ELECTRICITY supply and demand

Science content

Energy sources for power stations, distribution of electric power on a national scale.

Science curriculum links
AT11 Electricity and magnetism
AT13 Energy

Syllabus links
- GCSE Science, Physics
- Geography
- Sixth-form General Studies

Lesson time
2 hours

Links with other SATIS materials
701 Electricity in Your Home
704 Electric Lights
1007 240 Volts can Kill
1008 Why 240 Volts?
1010 Can it be done? (questions 12, 13, 34)

SATIS 16–19
25 Why 50 Hz?

BBC Radio SATIS Topics 14–16
Electricity on Demand

NERIS
Search on
ELECTRIC POWER GENERATION
and POWER STATIONS
or on POWER STATIONS and ENERGY SOURCES

Consultant **Alan Attwood**
Developed from SATIS 601, *Electricity on Demand*, (1986).

Published 1991

SUMMARY

This unit has been developed from SATIS 601, *Electricity on Demand*, which it replaces. It is set in the context of the restructured electricity supply industry. Questions and graphical work have been added to the text prior to the decision-making task.

STUDENT ACTIVITIES

- ☐ Home survey, reading, interpreting graphs and answering questions: the information relates to home demand, the National Grid, demand curves, types of power station.
- ☐ Problem-solving task for pairs: a Regional Control Centre simulation – planning the deployment of power stations to meet demand curves (cut and stick data supplied).

AIMS

- ☐ To complement prior work on electricity generation and energy transfer
- ☐ To describe the different types of power stations in use in Britain, and their relative advantages and disadvantages
- ☐ To show the planning decisions that have to be made to ensure a reliable and economic supply of electricity on demand
- ☐ To provide opportunities for data interpretation, planning and decision-making

USING AND ADAPTING THE UNIT

- ☐ Suitable for a wide range of abilities. May be used in conjunction with work on the generation and distribution of electrical power.
- ☐ Some teachers use the material as a source of information on the electricity supply industry and omit the task at the end.
- ☐ Activity A is optional.
- ☐ The supporting BBC Radio programme visits the London Control Centre to witness the 'TV pickup' after 'Neighbours'. The programme explains that frequency is high when too much electricity is being generated and falls when demand fails to meet supply. The programme is best used along with the section *Meeting the demand* on page 3.
- ☐ Less able students may need support with the task in part C, otherwise they tend to meet the demand with a random selection of power stations.

Other resources

A Town Like Wattville from the Electricity Association is a software package that contains a large data base together with graphical, numerical and spreadsheet presentations. It enables students to simulate electricity use in a modern city on a BBC microcomputer. It is available from The Electricity Association, 30 Millbank, London SW1P 4RD. Tel. 071-834 2333.

How Electricity is Made is a video that deals with the generation of electricity in power stations. It is available on free loan from Barbara Steinberg, Film and Video Officer, National Power, Film and Video Library, Sudbury House, 15 Newgate Street, London EC1A 7AU. Tel. 071-634 6337.

Further information

The electricity supply industry has been divided into:

- the National Grid Company which is responsible for transmission at 400 kV and 275 kV,
- twelve Regional Electricity Companies,
- the generating companies, National Power, PowerGen and Nuclear Electric. Nuclear Electric is responsible for nuclear power stations and remains a nationalised company. Other companies may offer electricity to the National Grid. There is a future commitment that 600 MW will be from renewable resources by 1998. (This is not much compared with a 1990 installed capacity of 52 000 MW.)

The *marginal* cost of generating from nuclear power, which is mainly the fuel cost, is still far lower than from any fossil fuel. It is the *capital* cost that now appears high. Only marginal costs contribute to decision-making in part C of this unit.

The generating companies offer electricity to the National Grid Company on a daily basis. Pricing is done in half hour periods. Power stations whose offers are lowest in price are used. Within each half hour, the final price paid to all generating companies is the same and is linked to the highest price chosen to meet the demand in that period.

Answers to the questions

Q1 *(a) 1000 V = 1 kV*

Q2 *(a) 25 000 V*
(b) 400 kV and 275 kV
(c) 132 kV, 33 kV, 11 kV, 240 V (the p.d. from phase to phase of the 3-phase supply is 415 V).

Q3 *1 000 000 W = 1 MW*

Q4 *(a) People getting up, making breakfast, turning on lights etc.*
(b) People cooking an evening meal, turning on electric appliances at home.
(c) Industry, commerce, transport, schools etc. running through the day but not the night.

Q5 *(a) People using electrical appliances before settling down to a day watching TV.*
(b) Most people watching TV (which does not use much electricity) to catch a first glimpse of the bride and her dress – about which there was much speculation.

Q6 *On the Royal Wedding Day, demand rose as usual but peaked somewhat lower (approx 20 GW instead of a typical 28 GW), suggesting many factories had the day off work. Demand then fell dramatically and remained uneven with periods of TV pickup.*

Q7 *Hydro and nuclear in particular. Coal and oil may be used if the price of these fuels is low.*

Q8 *Pumped storage, gas turbine. Coal and oil may also be used.*

Q9 *Dinorwig is using electricity to pump water uphill.*

Q10 *As graph rises from points (1) 2, 3, 4, 5, 6, 7 and 8 on the graph.*

Q11 *(a) (i) hydro, (ii) oil.*
(b) Fiddlers Ferry

Q12 *(a) 3200 MW, (b) just before 10.00.*

Q13 *3600 MW.*

Q14 *5/4 times the price of energy used to pump it up.*

Acknowledgements

Figure 1 is reproduced by permission of The National Grid Company.

Figure 3 is reproduced by permission from *Science* by Graham Hill and John Holman (Nelson).

Figure 6 is reproduced by permission of PowerGen.

ELECTRICITY supply and demand

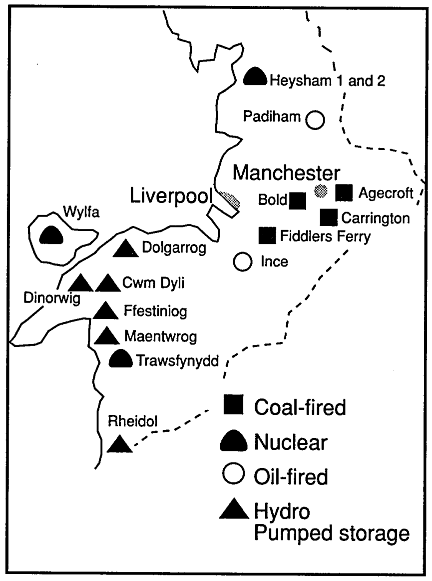


Figure 1 Power stations in the North West Region

Part A: Supplying electricity
Part B: Types of power station
Part C: A decision-making task for students working in pairs.

Part A – Supplying electricity

Think how often you switch on a light, the TV or electric kettle! Each time you do it, you create a demand for electricity.

