Energy futures

Introduction

Scenarios are used to identify a number of possible alternative futures. They are not predictions of the future. They show how different interpretations of the impact of factors that are causing change can lead to different possible futures.

One reason for developing scenarios in detail is that the process of doing so can help people to understand an issue and work towards a consensus about what should be done. The analysis can make explicit the assumptions and values that underpin people's views on the issue.

Scenarios can help policy makers to visualize the range of possible futures and have a clearer appreciation of the uncertainties in the evidence and the implications of policy options.

How science works

Hb (part) Decision makers aim to make evidence based decisions, taking into account factors that include: technical feasibility, benefits expected, economic cost, risks to human health and wellbeing, risks to the environment.

He In practice much of the evidence available to decision makers is often uncertain. It is not possible to make accurate predictions about the future. The system may be too complex; some issues may not yet be well understood.

Hf Decision makers are influenced by the mass media, by social interest groups and by public opinion as well as by expert evidence. Decisions about science and technology may be influenced by decision makers' prior beliefs or vested interests.

The activity

This group of three activities starts with students considering 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 the starting assumptions influence projections of energy demand.

There are three stages to the scenario-building:

- activity A - the simple extrapolation model
- activity B - investigation of the effect of assumptions on outcomes
- activity 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.

The units used in this activity are 'million tonnes of oil equivalent' (mtoe).

The activity ends with a brief exploration of the two contrasting scenarios developed by the Shell Oil company and published in 2008 (http://www.shell.com/scenarios).

Activity A Simple extrapolation model

Arrange the room so that students can work in small groups. At first just give students the first page of the activity sheets together with the data sheets on pages 2 and 3.

Students first 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 approximately as shown in table 1.

Sector	Use in 2006/mtoe	Predicted use in 2020 from graph
Transport	60	70 - 75
Domestic	47	50 - 60
Industry	33	25 - 30
Service	40	40 - 45
Total	180	185 - 210

Table 1 completed

Next students criticise the model. They discuss reasons why the assumption of a constant rate of change may not be valid. Draw this stage of the activity to a close by asking the groups to compare their predictions and their critique of the assumptions.

Reasons why the assumption of a constant rate of change may not be valid:
- international regulation and changes in taxation to cut greenhouse gas emissions
- implementation of policies to encourage sustainable development
- policies to cut food miles and encourage the more local distribution of foodstuffs
- rising costs of energy resources as sources of crude oil becomes more limited
- improved insulation in homes and improved energy efficiency of appliances
- improved fuel efficiency of cars and other vehicles
- a shift from private to public transport
- a further shift of manufacturing from the UK to other parts of the world.

In discussion with the class explore the extent to which predictions based on a continuation of current trends are likely to be too high or too low.

Activity B Constructing scenarios

Students remain in the same groups and work from pages 4 and 5 of the student sheets. 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 'business as usual' set of assumptions which would apply if current market forces were the only guiding principle so that people would continue to use as much fuel as they could afford.
- The set of assumptions which would apply if everyone began to act on the threat of global climate change, reducing their fossil fuel use in a context which includes carbon caps and carbon pricing.and the EU target of reducing energy demand in Europe by 20%

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.

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.

Samples of maximum and minimum scenarios

Sector	Use in 2006/mtoe	Assumption	Change in energy use by 2020/mtoe	2020 total energy/mtoe
Domestic	47	D	– 1.4	
		H	– 2.0	
		J	– 1.4	
		K	– 4.0	
		L	– 10.0	
Transport	60	B	0	
		J	– 1.8	
Industry	33	F	– 7.0	
		J	– 1.0	
Service	40	G	– 4.0	
		J	– 1.2	
		L	– 3.5	
Total	180		– 37.1	143

Table 2 for Minimum energy use scenario

Sector	Use in 2006/mtoe	Assumption	Change in energy use by 2020/mtoe	2020 total energy/mtoe
Domestic	47	A	+ 2.5	
		I	+ 10.0	
Transport	60	A	+ 3.3	
		C	+ 5.0	
Industry	33			
Service	40	E	+ 2.5	
		M	+ 0.8	
Total	180		+ 24.1	204

Table 2 for Maximum fuel use scenario

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 for activity B 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.

Finally you might compare the scenarios suggested by the students with those put forward by the Shell oil company in 2008. These can be presented with the help of the the video 'Shell energy scenarios to 2050' which you can download from:
http://www.shell.com/home/content/aboutshell/our_strategy/shell_global_scenarios/scenarios_videos/
or stream from the web site.

There is an introduction to the Shell scenarios at:
http://www.shell.com/home/content/aboutshell/our_strategy/shell_global_scenarios/what_are_scenarios/what_are_scenarios_30102006.html

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Introduction

In these activities you are going to see how scenarios can be used to identify a number of possible alternative futures. Scenarios are not predictions of the future. They show how different interpretations of the impact of factors that are causing change can lead to different possible future scenarios.

