INTERNATIONAL ENERGY AGENCY

Energy Policies of IEA Countries

SWITZERLAND 1999 REVIEW

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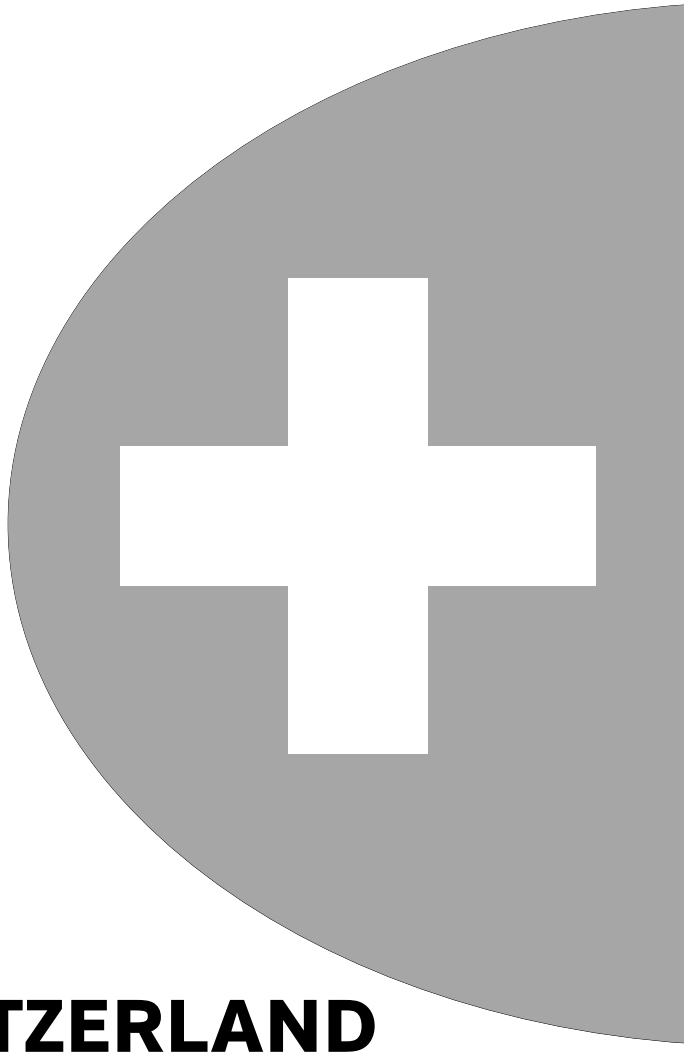

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INTRODUCTION

An IEA review team visited Switzerland in October 1998 to review the country's energy policies. This report was drafted on the basis of information received during and prior to the visit, including views expressed by various parties during the visit.

The team greatly appreciated the co-operation and openness demonstrated by the participants during this policy review process.

Members of the team were:

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Evelyne Bertel was responsible for drafting Chapter 7 (nuclear), in consultation with the team. Pierre-Marie Cussaguet was responsible for drafting all other chapters, in consultation with the team.

The team held discussions with representatives from the following organisations:

- The Swiss Federal Office of Energy (SFOE), including its several Departments
- The Swiss Agency for the Environment, Forests and Landscape (SAEFL)
- The Federal Office of Transport
- The Federal Office of Water Economy
- The Swiss Federal Nuclear Safety Inspectorate (HSK)
- The Swiss National Co-operative for the Disposal of Radioactive Waste (NAGRA)
- The Price Surveillance Authority
- The Cantons of Lucerne, Neuchâtel, Obwalden and Uri
- The Swiss Electricity Utilities Association (VSE)
- Nordostschweizerische Kraftwerke (NOK)
- Aare-Tessin AG für Electrizität (ATEL)
- Electrizitäts-Gesellschaft Laufenburg (EGL)
- City of Zürich Electricity Services (EWZ)
- The Oil Industry Association
- The Swiss Natural Gas Industry Association (ASIG)
- Swissgas
- The Swiss Association for Atomic Energy
- The Swiss Association of Engineers and Architects
- The Swiss Consumers' Protection Foundation
- The Swiss Union of Commerce and Industry
- The World Wide Fund For Nature (WWF)
- The Swiss Energy Foundation

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SUMMARY AND RECOMMENDATIONS

Switzerland is a federal country comprising 26 cantons which take their own policy decisions unless the Federal Constitution specifically gives the competence to the Swiss Government. Cantons are also responsible for the implementation of many policy measures decided at federal level. In such a system, close co-operation between the Swiss Government and the cantons is necessary for successful energy policies. Increased co-operation between cantons would also improve policy-making at the local level. Another important feature of the Swiss political system is that citizens can directly take decisions on legislation through referendums. Providing adequate information to the public is vital for such decision-making to function properly.

The "Energy 2000 Action Plan" is the core of Swiss energy policy. It aims to stabilise electricity consumption and to reduce fossil fuel consumption and CO_2 emissions beyond 2000. It also aims at increasing the supply of renewable and nuclear energy by upgrading the capacity of existing nuclear power plants. The Decree of 1991 on Efficient Energy Use followed by the Energy Law of 1998 defined the respective responsibilities of the Swiss Government and the cantons on energy policy.

Between 1990 and 1997, the slowing-down of fossil fuel use and electricity demand and the stabilisation of CO_2 emissions were achieved as a result of economic stagnation and the Energy 2000 Action Plan. One of the main aspects of the current plan is the importance given to assessing the cost-effectiveness of the measures implemented. The results of these studies should be valuable in formulating a new energy plan.

Although energy intensity in Switzerland is already low, progress can be made to improve energy efficiency. In particular, the effectiveness of voluntary measures could be increased, more stringent building codes could be adopted by cantons and the use of public transport could be more strongly encouraged.

The Swiss Government and the cantons have put strong emphasis on promoting non-hydro renewables. The best way to make energy production from renewables sustainable in the long term is to ensure that their overall production cost decreases to a level which makes them competitive. Policy measures should encourage competition among renewables in order to favour the most cost-effective ones.

Energy and CO_2 taxes are being seriously considered. Such taxes could better internalise the external costs of using energy. Improvements in the tax system would send the right price signals to energy consumers and suppliers, allowing them to take the right decisions on fuel choice and investments to increase energy efficiency.

A large number of companies are present in the electricity and natural gas sectors. Suppliers have monopoly rights in their areas and set prices for final consumers. These sectors are also characterised by strong involvement of local authorities in both ownership and regulation, e.g. price controls. Local authorities levy various taxes and hidden charges on the companies. These, together with the absence of competition, have contributed to high average electricity and gas prices, in particular for industrial customers.

Thus, the initiative by the Swiss Government to introduce competition in the electricity sector is a timely, welcome move. This reform, envisaging regulated Third Party Access, can increase the efficiency of this sector and reduce prices for final consumers if it is well designed and regulated so as to avoid cross-subsidies and discrimination. In addition, harmonising regulations with the European Union (EU) would be beneficial to Switzerland.

Corporatisation of all utilities would enhance efficient management and allow them to compete on a level playing field. Creating a single national company for transmission would facilitate Third Party Access in a transparent and non-discriminatory manner. It could also lead to increased rationalisation of the operation of the utilities transmission grid and improved dispatching within Switzerland.

The introduction of competition in the electricity sector is expected to oblige local authorities to reduce taxes and charges, but this will lead to a large decrease in the revenue of some municipalities and cantons. Such reductions in revenues need to be compensated. The introduction of competition is also expected to create stranded costs, in particular for some hydro plants. It should be ensured that payments for stranded costs to utilities do not increase their competitiveness artificially.

The Swiss Government is also considering introducing competition in the natural gas sector. Together with the corporatisation of all gas companies and improved management, this would allow the gas market to develop in an efficient manner in which management decisions, including investment decisions, would be taken on an economic basis. As light fuel oil is less taxed than gas, a rationalisation of the overall energy tax system would contribute to gas penetration. Switzerland is becoming a transit country for gas from the North Sea to Italy. This should increase diversity in supply sources, thus contributing to security of supply.

Oil consumption has stabilised since the beginning of the 1990s. Competition in the retail market is increasing although oil supply is still mainly concentrated in the hands of four large suppliers. Competitition has led companies to rationalise distribution in order to cut costs and to invest in the modernisation of refineries.

The Swiss nuclear power plants are efficiently run and contribute significantly to Swiss electricity supply. In addition, by providing 40% of electricity supply, nuclear contributes together with hydroelectricity to 98% carbon-free electricity production, making Switzerland the lowest emitter of CO_2 per GDP (calculated in purchasing power parity, PPP) among IEA countries. For these reasons, the nuclear option should be kept open. The proposed revisions of the Atomic Energy Act address several

concerns of the public and of policy-makers. The decision of October 1998 to start negotiations with all major players regarding the date of the closure of existing nuclear power plants does not actually impede the building of new nuclear power plants in the future. In the process of closing down nuclear power plants, the Government should consider the best timetable, taking into account the costs involved, and the consequences for CO_2 emissions and for the energy supply/demand balance in Switzerland.

Switzerland has a strong, comprehensive and efficiently managed energy R&D programme. In addition, R&D programmes are regularly assessed to increase their efficiency. Priorities are clearly defined. The Swiss Government should continue to ensure that the R&D programmes are effectively in line with Swiss energy policy. This is becoming increasingly important as Switzerland is committed to making large efforts to reduce CO_2 emissions.

RECOMMENDATIONS

The Swiss Government should:

Government Structure and Energy Trends

☐ Further strengthen public information on energy policy measures. Make sure that trade-offs between various policy options are well understood.

☐ Improve the review of the cantons' energy policies. Promote co-operation among cantons.

☐ Further enhance co-operation with the cantons on energy policy, especially on the Energy 2000 Action Plan and on the introduction of competition in the energy markets to ensure successful implementation of energy policy measures.

The Energy 2000 Action Plan and Energy Taxation

The Energy 2000 Action Plan

☐ Strengthen public information on the cost-effectiveness of policy measures in the Plan. Cost-effectiveness should be assessed, taking into consideration economic trends.

☐ Review the process of setting voluntary measures to identify whether and how it could be improved and consider setting more binding measures where possible.

☐ Establish a new energy action plan beyond 2000, based on a comprehensive assessment of the Energy 2000 Action Plan. The new plan should be adapted to the development of competition in the energy market.

☐ Further strengthen co-operation between the cantons and the Swiss Government. Promote co-operation among cantons.

Energy Efficiency

☐ Expand labelling for energy efficiency of domestic appliances and office equipment.

☐ Where needed, encourage cantons to adopt more stringent building codes and to make individual metering for heating and hot water compulsory.

☐ Develop public transportation systems and increase their use. Strengthen co-operation between administrations involved in energy policy and those involved in transport policy.

Renewables

☐ Focus on the most cost-effective measures to promote non-hydro renewables and ensure that these measures are designed to increase their competitiveness. Adapt the current system of promoting electricity from non-hydro renewables to make it compatible with the introduction of competition in the electricity sector.

☐ Ensure that the public receives accurate information about renewable energy available on the market.

Energy Taxation

☐ Make local taxes and charges on electricity and natural gas transparent.

☐ Better internalise the external costs of using energy, including environmental costs, through taxation or through more focused approaches, such as road taxes.

Fossil Fuels

☐ Introduce competition in the natural gas sector as soon as possible.

☐ Strongly encourage corporatisation of those gas industries which are not privatised, and the unbundling of accounts in order to allow the companies to compete on a level playing field.

☐ Establish a regulation to control tariffs and settle disputes in an unbiased manner and ensure that the regulator has enough legal competences and resources to carry out its missions.

☐ Introduce Third Party Access to the whole gas grid and make tariffs transparent in order to prevent discrimination between users.

Electricity

☐ Seriously consider the future of electricity supply, taking into account probable future developments (i.e. introduction of competition, CO_2 emissions reduction) and the merits of the different production options from the point of view of economy and environment.

☐ Continue to work on the introduction of effective competition in the electricity sector, based on regulated Third Party Access, with the eventual aim of ensuring a high level of competition among utilities, and consumer choice.

☐ Strongly encourage corporatisation of utilities when they are not privatised.

☐ Strongly encourage unbundling of accounts and regulate prices in the non-competitive segments of the electricity sector. Ensure that prices for captive consumers are cost-reflective and that there are no cross-subsidies.

☐ Ensure that regulatory authorities have enough legal competence and resources to carry out their mission.

☐ Set up a national grid company in order to facilitate Third Party Access and tariff setting in a transparent and non-discriminatory manner.

☐ Carefully assess the stranded costs calculated by the electricity companies and take measures to ensure that payments for these costs do not distort competition with the other electricity generators at national or international level.

Nuclear

☐ Take measures to ensure the implementation of radioactive waste repositories.

☐ Continue actions aimed at strengthening the legal framework for the use of nuclear energy and at enhancing the independence of safety authorities.

☐ Ensure that decisions on nuclear issues are reached in a democratic process accepted by the public.

☐ Maintain a sufficient level of technological competence to keep nuclear energy as a viable option.

Energy Technology, Research and Development

- ☐ Continue to fund R&D sufficiently to contribute to the objectives of Swiss energy policy.
- ☐ Strengthen the assessment of R&D programmes and fully reflect the results of these assessments to ensure maximum efficiency of future programmes.
- ☐ Further strengthen co-operation with industry in order to better disseminate R&D results into the market.
- ☐ Maintain strong participation in international R&D programmes.

3

GOVERNMENT STRUCTURE AND ENERGY TRENDS

BACKGROUND

Switzerland has been a federal country since 1848[1]. It has 26 cantons often referred to as the "states". Three of them are divided into half-cantons. All the cantons are divided into local political authorities (this report calls them "municipalities" to avoid confusion with cantons) which number 2 940. The Parliament comprises the National Council representing the people and the Council of States representing the cantons. The Swiss Government is called the Federal Council. The population can take decisions on legislation directly through "popular initiatives": the "right of initiative" and the "optional referendum" (see box).

Each canton and half-canton has its own constitution and government. Cantons have competences for all issues which are not specifically reserved for the Confederation. Municipalities' rights and duties are set out in the cantonal laws. The smallest canton is a half-canton, Appenzell Innerrhoden, with 15 000 citizens. The largest one is Zürich, with 1.8 million citizens.

The Federal Constitution covers a large number of issues, including energy, and is often changed. Changes to the Constitution are decided by Parliament and need approval by the majority of the voters and the cantons. At federal level, the Constitution and laws can be modified as follows:

- The "right of initiative" allows a minimum of 100 000 electors signing a petition within a time limit of 18 months to request a modification of the Constitution. Members of Parliament and cantons can also ask for a modification of the Constitution. The Federal Parliament is entitled to put forward a counterproposal and a popular vote is taken for both proposals. In most cases, the modification needs the approval of both the majority of the cantons and the electorate.