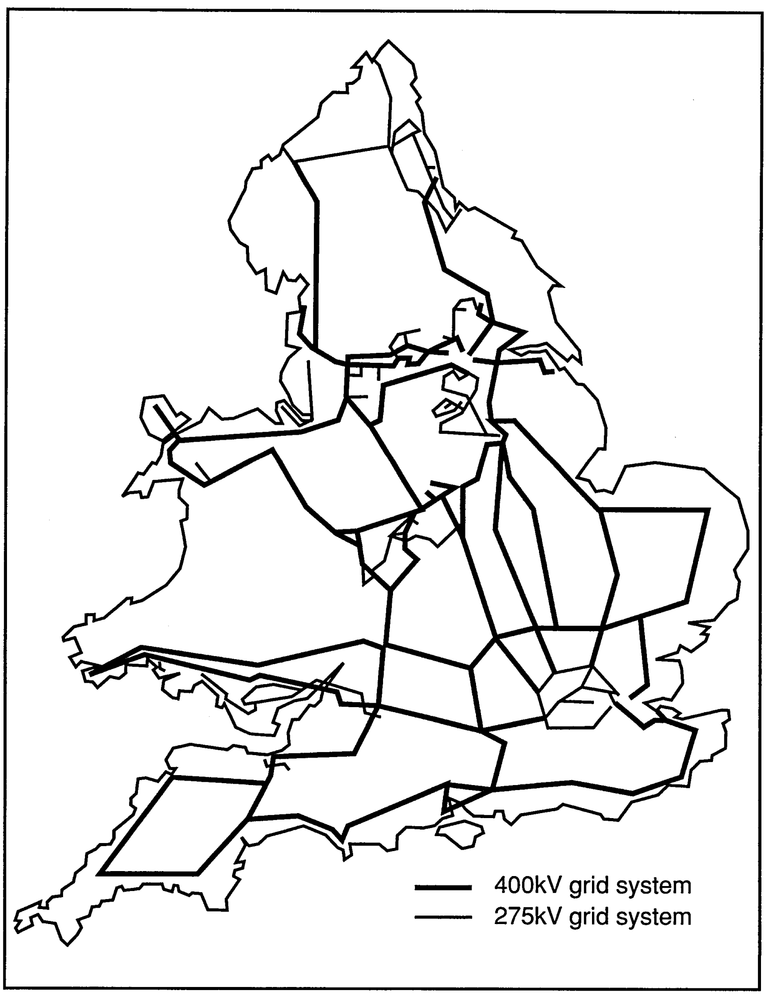
The **National Grid Company** (NGC) has the job of matching the supply of electricity to the demand in England and Wales.

In part C of this unit you will be able to simulate the job of engineers in the Control Centre of North West Region (figure 1). Your task will be to meet the demand for electricity at the lowest possible cost.

Electricity supply and the National Grid

Electricity is produced in power stations. They are linked into a network of power lines called the **National Grid** (figure 2).

Figure 2 The National Grid



Activity A

A survey to do at home

How many times do you switch on mains electricity?

☐ Try counting the number of times you *switch on* in an evening between 6 p.m. and bedtime. Combine the results of the class and plot a histogram.

☐ Or count how many times an hour your family *switches on* in a 24-hour day. Are there any appliances that are switched on all the time? How are you going to count them?

Draw a graph of your results.

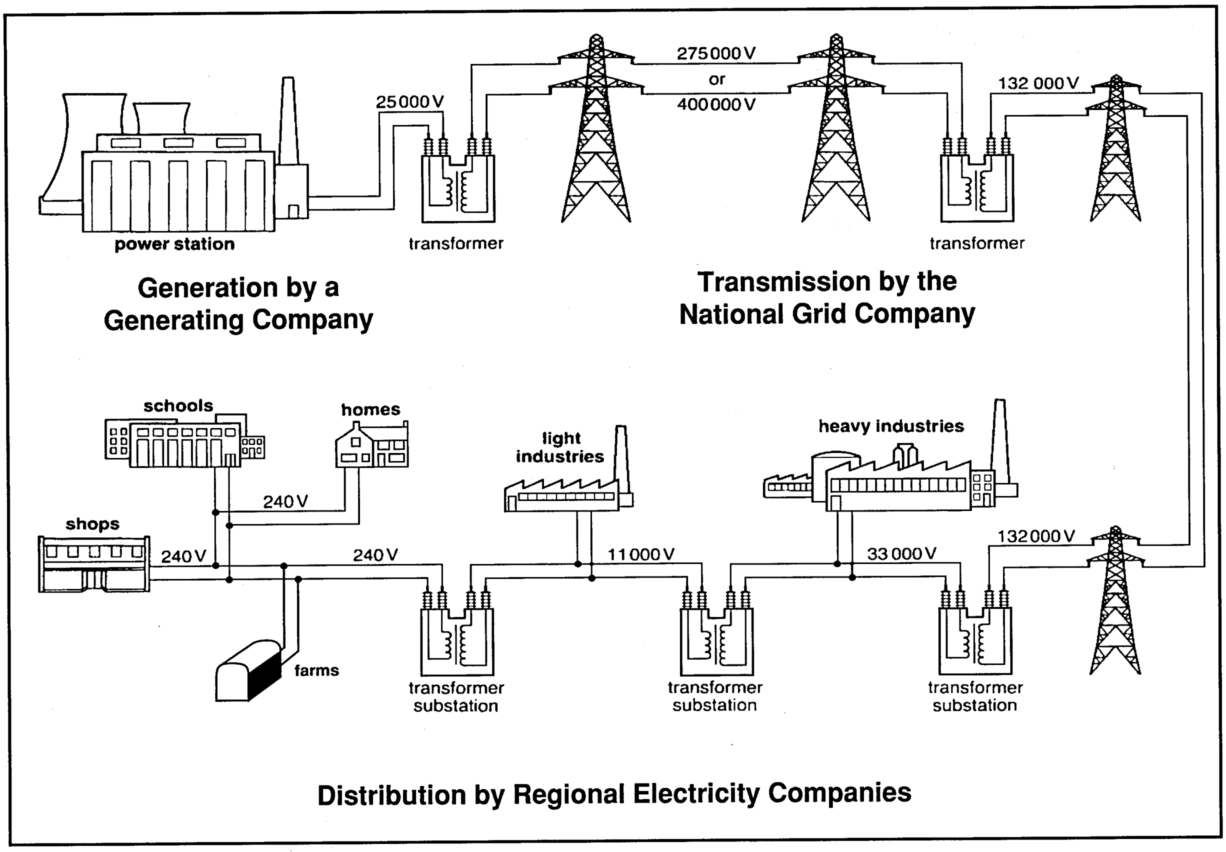


Figure 3 The transmission and distribution system

Questions on part A

Q1 *How many volts (V) are in a kilovolt (kV)?*

Q2 *Look at figure 3 showing the transmission and distribution system.*
At what voltages is electricity
(a) generated,
(b) transmitted on the National Grid,
(c) distributed by the Regional Electricity Companies?

Q3 *The output of power stations is given in megawatts (MW). How many watts (W) are in a megawatt?*

The National Grid is used to **transmit** electricity around the country to where it is needed. Transmission is at 400 kilovolts or at 275 kilovolts. The very high voltage allows a lot of energy to be transmitted and saves on energy wasted in power lines.

Transformers are used to step down the voltage to 132 kilovolts for local distribution by the **Regional Electricity Companies**.

