Sima hydro-electric power station

Location
Like most of the large hydro-electric power stations in Norway, Sima is located in western Norway (Figure A). It is about 6 km from Eidfjord on a branch of the Hardanger Fjord (Figure B). In this region the precipitation (rain and snow) is heavy and there is little evaporation. The annual rainfall is 2000 mm or more. Much of this falls as snow in winter and can only be used in spring and summer when it melts.

Glaciers and rivers have carved deep valleys in the mountains (Figure E) and this provides a large drop, or head, of water (Figure C). Sima is built 700 metres inside a mountain at Simadalen. It has a head of water of 1158 metres and is the second largest power station in Norway.

Storage
The Sima power station, which started generating in 1980, uses water from several river basins. This makes more water available to the power station and also enables more water to be stored in reservoirs.

The storage of water is important. As it is difficult to store electricity, water is held back to generate electricity when extra supplies are needed. The demand for electricity is greatest in the winter when extra light and heating are required, but the reservoirs are filled up during the summer. It is also necessary to hold back water in wet years to make up for dry years. This becomes more important as the overall demand for electricity grows because of rising living standards in Norway.

Over the last 20 years, the world's total energy use has grown by about 50% The World Energy Council estimates that by the year 2020 the world's demand for energy may well be twice the present levels.
Some effects of building a hydro-electric power station

Building a hydro-electric power station increases the supply of electricity and provides jobs. However, building water reservoirs, electricity production plants, power lines and access roads also affects the local environment. The rate of flow in the rivers may change. The works can also harm the habitats of many species of plants and animals.

Sysendammen
Sysendammen is the dam which holds back the water stored in a reservoir called Sysenvatnet (Figure D). The dam was built of rock which had been blasted out of the mountains to make the tunnels. The rocks have been sealed with clay to prevent water seeping through them. Sysenvatnet is a long way from Sima power station. When water is needed, it has to be pumped through the mountains to a holding reservoir above the shaft to the power station. The pumping is usually done at night when demand for electricity is low and there is energy to spare. The water can then be used in the day when demand is high.

Vøringsfossen
Vøringsfossen waterfall is an important tourist attraction (Figure E). The development of the Sima power station project has affected the flow of water to the falls. However, during the tourist season from 1 June to 15 September enough water is released to maintain a discharge of at least 12 m per second. With this discharge of water the falls are spectacular.

Kjeåsen farm
Kjeåsen in Eidfjord has been described as the world's most isolated farm (Figure F). Well into the 20th century, two families made a living there. When their children were small, they had to be tied to a rope so they did not fall over the mountain edge. In winter the farm was cut off by snow. People still live there now. When Sima was developed, a road was built to the power station through an S-shaped tunnel 2.5 km long. This improved access to the farm and to the area for tourists. However, many visitors still use the old pack road which has been restored. It involves 125 bends and 1500 steps!
Should hydro-electricity be the only energy source in Norway?

Hydro-electricity: renewable energy

A great advantage of hydro-electricity is that it is a renewable form of energy. The water is not used up but is returned to the rivers and the sea as part of the water cycle. It then evaporates and falls again as rain. There are other renewable energy sources such as the wind, the waves and the sun.

Norway’s high mountains and great waterfalls provide sites where hydro-electricity schemes can be developed (Figure G).

How many more hydro-electricity sites could be developed in Norway?

| Developed or under construction | 63.1% |
| Protected (to avoid spoiling environment) | 19.5% |
| Could be developed | 16.6% |

Fossil fuels: non-renewable energy

Most of the world’s energy is provided by the burning of fossil fuels such as coal, oil and natural gas. Fossil fuels were formed in the earth millions of years ago. They will eventually be used up and cannot be replaced. They are non-renewable, though they may last a long time.

Natural gas power stations are less polluting than coal- or oil-fired plants. They do not produce oxides of sulphur or nitrogen. They do, however, discharge carbon dioxide into the atmosphere, though much less than coal-burning plants.

Some scientists regard burning natural gas as wasteful. They think it should be used as a raw material for the following: ammonia, methanol, fertiliser, artificial fibres, detergents, heating, glue and paint.