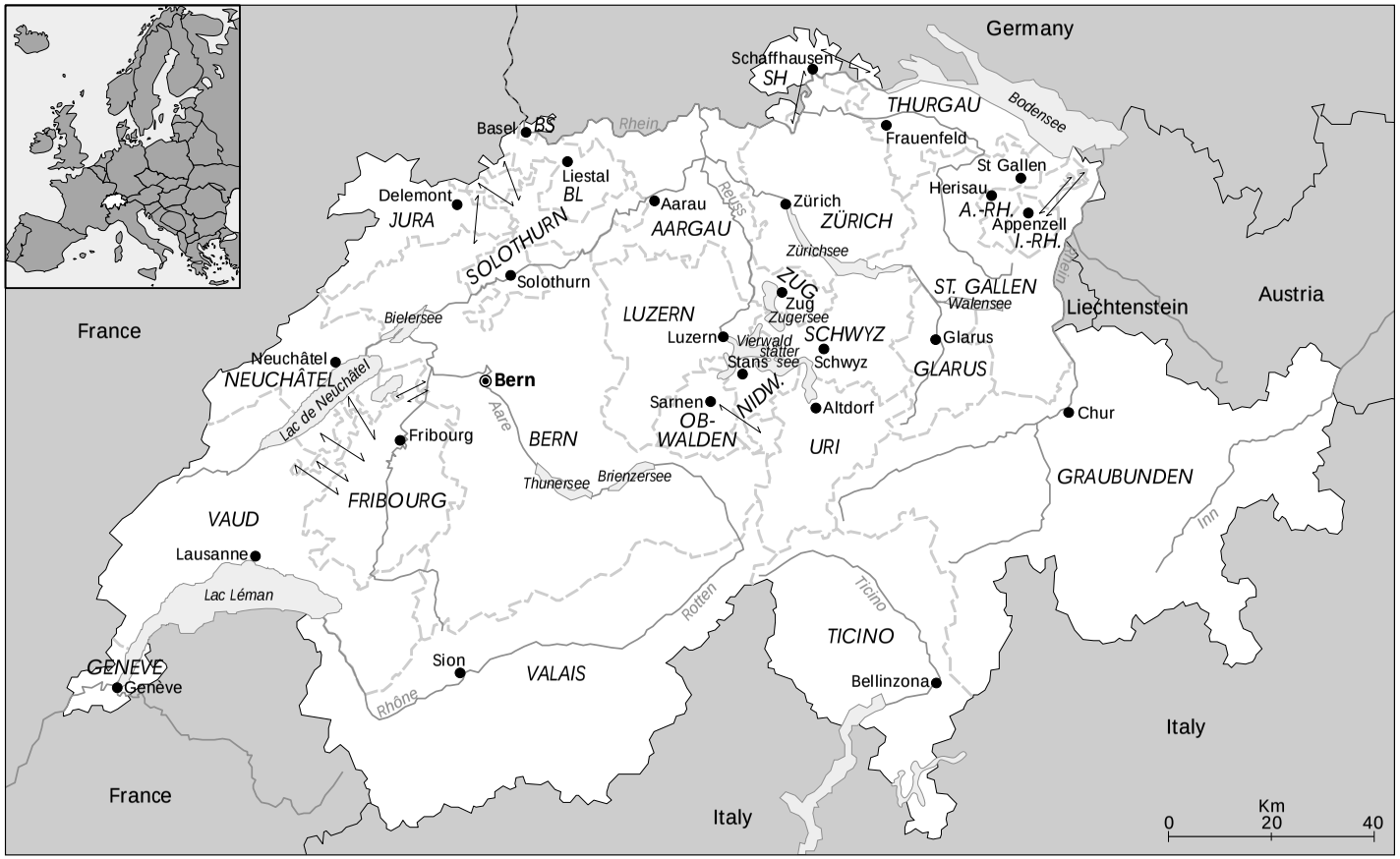
- The "optional referendum" allows at least 50 000 citizens or eight cantons to request a popular ballot within 90 to 100 days upon new or modified federal legislation or general decree. Then a national vote takes place.

These two systems also exist at canton level but their functioning may differ.

1 The term "Confederation" is also frequently used.

Figure 1

Map of Switzerland



Switzerland's total area is 41 000 km^2 (see Figure 1), and the resident population was 7.1 million in 1997. Population density was 173 inhabitants per km^2 and 350 inhabitants per km^2 of habitable area. The Alps cover 40% of the country and the Jura around 12%. With the exception of hydro, Switzerland has very limited natural energy resources.

At official parity level in 1997, GDP per inhabitant was around US$ 35 900, one of the highest of OECD countries. In 1996, GDP was slightly lower than in 1990. It increased by 1.7% in 1997.

External trade is mainly with the European Union, but Switzerland is not a member of the Union. Economic relations between Switzerland and the European Union (EU) are established in a free-trade agreement drawn up in 1972. A referendum of December 1992 rejected the participation of Switzerland in the European Economic Area (the economic core of the EU Treaty). However, most new Swiss legislation is compatible with EU regulations.

ADMINISTRATIVE ORGANISATION

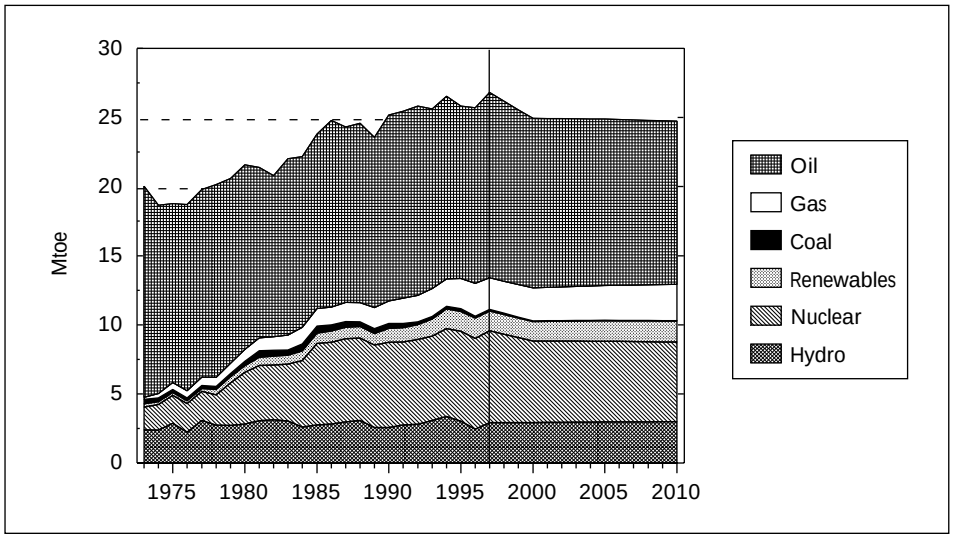
Cantons make their own policy when the law does not specifically give the competence to the Swiss Government. Cantons are also responsible for the implementation of many measures decided at federal level. Measures taken at canton level are implemented at municipal level in the majority of cases and the rest are implemented at canton level.

At federal level, the Federal Department for Environment, Transport, Energy and Communication (DETEC) is in charge of energy, through the Swiss Federal Office of Energy (SFOE) and the Swiss Agency for the Environment, Forests and Landscape (SAEFL), which before 1998 reported to the Ministry of the Interior. In January 1998, responsibilities related to the CO_2 law were transferred from the Department of Home Affairs (DTI) to the DETEC, which is now in charge of the strategy to limit CO_2 emissions and improve air quality. Within the DETEC, the SFOE is in charge of the Energy 2000 Action Plan (see Chapter 4).

ENERGY SUPPLY AND FINAL CONSUMPTION

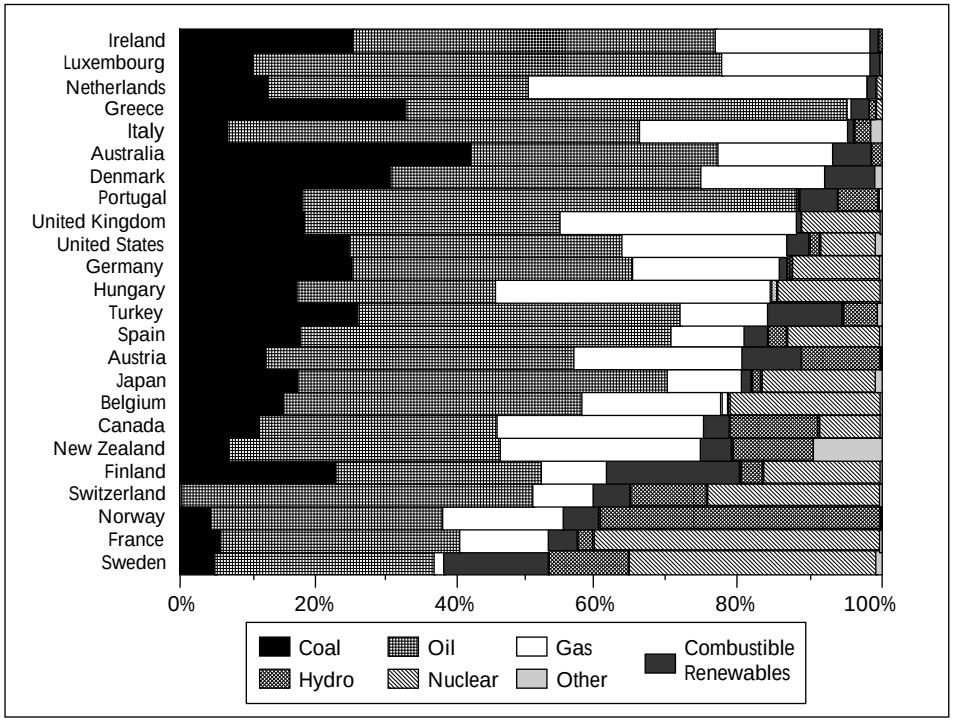
In 1997, total primary energy supply (TPES) was 26.2 Mtoe, 4.9% higher than in 1990 (25 Mtoe). Oil had the major share (51.1%) in spite of a decrease over the past two decades, followed by nuclear energy (25.3%), hydro (11.2%) and natural gas (8.7%), the share of the latter having increased rapidly over the past two decades (see Figure 2). Coal and natural gas have a low share in TPES in comparison with the other IEA countries (see Figure 3).

Figure 2
Energy Supply by Fuel, 1973-2010



Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 1998, and country submission.

Figure 3
TPES by Fuel in IEA Countries, 1997

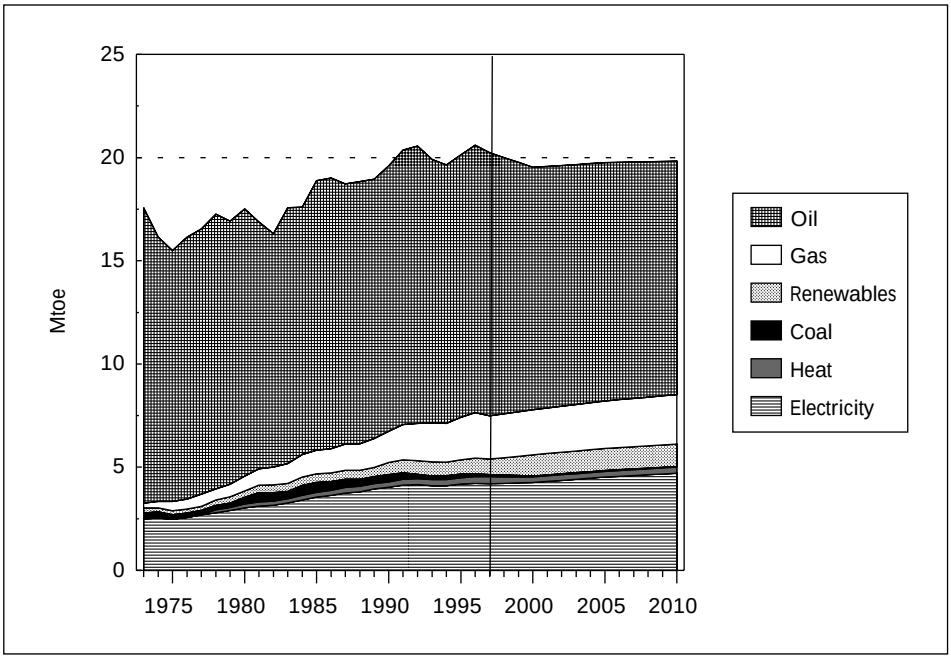


Source: *Energy Balances of OECD Countries*, IEA/OECD Paris, 1998.

In 1997, total final consumption of energy (TFC) was 20.2 Mtoe, 3.2% above 1990 (see Figure 4). Oil had the major share (63%) followed by electricity (20.7%) and natural gas (10.4%). Although limited, district heating has expanded.

The residential/commercial sector[2] is the largest consumer of energy (46.4% of TFC in 1997[3]) and consumption has slightly increased since 1990 (see Figures 5 and 6). Oil has the major share (although it is decreasing) followed by electricity, whose share is increasing quickly[4]. According to the SFOE, insulation in buildings has improved, increasing energy efficiency, but the benefits have been offset by the 16.5% increase in heated areas between 1990 and 1997.

Figure 4
Total Final Consumption by Fuel, 1973-2010



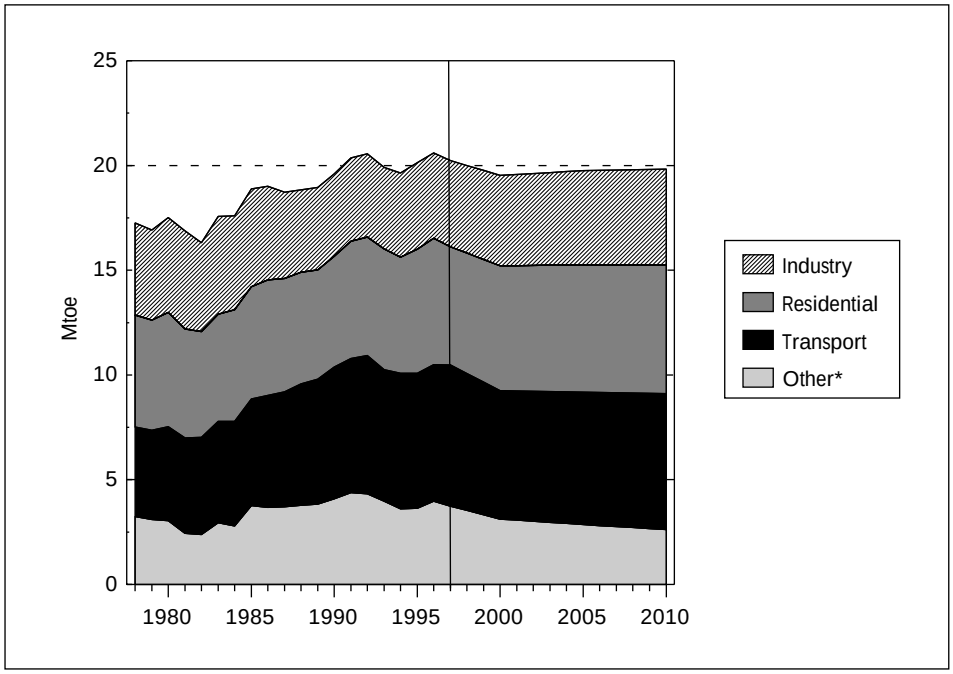
Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 1998, and country submission.

2 In the text, the residential/commercial sector includes the public services and the agricultural sector. In the figures, the residential/commercial sector is separated from the other sectors (public services and agriculture).

3 In 1997, warmer weather was partly responsible for the low level of consumption in this sector.

4 In particular, electricity consumption is increasing in the residential/commercial sector as a result of the newly installed appliances and office/entertainment equipment. Electricity for heating has also increased.

Figure 5
Total Final Consumption by Sector, 1978-2010



* Includes commercial, public service and agricultural sectors.

Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 1998, and country submission.

In 1997, the transport sector accounted for 33.3% of total final consumption of energy. Annual energy consumption in this sector increased at the fastest pace but has slowed down since 1990.