The National Grid Company must balance the supply of electricity with the demand for electricity. It tries to do so at the lowest possible cost. It instructs the power stations (owned by the Generating Companies) how much electricity to generate minute by minute as the day goes by.

Britain has a variety of power stations, mostly coal, oil, nuclear and hydro. The cost of producing electricity in each power station is different. The cheapest power stations are used all the time as the **base load**. The more expensive power stations are used when demand is high – for example, at dusk in winter when people turn on lights.

Power stations differ in the amount of electricity they can generate. In the North West Region, the smallest produces only 10 megawatts of power, the largest generates 1900 megawatts when all its four generators are running.

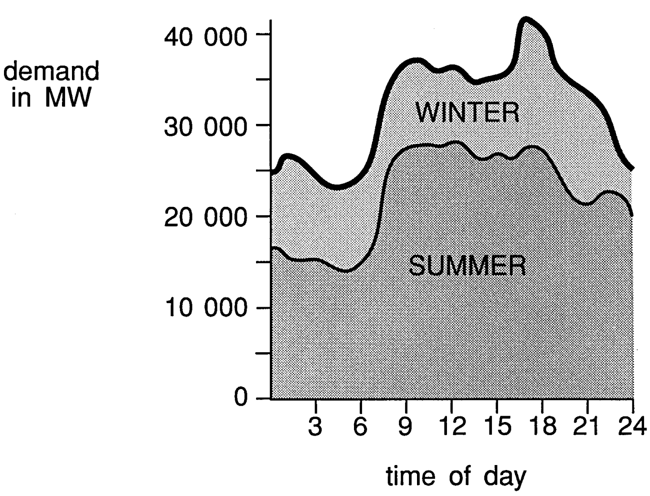
Meeting the demand

Electricity is generated as it is needed. If people want more electricity than the generating companies can supply at any moment, there have to be voltage reductions or power cuts.

The demand for electricity varies enormously from night to day and from summer to winter (figure 4). Engineers in the Control Centres watch the demand very carefully and try to predict what it will be. They study weather forecasts and follow television programmes. After a popular TV programme like 'Neighbours' there is a sudden surge in demand – known as 'TV pickup'.

The demand curve in figure 5 was for a day in which the Nation behaved differently. Fortunately, the engineers predicted what would happen.

Figure 4 Demand curves for typical summer and winter days

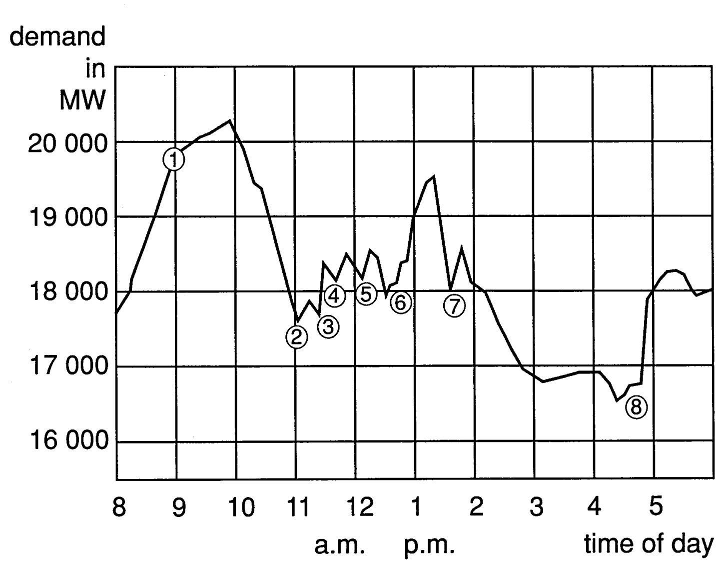


Q4 Look at figure 4. Suggest why the demand
(a) rises between 6.00 and 9.00,
(b) peaks between 17.00 and 18.00,
(c) remains higher during the day than the evening.

Q5 Look at figure 5, the demand curve for the Royal Wedding Day 1981.
(a) Suggest why the demand for electricity was (i) high at 10 a.m., (ii) low at 11 a.m.
(b) Which parts of the curve clearly show 'TV pickup'?

Q6 Describe the differences between the demand curve for a typical summer day and that of the Royal Wedding Day.

Figure 5 Changes in demand for electricity during Royal Wedding Day, 1981



Notice how the demand jumped after each high point of the wedding, as people left their TVs to switch on kettles etc.

1 Television broadcast sets the scene
2 The bride's arrival at the altar
3 End of the marriage
4 End of prayers
5 Signing the registers
6 Procession returns to Buckingham Palace
7 Last appearance of the couple on the royal balcony
8 Couple leave Waterloo Station

Part B – Types of power stations

1 Coal fired power stations

Coal-fired power stations are often sited near Britain's major coal fields to save moving coal long distances. Almost all small coal-fired power stations have now been closed.

It takes many hours to start up a coal-fired power station so their use has to be carefully planned in advance. However, they can be run at less than full load so that they can pick up their full output in minutes if needed. Coal-fired power stations are usually cheaper to run than oil-fired stations.

Sources of energy used for electricity generation in Britain in 1989

Coal	63%
Oil	7%
Nuclear	19%
Hydroelectricity	2%

(Electricity imported from France by cable under the Channel 4%.)

2 Oil-fired power stations

Oil stations are used flexibly because the price of oil is unpredictable. They are run as base load when oil is cheap, for daily load (on and off once a day) as prices rise and for peak load (on and off for just two or three hours at a time) when prices are high.

3 Nuclear power stations

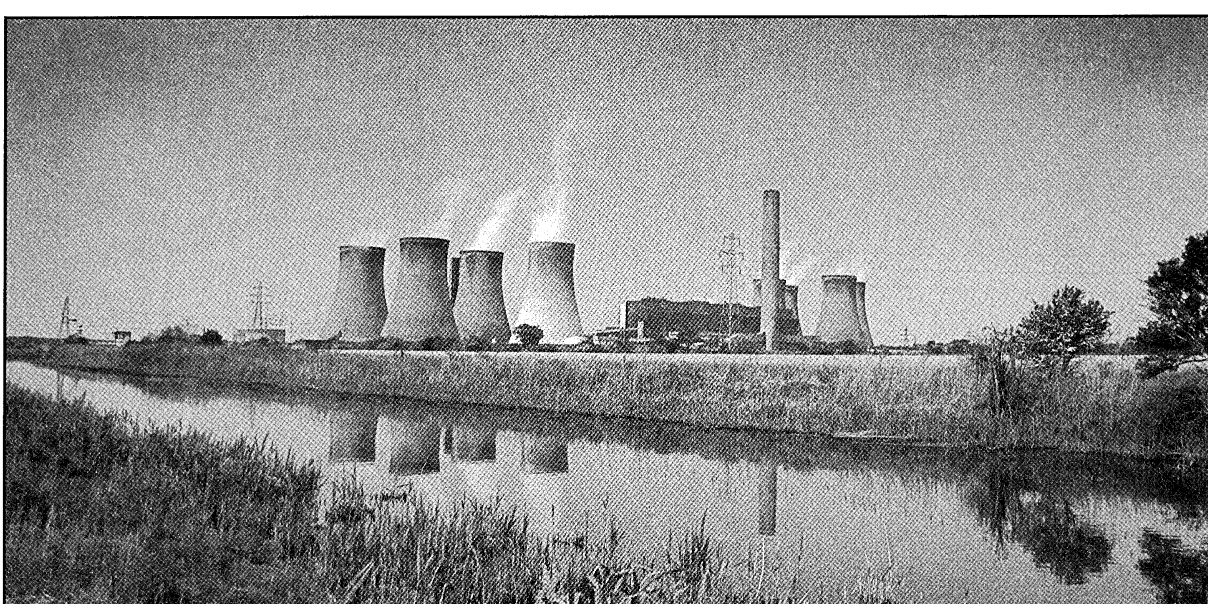
Once they have been built, nuclear power stations make electricity fairly cheaply. They are used to provide the base load.

