

References

Textbook

Chapter 9 pages 120-122

Specification

10.1 Using Fuels

12.2b, 12.5d

Data

http://www.dti.gov.uk/energy/inform/energy_consumption

www.cabinet-office.gov.uk/innovation/2002/energy/report

Future Energy Demand

This activity allows students to consider some of the ways in which predictions about future energy demand have been made. It allows them to build different scenarios and to discover how starting assumptions will influence projections of energy demand.

There are three stages to the activity:

- A the simple extrapolation model
- B investigation of the effect of assumptions on outcomes
- C discussion of the values which will influence the assumptions and outcomes.

The main learning method is discussion in small groups, with groups expected to reach a conclusion at each stage.

The exercise is focussed on demand rather than supply so that issues such as the percentage of electricity generated by renewables are not included. Electricity generation is considered later. These issues will inevitably come up in Activity C and will be a useful preparation for future work. (Explain that the units used in this activity are 'million tonnes of oil equivalent' (mtoe))

Activity A

Simple extrapolation model

You need: Pages 1-3 of the student sheets
Rulers

Arrange the room so that students can work in small groups, not more than 3 or 4 students per group.

Give students pages 1-3 of the student sheets.

They then extrapolate the graphs to 2020 assuming a constant rate of increase. Remind students that this extrapolation model has been widely used by policy makers to predict the future.

The values should be around the following

Sector	Current use/mtoe	Predicted use in 2020 from graph
Transport	55	75
Domestic	49	55
Industry	35	35
Service	22	24
Total	161	187

Table 1

10 minutes

Criticise the model

Get each group to discuss the model critically by identifying, for each of the 4 sectors, at least one reason why the assumption of a constant rate of change may not be valid.

For example:

Road travel cannot go on growing at the current rate or the whole UK would eventually be covered by roads.

Domestic use is unlikely to continue increasing at the current rate as our homes would become too hot.

5 minutes

Class discussion on criticisms

Get each group to report to the class and write up a sample of the critiques for each sector.

In discussion with the class analyse the responses to see how many suggest that the model gives values which are too low and how many give values which are too high.

5-10 minutes

Activity B**Constructing scenarios**

You need: Pages 4 & 5 of the student sheets
Calculators

Students remain in the same groups. Each group creates their own scenario by choosing some of the assumptions A - M from the list. They use Table 2 to keep track of the figures.

Give students a principle to guide their choice of assumptions. Give different groups different briefs to guide their choices. The simplest version of this is to tell them to choose either;

- The set of assumptions which would lead to a maximum demand scenario.
- The set of assumptions which would lead to minimum demand scenario.

A more complex version suitable for some groups might include principles such as;

- The set of assumptions which would apply if everyone began to act on the threat of global climate change, reducing their fossil fuel use.
- The set of assumptions which would apply if market forces were the only guiding principle so that people would continue to use as much fuel as they could afford.

The aim of this exercise is to allow students to discover for themselves how the starting assumptions will alter the projections generated by a model and to recognise that a scenario is made up of a whole set of internally consistent assumptions.

When the government did the exercise, it worked on four different scenarios based on a range of economic and technical assumptions, some of which are included in the set here. The scenario building exercise used here is very much simplified as it treats each starting condition as if it were independent.

10 minutes

*Method***Use small group discussion because**

- Students enjoy it
- It allows active involvement by everyone
- One loud or quicker thinking student cannot dominate the class
- The shy and less articulate are more able to contribute
- Students learn from each other
- Everyone gets more practice at expressing their ideas
- A two way discussion is almost always more creative than individual thoughts
- Social skills are practiced in a "safe" environment
- It helps individuals clarify arguments for a topic where there are no "right answers"

Running small group discussion

- Make sure that the task is clear and has a definite product which has to be communicated back
- Make sure they have enough knowledge and resources to complete the task
- Don't let it run for too long - Some groups will stray off task
- Drop in on groups for short periods with support or challenge as appropriate
- Make sure that seating allows everyone in the group to see each other, best round a table not side by side
- Do not allow one group to become too noisy - they will attract interest from other groups, who will then lose their own identity
- Normally groups work best with friends because they trust them but be prepared to break up groups which are not working - some members will be pleased
- Allow time for feedback at the end and value the contributions of all groups.

Ideas about Science

12.5d Mainly technical

Class discussion of scenarios

Get the groups to share their total demand figures in a whole class discussion. (The final figures range between about 200 mtoe and 140 mtoe depending on the choice of assumptions). It is worth pointing out that the exercise uses a limited range of factors and rather crude criteria. The figures for two possible scenarios are shown below.

