PUPIL
RESEARCHER
INITIATIVE

PHEPPs

Setting the Scene

You work for a research department that is designing a portable hydro-electric power plant (PHEPP). You will carry out some investigations to improve the design of the PHEPP. You will also look at the environmental benefits and drawbacks of a range of different ways of producing electricity and write a report of your findings.

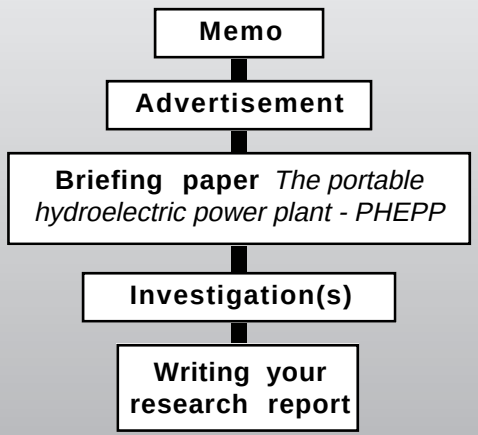
Pupil Research Brief

Study Guide

Syllabus Targets *Science you will learn about in this Brief*

- ❑ electricity is generated by rotating a coil of wire in a magnetic field, or by rotating a magnet inside a coil of wire
- ❑ if a wire, or coil of wire, 'cuts through' a magnetic field, or vice-versa, a voltage (potential difference) is produced between the ends of the wire
- ❑ this induced voltage causes a current to flow if the wire is part of the complete circuit
- ❑ the size of the induced voltage increases when:
  - the speed of the movement increases
  - the strength of the magnetic field is increased
  - the number of turns of the coil is increased
  - the area of the coil is increased
- ❑ fossil fuels are non-renewable energy resources
- ❑ when non-renewable energy resources are used up they cannot be replaced
- ❑ renewable energy resources include sunlight, the wind, waves, running water and the tides
- ❑ renewable energy resources will not run out
- ❑ renewable energy resources can be used to produce electricity
- ❑ the costs to the environment of using various energy resources to generate electricity

Route through the Brief



Outcome Checklist

You will produce a research report for the head of the Engineering Department. A memo guides you through the Brief. You should make sure you produce the following items as you work through the Brief.

Memo

- ❑ chart showing benefits and drawbacks of a range of different ways of producing electricity

Paper

- ❑ report of investigation(s) on ways to improve the PHEPP design

Department of Engineering

Memo

From: M. Widden, Engineering Department,
Lancaster University

To: PHEPP Research Team

Date:

Application for funding for the development of a portable hydro-electric power plant (PHEPP)

I intend to submit an outline research proposal to the Research Council following the recent advertisement in *Research News* (copy attached), to seek funding to develop further the portable hydro-electric power plant (PHEPP) we have recently been working on.

I have just re-read the summary of the internal briefing paper we put together earlier in the year outlining our ideas about the PHEPP. This summary paper (copy attached) could give us a good start in writing a proposal to the Research Council. I have put some notes on it suggesting possible investigations which need carrying out so we can improve the PHEPP design. It would be very useful to me if the team could:

1 follow up some of the suggestions with practical work;

2 write a short report for me on what you find out from this work;

3 carry out some research into the benefits and drawbacks of a range of different ways of producing electricity, so we can produce a balanced case in the proposal.

The advertisement in *Research News* asks us to include a section on 'the possible environmental advantages of using the device...' in our application. This could be covered by your research under item 3 in the above list. This information could be set out as a chart, comparing the benefits and drawbacks of a range of methods, such as burning fossil fuels, hydro-electricity, photovoltaic cells (solar cells), wind power, geothermal energy, wave power and tidal power.

Please let me have your investigation report and comparison chart as soon as possible.

a copy of the ad from Research News

Research News April 1996

Engineering for *clean technology:* alternatives to fossil fuels

Invitation to submit outline research proposals

The Research Council is inviting outline research proposals under a new programme of research. Applications are invited from researchers based at UK Higher Education Institutions and other institutions eligible for funding by the Research Council.