4 Gas turbine power stations

Both Heysham and Fiddlers Ferry power stations also have gas turbine generators. They are based on gas turbine aero-engines burning aircraft fuel. Although cheap to build they are very expensive to run. They can be started up in a few seconds and are used at moments of peak demand.

There are plans to build combined cycle gas turbine power stations in Britain. These burn natural gas and use the heat to drive gas and steam turbines. They are 40 – 45 per cent efficient and produce little pollution. However, some people think that gas should not be used for electricity generation when other fuels are available.

Figure 6 Fiddlers Ferry coal-fired power station



5 *Hydroelectric power (HEP) stations*

Hydroelectric power stations provide very cheap electricity. Although they use renewable energy, hydroelectric schemes may flood beautiful valleys. Plans to build them often meet with strong opposition. In the North West Region there are a few small hydroelectric power stations in North Wales.

6 *Pumped-storage*

The North West Region has two **pumped-storage schemes**. They provide a way of storing energy when demand in low, ready to turn it into electricity when demand is high. Overall efficiency is about 80%. Pumped storage power stations are used for peak demand – when extra electricity is needed for a short time.

Pumped storage power stations are 'reversible'. They can work as hydroelectric power stations and generate electricity. Or, their generators can be used as motors to drive their turbines which then act as pumps. When demand for electricity is low, usually during the night, they receive electricity from the Grid and pump water up to the top reservoir, converting electrical energy into gravitational potential energy (g.p.e.). When they are generating, they convert gravitational potential energy into electrical energy again.

There are two pumped-storage stations in the North West Region, both in the mountains of Snowdonia. The larger one is at Dinorwig. Dinorwig can be 'switched on' in 10 seconds and can generate 1800 megawatts for up to 5 hours.

Questions on part B

Q7 Which types of power station are best used all the time?

Q8 Which types of power station are best used only for times of high demand?

Q9 Why does Dinorwig power station use electricity at night rather than generate it?

Q10 Look back at figure 5, the Royal Wedding Day. Suggest at least two times of day when you think Dinorwig pumped storage power station may have been needed to generate electricity.

Figure 7 How a pumped storage scheme works

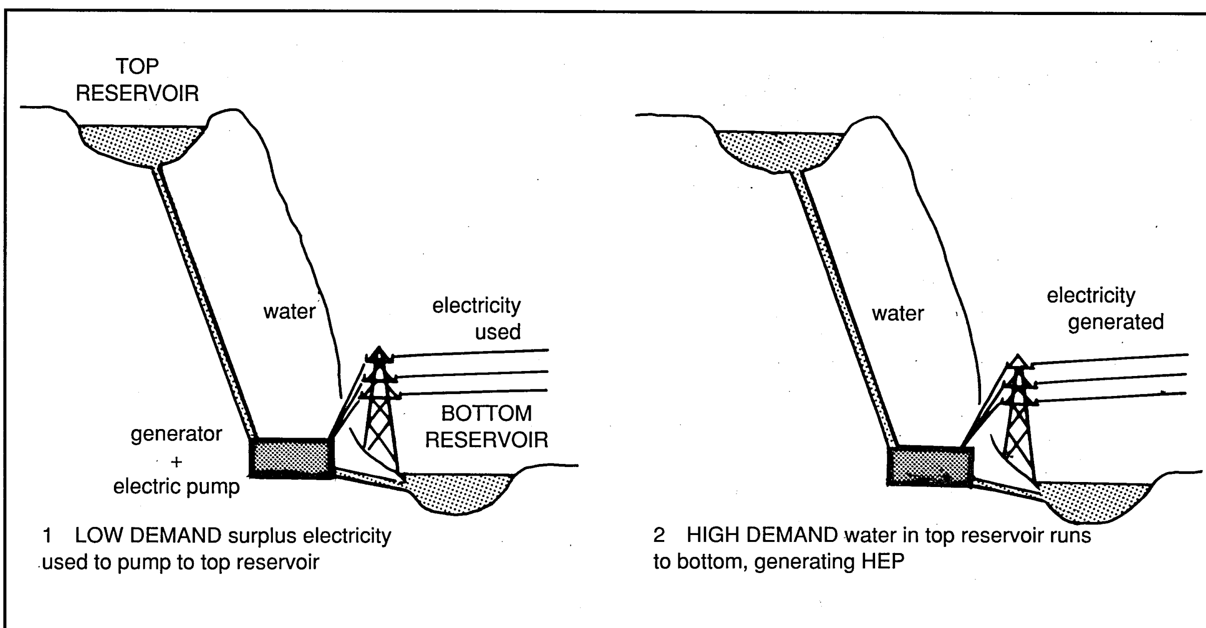


Table 1 Power stations in the North West Region

Name of power station	Type	Normal output in megawatts	Fuel cost per megawatt-hour
Heysham 1	Nuclear	1320	£7.00
Heysham 2	Nuclear	1320	£6.50
Trawsfynydd	Nuclear	380	£8.00
Wylfa	Nuclear	800	£7.50
Agecroft	Coal	215	£18.50
Bold	Coal	160	£21.00
Carrington	Coal	230	£21.00
Fiddlers Ferry	Coal	1900	£15.00
Ince B	Oil	1000	£26.00
Padiham	Oil/Coal	200	£26.00
Cwm Dyli	Hydro	10	Nil
Dolgarrog	Hydro	25	Nil
Maentwrog	Hydro	24	Nil
Rheidol	Hydro	50	Nil
Dinorwig	Hydro/Pumped-storage	1800	Nil*
Ffestiniog	Hydro/Pumped-storage	360	Nil*

* For the pumped-storage stations, fuel costs are nil when generating. When pumping water up, fuel costs depend on which other power stations are running.

Part C – Deciding which power stations to use

It is best to work on this part in pairs.

Imagine you are engineers working for the National Grid Company. You are based at the Regional Control Centre. Your job is to make sure enough electricity is generated, *at the lowest possible cost.*

The generating companies tell you the price of electricity from each of their power stations. The prices are given in the table above.

Answer question 11.

Look at the demand curve for a typical summer day in figure 9.

Answer questions 12 and 13.

Questions on part C

Q11 (a) Which types of power station are the (i) cheapest, (ii) most expensive in fuel costs?
(b) Which is the cheapest coal-fired power station to run?