Scenarios can help policy makers to visualise the range of possible futures and have a clearer appreciation of the uncertainties in the evidence and the implications of policy options.

Activity A 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 on the data sheet to 2020. For each graph, with the help of a ruler and, using a line of best fit, continue the line onwards to 2020. Add the 2020 values together to get a total for energy consumption in the UK in 2020, recording your answers on Table 1.

Sector	Use in 2006/mtoe	Predicted use in 2020 from graph
Transport	60	
Domestic	47	
Industry	33	
Service	40	
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.

Data sheet

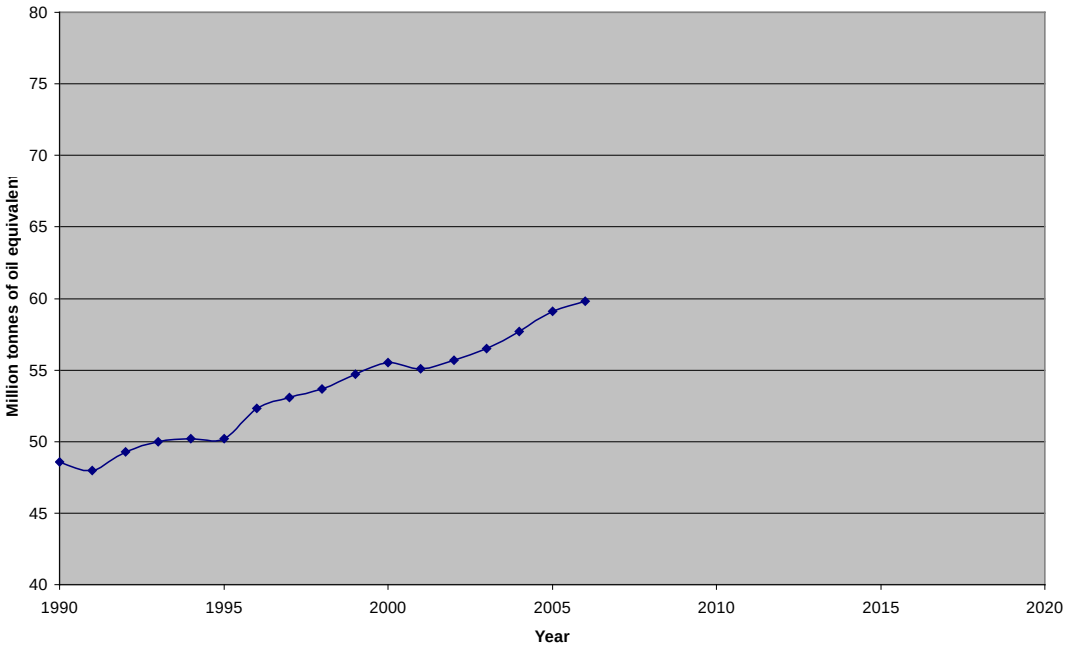

Figure 1 Total UK transport energy consumption. (Source: Department for Business, Enterprise and Regulatory Reform)