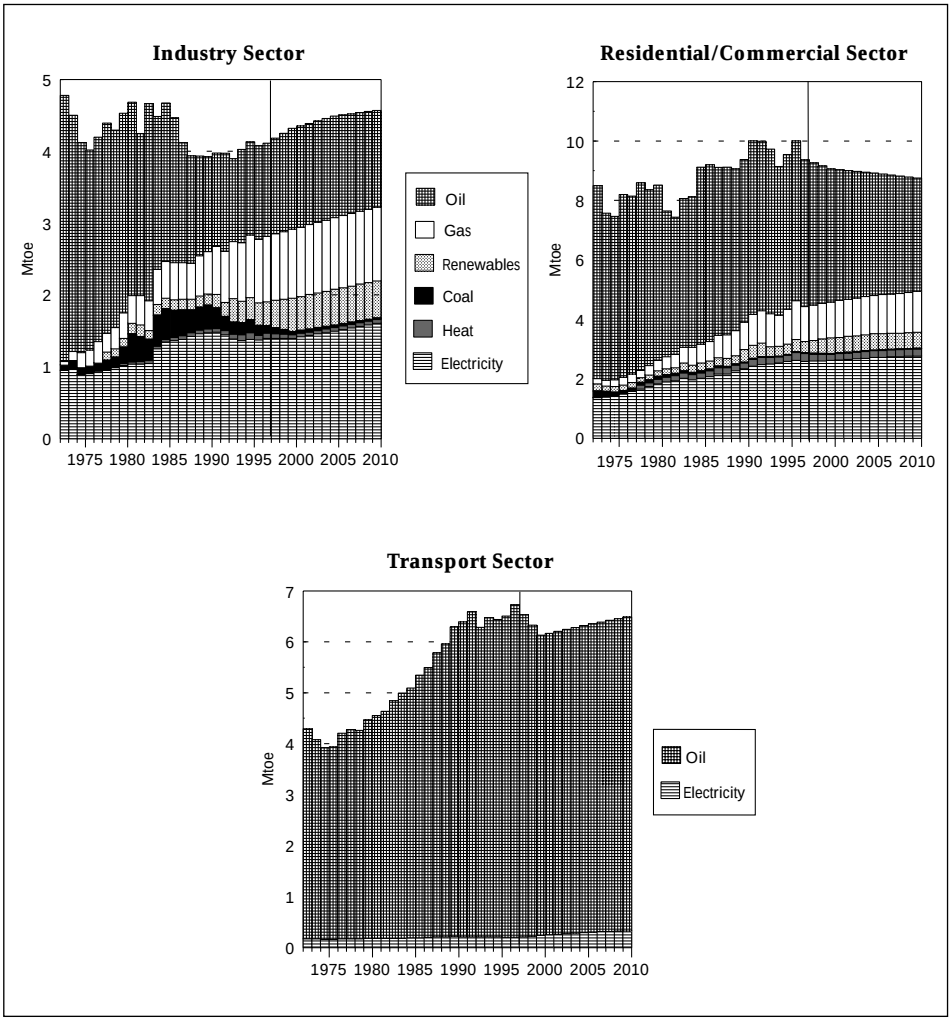
Road traffic accounts for 80% of energy consumption in transport. The number of private cars increased by 12.7% between 1990 and 1997. There were 46 cars per 100 inhabitants in 1997, more than the OECD Europe average (37). Road traffic (7 300 vehicle-kms/inhabitant) was higher than the OECD Europe average (5 700). According to the SFOE, the increase in the number of cars has been offset by an improvement in specific fuel consumption (fuel efficiency) of private cars, and the increase in gasoline consumption is due to "gasoline tourism"(see the section on oil in Chapter 5).

Switzerland is an important transit country for road and rail freight. In 1995, rail freight amounted to 40% of total transport of goods compared with 15% in the rest of OECD Europe. About 82% of goods in transit were transported by rail. However, road freight (in tonne-kms), including transit, is increasing more quickly than rail

freight. Transport of passengers (in passenger-kms) by train increased more quickly than by car between 1985 and 1990. Traffic by rail and road has remained at about the same level since then.

In 1997, energy consumption in industry was 20.3% of total final consumption of energy. Swiss industry has very low energy intensity because of its industrial specialisation. Electricity has the major share (33.9% in 1997) followed by oil (31.4%) and natural gas (22.1%), whose share has increased rapidly.

Figure 6
Total Final Consumption by Sector and by Fuel, 1973-2010

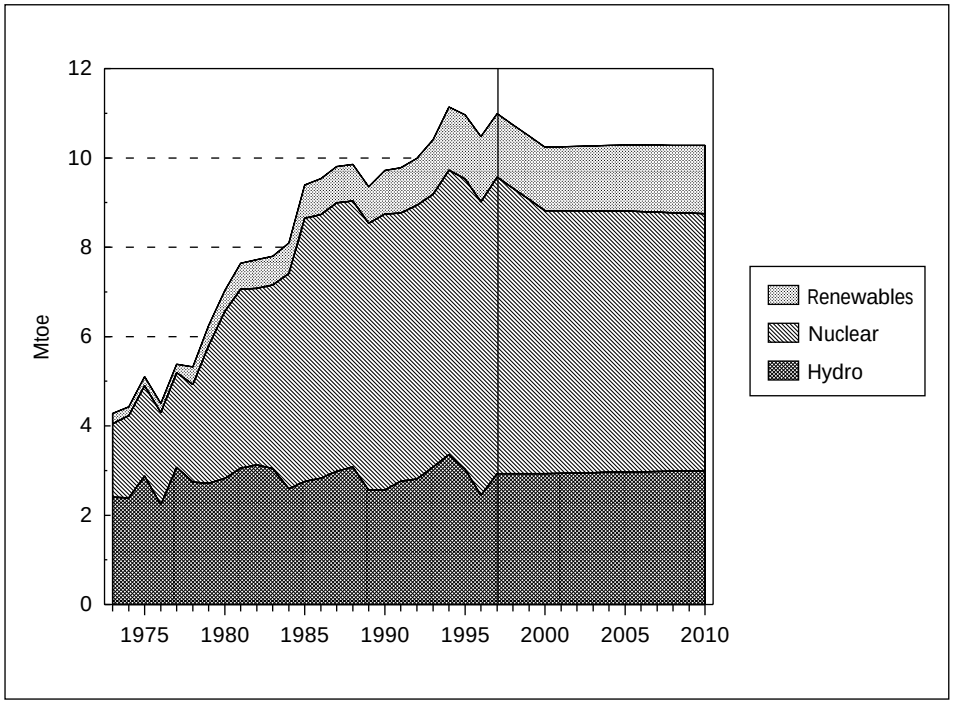


Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 1998, and country submission.

ENERGY PRODUCTION

In 1997, domestic energy production was 11 Mtoe, a level slightly higher than in 1996 (see Figure 7). Domestic production comes from nuclear (6.6 Mtoe in 1997) followed by hydro (2.9 Mtoe) and other renewables (1.4 Mtoe – see box). Switzerland does not produce fossil fuels. In the past two decades, dependence on imported energy has decreased, in particular thanks to the increase in electricity generation from nuclear.

Figure 7
Energy Production by Fuel, 1973-2010



Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 1998, and country submission.

FORECASTS

The most recent forecasts about energy production and supply made in 1996 by independent institutes under the supervision of the SFOE are:

- Energy production was expected to increase slightly between 1990 and 2010, with some increase in hydro power and energy from renewables.

- After 2000, energy supply was expected to remain almost stable.
- Electricity consumption was expected to continue to increase. There are several scenarios for future electricity generation and consumption (see Chapter 6).

Renewable Energy Sources

In 1997, hydropower accounted for 34.8 TWh and generated 55.3% of all electricity. Approximately 800 small scale (<300 kW) hydro installations are in use, generating about 270 GWh from a capacity of 60 MW.

The major non-hydro renewable energy is waste. Municipal and industrial wastes together contributed 757 ktoe to Switzerland's energy supply in 1997, up from 554 ktoe in 1990. Approximately three-quarters is used for electricity and heat generation: 519 GWh, and 5 753 TJ in 1997. The remainder is used directly in industry (mainly the chemical industry). There is only limited potential to increase energy extraction from wastes. This potential is expected to decrease after 2000.

Use of biomass (mainly wood) grew steadily during the 1990s. Biomass supplied 543 ktoe in 1997 up from 436 ktoe in 1990. The majority of this energy was used directly in the residential sector, although some was also used in industry and the commercial sector. Small amounts of wood, landfill gas and sewage sludge were also used to generate electricity (137 GWh in 1997).

In 1997, installed solar capacity in Switzerland was around 39 MW. Energy generation from solar was around 19 ktoe. Hay driers accounted for half of the installed solar capacity. Unglazed solar collectors and heat-pipe or flat-plate collectors each accounted for around 150 000 kilowatt-hours of increased electricity production.They account for most of the newly installed capacity; the increase in new capacity of photovoltaics and hay driers is slowing down.

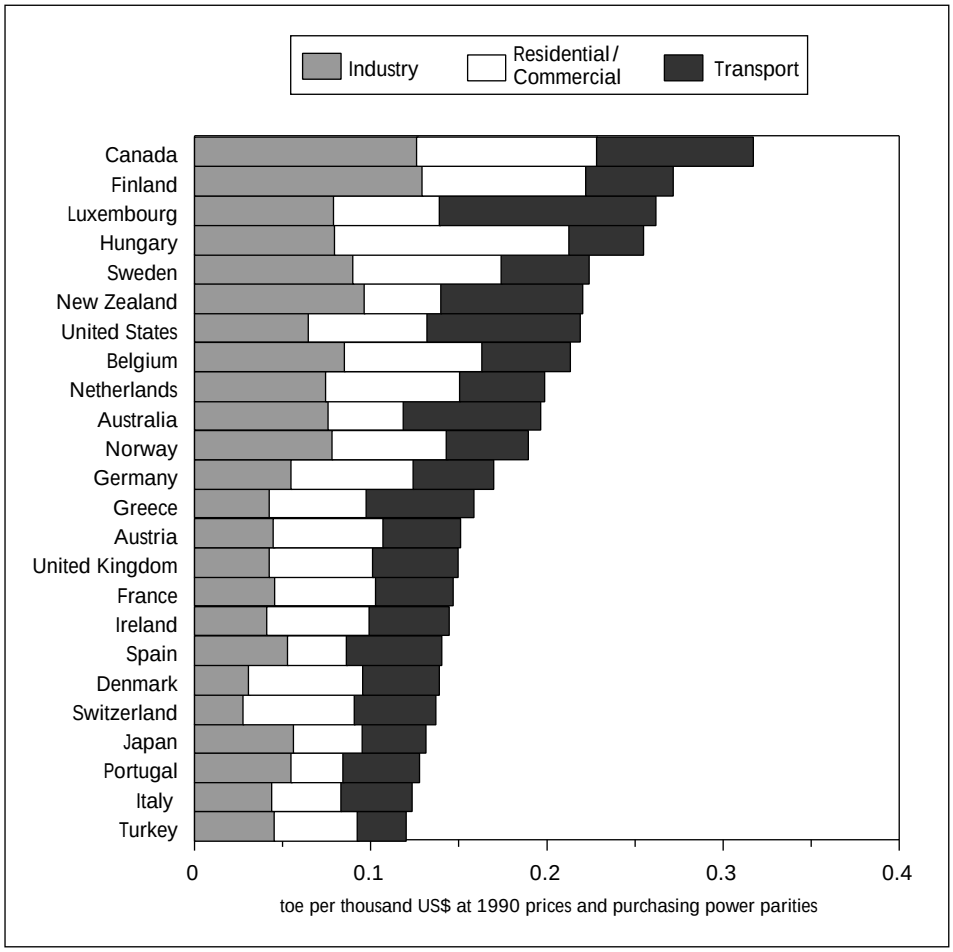
Between 1990 and 1997, approximately 29 000 heat pumps were installed in Switzerland. Total heat pumps installed numbered 54 900 and the heat extracted was 132 ktoe. About 40% of new individual houses are equipped with heat pumps.

In 1996, three 600 kW plants using wind energy were installed at Mont Crosin. Their potential has been estimated at 3% of total electricity demand.

TRENDS IN ENERGY INTENSITY

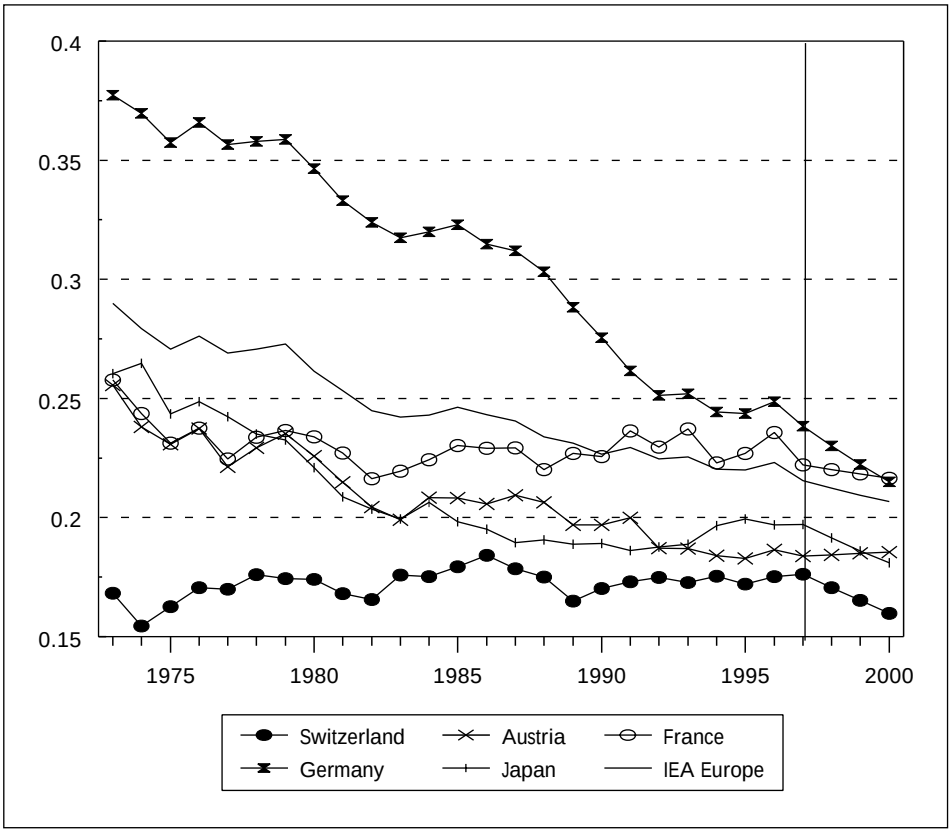
Energy intensity in Switzerland measured with purchasing power parities is among the lowest of all IEA countries (see Figure 8). This low level of energy intensity is mostly due to the structure of the industry sector, which comprises mainly low energy-intensive industries (see Figures 8 and 10). Since the end of the 1970s, energy intensity has fluctuated (see Figure 9) but has increased slightly since the start of the Energy 2000 Action Plan (see below). Energy intensity has increased mainly in the transport sector but at a slower pace than previously.

Figure 8
Energy Intensity in IEA Countries by Sector in PPP, 1997



Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 1998, and *National Accounts of OECD Countries*, OECD Paris, 1998.