Q12 Look at the summer demand curve in figure 9.
(a) Find the demand for electricity at 06.00.
(b) At what time of day is demand highest?

Q13 Look again at figure 9. What is the least amount of power you need to be sure of meeting the demand between 00.00 and 06.00?

Your task

Start with a typical summer day (figure 9). Plan which power stations to use during each 6 hour period of time. (00.00 to 06.00; 06.00 to 12.00; 12.00 to 18.00; 18.00 to 24.00.)

The amount of power each station produces has been drawn to scale in figure 11. You can cut out these rectangles and put them on the demand curve to help you. An example (figure 8) has been started for you.

- □ You must choose power stations to give electricity at the lowest cost. Remember that some power stations are more expensive to run than others.
- □ You must generate exactly as much power as you need at any time. But you cannot know precisely how much that will be – so you must always keep a bit of generating capacity in reserve.
- □ Remember that some power stations can be started up quickly when there is a sudden demand for electricity. Others, like nuclear, are best kept running all the time.
- □ When demand is low, you can use surplus electricity to store energy with pumped-storage stations. You can use this stored energy at high demand times.
- □ Draw in the power stations as you plan each 6 hour period, so that you have a record of what you decided.
- □ Do the task for summer first (figure 9), then winter (figure 10).

A more difficult question

Q14 *When you have finished, see if you can work out a price for electricity from pumped storage knowing that efficiency of pumped storage is 80%.*

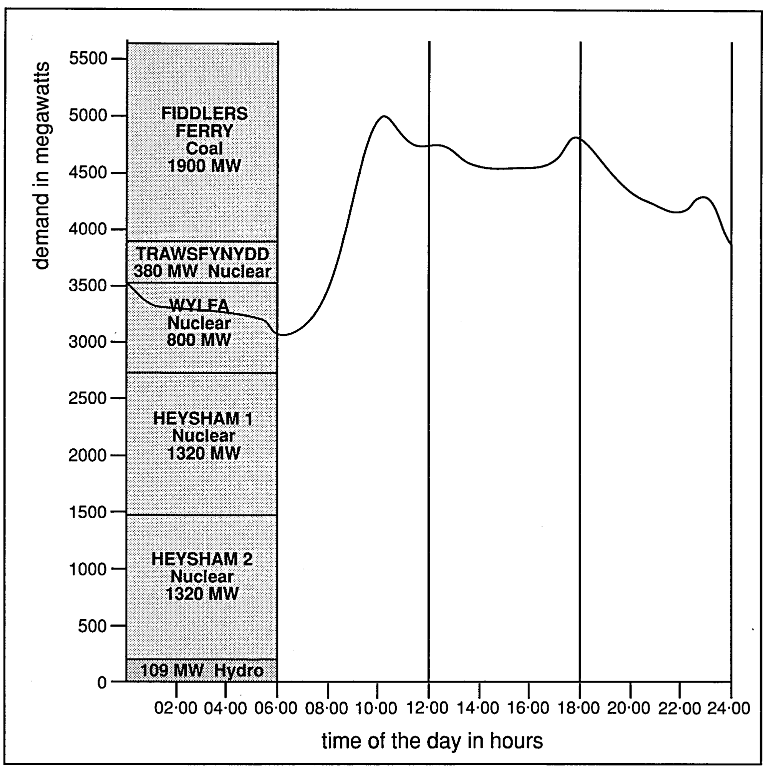


Figure 8 Using the cut-out blocks from figure 11

You have worked with fixed prices and 6 hour blocks of time. In real life, the prices of electricity for the Grid may change every half hour.

Engineers in the Control Centre must make minute by minute decisions as to which power stations to use.