At this stage emphasise to the class that the exercise has shown how the final information gained from the models depends almost entirely on the assumptions made. Remind them that any predictions of the future will have similar uncertainties and be susceptible to the choices made by those using the model, choices made on both scientific and other grounds.

As an example of this you could get each group to choose the 5 assumptions from the list that they think are most probable or the most improbable and then to feed these back to the class. Make a list on the board noting the effect each has on total demand.

10 minutes

Samples of maximum and minimum scenarios

Sector	Current use - 2001/ mtoe	Assumption	Change in fuel use by 2020 /mtoe	2020 Total fuel use/ mtoe
Domestic	49	H	-1.0	
		J	-1.5	
		K	-2.0	
		L	-10.0	
Transport	55	A	0	
		J	-1.7	
Industry	35	F	-3.2	
		J	-1.0	
Service sector	22	J	-0.7	
		L	-3.3	
TOTAL	161		- 24.4	137

Table 2 Minimum fuel use scenario

Sector	Current use - 2001/ mtoe	Assumption	Change in fuel use by 2020 / mtoe	2020 Total fuel use/ mtoe
Domestic	49	D	+10.0	
		I	+1.0	
		M	+2.5	
Transport	55	B	+7.2	
		C	+5.0	
		I	+1.1	
Industry	35	M	+3.3	
		I	+0.7	
Service sector	22	G	+6.0	
		I	+0.4	
TOTAL	161		+37.2	198

Table 2 Maximum fuel use scenario

Ideas about Science

12.5d mainly economic,
social environmental

Activity C

Social Values and decision-making

At this stage include social values explicitly. Remind the class as a whole of how the future fuel use will depend very largely on decisions which are made now by the government, private companies and individuals. For example; the government can decide to put more subsidies into energy efficiency measures such as home insulation, build more roads or tax fuel so that technologies for efficiency become more cost effective. Individuals can buy small cars or 4 x 4s.

Get the groups to identify which of the assumptions in the list on page 5 depend on technical factors and which on economic/political/social.

To broaden the discussion beyond the UK you may decide to give the following information to the class before they decide on their preferred scenario.

Within 50 -100 years almost all the world's oil and gas reserves will have been used up at current rates of production. Reduced output will increase prices. This will impact particularly severely on Low Income Countries who are increasing their fuel use as they develop. They will be unable to afford higher prices to compete with richer countries for a share of the dwindling resources.

Each group should then discuss what sort of scenario they think is the most desirable and identify the assumptions underlying this scenario. They then discuss the implications of these assumptions, identifying some of the costs and benefits, social, environmental and financial.

Writing up this evaluation of a desirable scenario would make a good homework exercise, or each group could report to the class.

30 minutes or homework

Activity D

Critical reading activity

Get the students to read an article on future energy needs. They should then prepare a short analysis of the argument used under the following headings.

- The main conclusion
- The reasons behind the conclusion
- The evidence and assumptions used in developing the reasons
- The extent to which these assumptions are made explicit in the article
- A discussion as to whether the conclusion is justified

Reasons for rejecting the conclusion could be either that the evidence or assumptions do not lead to the conclusion drawn, that the evidence itself is suspect or that a set of assumptions is chosen to give the required conclusion.

Ideas about Science

12.5f

Future Energy Demand

Activity A

Will we run out of fuel?

We need nuclear power if we are to meet our energy needs

Our way of life depends on a secure energy supply

How much energy will the UK need in 2020?

The government and the supply industry have to make predictions. They do this using models. The first model you consider is based on the assumption that current trends in demand will continue at the same rate as at present. This approach has been widely used for decision-making. The units of energy used are millions of tonnes of oil equivalent, abbreviated to mtoe.

1. Use the extrapolation model

Extrapolate each of the graphs in Figures 1, 2, 3 and 4 to 2020 and add them together to get a total for energy consumption in the UK in 2020 recording your answers on table 1. You take a ruler and, using a line of best fit, continue this line onwards to 2020.