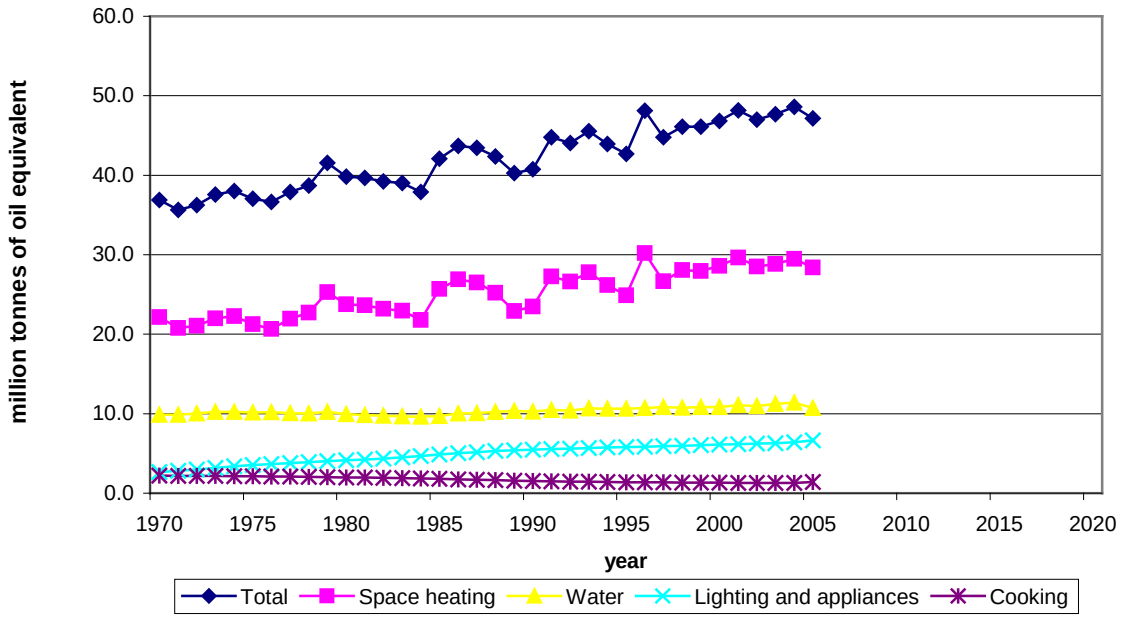

Figure 2 Domestic final energy consumption by end use (Source: Department for Business, Enterprise and Regulatory Reform estimates from data supplied by the Building Research Establishment)

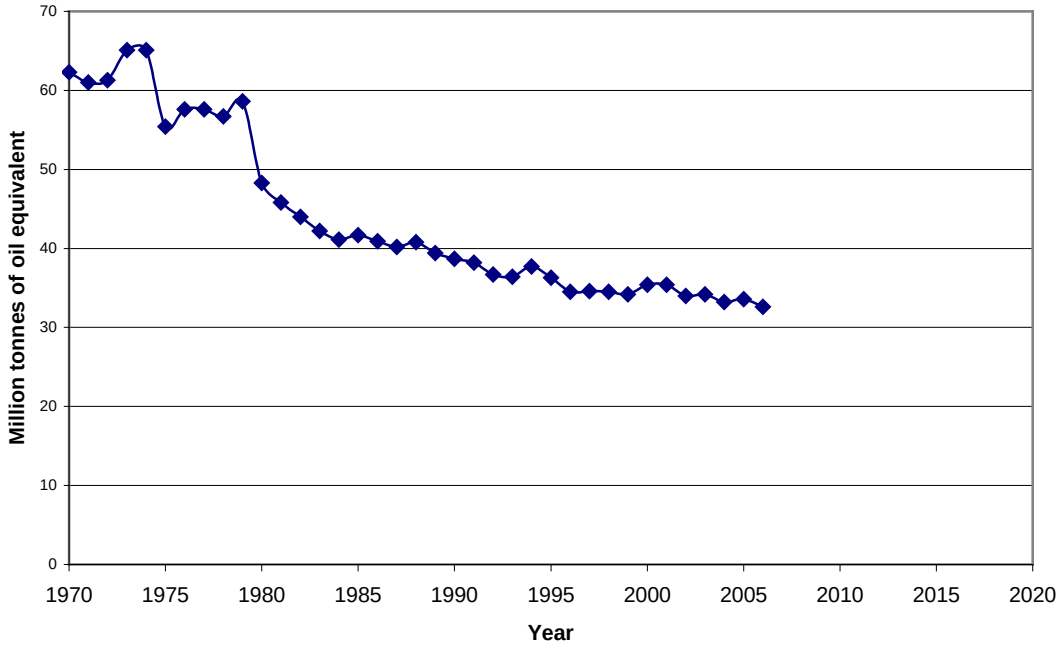

Figure 3 UK total industry energy consumption. Note that energy used in transformation activities is excluded from the total from 1996 onwards. (Source: Source: Department for Business, Enterprise and Regulatory Reform)