Figure 9

Summer day demand curve

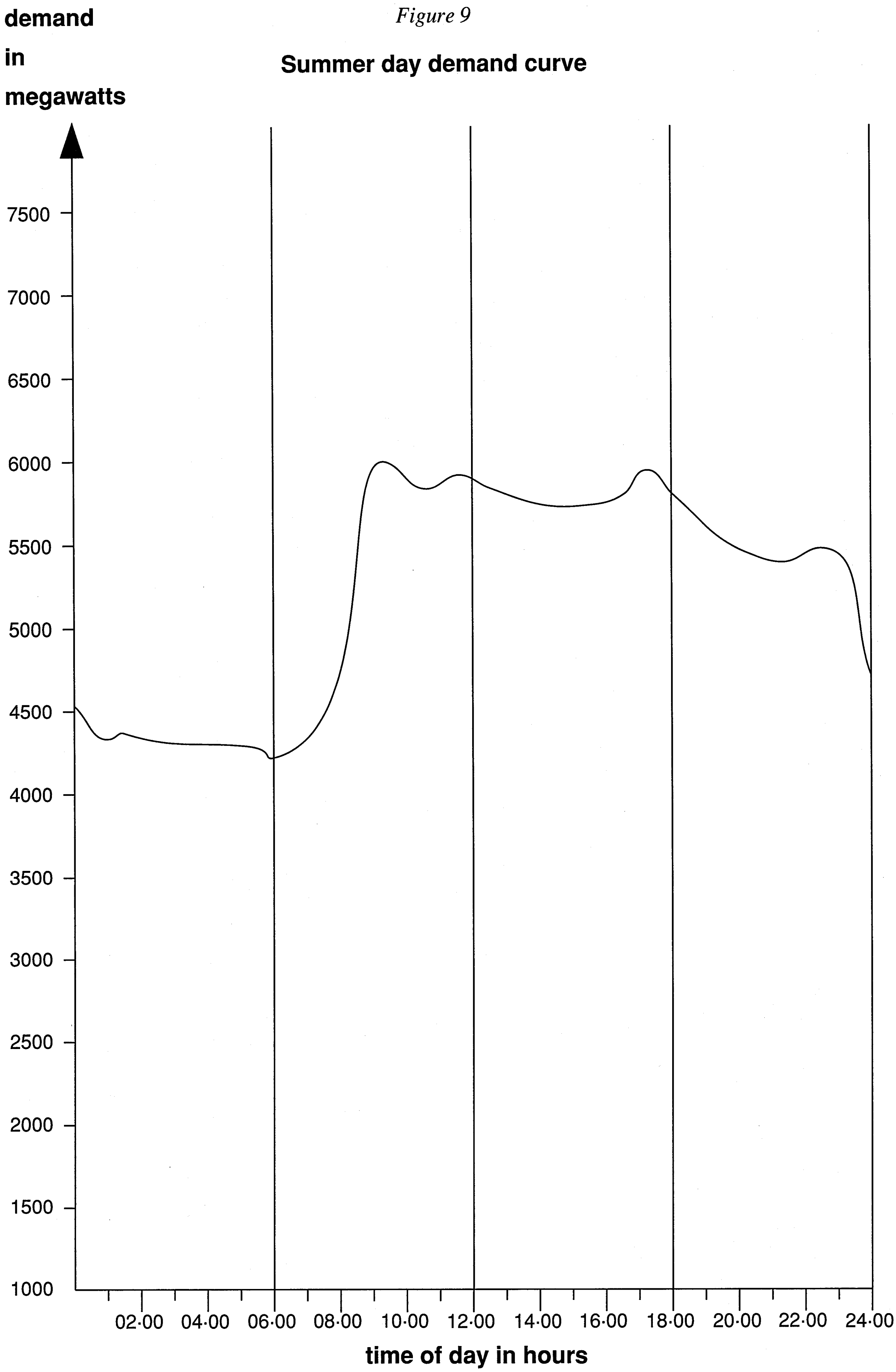


Figure 10

Winter day demand curve

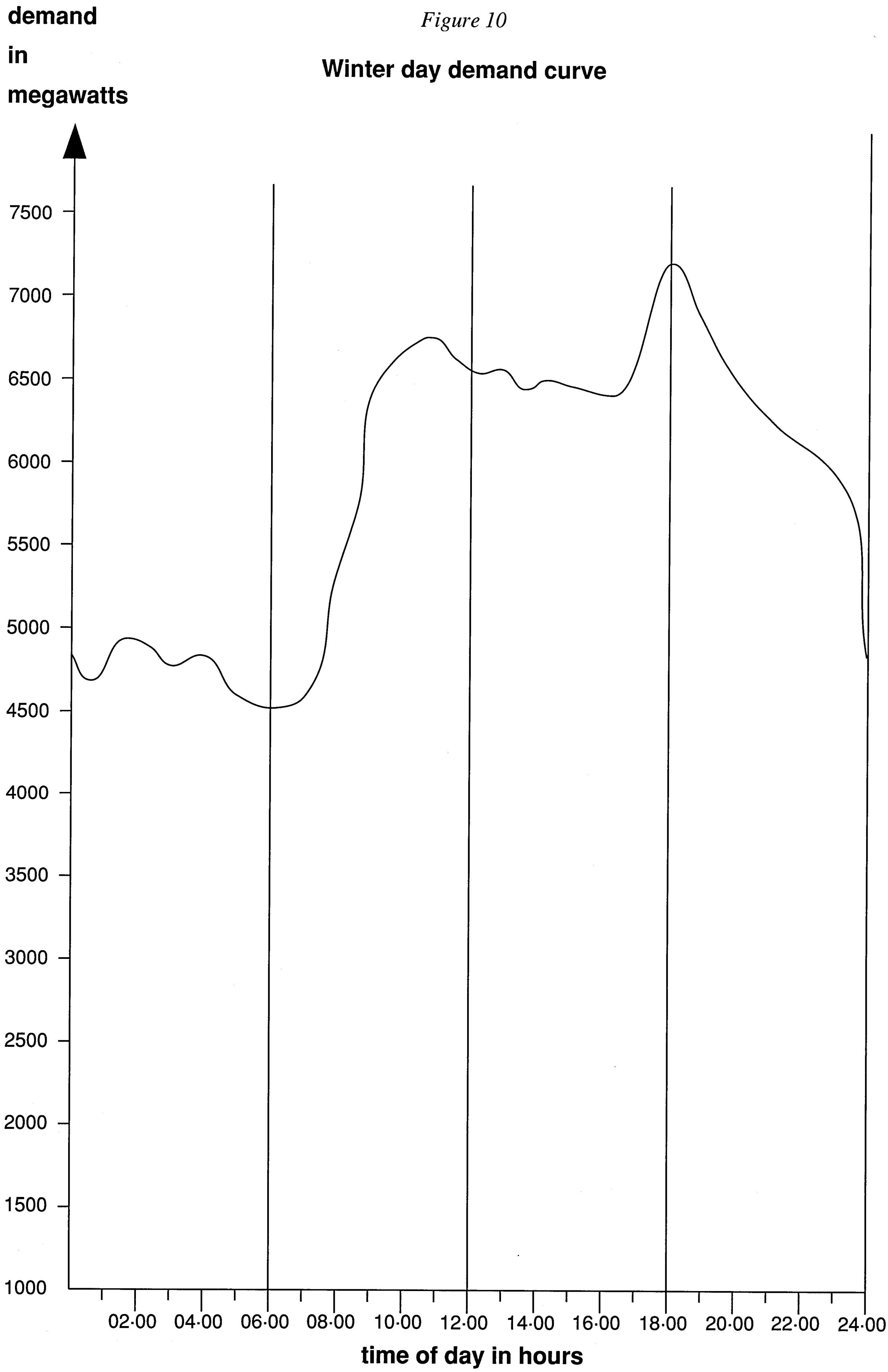


Figure 11 Blocks to represent power station generating capacities. Cut them out to help you with the task

NUCLEAR

Heysham 1
Nuclear
1320 MW
£7.00 per MWh

Heysham 2
Nuclear
1320 MW
£6.50 per MWh

Wylfa
Nuclear
800 MW
£7.50 per MWh

Trawsfynydd
Nuclear 380 MW
£8.00 per MWh

COAL

Fiddlers Ferry
Coal
1900 MW
£15.00 per MWh

Agecroft
Coal
215 MW

£18.50 per MWh

Bold
Coal
160 MW

£21.00 per MWh

Carrington
Coal
230 MW

£21.00 per MWh

OIL

Ince B
Oil
1000 MW
£26.00 per MWh

Padiham
Coal/Oil
200 MW

£26.00 per MWh

HYDRO and PUMPED STORAGE

Cwm Dyli, Dolgarrog
Rheidol, Maentwrog
Hydro
Total 109 MW
£nil per MWh

Ffestinlog
Hydro/Pumped
storage
360 MW

£nil per MWh

Dinorwig
Hydro/Pumped
storage
1800 MW
£nil per MWh

PROJECT MANAGEMENT

Science curriculum links
AT 1 Exploration of science

Syllabus links
- GCSE Science
- Sixth-form General Studies
- Technology

Lesson time
1 hour

Links with other SATIS materials
605 The Great Chunnel Debate

NERIS
Search on
PROJECTS and PLANNING
and UPPER SECONDARY

SUMMARY

The material is designed for students working in pairs. It shows how a project may be divided into a series of activities, arranged in the best sequence and organised to complete it in the shortest time by a process of 'critical path analysis'.

This unit links with both the Technology and the Science National Curriculum.

STUDENT ACTIVITIES

- ☐ Introduction to project management: sequencing the setting up of a fish tank.
- ☐ Producing a network and finding the critical path: demolition of the school.

AIMS

- ☐ To link with project work in science and technology
- ☐ To simulate the management of large projects
- ☐ To introduce the key terms of activity, network, critical path, activity float
- ☐ To introduce the technique of critical path analysis
- ☐ To provide an opportunity for collaborative problem solving

USING AND ADAPTING THE UNIT

- ☐ In trials, the unit has been used to help students plan project work in science and to introduce study skills.
- ☐ Activity A is for students working in pairs. (It may help them to write the activities on paper, as has been done for activity B, so that they can rearrange them in any order.) Students need 5 minutes or so to solve the problem when the teacher may ask groups to compare their results and discuss their strategies.
- ☐ Activity B is for students working in groups of 2 to 4. Pages 4 and 5 are designed for photocopying on thin card and cutting up.

REQUIREMENTS

- ☐ Copies of pages 5 and 6 should be printed single-sided onto paper or card. Cards sets may be stored in envelopes for further use.