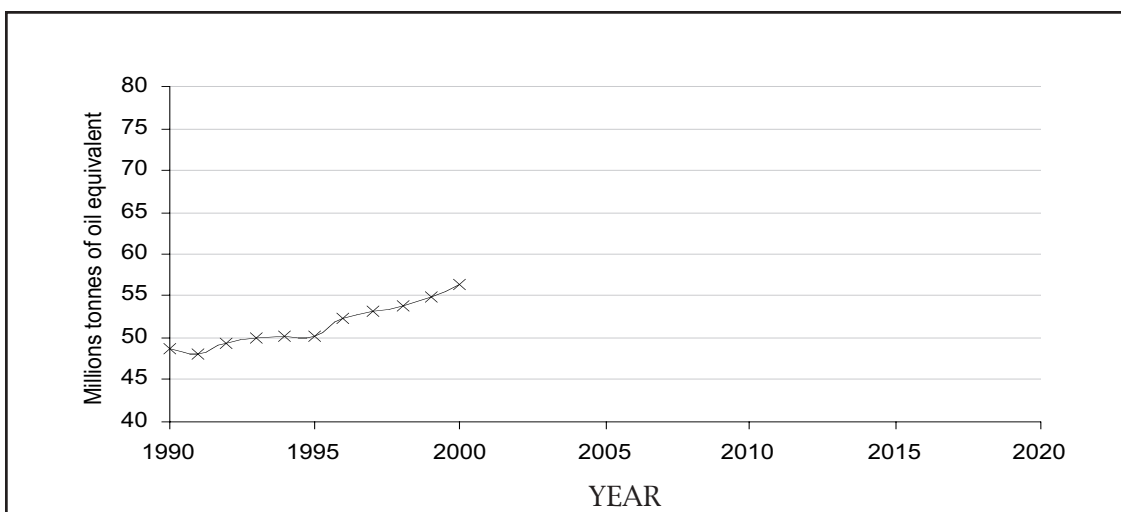


Figure 1 Total U.K. transport energy consumption 1970 - 2000

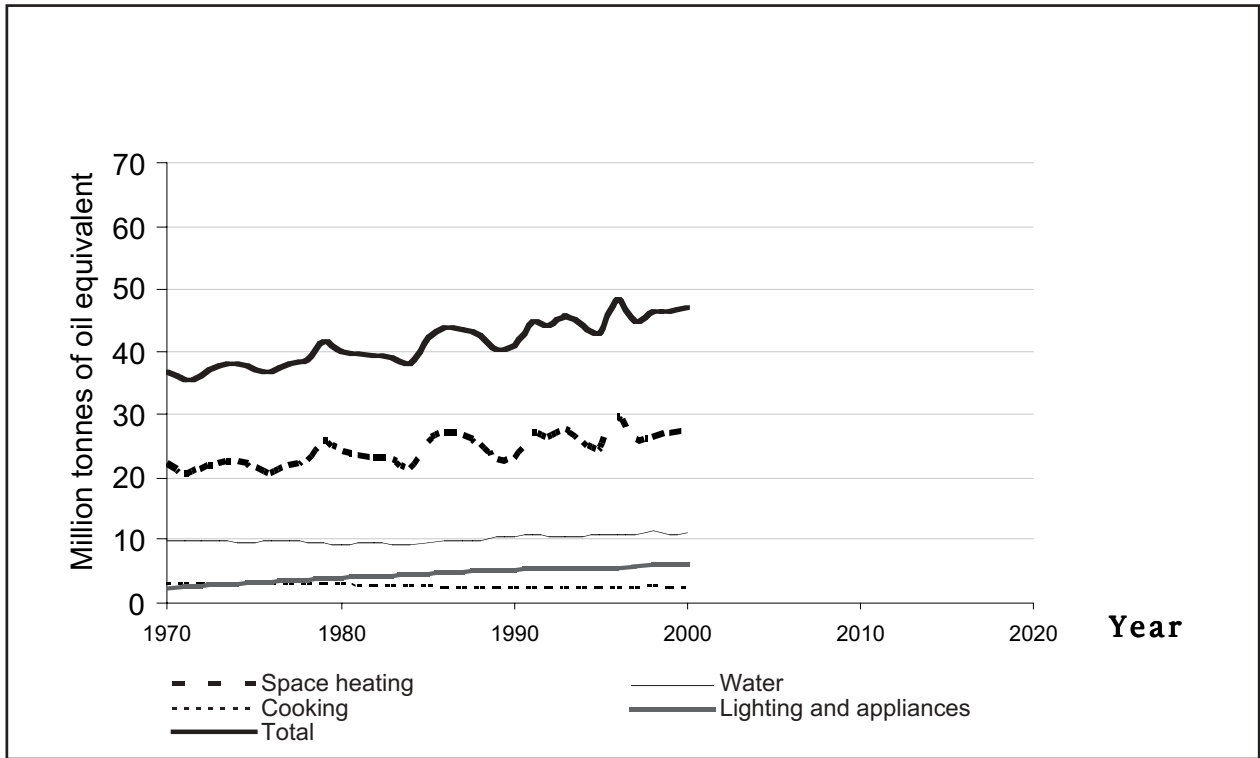


Figure 2 U.K. Domestic final energy consumption by end use, 1970 to 2000

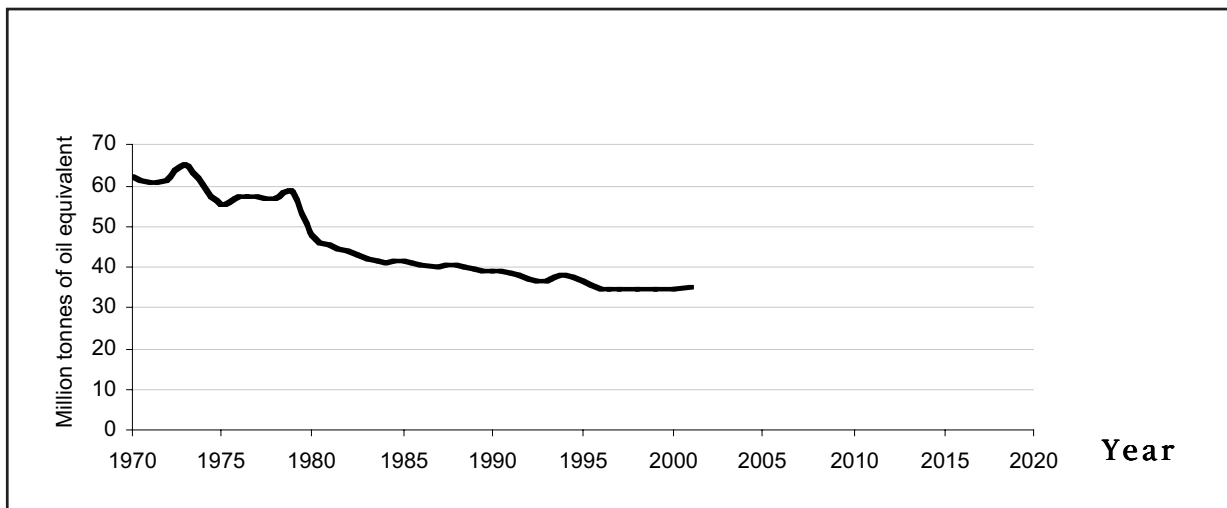