The programme is designed to support the development of small scale electricity generators that may replace those that use fossil fuels. Applicants should address the following points in their applications:

- the technical information about the proposed device should be included but this should be clear, to the point and not more than one side of A4 paper;
- the possible environmental advantages of using the device should be explained;
- the actual investigations to be carried out must be fully described;
- details of any previous research work done by the department or group in this area should be summarised.

The Research Council is keen to fund research which involves teams of co-workers and involves collaboration with researchers in different fields.

The closing date for applications is two weeks after the appearance of this advertisement.

We could get funding for the PHEPP project!

We need a comparison chart - (ask research team)

We could follow up the work in the first PHEPP internal briefing paper - I will get the research team onto this.

The portable hydro-electric power plant - PHEPP

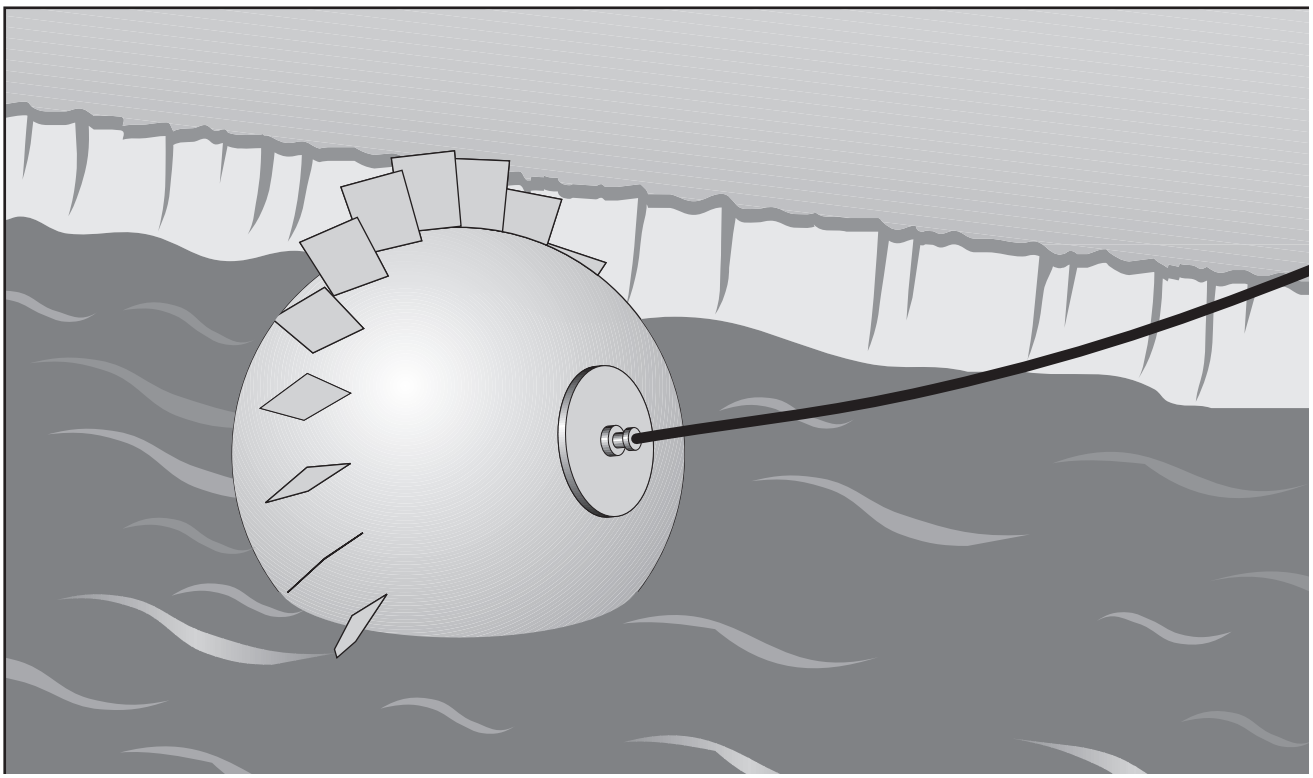
Internal briefing paper (summary)- first draft
Engineering Department
Lancaster University