Authors **Stephen Carver**
Jane Vellacott
Drawings **Laurie Fahy**

First published 1991

General information

The unit is designed to introduce students to the idea of project management. By the end of the unit students should understand how to get a logical sequence, find the critical path and recognise float as an idea. (The examples in this unit are deliberately kept simple and restricted to produce a network showing activities and not events, or dummy activities etc.)

Changing the critical path to reduce the time taken may be done by increasing the resources e.g. by using twice the labour and completing in half the time. It should be noted however, that reducing the time for an activity may remove it from the critical path.

Teaching notes

Activity B The activities listed on page 3 are already roughly in sequence to encourage students to consider float activities. (It would be unrealistic and would make the task very much harder to present the activities in a random order.) There is one blank card on page 5 for students to add an activity of their choice.

It is important that students do not waste time when drawing out their final network. Naming the activity and the number of days is sufficient for each stage.

Less able students may be given the cards to cut out.

Answers to the questions

Q1 *7*

Q2 *Buying the tank, gravel, lights and plants; washing the gravel and putting it in the tank.*

Q3 *Five and a half weeks:*

Week one – 'Buy tank etc.' and 'Wash gravel'
*Week two – 'Fill tank' and 'Plant plants'**
Week three – (plants establishing)
Week four – (plants establishing)
Week five – (plants establishing)
Week six – 'Buy fish etc.'

'Set up the pump' and 'Wire up the lighting' can be done during any of the lessons. They are 'float activities', as described on page 4.

** Assumes plants are kept in water after purchase until planted.*

Q5 and Q6 *See network below – several variations are possible. (The network would look more simple if space permitted the critical path to be drawn as a straight line.)*

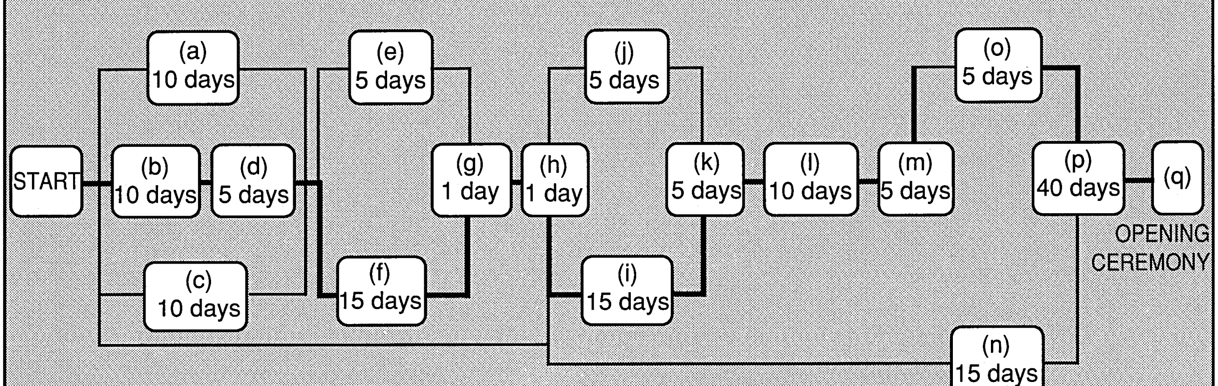
Q7 *112 days*

Q8 *(a) Fence site, (c) Publicity, (e) Disconnect services, (j) Strip tarmac, (n) Order equipment, (o) Topsoil.*

Q9 *Add 5 days to critical path.*

Q10 *This activity becomes critical and the project will be delayed by 5 days.*

Network for demolishing your school to make playing fields



Critical path is shown in dark.

PROJECT MANAGEMENT

Any project needs management if it is to run smoothly.

This unit shows you how to plan projects of any size and scale.

This unit is about planning and managing projects. It contains two activities:

- sequencing the task of setting up of a fish tank,
- a simulation exercise: involving critical path analysis of managing the demolition of the school and turning it into a green field site.

Activity A – Setting up a fish tank

Work in pairs on this task.

Imagine that you and your partner are to set up a fish tank as part of a science project. You plan to buy a tank with lighting, pump, gravel, plants and fish.

The problem is that the plants need three weeks to establish themselves and grow roots before you can put the fish in.

The job has been divided into activities for you. You may assume that each activity will take one person one science lesson. You have two science lessons a week in which to work on this project. You and your partner could decide to work on different activities at the same time.

- ☐ Plant plants. Wait three weeks.
- ☐ Buy fish. Put in fish.
- ☐ Fill the tank with water.
- ☐ Set up pump to aerate and circulate the water.
- ☐ Buy the tank, gravel, lights and plants.
- ☐ Wash the gravel and put it in the tank.
- ☐ Wire up the lighting.

Work out the best order in which to set up the tank in the shortest time. Drawing a flow chart listing each activity may help you.

Questions

Q1 How many activities was the project divided into?

Q2 Which activities had to be complete before filling the tank with water?

Q3 How long would it take you to set up the tank and put in the fish?

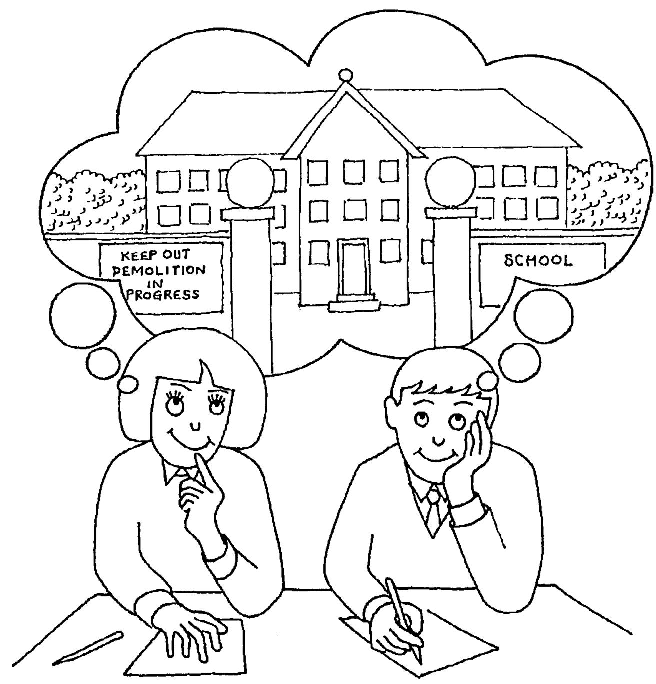
Q4 Assuming you were to start the fish tank project next science lesson and spend two lessons a week on it, use a calendar or diary to plan a schedule for the project (that is the date of each science lesson and what you would do during it).

What is project management?

Have you ever wondered how people organise *really large projects* like building a hospital?

Although such projects are complex, they have to be planned just like setting up the fish tank. It is the task of project managers to ensure that the hospital is completed with all the equipment *to the agreed specification on time* and *within the cost allowed* – before the patients arrive!

Activity B lets you try your hand at managing a larger project – demolishing your school. Demolition requires expert knowledge of civil engineering so some of the planning has been started for you.



Activity B – Demolish your school

Due to a lower birthrate there are fewer children in your area and your school is to be closed and demolished. The local council will use the site for playing fields.