Hydro-electricity or fossil fuels?

In Norway, production of hydro-electricity varies from year to year. This depends on how much rain or snow falls over a given area. The more rain and snow, the more water is available for energy production.

Electricity in Norway increased by 47% during 1980-99. When Norway's production of electricity is greater than the country’s own demand, electricity is exported to neighbouring countries. At other times, when demand is greater than production, Norway needs to import electricity. This electricity may come from coal-burning power plants which, unlike hydro-electric plants, pollute the atmosphere.

The Norwegian authorities want to limit such imports by keeping energy use stable and increasing Norway’s own production of hydro-electricity. For this reason, it is likely that gas-fired power stations will be built in Norway at Kollsnes and Kårstø (Figure I), e.g. Kårstø is currently the world’s third largest producer of LPG (liquid petroleum gas). The electricity produced here would be intended solely for export to neighbouring countries, where it would help to replace electricity generated by coal, oil and nuclear power. The gas-fired power stations would also create jobs in Norway.

Figure G  Power lines near Eidjford

Figure I  Gas fields and pipeline links to the planned power stations
**C S**

**Sima hydro-electric power station**

1a Why is the Sima area suitable for the production of hydro-electricity?
b Why does the Sima power scheme use water which falls in several river basins?
c How many kilometres of tunnels were built? Why were they necessary?

2 Draw a copy of Figure C. Replace the labels on the diagram with:
- Reservoir on the Hardanger plateau
- Head of water: 1158 metres
- Steep power shaft
- Sima power station
- Eidjford

3 Study Figure 1.
a Describe the way in which the inflow of water into the reservoirs changes during the year.
b Explain why:
- the reservoirs are not being filled during the winter
- the greatest inflow of water occurs in spring and early summer.
c Describe the changes in production of electricity during the year and give reasons for them.
d On the graph:
- Shade the areas where electricity production is greater than the inflow of water. Label the areas ‘Reservoir levels falling’.
- In another colour, shade the area where the inflow of water is greater than production. Label the area ‘Reservoir levels rising’.
e Explain why reservoirs are necessary in the Sima power scheme.

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*Figure 1 The production of electricity and the inflow of water during the year for the Sima power station*
Some effects of the Sima power scheme

1a Complete Figure 2 and add the following labels in the appropriate places:
- Rock-fill dam
- Sysenvatnet reservoir
- Gentle slopes of plateau
- Low-lying vegetation
- Bare rock

b Explain why building a reservoir in this location would not affect many people.

2a Describe the scenery shown in Figure E.

b Why do you think the Sima power station might affect the flow of water over the falls?

c How has the power company ensured that tourists can still enjoy the sight of a spectacular waterfall?

3a How have the inhabitants of Kjeåsen (Figure F) been affected by the construction of the power scheme? Write a letter from a boy or a girl who lived there. Describe the changes and the way it has affected your life.

b What is the impact of hydro-electricity schemes on the local environment?

c Explain why you think some areas should or should not be allowed to remain as wilderness areas.
Should hydro-electricity be the only energy source in Norway?

1. There are many sources of energy. They include: coal, water, waves, solar heating, natural gas, the tides, oil, geothermal heating (heat from hot volcanic rocks deep underground).
   a. What is the difference between renewable and non-renewable sources of energy?
   b. Draw a table with two columns headed ‘Renewable sources’ and ‘Non-renewable sources’. Write each of the sources of energy listed above in the appropriate column.

2. Study Figures 3 and 4. For each, in the spaces provided:
   a. Name the type of energy.
   b. Say whether it might be suitable for Norway.
   c. Explain your decision.

3. Two gas-fired power stations may be built on the west coast of Norway. Some people are against this idea. Working in groups and using information in the case study:
   a. Draw up two lists, one using arguments to support the project, the other using arguments against it.
   b. Suggest what arguments might be used by:
      • a spokesman for a company that supplies equipment for hydro-electric power stations
      • an environmentalist
      • a tourist
      • a worker on a gas production platform.
   c. Suggest which arguments carry most weight and decide whether you are for or against the project.

4. Debate the motion that ‘This class believes that only renewable resources should be used to produce energy in Norway’.