video showing them working would be very useful. Failing that, slides would be better than nothing.

Useful Videos on wind include:
Wind Turbines in the Landscape. Produced by ETSU and distributed by CFL Vision Tel: 01937 541010. 20 minutes long, available on 5 day free loan up to 15 days max.

Wind Power. Distributed by Curriculum Video, 6C Aberystwyth Science Park, Dyfed SY23 3AH. 10 minutes aimed specifically at KS4 students and costs £25.

If it is not possible to see working solar panels, then it would be useful to obtain manufacturers' information about a range of different solar systems to give students a feel for the commercially available products.

Process
At an early stage it would be appropriate to discuss in some detail why they should be using wind power or solar power at all - what the advantages and disadvantages are of different methods of producing useful energy and what sort of wind or solar resource is available in Britain. Many, if not all, of the students may be very well informed about these issues already.

It is important that students should at least be familiar with the following before moving into detailed design work.

- *what wind or solar power is available to them on the school site,*
- *what makes wind turbines or solar panels work,*
- *what the financial constraints are,*
- *what existing designs there are and how they work.*

Within both units Briefing Sheet 1 provides a starting point for the students. It is then up to the teacher and the requirements of the relevant curriculum, and therefore maybe the students, how the materials are then used.

The briefing sheets provide a framework for students to follow within the design and make process if required. The sheets split the whole project into distinct elements that can be tackled separately, encouraging a structured approach to the project. Discrete problems are highlighted with guidance for the student about how the problems might be tackled

The information sheets provide extensive research material and relevant theory, that can be used where necessary to support the teacher and the student at different stages during the project.

EXPERIMENTAL INVESTIGATIONS OF GENERATORS

These investigations support the design process for technology by providing an experimental scientific approach to gathering data on a selected generator for use in detailed design.

The investigations have been designed to satisfy the needs of students working at several levels:

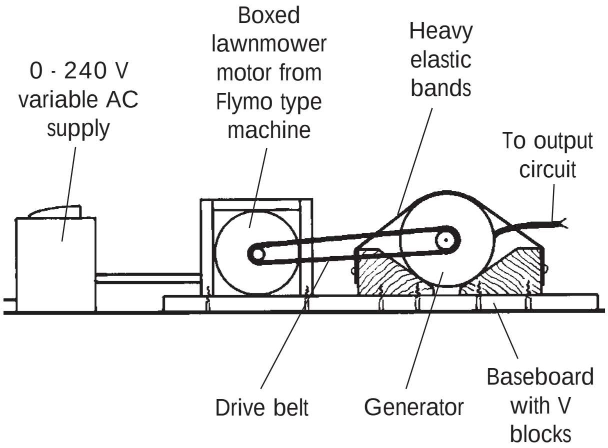
Technology 'A' level and GNVQ students will find the theory good background information but will focus on the gathering of detailed design data. These students will require a greater level of support with the setting up of the experiments.

'A' level Physics students will find the theory at an appropriate level and will be able to use the investigations to satisfy assessed practical requirements, especially for design experiments and extended investigation work.

Apparatus
There is a requirement for specialist items of test apparatus, but most of this will usually be held by science or physics departments. Physics departments may well want to make use of these materials as part of assessed practical work.

Major items:

1. Voltmeters, ammeters and cathode ray oscilloscopes to measure output characteristics. All physics departments have these.
2. Variable frequency stroboscope. With a range of 0-100Hz to measure generator speeds. Most physics departments will have these.
3. Resistance boxes - to provide known load resistances in investigation 4. All physics departments have these.
4. Driver motors - to power the generators on the test bench. As stated in the information sheets, these can be devised by the students, but the following arrangement has been found to work well. The 0-240v power supply is usually available in physics departments.



Risk Assessment!

1 Beware of 'frozen' generator motion under strobe lighting being misinterpreted as a stationary generator.

2 Frequencies of 8-15Hz can induce fits for some epileptics.

3 SHOCKS MUST BE AVOIDED IN THE 240V INPUT SIDE.

Management
The investigations are arranged so that they can be largely self directed study, or closely organised with greater teacher input.
Use of limited apparatus will be a key management issue. Two possible solutions are to arrange for all similar investigations to happen together or to operate an apparatus booking system where the strobe and driver motor could be booked by a student for a 15 minute slot. This is a similar arrangement to that operating for many engineers only able to test processes during shut downs.

Timescale for Generator Investigations
The investigations should occupy approximately five to eight one hour sessions.