Figure 9
Energy Intensity in Switzerland
and in Other Selected IEA Countries, 1973-2000
(Toe per thousand US$ at 1990 prices and purchasing power parities)



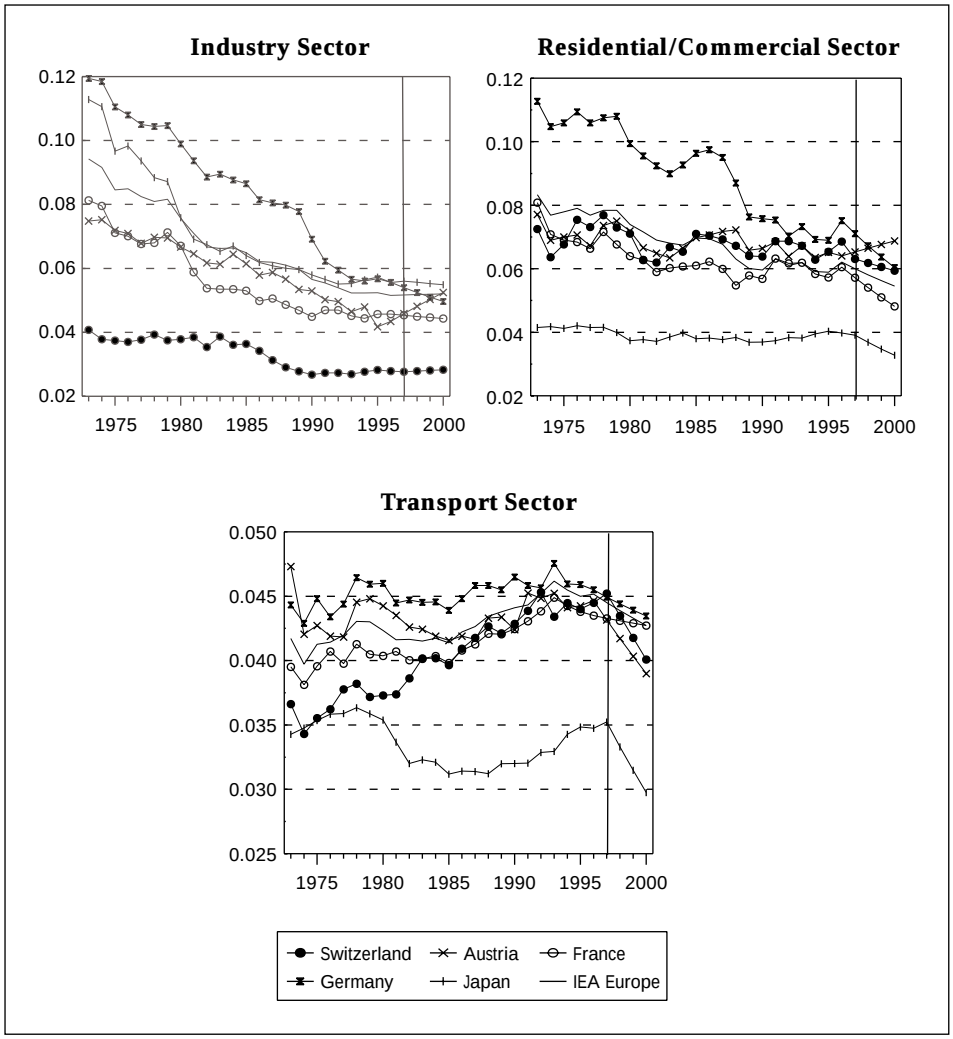
Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 1998; *National Accounts of OECD Countries*, OECD Paris, 1998; and country submissions.

Energy intensity was expected to decrease quickly in the 1990s. The annual increase in GDP was expected to be 1.8% between 1990 and 1995 and 2.1% between 1995 and 2000, and energy consumption was expected to stabilise. Actually in 1996, GDP was slightly lower than in 1990 and increased 1.7% in 1997, while energy supply increased 4.9% between 1990 and 1997. According to the 1996 forecasts, energy and electricity intensity will decline (see Figures 9 and 11). This would represent a change from previous trends.

Electricity intensity in Switzerland is also low in comparison with the other IEA countries (see Figure 11). This is mostly because of the higher prices of electricity

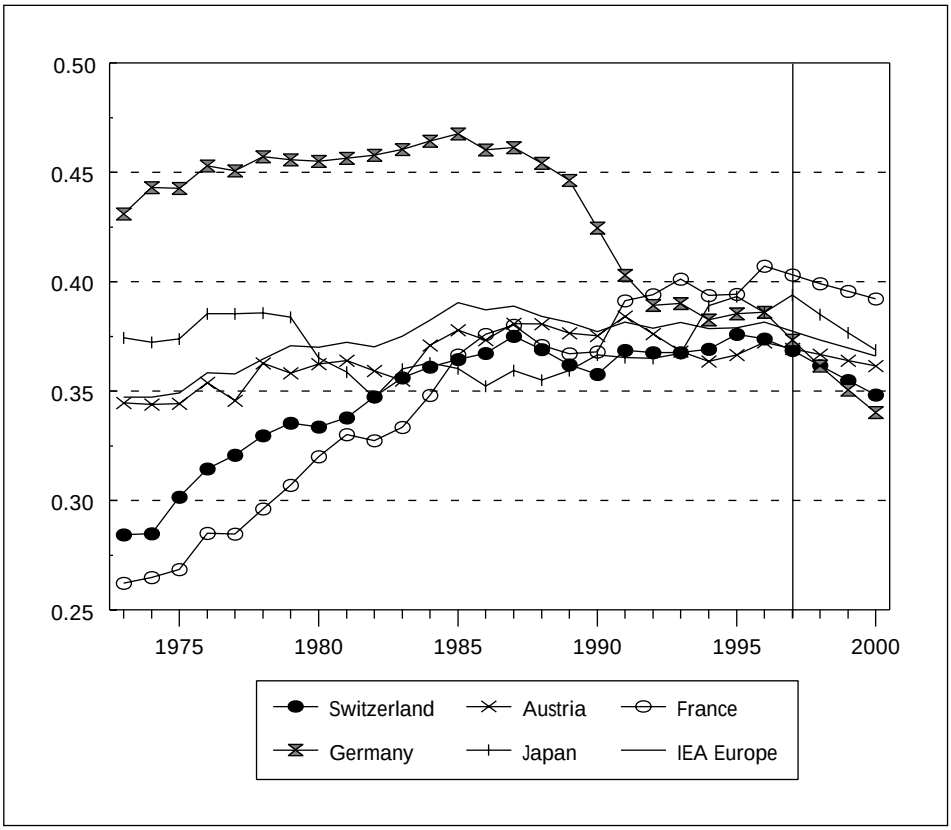
in Switzerland (in particular for industrial consumers as shown in published tariffs). Electricity intensity increased quickly until the mid-1980s. Since then, it has increased at a slower rate.

Figure 10
Energy Intensity by Sector in Switzerland and in Other Selected IEA Countries, 1973-2000
(Toe per thousand US$ at 1990 prices and purchasing power parities)



Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 1998; *National Accounts of OECD Countries*, OECD Paris, 1998; and country submissions.

Figure 11
Electricity Intensity in Switzerland and in Other Selected IEA Countries, 1973-2000*



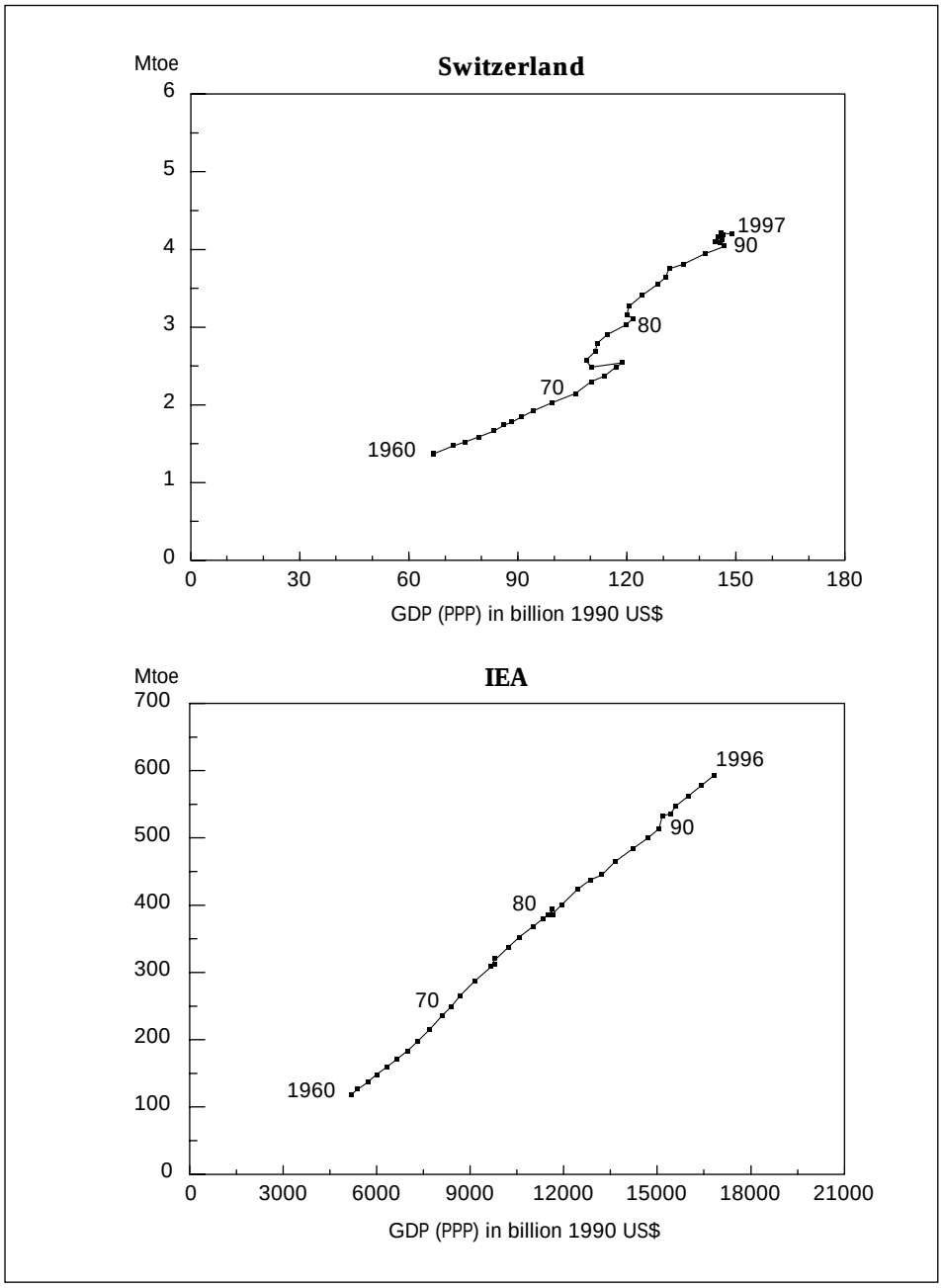
* Calculated as production plus net imports divided by GDP (PPP) and measured in kWh per dollar of GDP (PPP) at 1990 prices and purchasing power parities.

Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 1998; *National Accounts of OECD Countries,* OECD Paris, 1998; and country submissions.

Figures 12 to 14 illustrate the evolution in energy consumption of energy-related service sectors (electricity, transport excluding electricity, and stationary fossil fuel uses) and GDP calculated in purchasing power parity. Figures 12 and 13 indicate a close correlation between the growth in electricity consumption and transport and GDP. These figures also indicate that between 1990 and 1996, final energy consumption of energy-related services continued to increase despite a stabilisation of GDP. In 1997, both energy consumption and GDP increased.

Figure 12

Electricity Consumption vs GDP (PPP)
in Switzerland and in IEA Countries, 1960-1997*

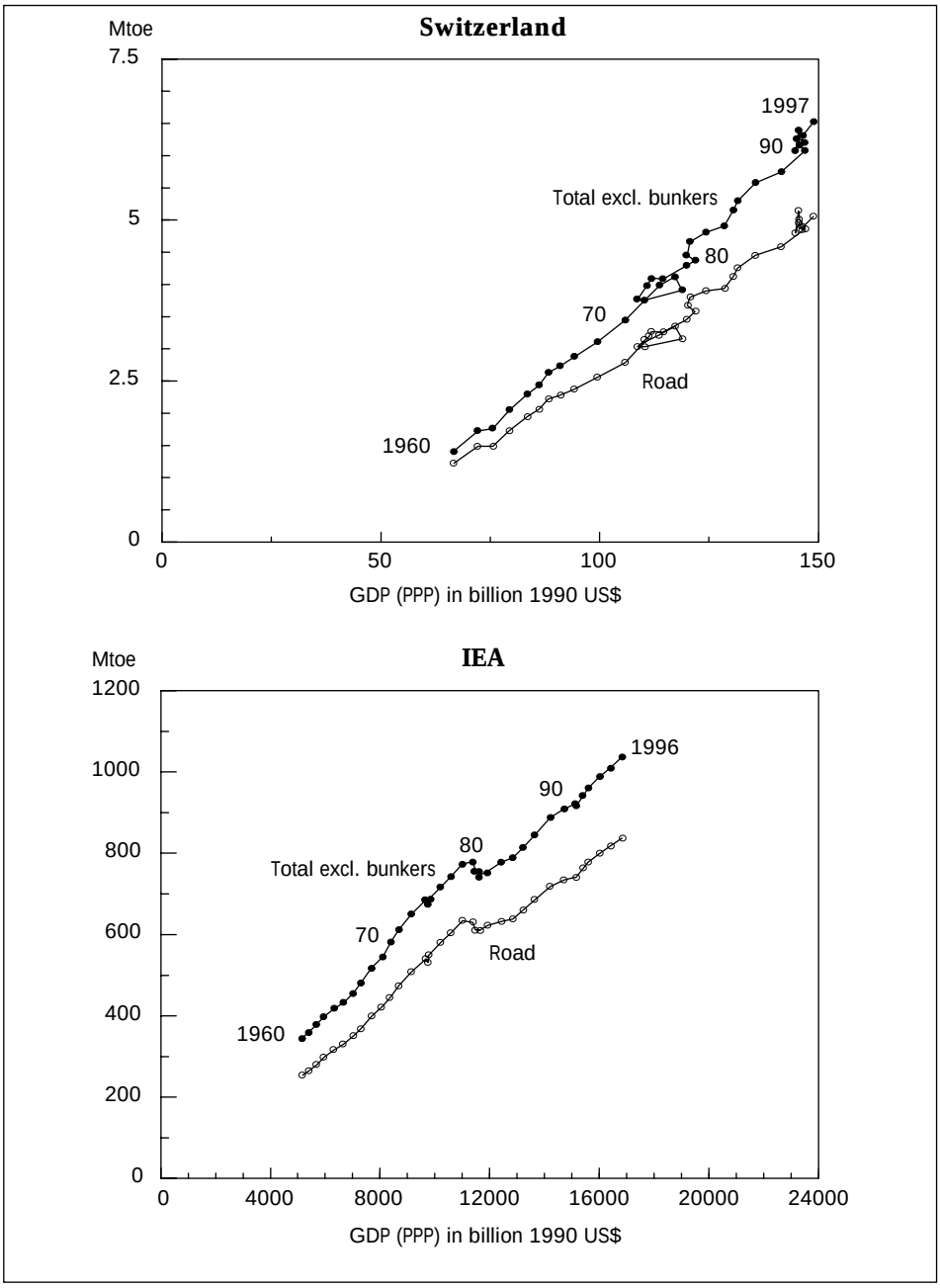


* 1997 data not available for total IEA countries.

Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 1998; and *National Accounts of OECD Countries*, OECD Paris, 1998.