Local council managers in the works department have decided to break down the job into the stages set out on the next sheet.

- ☐ As project managers your task is to sort these stages into the best order and to find shortest time to do the job.
- ☐ The 17 stages are printed on card. Cut them out. Arrange and rearrange them as you like. See if some stages can be done at the same time. Put them in the order that gives the shortest time to do the job.

PROJECT MANAGEMENT

LIST OF ACTIVITIES

(a) **FENCE SITE** The school has closed. To stop vandalism a high fence must be built around the school and this has to be finished before the contractor can go onto site. **10 days**

(b) **FIRMS QUOTE** A demolition firm needs to be chosen so several are asked to quote a price (tender) for blowing up the school. **10 days**

(c) **PUBLICITY** You need to publicise in the local paper what is happening on the old school site before work starts. **10 days**

(d) **FIRM SELECTED** Tenders are compared and a firm is chosen and told to proceed. **5 days**

(e) **DISCONNECT SERVICES** The demolition firm has to disconnect electricity, gas and water supplies to the school before any demolition occurs. **5 days**

(f) **REMOVE FITTINGS** The fittings inside the buildings must be removed by the demolition firm before the buildings are blown up. **15 days**

(g) **PLANT EXPLOSIVES** Explosives are set after the services are disconnected and the building is cleared of fittings. **1 day**

(h) **DEMOLISH SCHOOL** Press the button. Bang!! **1 day**

(i) **CRUSH RUBBLE and SORT METAL** The building rubble needs to be crushed and the metal girders sorted. **15 days**

(j) **STRIP TARMAC** Strip the tarmac from the playgrounds etc., which can be done while the concrete from the buildings is being crushed. **5 days**

(k) **CLEAR RUBBLE** The crushed concrete, sorted metal and stripped tarmac must be removed from the site in lorries. **5 days**

(l) **DIG OUT FOUNDATIONS** The deep foundations must be dug up and taken away before the land can be levelled. **10 days**

(m) **LEVEL SITE** The site is to be levelled ready to receive the topsoil. **5 days**

(n) **ORDER PLAYING FIELD EQUIPMENT** Playing field equipment needs to be ordered, e.g. goal posts. **15 days**

(o) **TOPSOIL** Topsoil is delivered and spread on site, grass is seeded. **5 days**

(p) **FINAL PREPARATIONS** Grass on pitches matures and the equipment is installed. **40 days**

(q) **OPENING CEREMONY** Mayor opens playing fields.

Project management involves

Planning
The process of dividing the task into activities and building up a network.

Analysing
Working out the earliest and latest times for starting and finishing activities.

Scheduling
Preparing a schedule of activities with dates when they are to take place.

Control
Monitoring progress, comparing with the plan, deciding what action to take.

Critical path analysis

The method you have used to plan the the setting up of a fish tank or the demolition of your school is called **critical path analysis.** You do it in your head when you organise a busy day – which homework has to be finished before another and before you can go out! But large projects have to be organised more formally.

Project managers firstly break down the project into stages or **activities.**

Each stage is **analysed** to decide which activities must be done first, which must be finished before another can begin and which can be carried out at the same time. From this they produce a flow chart called a **network** giving the order in which the activities should be done.

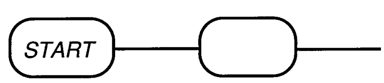
To work out how long the project should take, they look for the shortest route through the network. This is called the **critical path.** Activities which do not lie on the critical path are called **float activities.** It is not critical when they are done – like wiring up the lighting in the fish tank project.

When the starting date is known, they work out a **schedule** of dates when each activity is to start and end.

While the project is going on, the managers monitor progress and compare it with the schedule. If progress is not according to plan, they can make adjustments to the network and use it to reschedule the remaining activities.

Questions about activity B

Q5 *Make a copy of your* ***network*** *of cards, for example:*



Q6 *Use a coloured pen to mark the* ***critical path*** *– the way through the network that gives the shortest time.*

Q7 *How quickly can the job be done?*

Q8 *Some activities are not on the critical path. These are called 'float' activities. Which are they?*

Q9 *Suppose the transport firm let you down and shifting the rubble takes you twice as long. What effect will this have on the time it takes to do the job?*

Q10 *The subcontractors due to strip the tarmac arrive 15 days late. Will this delay the project and if so by how much?*

START

(a)
FENCE SITE
10 days

(b)
FIRMS QUOTE
10 days

(c)
PUBLICITY
10 days

(d)
FIRM SELECTED
5 days

(e)
DISCONNECT SERVICES
5 days

(g)
PLANT EXPLOSIVES
1 day

(f)
REMOVE FITTINGS
15 days

(h)
DEMOLISH SCHOOL
1 day

You may use this card to add an activity of your choice

(i)
CRUSH RUBBLE & SORT METAL
15 days

(j)
STRIP TARMAC
5 days

(k)
CLEAR RUBBLE
5 days

(l)
DIG OUT FOUNDATIONS
10 days

(m)
LEVEL SITE
5 days

(n)
ORDER PLAYING FIELD EQUIPMENT
15 days

(o)
TOPSOIL
5 days

(p)
FINAL PREPARATIONS
40 days

(q)
OPENING CEREMONY

The SATIS Team

Project Organiser and Editor	Anabel Curry	*Design*	Stephen G. Park
Project Director	John Holman	*Secretary*	Vivien Samson
Publishing Editor	Donna Evans	*Evaluation Officer*	David Walker

Publishing Manager at ASE Jane Hanrott

The SATIS Central Team

The central team determined overall policy for this project.

Paul Adams, St Michael's High School, Rowley Regis

Vivien Bates, Tapton School, Sheffield

Susan Benjamin, Teachers' Centre, Cardiff

John Coulton, Yewlands School, Sheffield

Peter Ellis, Ryde School, Ryde

Joan Fraser, Faculty of Education, Liverpool University

Bill Harrison, Sheffield City Polytechnic

Colin Johnson, School of Education UWCC

John Murphy, North Border Comprehensive, Doncaster

Dave Pierson, Hampden Park School, Eastbourne

Linda Scott, County Curriculum Centre, Gloucester

Phil Stone, Bishop Hedley High School, Merthyr Tydfil

Jane Vellacott, The Mountbatten School, Hemel Hempstead

The SATIS team wish to thank the following people who have made a special contribution to the development of units for SATIS 11 and SATIS 12

Dr Peter Borrows, ASE Laboratory Safeguards Sub-committee

Robert Bailey, NERIS

Andrew Hunt, Project Director of SATIS 16–19

John Stringer, Project Director of SATIS 8–14

Simon Albrecht, Nature Conservancy Education Liaison Officer

Stephen Carver, Brown & Root Ltd.

Duncan Hawley, Royal Forest of Dean Centre for Environmental Studies

Gareth Large, Saltwells EDC

Derek Raine, Astronomy Department, Leicester University

Janet Major, Diss High School

ınk those people in education, industry and the professions who gave so freely of their
rial material. The team also wish to thank the many teachers who responded with ideas
those teachers and students who trialled the units.

List of units in this book

The Association for Science Education
College Lane, Hatfield, Herts AL10 9AA

ISBN 0 86357 140 9