Figure 3 U.K. Total industrial energy consumption, 1970 to 2001

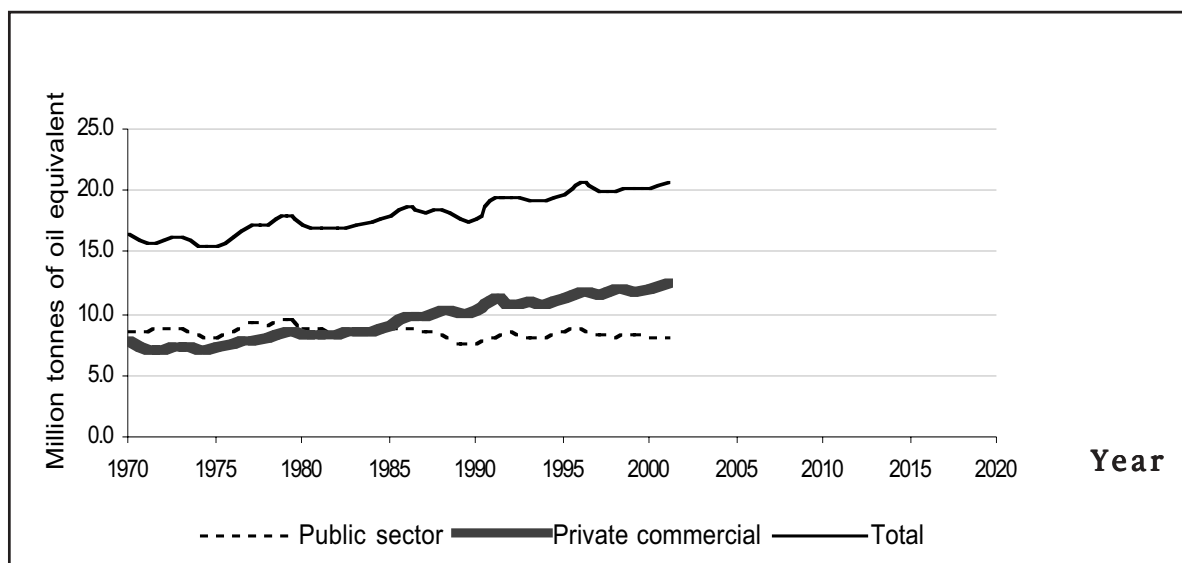


Figure 4 U.K. Service sector energy consumption, 1970 to 2001

Sector	Current use/mtoe	Predicted use in 2020 from graph
Transport	55	
Domestic	49	
Industry	35	
Service	22	
Total		