Figure 13

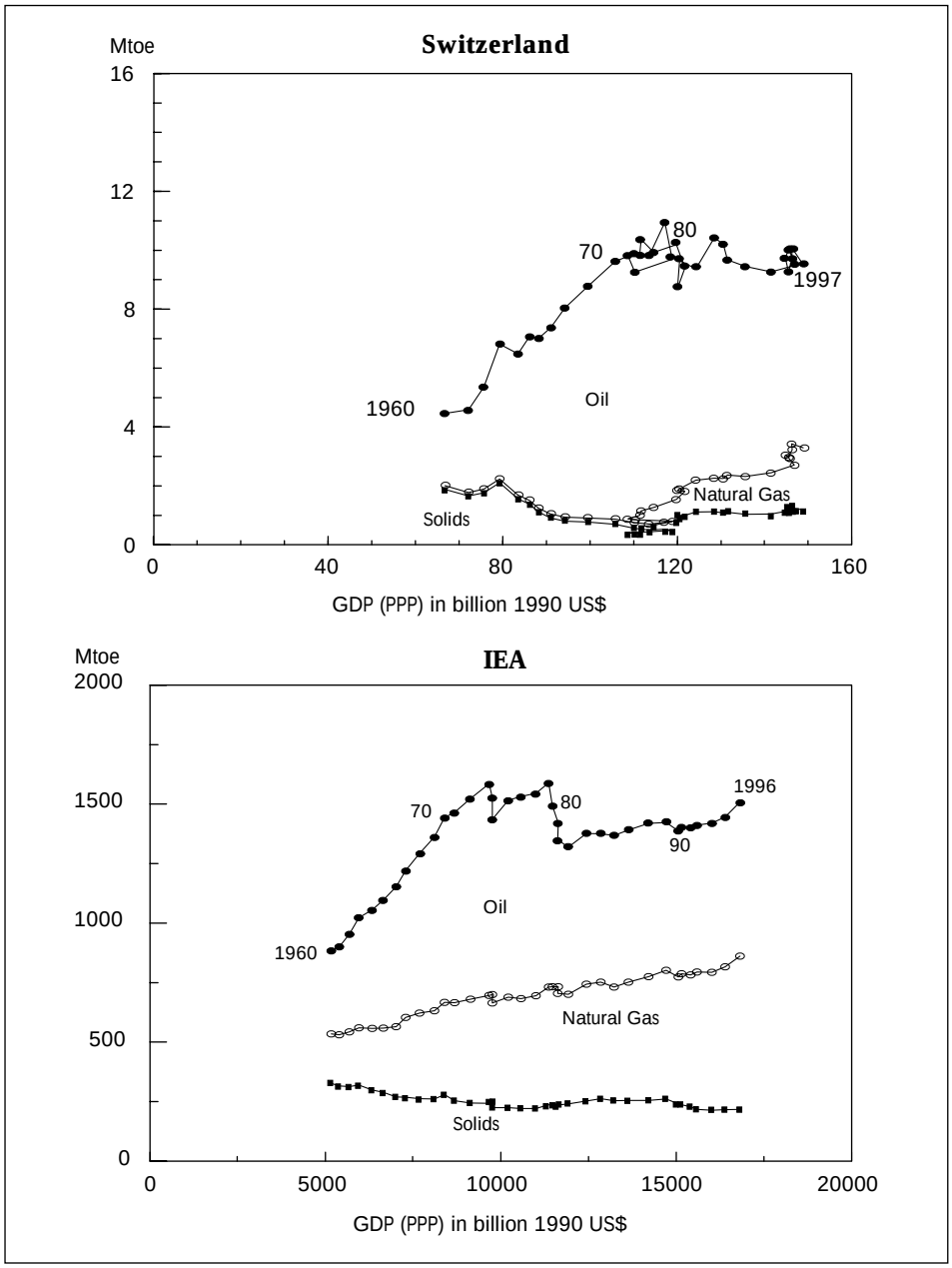
Energy Consumption in the Transport Sector, Excluding Electricity, vs GDP (PPP) in Switzerland and in IEA Countries, 1960-1997*



* 1997 data not available for total IEA countries.

Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 1998; and *National Accounts of OECD Countries,* OECD Paris, 1998.

Figure 14
Stationary Fossil Fuel Use vs GDP (PPP) in Switzerland and in IEA Countries, 1960-1997*



Note : data inputs to production of electricity and heat Autoproducers in the US are estimated until 1990.

* 1997 data not available for total IEA countries.

Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 1998; and *National Accounts of OECD Countries*, OECD Paris, 1998.

CO_2 Emissions

According to national statistics, CO_2 emissions from energy in Switzerland increased slightly between 1990 and 1996, but total net CO_2 emissions decreased (see Table 1). IEA's statistics on energy-related CO_2 emissions indicate a 1.4% increase in Switzerland between 1990 and 1997. In 1995, CO_2 emissions amounted to 82% of total greenhouse gas (GHG) emissions.

Table 1
Trend in CO_2 Emissions in Switzerland, 1990-1997
(Mt)

	1990	*1995*	*1996*	*1997*
CO_2 Emissions from Energy	40.4	40.2	41.4	n.a
Total Net CO_2 Emissions*	40.7	39.1	39.8	n.a
CO_2 Emissions from Energy (Source: IEA)	44.2	41.9	42.9	44.8

* CO_2 emissions from energy, excluding bunkers, and non-energy use, minus CO_2 sinks.

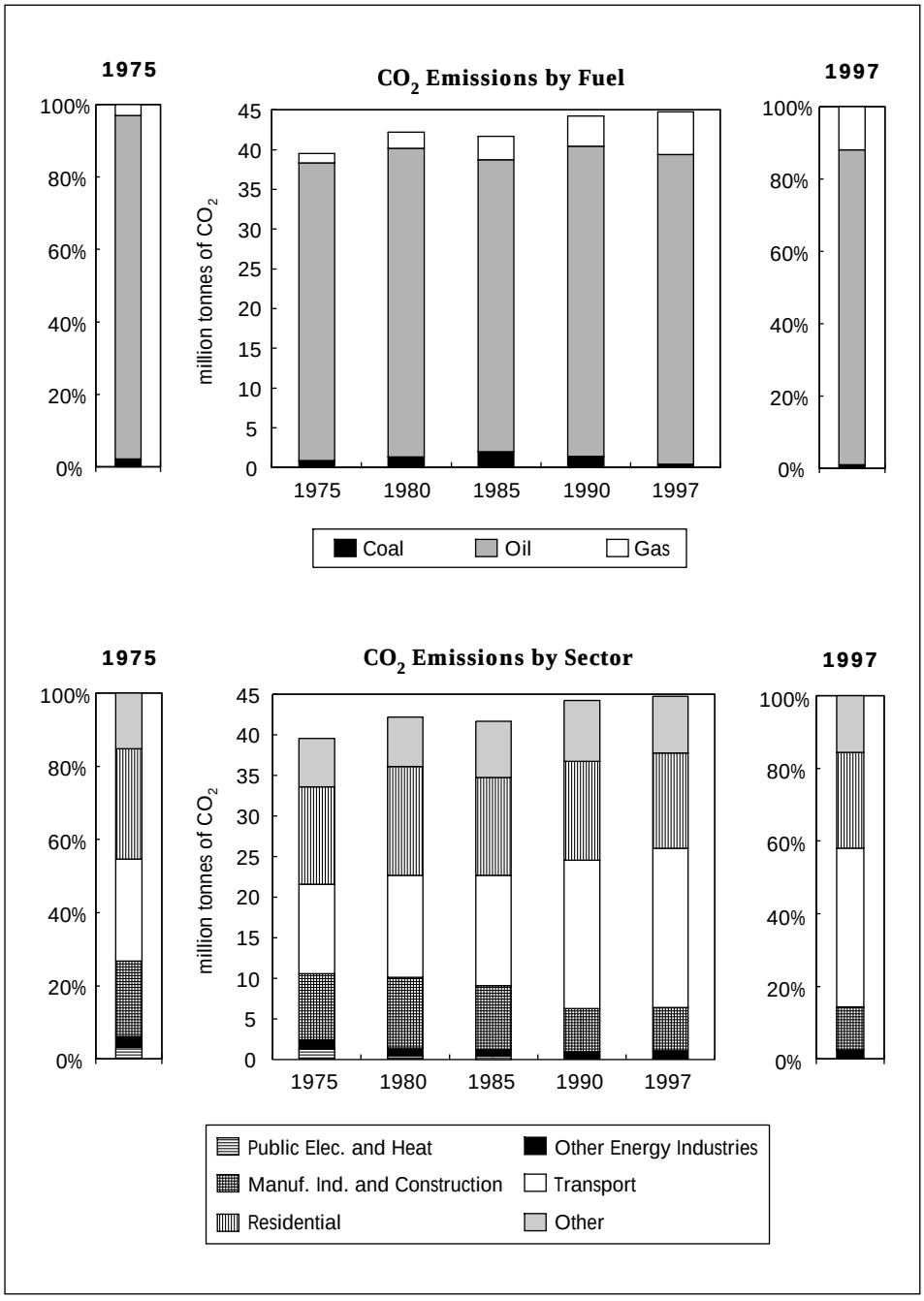
Source: Swiss Agency for the Environment, Forests and Landscape.

According to IEA's statistics, oil consumption causes more than 80% of energy-related CO_2 emissions, in spite of a decrease in emissions since 1990. The transport sector is the major emitter of energy-related CO_2, followed by the residential sector (see Figure 15).

Swiss energy-related CO_2 emissions per GDP (PPP) are the lowest of all IEA countries. This is because Switzerland has low energy intensity and nearly all energy input for electricity production is hydro and nuclear. Between 1990 and 1997 the trend stabilised while it continued to decrease in the IEA Europe (see Figure 16).

Figure 15

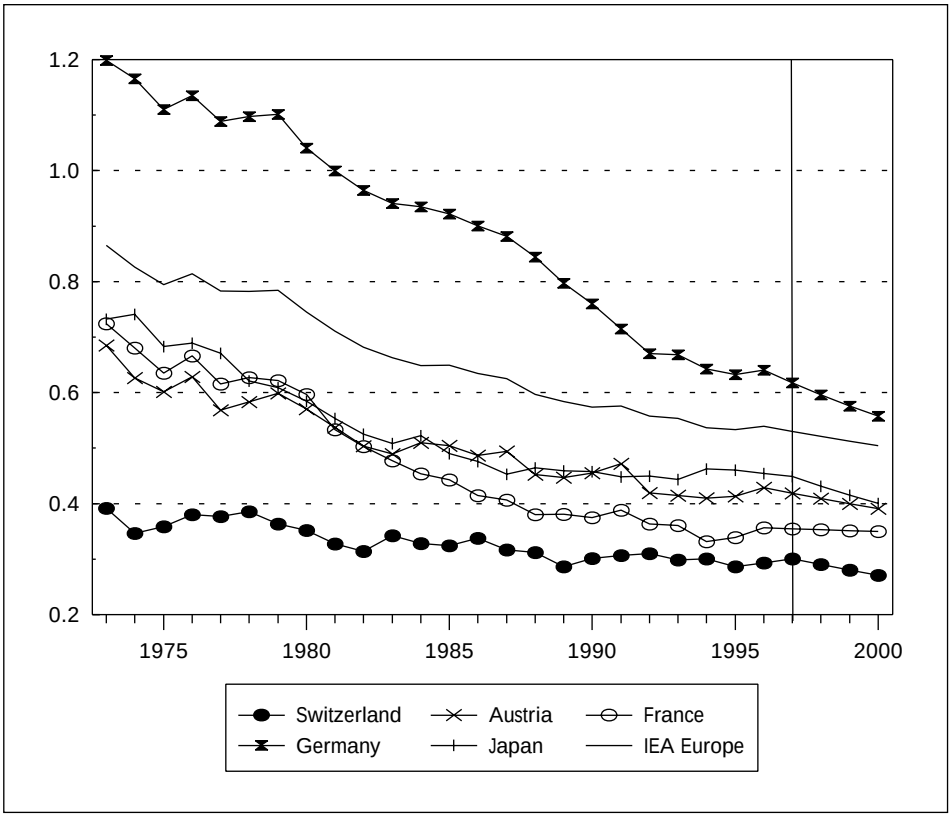
Energy-related CO_2 Emissions by Fuel and by Sector, 1975-1997



Note: For presentational purposes, the statistical differences and the differences due to losses and/or transformation have been allocated between the sectors.

Source: *CO_2 Emissions from Fuel Combustion*, IEA/OECD Paris, 1998.

Figure 16
Energy-related CO_2 Emissions per GDP (PPP)
in Switzerland and in Other Selected IEA Countries, 1973-2000
(CO_2 emissions/GDP using 1990 prices and purchasing power parities)



Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 1998; *National Accounts of OECD Countries*, OECD Paris, 1998; and country submissions.

Other Pollutant Emissions

The Ordinance on Air Policy Control of 1985 was revised in 1992 and 1998. The law is source-oriented (it includes emissions standards, including quality requirements for fuels) and effect-oriented (it includes air quality standards). In addition to the Ordinance, in 1986 the Federal Government set ambitious national targets for the reduction of pollutant emissions. SO_2 emissions are to be reduced to the level of 1950 and NO_x and Volatile Organic Compounds (VOC) to the level of 1960.

A mix of measures is used to reduce pollutant emissions: standards, economic instruments and voluntary measures. For instance, Swiss policy is to tighten standards for exhaust emissions from motor vehicles in step with the EU. An incentive tax to

reduce the sulphur content of light fuel oil has been adopted (see below) and a tax on VOC emissions is planned to take effect in January 2000.

Responsibility for implementing the Ordinance lies essentially with the cantons. Cantons may also implement their own measures. They measure the air quality within their boundaries, establish emission inventories and take measures to limit emissions. All cantons but one have drawn up action plans to control air pollution.

SO_2 emissions amounted to 32.5 Mt in 1997, a 23% reduction from 1990. According to the SFOE, the reduction was due to lower limits for the sulphur content of heavy fuel oil and diesel. The future tax on the sulphur content of light fuel oil is expected to further reduce SO_2 emissions (see below). NO_x emissions amounted to 128 400 tonnes in 1997 (an 18% reduction from 1990) and VOC emissions amounted to 195 000 tonnes (a 30.6% reduction from 1990). Emissions of SO_2 have been reduced below the target, but emissions of NO_x and VOC need further reduction. In cities, NO_x emissions markedly exceed the standard of 30 micrograms/m^3 – annual mean value. The concentration of ozone (O_3) also often exceeds the limit (120 micrograms/m^3 – one hour mean value).

CRITIQUE

Switzerland carries out energy policy in a federal system with very decentralised decision-making. Most of the legal competences belong to the cantons, which often delegate them to the municipalities. Policy decisions are often taken by public vote. Under such conditions, the Government has been making special efforts to provide information and to seek consensus on energy policies. Thanks to these efforts, public awareness on energy policies seems to be higher in Switzerland than in many other IEA countries. In particular, the Energy 2000 Action Plan, which is discussed in the next chapter, has been successful in implementing policy measures and informing citizens about energy policies and issues.

Direct involvement of the population in energy policy decisions may prevent special interest groups from exerting political power to impose their interests over general public interests. However, this system allows good policy-making only if the population understands the trade-offs among various energy policy options. All the players in the Swiss system, including the cantons and the general public, must fulfill their responsibilities in energy policy. They must respond to new challenges, such as the creation of competitive energy markets and the reduction of CO_2 emissions from fossil fuels in a cost-effective way. To ensure the coherence and continuity of its energy policy, the Swiss Government should continue to provide accurate information, including assessments of cost-effectiveness, on policies. The Government should offer policy options for the future, with analysis of various trade-offs. It should also continue its efforts to reach consensus among different groups, in particular through conflict-solving groups and dialogue on energy policy.

In order to ensure that the cantons have the resources to carry out their missions related to energy, they should be able to collect all necessary information, such as data on energy consumption and supply. Information on other cantons' policies together with assessments of those policies would also help the cantons to improve their policies. The report on energy policy and measures at canton level issued in 1998, like all the reports published since 1985, is a valuable document. Using such information, the cantons can carry out their own missions and improve co-operation with the other cantons. Some cantons may be too small to have energy administrations able to carry out all their missions. Increased co-operation between cantons can mitigate this disadvantage in scale, and increase cost-effectiveness. Increased co-operation between cantons and their municipalities would also help.