1. Summary

Lancaster University Engineering Department has been doing research into alternative energy sources for almost 20 years. Much of this effort has been in the fields of wave power and solar energy. The development of a highly portable and lightweight device for generating electricity is a recent and exciting project. The PHEPP will be able to generate electricity using the movement of water in a river. The PHEPP is cheap and simple to use, quick to set up and is inflatable and so will be easy to transport. It will be a superior alternative to diesel powered generators and will not cause any pollution.

2. How the PHEPP works

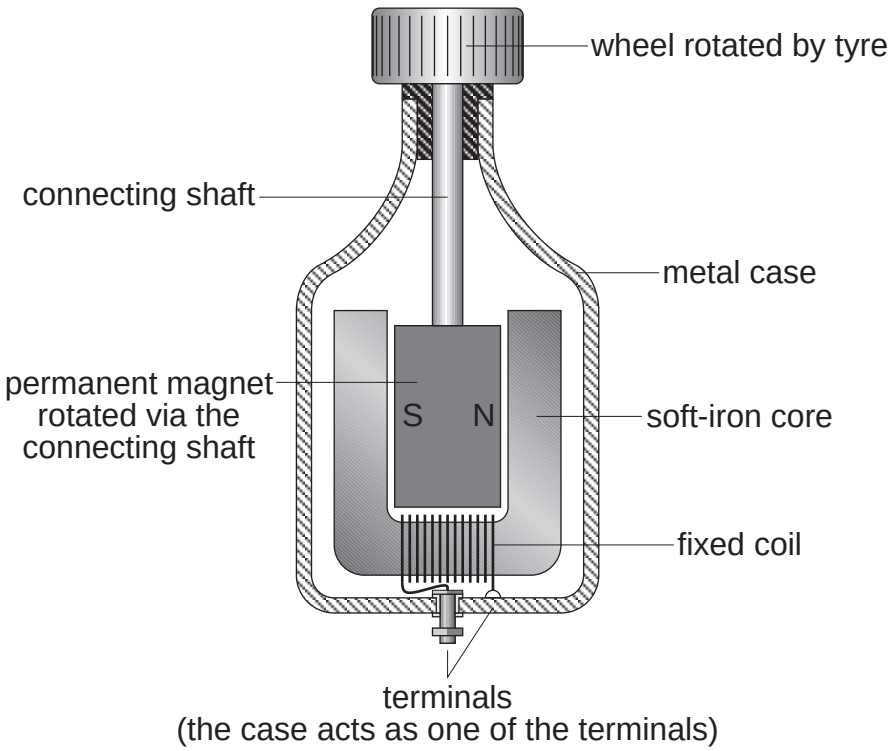
Figure 1. A PHEPP in a river



The PHEPP makes electrical energy from movement energy in the same way as a bicycle dynamo (see Figure 2). The movement of the water pushes against blades on the outside of the PHEPP and turns it while the inside stays still held by a weight.