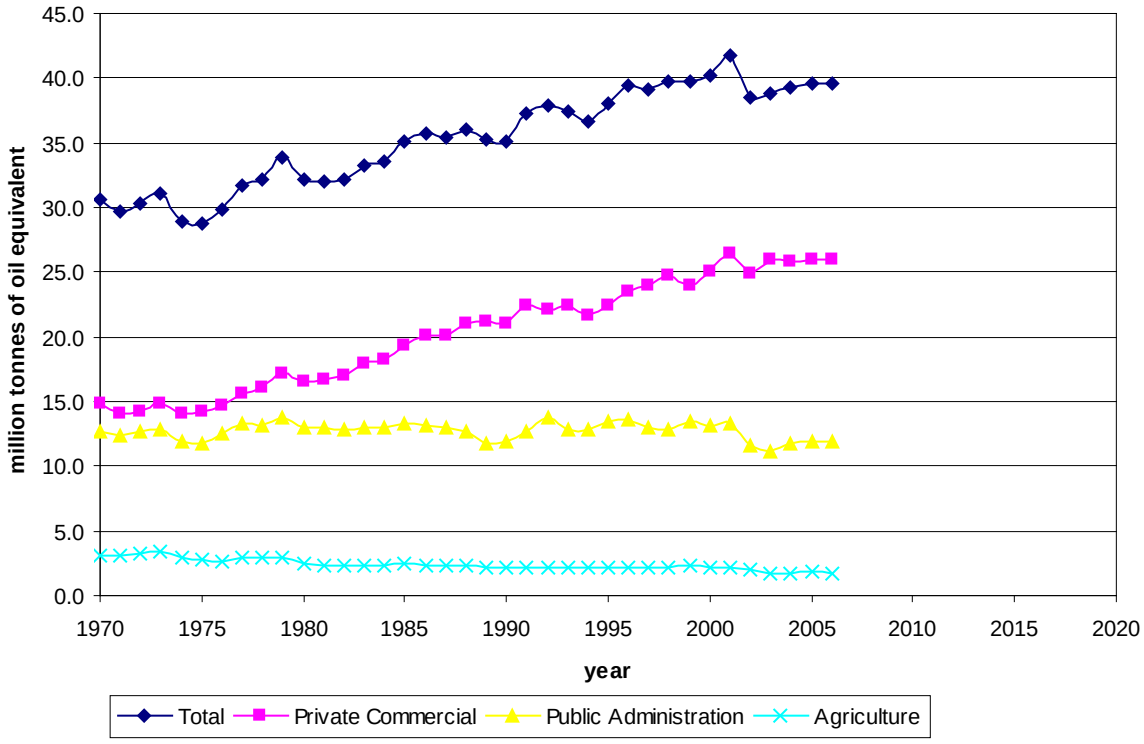

Figure 4 UK total service sector energy consumption. (Source: Department for Business, Enterprise and Regulatory Reform)

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	Use in 2006/mtoe	Assumption	Change in fuel use by 2020/mtoe	2020 total fuel/mtoe
Domestic	47			
Transport	60			
Industry	33			
Service	40			
Total	180			

Table 2

2 Share your figures for total fuel use with the class. Compare these figures with the ones you got by simple extrapolation.

3 Discuss which of the two scenarios include the most probable assumptions. Is it likely that the UK will conform to the EU target of a 20% cut in energy demand by 2020 as a contribution to the planned 30% reduction in emissions of carbon dioxide?

Assumptions

A The population of the UK increases from 61 million to 65 million by 2020. This raises fuel demand in the domestic sector by 2.5 mtoe and in the transport sector by 3.3 mtoe.

B Use of private transport remains much the same as now as more people live closer to their work and there are social pressure to cut unnecessary car journeys and to use public transport. Improved efficiencies in the sector and a shift to smaller vehicles means that, despite the growth in the number of journeys, there is no overall increase in the demand for fuel.

C After the recession, air travel starts to grow again, airlines do not take climate change seriously and the failure of international negotiations to tax aircraft fuel leads to an increase in the fuel for transport of 5 mtoe by 2020.

D Changed patterns of behaviour at home mean that people turn off electrical appliances when not in use, use thermostats to control heating, monitor their energy use with smart metering and overall lead to a cut in domestic energy demand of 3% by 2020

E Short-term cost considerations, lack of information and market failures prevent the service sector investing in energy-saving measures so that the demand for energy continues to grow at the current rate.

F Manufacturing output returns to pre-recession (of 2008/9) levels, but higher fossil fuel prices, the EC Climate Change Levy and carbon trading regimes lead to increased focus on energy efficiency, particularly through industrial combined heat and power CHP so that there is a reduction in energy use of 7 mtoe by 2020.

G Organisations in the private and public service sectors eliminate the waste of 10% of the energy they buy, with the help of smart metering, through improved control of heating, air conditioning and ventilation and through turning off lights and all electrical appliances including computers and printers when not in use.

H More efficient electrical appliances and the phasing out of inefficient light bulbs means that domestic energy use drops by 2.0 mtoe by 2020.

I 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.

J In the years following ‘peak oil’, and in a period of political turmoil that disrupts gas supplies from Russia and Eastern Europe a sharp rise in the cost of fossil fuels reduces energy use in all sectors by 3%.

K The government initiates a range of schemes to improve insulation, install more efficient boilers and reduce fuel use for heating in existing and new buildings and ensures that new homes are zero-carbon from 2016. This means that domestic energy use in 2020 is 4 mtoe less than current projections suggest.

L 50% of all electricity is generated by the more efficient method of CHP and other efficient distributed energy schemes. This reduces overall domestic demand by 10.0 mtoe by 2020 and service sector demand by 3.5 mtoe by 2020.

M Increased installation of devices run on electricity in the growing service sector, such as office equipment, air conditioning, automated teller machines, telecommunications equipment, and medical equipment, leads to a growth of 2% of energy demand in this sector.

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