The success of energy policy depends on effective co-operation between the Swiss Government and the cantons. The current discussion to clarify their respective roles is welcome as it is a precondition for improved co-operation. The 1998 Energy Law returned some regulatory powers to the cantons and established a financial mechanism allowing the Swiss Government to give funding to cantons which have implemented measures for energy savings and the use of renewables. The Swiss Government and the cantons must continue to co-operate closely in order to make this system function effectively. Funds should be allocated according to transparent criteria established by the Swiss Government, fully in line with its energy policy.

RECOMMENDATIONS

The Swiss Government should:

□ Further strengthen public information on energy policy measures. Make sure that trade-offs between various policy options are well understood.

□ Improve the review of the cantons' energy policies. Promote co-operation among cantons.

□ Further enhance co-operation with the cantons on energy policy, especially on the Energy 2000 Action Plan and on the introduction of competition in the energy markets to ensure successful implementation of energy policy measures.

4

THE ENERGY 2000 ACTION PLAN AND ENERGY TAXATION[5]

THE ENERGY 2000 ACTION PLAN

Objectives and Organisation

The "Energy 2000 Action Plan" is the core of Swiss energy policy. The result of a government decision in November 1990, it came into effect in 1991. In September 1990, the Swiss adopted by referendum a constitutional amendment authorising the Government to carry out a national energy policy and setting a moratorium on the construction of new nuclear power plants until the year 2000.

The plan sets the objectives for 1990 to 2000 as follows:

- To stabilise the consumption of fossil fuels by 2000 to the level of 1990 and to reduce it afterwards.
- To slow down the rate of increase in electricity consumption between 1990 and 2000 and to stabilise it afterwards.
- To increase the contribution of non-hydro renewables to electricity generation by 0.5% and to heat production by 3%.
- To increase hydroelectricity generation by 5%.
- To upgrade the capacity of existing nuclear power plants by 10%.
- To stabilise CO_2 emissions between 1990 and 2000. In addition, in March 1997 the Swiss Government submitted to Parliament a law on CO_2 reduction, setting a target of a 10% decrease between 1990 and 2010 (see below). At Kyoto, the Swiss Government agreed to cut greenhouse gas (GHG) emissions by 8% from the 1990 level between 2008 and 2012.

The implementation of energy policy is based on a partnership between the Swiss Government, the cantons and municipalities as well as with the private sector and various non-governmental organisations. The Energy 2000 Action Plan has three components:"voluntary measures", legal measures and dialogue.

"*Voluntary measures*" are non-legal measures. They are carried out by:

- The Swiss Government (funding of pilot and demonstration projects, promotion of renewable energy and heat recuperation, training courses, and dissemination of information).

5 This chapter includes issues related to energy efficiency and renewables policy, energy and environment, and energy taxation.

- The cantons and municipalities (own measures and implementation of recommendations by the Swiss Government).

- Private enterprises. At federal level, the follow-up of these measures is the responsibility of seven "marketing departments": Public Sector, Residential Buildings, Industry, Small Industries and Services[6], Hospitals, Motor Fuels, and Renewables.

Legal measures included the 1991 Decree on Efficient Energy Use until the end of 1998. Since the beginning of 1999, they include the 1998 Energy Law, which is described later.

Dialogue includes conflict-solving groups which were created to reach agreements between the different groups (political parties, federal and local administrations, non-governmental organisations [NGOs], industries, unions) on contentious issues, i.e. nuclear waste disposal, new transmission lines, potential for hydropower generation, CHP policies and issues related to energy use in transport.

Financing

Total government financing of the Energy 2000 Action Plan has been around SFr 50-55 million[7] per year, well below what was planned when the programme was launched (SFr 170 million per year – see Table 2). Figures from 1997 to 1999 include the sums related to the Federal Investment Programme, which is described later.

Table 2
Federal Government's Contribution to the Energy 2000 Action Plan, 1991-2000
(SFr million)

	1991	*1992*	*1993*	*1994*	*1995*	*1996*	*1997*	*1998*	*1999*	*2000*
Expenditure	16	50.2	59	57.8	54.6	56.4	55.1	71	99	57.4
Initial Budget	0	100	125	150	170	170	170	170	170	170

Source: SFOE.

These sums aim mostly at promoting the "voluntary measures" mentioned above. About one-third of the funding has been dedicated to the promotion of renewables through information, advice, multi-level training, quality insurance and subsidised installations. Funding for renewables and their share of total funding have increased in recent years (see Table 3).

6 Small Industries and Services were merged in 1998.

7 On average in 1997 and 1998, SFr 1 = US$ 0.69.

Table 3
Federal Government's Expenditure on Renewables*, 1990-1998
(SFr million)

	Annual Average 1990-1995	*1996*	*1997*	*1998 (Planned)*
Total Solar	9.9	12.5	12.3	13.9
Wood	2.6	7.4	5.9	7.2
Ambient Heat	3.0	7.0	6.4	6.6
Other	3.6	7.2	8.2	5.6
Total	19.1	34.1	32.8	33.3

* Includes R&D, pilot and demonstration programmes and promotion.

Source: Country submission.

At canton level, administrative staff dedicated to energy policy, as well as expenditures, have been reduced since 1992 (see Table 4). In 1998, cantons' expenditures amounted to nearly 40% of total Swiss Government expenditure.

Table 4
Evolution in Energy Staff and Expenditure at Canton Level, 1990-1998

	1990	*1991*	*1992*	*1993*	*1994*	*1995*	*1996*	*1997*	*1998*
Expenditure*	20.9	24.4	27.1	27.5	33.7	27.4	24.3	26.6	27.6
Staff Level	68	75	80	73	73	74	72	71	73

*SFr million, excluding staff expenditure.

Source: SFOE.

LEGAL FRAMEWORK OF ENERGY POLICY

Swiss Government Level

The Decree of May 1991 on Efficient Energy Use and the corresponding ordinances on energy use established the main legal framework for energy policy at federal level until the end of 1998. The goals of the Decree are: to ensure a safe energy supply that is environmentally compatible and economically feasible in the long term, to secure the production and delivery of a sufficient amount of energy under optimal economic and ecological conditions, to contribute to rational and efficient use of energy and to encourage domestic and renewable energy sources. The Decree allowed the following measures to be taken by the Swiss Government:

- To establish procedures and energy consumption targets for appliances and vehicles.
- To make individual metering mandatory for heating and hot water (with implementation at canton level).
- To establish a licensing procedure for electric heating and outdoor heating systems as well as for heatable outdoor swimming pools (with implementation at canton level).
- To establish regulations for public lighting (with implementation at canton level).
- To establish regulations for connection to the grid and for the buy-back tariff for electricity autoproducers (with implementation at canton level – see Chapter 6).
- To encourage information and training courses related to energy savings.
- To fund R&D as well as demonstration projects (see Chapter 8).
- To fund renewable energy and heat recuperation.

In July 1998, the Government issued an energy law to replace the Decree on Efficient Energy Use, which expired in December 1998. The new law takes into account the results of the energy dialogue (see box).

An energy policy dialogue took place between August 1996 and June 1997. It involved representatives of political parties, cantons, energy suppliers, small and large industries, non-governmental organisations (NGOs) and trade unions. The following conclusions by the Federal Department for Environment, Transport, Energy and Communication (DETEC) will serve as a basis for energy policy after 2000:

- ☐ There is a consensus on energy policy priorities, i.e. efficiency policy as well as the confirmation that hydropower has to remain the main fuel for electricity generation in the foreseeable future.
- ☐ Emphasis will continue to be put on voluntary and market-based measures rather than regulatory measures.
- ☐ The electricity market should be opened progressively to competition in harmony with the other European countries.
- ☐ No consensus was reached on the future of nuclear power (upgrading existing nuclear reactors, extending their operating permits and building new reactors). However, there was agreement that existing nuclear power stations should continue operation as long as they are safe. There was also agreement that the building of new nuclear reactors should be subject to a referendum.
- ☐ There was also no consensus on the introduction of an energy tax.

The Energy Law made the following changes to the Decree:

- It calls for more extensive co-operation with the private sector, reaffirms the principle of subsidiarity (cantons are free to act as long as there is no federal regulation) and gives priority to "voluntary measures" over regulations.
- It gives more regulatory responsibilities to the cantons.
- It allows the Swiss Government to fund measures favouring energy savings and renewables through annual funding to those cantons that have established a programme favouring energy efficiency and renewables. Direct funding from the Swiss Government for projects is allowed but should be an exception. Funding from the Swiss Government and the cantons cannot exceed 40% of the incremental investment cost (exceptionally 60%). Subsidies should not cover operating costs.
- Before licensing the building of a fossil fuel power plant, the cantons need to assess whether supply can reasonably be met by renewable energy and whether there are possibilities of recovering heat.

Other measures to promote energy efficiency and renewables include R&D (see Chapter 8). There are special measures to promote electricity from renewables (see Chapter 6). Special tariffs for the purchase of "green electricity" from renewables have also been developed (see box).

Green Electricity

Approximately 23 Swiss utilities have recently made available green electricity, i.e. electricity from renewables at a premium price. Another 30 utilities are planning to make green electricity available. Half of the utilities offer electricity from solar photovoltaic; the others offer electricity from wind energy, biomass or a mix. About 1% of customers buy green electricity. The price premium ranges between 90 and 100% of the normal price for wind energy and between 400 and 650% for solar energy. Each utility ensures that the supply of green electricity clearly corresponds to its available capacity.

Canton Level

All cantons but one have an energy law. Some of them need to adapt their legislation to the 1998 Federal Energy Law. Energy policy and means differ widely in the different cantons. For instance, some cantons, such as Neuchâtel, provide an annual energy report including supply and demand balances. Some other cantons are unable to obtain reliable data on energy consumption within their boundaries. Some cantons have implemented energy planning, in particular to favour the consumption of specific fuels in defined areas (i.e. in some areas, natural gas consumption is favoured; in others, biomass is favoured for heating or district heating).

A 1998 report by the SFOE on energy policies in cantons mentioned that in 1997, 11 cantons had local regulations on evaluation and monitoring of energy policy measures. The Cantons of Lucerne and Basel have implemented a cantonal vehicle tax differentiated according to specific fuel consumption. Eight cantons have developed standards for electricity devices in new cantonal buildings. Nine cantons assess the measures they take. All cantons have adopted legislation to establish measures related to energy efficiency in buildings. However, the standards adopted by the different cantons vary widely. Only seven cantons fully implement the most efficient codes for buildings and only four cantons give incentives for the renovation of existing buildings. Implementation of the regulation on individual metering also varies widely among cantons.

In April 1996, the Conference of Cantonal Energy Directors adopted the "Programme of the Cantons for the 2nd Half of Energy 2000". This programme includes measures to be taken in the building sector (electricity consumption, retrofitting), transport, assessment and information.

MEASURES ON ENERGY EFFICIENCY AND RENEWABLES BY SECTOR

Appliances

Target values and registration requirements have been set for 12 main domestic appliances (i.e. refrigerators, electric ovens, dishwashers, washing machines, tumble dryers) and office equipment (i.e. fax machines, printers, video recorders). Energy consumption for household appliances should be reduced by 7 to 19%, depending on the appliance. The aim is to have 90 to 95% of the appliances sold meet the target value. This applies to manufacturers and importers. To this end, deadlines differentiated by equipment have been set. By 1997, in spite of progress in energy efficiency, almost none of the targets had been reached.

Energy labelling was introduced in 1994. The label "Energy 2000" is given for energy efficient appliances and office equipment (i.e. fax and photocopy machines, printers, televisions and videos recorders), but only half the targeted appliances are labelled.

Buildings

Building codes are the responsibility of the cantons. A model decree on efficient use of energy in new buildings and for retrofitting, based on the recommendations of the Association of Swiss Engineers and Architects, is available to cantons. Most of them have thus implemented corresponding measures to increase energy efficiency in buildings based on the model decree, but standards still differ among cantons.

Deductions from the income tax for such investments have been harmonised since 1995 at federal level.

About 81% of households rent their housing. In 1997, about 450 000 dwellings out of the 1.2 million that could be converted had individual metering for heating and hot water. The Decree of 1991 made individual metering mandatory only for buildings with five or more heating accounts and built after 1992. The new Energy Law makes it mandatory for new buildings but leaves the regulation of existing buildings to the cantons.

The 1998 Energy Law cancelled the licensing procedure for electric heating, outdoor and hot air heating and heatable outdoor swimming pools. Regulations are the cantons' responsibility.

The Swiss Government gives technical support for energy savings in public and complex buildings (such as hospitals) and offers promotional programmes such as check-ups for heating systems.

Industry

Around 120 large companies with annual energy costs above US$ 100 000, representing 18% of energy consumption in this sector, are involved in the "voluntary measures", which mainly include sharing information about energy savings. Other initiatives supported by the SFOE include training courses and dissemination of information, which also apply to small and medium enterprises.

Transport

Voluntary Measures

The Decree on Efficient Energy Use allows the Swiss Government to issue regulations on specific fuel consumption of newly registered road vehicles. In December 1995, the Swiss Government issued an Ordinance on the Lowering of Specific Fuel Consumption for Passenger Cars. This ordinance sets for car importers an objective of a 15% reduction in specific fuel consumption by the new car fleet between 1996 and 2001. The ordinance also establishes the technical and organisational procedures for monitoring progress in reaching the target.

The Swiss Government spends about SFr 6 milion per year to encourage energy savings in transport, such as improvement of fuel consumption awareness and promotion of new technologies and management facilities in the freight sector. One example is training in "Eco driving", mainly for captive fleets (primarily buses). According to assessments, between 5% and 15% of fuel consumption can be saved. The Swiss Government also supports businesses which promote motor

fuel savings. One example is the "CarSharing" initiative, which is a system of car rental by membership. Since this system enables customers to rent a car by km driven and by hour (and not by day) from numerous points which are within walking distance from homes and public transport stations, many members opt not to own a car at all. A study showed that users of this service increase their use of public transportation and use a car only when necessary, thus consuming less fuel for transportation. The Government estimates that this system can develop and enhance energy efficiency and thus mitigate CO_2 emissions.

Public Investments in Transport

In the 1960s and 1970s, Switzerland implemented an ambitious programme to build motorways. Building road infrastructure has been facilitated by the earmarking of revenues from gasoline and diesel taxes for roads[8]. This programme was followed by three important projects related to rail transport (see Figure 17). In 1986, the first project, a programme to facilitate passenger transport, called Railways 2000, was launched. The first stage runs until 2010 and is expected to cost SFr 7.5 billion. The second stage (2010-2020) is expected to cost SFr 6 billion. The second project is the Trans-Alpine Railway Axis to improve freight transport (see below). The third project is the planned building of infrastructure for connection to German and French high speed trains. In 1996, a law was passed to improve the management of the national railways company and reduce deficits. In a referendum of 29 November 1998, the financing of investments in rail infrastructure (Trans-Alpine Railway Axis, "Railways 2000" and access to the French and German high speed train networks) was approved.

Investments for rail increased from SFr 500 million in 1980 to SFr 2 billion in 1990 and have since remained at the same level. Investments in roads increased from around SFr 2.5 billion in the mid-1980s to SFr 4 billion in 1990 and have since remained at the same level.