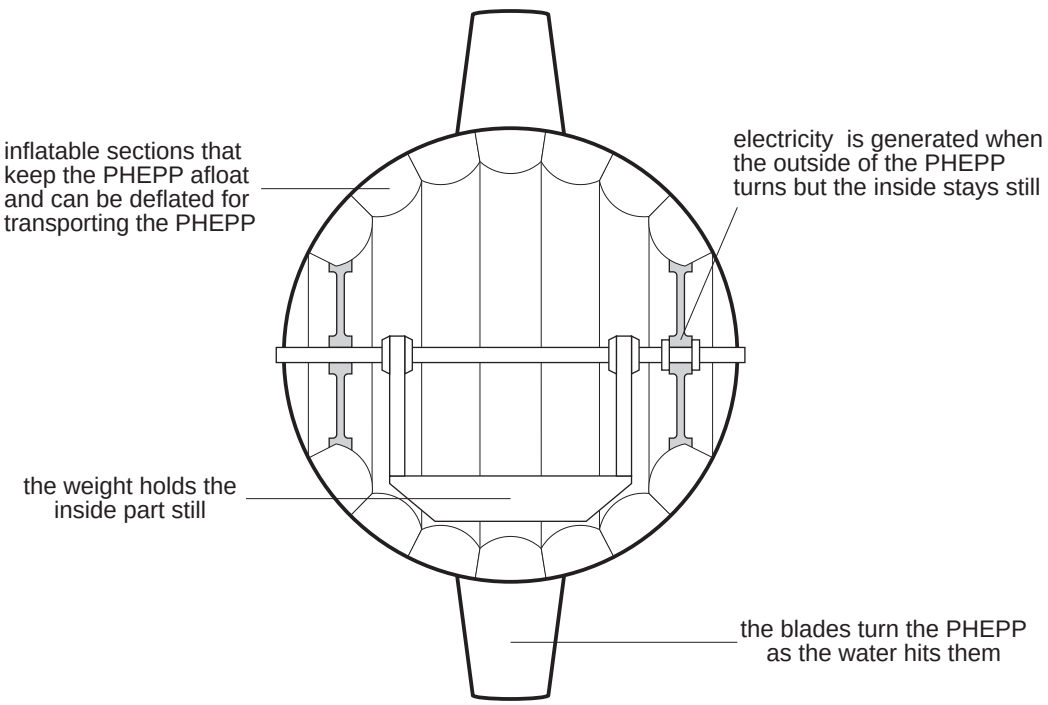
As the PHEPP turns, a magnet on the inside turns inside a soft iron core, housing a coil of wire. The magnet turning inside the soft iron core causes an induced electrical current in the coil.

Figure 2. A dynamo - the basis of the proposed PHEPP design.



The PHEPP floats on the surface of the water and is tied to the side to stop it floating away. The shape of the blades keeps the PHEPP in the fastest moving part of the river. In a tidal river more ropes are needed to stop the PHEPP floating away in the other direction. We predict that a machine that is 1.8m in diameter with blades 0.5m long will deliver about 2.5kW of electricity - enough to power at least a two-bar electric fire on full or keep twenty five 100W light bulbs bright. This would make it useful to power small machines (pumps, refrigeration units, electric tools) in remote places.

Figure 3. Cross section through a PHEPP



3 Outline research programme

The first step is to make an experimental prototype of the PHEPP which we can test in the laboratory and then on a nearby river. We will be working with the Environmental Science Department and using their expertise in river flow.

The aim of the programme is to carry out an experimental investigation of a small-scale prototype of the hydro-electric plant, and thus to develop design expertise for a more advanced, full-scale and possibly commercial version. This will involve investigating:

1. ways of getting maximum voltage from the PHEPP generator, by looking at:
    - the number of turns on the coil
    - the strength of the magnetic field
    - the area of the coil
    - the turning speed of the PHEPP

try these - particularly the first and last ones

2. ways of getting maximum turning speed for the PHEPP, by varying such factors as:
    - blade numbers
    - blade sizes
    - blade shapes

follow this one up if you have the time - you will need to develop a method for measuring the speed at which the PHEPP turns

Initially, small models will be made and tested in the laboratory, in order to discover how the device behaves. Using the results of this, a larger model will be built and tested in a river or tideway. This phase is expected to take between 2 and 3 months to complete and then a further 3 months will be needed to build and test a full scale model.

The project will be judged a success if the investigations that are carried out lead to promising design methods for a full-scale, commercial device.

build a small model of a generator and find out if the voltage produced is directly proportional to the various factors you are investigating in section 1 above - this will be important to know when we scale-up to the full size PHEPP