Table 1

2. Criticise the model

Working in your group, criticise the assumptions behind the model used in this activity. For each of the four main sectors you should suggest at least one reason why the simple assumption that demand will continue to change at the same rate may not be valid. Share your criticisms with the rest of the class.

Activity B Scenarios

Instead of simply assuming that current trends will continue, more complex models include a wide range of different factors affecting energy consumption in the UK. The choice of a set of assumptions about these factors leads to a scenario. The factors will be social and economic as well as technical. Often when this method is used several scenarios are developed and compared. Below is a list of assumptions which might be made about future demand for energy in Britain.

Choosing assumptions to build a scenario

1. The choice of assumptions used will depend upon the principles on which the scenario is to be based. You will be told to base yours on either the maximum probable energy demand or the minimum. Choose appropriate assumptions from the list below. Use table 2 to calculate the total UK demand for energy in 2020 based on these assumptions. Remember to put + or - in front of the change figures in your table.

Scenario

Sector	Current use - 2001/ mtoe use/ mtoe	Assumption	change in fuel use by 2020 /mtoe	2020 total fuel
Domestic	49			
Transport	55			
Industry	35			
Service sector	22			
TOTAL	161			

Table 2

- Share your figures for total fuel use with the class. Compare these figures with the ones you got by simple extrapolation.
- Discuss which of the two scenarios include the most probable assumptions.

Assumptions

- A. Car travel continues to grow at the same rate of 2% per year as at present but this is balanced by increasing efficiency resulting in no overall change in demand for fuel.**
- B. Car and freight transport continues to increase and efficiency gains are wiped out by the use of larger and heavier cars and more short freight journeys. Fuel consumption rises by 7.2 mtoe by 2020.**
- C. Air travel increases by 60% increasing the total fuel used for transport by 5.0 mtoe by 2020.**
- D. The trend to keep homes warmer and warmer in winter and to use air conditioners in summer continues and domestic fuel use increases by 10 mtoe by 2020.**
- E. The average domestic temperature having risen for the last 20 years is now a comfortable 17.5°C and does not go on increasing. Domestic fuel use for heating does not change.**
- F. The present decline in heavy industry continues and industrial use declines by 3.2 mtoe by 2020.**
- G. The rapid increase in the service sector continues and demand increases by 6.0 mtoe by 2020.**
- H. More efficient appliances means that domestic energy use drops by 1.0 mtoe by 2020.**
- I. An increase in GDP of 5% increases demand in all sectors and all sectors increase fuel use by 2% of the 2001 figures.**
- J. Shortages in fossil fuels begin to be felt and prices rise, reducing use in all sectors by 3%.**
- K. The government takes environmental concerns seriously and provides grants to homeowners to improve insulation and reduce fuel use for heating. This reduces domestic use by 2.0 mtoe by 2020.**
- L. 50% of all electricity is generated by the more efficient method of CHP. This reduces overall domestic demand by 10.0 mtoe by 2020 and service sector demand by 3.5 mtoe by 2020.**
- M. The population of the UK increases from 60 million to 63.6 million by 2020. This increases fuel demand in the domestic sector by 2.5 mtoe and in the transport sector by 3.3 mtoe.**

Activity C Social values and decision-making

1. The most desirable scenario

You have explored different possible scenarios. We do have some control over what happens because many of the assumptions made in developing the scenarios represent decisions, which are made by governments, businesses and individuals. In your group develop a new scenario which you think is the most desirable one. Make list of the assumptions involved and the reasons why you chose this scenario.

2. The costs

Even a desirable scenario with many benefits will have costs for some sectors of society, in the UK or elsewhere. Identify some of the costs of your chosen scenario, which may be social, environmental or economic.

3. Report on scenario

Write a report of about 2 pages on your chosen scenario. Include

- the main assumptions
- the projected benefits
- the projected costs