Road Freight

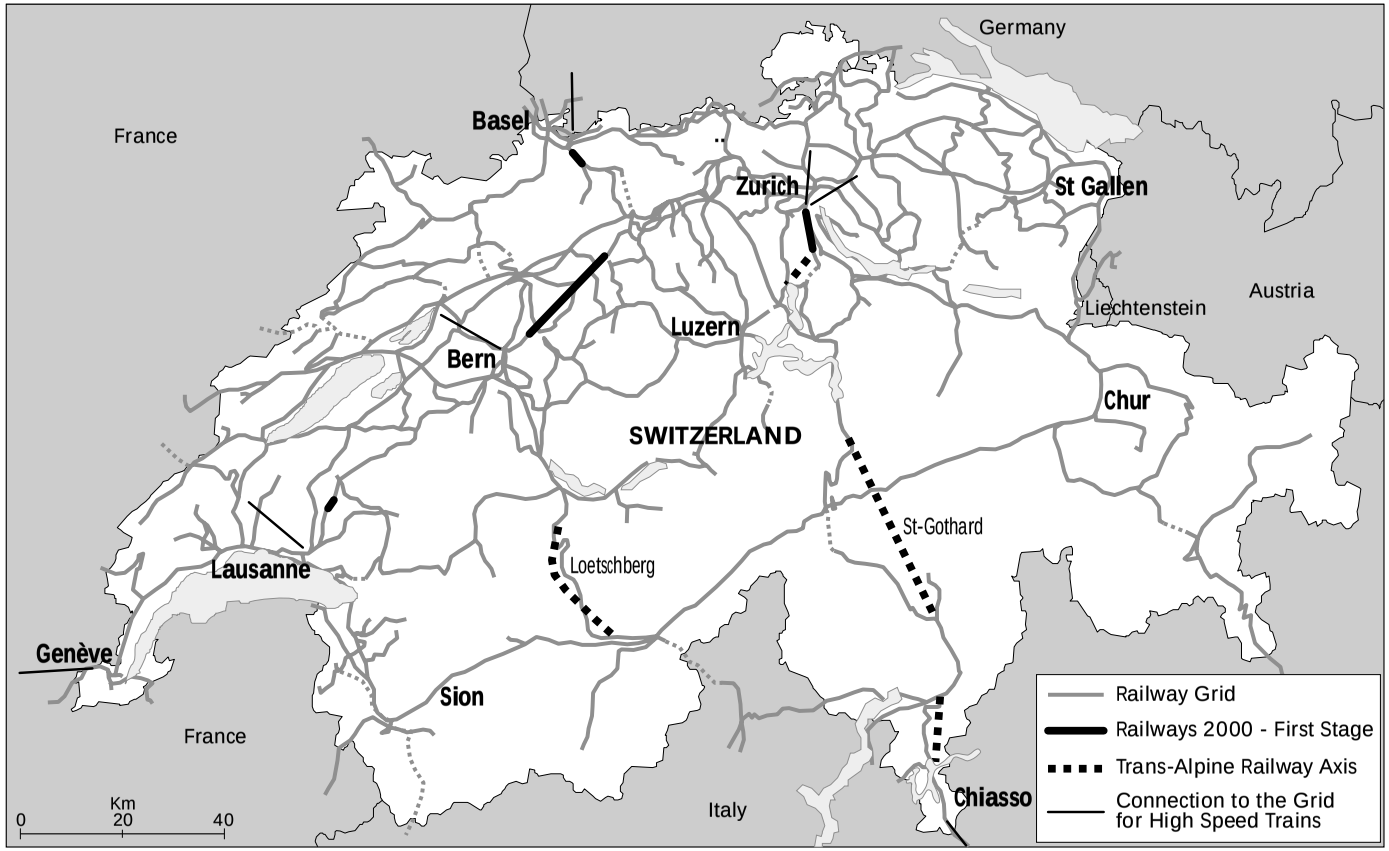
In 1996, a law was adopted introducing a new tax on trucks over 3.5 tonnes to replace the existing heavy goods vehicle tax. This tax is related to distance and weight and is intended to internalise the cost of freight transport (infrastructure, noise, accidents, damages to buildings and health[9]). This tax was accepted by

8 The referendum of March 1993 allowed an increase of SFr 0.3 per litre of gasoline and automotive diesel (i.e. an average increase of 20%). Half of the increase in the tax is used to finance road infrastructure.

9 External costs were calculated by consultants for the DETEC in 1993. Estimated external costs for trucks (SFr 1.1 billion per year) and for passenger cars (SFr 2.3 billion) are much higher than for rail (SFr 29 million for the transport of goods and SFr 120 million for passengers). The cost of road infrastructure is higher than the revenue from gasoline and automotive diesel taxes.

Figure 17

Planned Infrastructure for Railways



Source: Federal Office of Transport.

the referendum of September 1998. The maximum charge will increase from SFr 0.016 per km-tonne in 2001 to SFr 0.03 in 2005. One-third of the tax revenue will go to the cantons; the rest will be used by the Swiss Government for investments in rail infrastructure. Implementation of the tax will parallel repeal of the 28 tonne limit for trucks[10].

As of 2001, an Alpine transit tax is envisaged for trucks of more than 3.5 tonnes transiting the San Bernardino, Saint-Gotthard, Simplon and Grand-Saint-Bernard passes.

Rail Freight

In September 1992, the Swiss electorate approved a federal decree on the building of two new Alpine tunnels through the mountains of Saint-Gotthard (57 km) and Loetschberg (36 km). The new tunnels aim at doubling rail transit capacity to 70 billion tonnes per year and speeding up transit between northern and southern Europe. The total cost is expected to be more than SFr 15 billion. This amount will be financed out of the new tax on trucks (see above) and possibly by a temporary increase in automotive fuel taxes. This would allow implementation of the measures requested in the referendum of April 1994[11].

The Federal Investment Programme

In April 1997, the Federal Parliament launched an investment programme aimed at creating employment, stimulating the economy and promoting sustainable development. The energy investment programme includes SFr 64 million to be spent between 1997 and 1999 on subsidising private investments in energy savings and renewable energies in the building sector. Owners must invest more than SFr 50 000 and subsidies amount to an average of 10% of the total investment. More than 3 100 projects have been proposed, totalling SFr 92 millions: 81% of the funds are for retrofitting buildings, 13.3% for renewable energy, 2.5% for improving lighting, 2.9% for heat recuperation and 0.5% for photovoltaic. According to the SFOE, this will reduce CO_2 emissions by 60 000 tonnes per year. In addition, a fund of SFr 200 million has been made available to assist public projects in general (some of these projects are energy-related, such as municipal waste incinerators).

10 The Transit Treaty between Switzerland and the EU was signed in 1993. It expires in 2005. The agreement allows Switzerland to maintain for this period the 28 tonne weight limit for trucks (in force since 1972) and provides for the progressive introduction of a heavy goods vehicle tax, co-ordinated between the two parties if possible.

11 The Alpine initiative (referendum of April 1994) requests a shift of total transalpine truck traffic (from border to border) from road to rail within 10 years.

RESULTS AND ASSESSMENT OF MEASURES

The results of the Energy 2000 Action Plan in 1997 are shown in Table 5. In addition to these results, net CO_2 emissions stabilised between 1990 and 1996 (see Chapter 3).

Table 5
Achievements of the Energy 2000 Action Plan in Comparison with Objectives*

	1997-1990	*Achievement in Comparison with Objective*
Fossil Fuel Consumption	+2.5%	Objective: to stabilise the consumption of fossil fuels.
Electricity	+4.4%	Objective: to slow down the rate of increase in electricity consumption between 1990 and 2000.
Heat from Renewables	+33.5%	55% of the objective.
Electricity from Renewables	+52.7%	77% of the objective.
Hydro Production	+3.8%	76% of the objective.
Nuclear Capacity	+5.1%	51% of the objective.

* Data may differ from IEA's statistics.

Source: SFOE.

The effects of the Energy 2000 Action Plan in 1997 estimated by the SFOE are shown in Table 6.

Table 6
Effects of the Energy 2000 Action Plan, 1997

	Savings (PJ)	*% 1997*	*CO_2 Reduction (Mt)*	*Job Creation*	*Investments (SFr million)**
Voluntary Measures	11.7	1.5	0.6/1	2 850	346
Legal Measures	15.1	1.9	0.9/1.3	1 450	166
Total	26.8	3.3	1.5/2.3	4 300	512

* Private investments.

Source: SFOE.

The SFOE believes that assessment of measures is essential to improve energy policy. The SFOE aims to promote those individual measures which have the greatest impact on energy savings and reduction in CO_2 emissions with the lowest amount of subsidy and eventually to reduce and eliminate subsidies. If voluntary measures or targets for standards are not sufficient, further measures are envisaged (regulations and/or taxation). The effects of approximately 40 measures, chosen because they are new, costly or controversial, have already been assessed.

A report assessing the Energy 2000 Action Plan was released in September 1996. Assessment was by independent experts on the basis of standards set by the SFOE. The main findings of this report were:

- The combination of voluntary measures, regulations and dialogue is efficient. These three methods are interdependent.
- The measures need more time to be effective than originally expected.
- Voluntary measures need more involvement by the different players. Increased funding to better develop these measures is needed. Quantitative objectives and improvements in assessment enhance the efficiency of the Action Plan.

The 1996 Evaluation of Renewable Energy Policies

In 1997, the renewables component of the Energy 2000 Action Plan was estimated to have reduced CO_2 emissions by 200 to 210 kt (this amounts to about 0.5% of CO_2 emissions).

Policies directed towards increased penetration of renewables in the domestic sector, such as heat pumps, have resulted in a significant number being installed– albeit at a lower current rate than hoped for in the Energy 2000 Action Plan. The most important factor in influencing people's choice to install a heat pump was the availability of adequate information. Because 85% of the people stated they would have acted in the same way even without subsidies, heat pump subsidies for individuals were found to be of limited use and were therefore dropped.

Evaluation of policies designed to encourage use of solar collectors in dwellings has indicated that some consumers are willing to pay two or three times more for solar energy than for normal energy. Since a large proportion of people questioned (40% in the solar collector evaluation study) were unaware of the promotional programme, funds would be best directed towards increasing availability of information.

Subsidies are more important for public institutions than for private organisations: the former accepted additional costs for environmental purposes more readily than private business, which wanted returns on investments in less than 10 years.

The annual reports of the Energy 2000 Action Plan compare the cost–effectiveness[12] of the different categories of measures. The 1998 report indicates the following results in terms of public costs:

12 The calculation of costs only covers the cost of investment.

- The cost-effectiveness of voluntary measures and the investment programme is lower than prescriptive measures.

- With regard to voluntary measures, support to energy efficiency programmes for small and medium enterprises and support to renewables are the least cost-efficient. Results vary according to the different renewables, the most profitable being energy plants using sewage as fuel and the least being photovoltaics. For the final phase of the Action Plan, the organisation of voluntary measures will be reformed, in particular to give an additional push to the most cost-effective measures and to improve information, assessment and organisation.

ENERGY TAXATION

Federal Level

The Swiss Government levies VAT and excise taxes on coal[13] and oil products, natural gas and products from gas and all other fuel products. Before 1995, a turnover tax of 6.2% was applied only to gasoline and diesel. In January 1995, the Swiss tax system was changed from a turnover tax system into a value added tax system. VAT is also applied to the other fuels and electricity, which were previously exempt from the turnover tax. In addition, there is an Emergency Fund tax on oil products and natural gas[14].

In July 1998, an additional tax was set on light fuel oil with a sulphur content exceeding 0.1%. This tax aims to promote the consumption of low sulphur light fuel oil. The Swiss Government also intends to change its taxation system for road freight to better internalise the environmental costs of road transport and promote transport by train (see above).

Local Level

Cantons levy several taxes and charges. The most important one is the royalty on the use of water which is paid by hydro-power plants to municipalities and to the cantons. These royalties are based on the nominal capacity of the plants. In 1997, the maximum fee was increased by law from SFr 54/kW to SFr 80/kW. Small-scale hydro plants (< 1 MW) are exempted from the increase in royalties, and systems

13 SFr 0.9 per tonne since January 1997.

14 The emergency fund for coal was abolished in 1996 together with the end of the obligation to keep strategic coal stocks.

between 1 and 2 MW receive a reduced rate. Cantons and municipalities also levy various taxes and hidden charges on electricity and natural gas which constitute a large part of the cost of supply to final consumers (for more details see Chapters 5 and 6). Other taxes at local level include the annual automobile tax.

Taxation

In 1993, excise taxes on automotive fuel increased by one-third. However, taxes on gasoline are still low in comparison with neighbouring countries (see Table 7 and Figure 18). This creates a price gap with them and has been a strong incentive for "gasoline tourism"[15]. Taxes on automotive diesel are higher than taxes on gasoline. The price of automotive diesel is higher than in neighbouring counties, because of higher taxes, which is an incentive for diesel engine drivers to refuel outside Switzerland (see Figure 19). In the household sector, taxes on light fuel oil are among the lowest of all IEA countries and marginally lower than on natural gas (see Table 7 and Figure 20). In addition, at local level, there are charges on natural gas as well as taxes and charges on electricity (see above). They do not appear in IEA's statistics and are included in the pre-tax price of these fuels.

Table 7
Taxes in Average Energy Prices, 1997
(US$/toe)

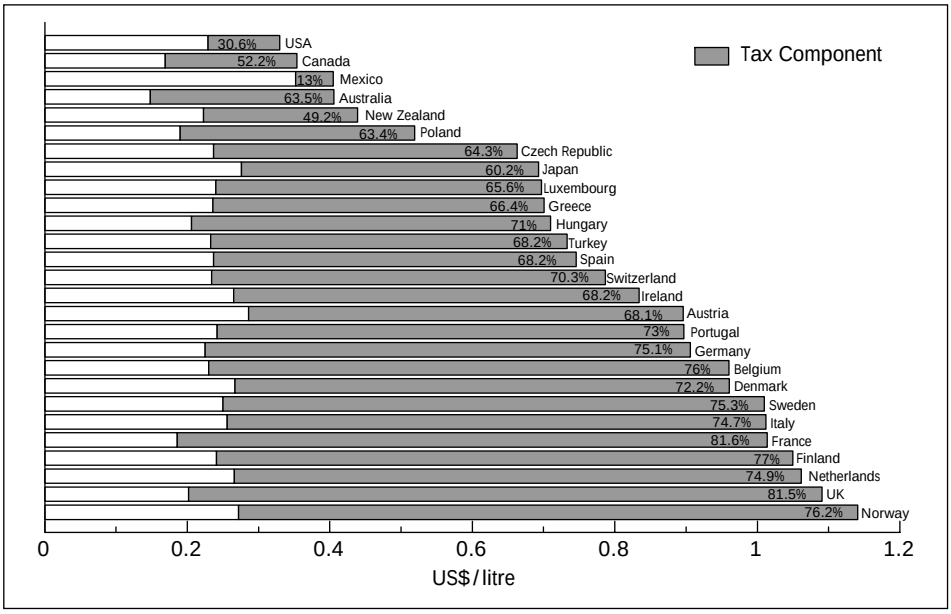
	*Gasoline**	*Auto. Diesel***	*Light Fuel Oil*	*Nat. Gas*	*Electricity*	*LSFO****	*Nat. Gas*
			Households			*Industry*	
Austria	754.7	546.5	167.7	130.8	423.1	50.5	0.0
France	993.3	637.8	183.3	80.9	438.1	20.9	0.0
Germany	856.0	518.9	96.0	87.2	257.5	17.7	26.8
Italy	976.7	726.8	674.9	366.8****	491.6	27.5	18.6
Switzerland	702.1	737.2	30.2	32.7*****	96.3*****	9.7	3.1*****

* Premium (95 RON) unleaded.
** Non-commercial.
*** LSFO: Low Sulphur Fuel Oil.
**** 1996.
***** Not including taxes and charges at local level.

Source: *Energy Prices and Taxes*, IEA/OECD Paris, 1999.

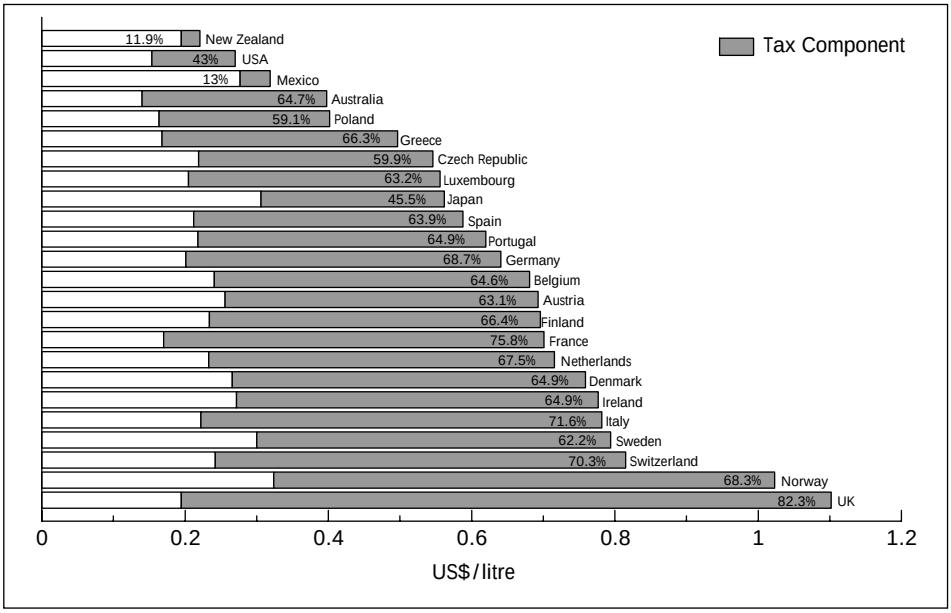
15 Drivers from neighbouring countries come to Switzerland to refuel.

Figure 18
OECD Gasoline Prices and Taxes, Third Quarter 1998



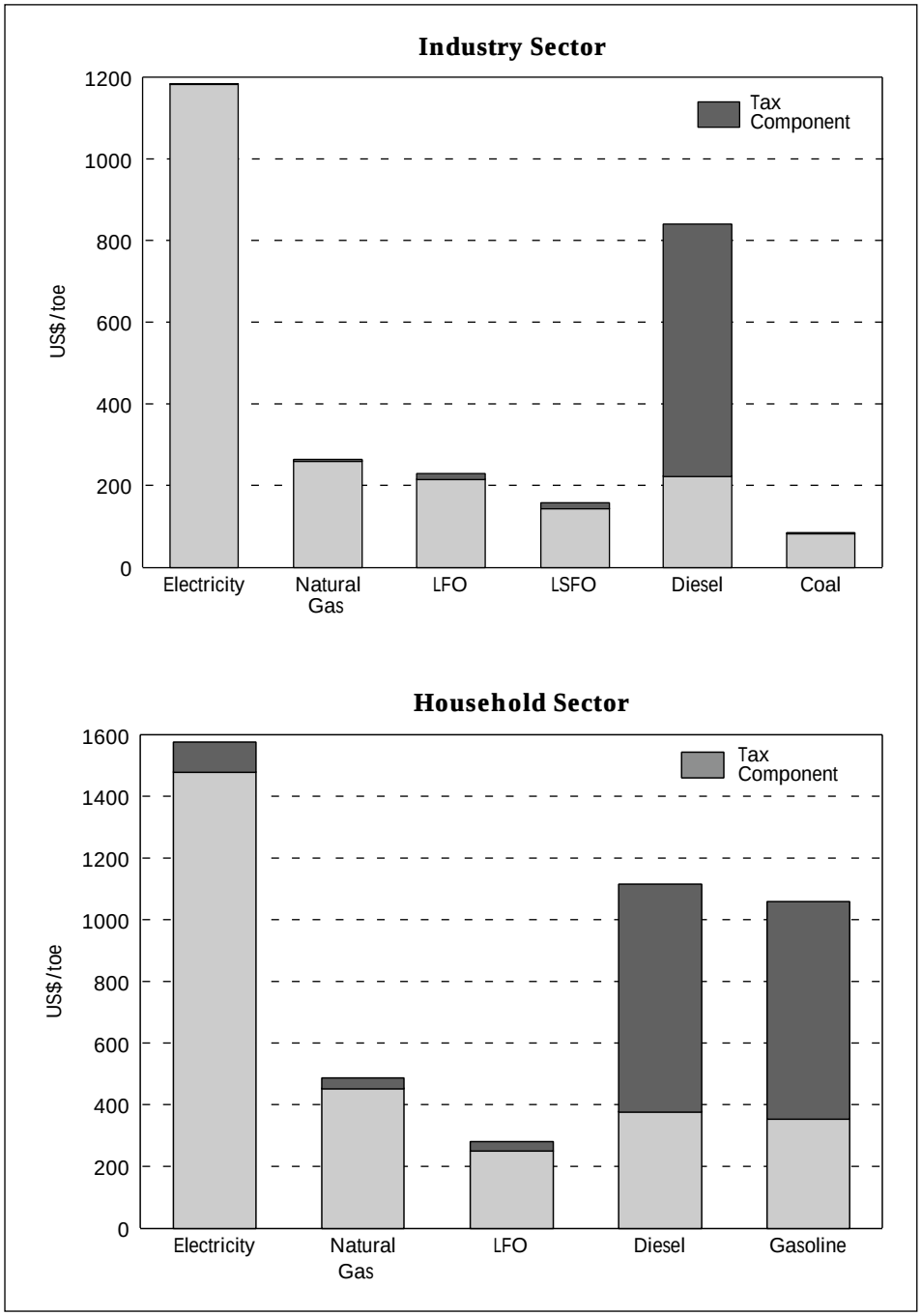
Source: *Energy Prices and Taxes*, IEA/OECD Paris, 1998.

Figure 19
OECD Automotive Diesel Prices and Taxes, Third Quarter 1998



Source: *Energy Prices and Taxes*, IEA/OECD Paris, 1998.

Figure 20
Fuel Prices and Taxes, 1997



Note: LFO : Light Fuel Oil ; LSFO = Low Sulphur Fuel Oil.
Source: *Energy Prices and Taxes*, IEA/OECD Paris, 1999.

Energy Taxation Proposals under Discussion

At the beginning of 1999, there were six proposals aimed at taxing energy/CO_2 (see Table 8): the law on CO_2 taxation, three popular initiatives (i.e. initiatives from the population – see Chapter 3) called "Energy and Environment Initiative", "Solar Initiative" and "Tax on Energy, not Labour", and the two energy tax proposals from the National Council and the Council of States:

- The CO_2 law provides a legal basis to introduce a CO_2 tax by 2004 at the earliest. The tax would be implemented only if other measures such as those included in the energy law, new taxes on transport and the "voluntary measures" described in the Energy 2000 Action Plan are not sufficient. Enterprises would be exempt from this tax if they make voluntary agreements to reduce CO_2 emissions. Although the law has been approved in principle by Parliament, no agreement had been reached at the beginning of 1999 on whether the Government or the Parliament will decide on the introduction of the tax.

- The "Energy and Environment Initiative" aims at introducing an energy tax on fossil fuels, nuclear energy and electricity from hydro plants with a capacity of more than 1 MW, to stabilise energy consumption within eight years and then to reduce it by 1% per year for 25 years. This tax would increase the price of fossil fuels by 3.5% per year and the price of electicity by 2%.

- The "Solar Initiative" concerns a tax on fossil fuels and on nuclear energy increasing progressively from SFr 0.001 to SFr 0.005 per kWh. At least 50% of the fund levied should be dedicated to promote mainly solar energy[16]; the remainder would promote energy efficiency.

- The popular initiative "Tax on Energy, not Labour" aims at introducing an energy tax on the same energies as the "Energy and Environment Initiative" and at using the tax revenue for lowering the costs of social insurance.

- In March 1999, the National Council voted in favour of an energy tax of SFr 0.006 per kWh on oil, natural gas and nuclear electricity; the Council of States however voted in favour of a tax of SFr 0.002 per kWh (see Table 9). Both proposals aim to promote renewable energies and energy efficiency. In the case of the National Council, the earmarking should be for 20 to 25 years, and in the case of the Council of States, it should be for 10 to 15 years. Both proposals also aim to support the renewal of existing hydro plants. An agreement is expected to be reached in 1999.

16 Some biomass is also included.

Table 8

Overview of Energy Taxation Proposals

	Popular initiative: Energy/Environment	*Popular initiative: Tax on Energy, not Labour*	*Popular initiative: Solar Initiative*	*National Council (1998)*	*Council of States (1999, Commission)*	*CO_2 Law*
Legislation	Constitutional amendment	Constitutional amendment	Constitutional amendment	Decree on energy tax (law)	Constitutional amendment and decree (law)	Law
Goals	Stabilisation of consumption of non-renewable energy within 8 years, then reduction by av. of 1% p.a. over 25 years	Reduction of environmental pollution Financing of lowering of retirement age, reduction of compulsory supplementary wage costs	Promotion of use of solar energy and energy efficiency	Improvement of quality of the environment through use of renewables and greater energy efficiency Renewables to provide at least 50% of national energy supply Energy yield to be greater than energy loss	Energy tax as part of the energy and environmental protection policies, reduction of compulsory supplementary wage costs Promotion of renewables and energy efficiency	CO_2 reduction by 10% by 2010 versus 1990 (heating fuels by 15%, motor fuels by 5%)
Means	Regulatory energy tax, socially compatible and budget-neutral refund of revenue	Regulatory energy tax, use of revenue for social insurance purposes	Earmarked tax on non-renewables, use of revenue for energy policy purposes	Earmarked tax on non-renewables, use of revenue for energy policy purposes	Regulatory tax on non-renewables, use of revenue for social insurance purposes and for energy policy purposes to some extent for a specified period (transitory regulation for earmarked law)	Voluntary measures, govt. measures, secondary CO_2 tax (not before 2004 if introduction proves necessary)
Taxable items	– Fossil fuels – Nuclear energy – Electricity from hydropower plants > 1 MW	– Fossil fuels – Nuclear energy – Electricity from hydropower plants > 1 MW	– Fossil fuels – Nuclear energy	– Fossil fuels – Nuclear energy	– Fossil fuels – Nuclear energy	CO_2 emissions from fossil fuels
Tax rate	As per model calculation: annual increase by 3.5% for fossil fuels, 2% for electricity	open	Step-by-step introduction up to 0.5 cents/kWh in 5 years	Step-by-step introduction up to 0.6 cents/kWh in 6 years	open	– max. SFr 210/t CO_2 (motor fuels) – max. SFr 30/t CO_2 (heating fuel)
Duration of levy	For stabilisation and reduction of consumption: 33 years, then open	open	25 years	25 years or until goals have been achieved (see above)	Regulatory tax: open (levy from 2004 at the latest); Earmarked tax: levy 10-15 years (from 2001)	open (earliest 2004 if introduction proves necessary)

Table 8 (continued)

	Popular initiative: Energy/Environment	*Popular initiative: Tax on Energy, not Labour*	*Popular initiative: Solar Initiative*	*National Council (1998)*	*Council of States (1999, Commission)*	*CO_2 Law*
Revenue (gross)	– 2010: approx. SFr 3.8 bn p.a. – 2030: approx. SFr 14.7 bn p.a.	open	approx. SFr 0.9 bn p.a.	approx. SFr 1 bn p.a.	Regulatory tax: SFr 2.5-3 bn p.a. Earmarked tax: SFr 0.32-0.48 bn p.a.	– max. SFr 2.5 bn p.a. (motor fuels) – max. SFr 0.5 bn p.a. (heating fuels)
Use	Full distribution to the economy (according to wages on which pension funds are levied) and the population (per capita)	– Financing of lowering of retirement age – Reduction of contributions to compulsory social insurances	– Promotion of solar energy (at least 50% of tax revenue) – Promotion of efficient use of energy	At least 25% each of revenue for: – Promotion of solar, wood, biomass, wind energy – Promotion of improvements in energy efficiency of existing installations and buildings, energy processes, promotion of heat pumps, co-generation, geothermal energy, etc. – Preservation and upgrading of existing hydroelectric power plants	Easing of supplementary wage costs, and partially (at least 25% each of revenue) for the following purposes as per interim provisions (SFr 320-450 m p.a. on average): – Promotion of use of domestic renewables (esp. solar power, wood) – Preservation and upgrading of existing hydroelectric power plants – Promotion of efficient use of energy	Full distribution to the economy (according to wages on which pension funds are levied) and the population (per capita)
Max. level of promotion	—	—	open	Not more than 60% of countable costs	open	—
Duration of use of funds	open	—	open	25 years, subject to achievement of goals (see above)	10-15 years for promotion of purposes mentioned above	
Special regulations, exceptions for companies	Fed. Gov. may issue certain special regulations for energy-intensive companies. Model calculation: Additional burden not to be more than 1% of gross production value	Special regulations possible in cases of hardship	Fed. Gov. may issue special regulations for energy-intensive companies	– Energy intensity > 2%, tax rate reduction max. 80% – Additional compensation	Special regulations for production processes	Release from tax obligation through commitment to voluntary agreement (possible for energy-intensive companies if additional burden more than 1%)

Source: SFOE, February 1999.

Table 9

Price Increases Entailed by the New Tax Proposals of the National Council and the Council of States

Fuel	*Price Increase (in %)*	
	National Council	*Council of States*
Electricity (average)	1.4	0.5
Gasoline	4.5	1.5
Diesel	4.8	1.6
Light Fuel Oil	20.4	7.0
Natural Gas for Households	10.9	3.6
Natural Gas for Industries	30.0	10.0
Coal	66.9	23.0

Sources: National Council and Council of States.

The energy tax proposals have the following common features:

- Fossil fuels and nuclear energy are taxed (in the energy/environment initiative, electricity from hydropower plants of more than 1 MW is also taxed).
- The levies are either redistributed to the economy by lowering labour or social charges or earmarked to promote energy efficiency and renewables.
- There are exemptions for energy-intensive enterprises.

In October 1998, the Swiss Government announced its support for an energy tax earmarked for funding energy efficiency and renewables, as a transition to an ecological tax.

CRITIQUE

The Energy 2000 Action Plan: General Remarks

The Energy 2000 Action Plan has been a vital instrument in Switzerland to promote dialogue among all the parties involved and to mobilise public resources, both institutional and fiscal, at federal, cantonal and municipal levels. It has also served as a very effective instrument to raise public awareness about the energy situation.

Now that the plan is coming close to its end, it is very important to use the assessments of its achievements to design the most cost-effective action plan beyond 2000. One of the main aspects of the Energy 2000 Action Plan is the assessment of the cost–effectiveness of the measures implemented. The results of these studies should be valuable in formulating a new energy plan for the future. The assessment of the cost–effectiveness of these measures should also be valuable in determining the optimal funding needed to carry out these measures efficiently.

These results should be reflected in the initiative to prepare and implement another action plan for the period beyond 2000. The initiative recognises that energy policies such as improving efficiency and encouraging renewables take a long time to produce results, because of factors such as the low rate of capital stock turnover. These measures need continuity. "Stop and go" policies should be avoided as they may lead to a waste of resources and end up with poor results.

A comprehensive energy policy is also needed to address additional goals which emerged during this decade. The most important example is the new commitment to reduce CO_2 emissions. Switzerland has both a low level of CO_2 emissions in relation to its economic output and a commitment to reduce them by 2008-2012, which calls for increased efforts to reach the target[17]. In Switzerland, the cantons have an important role in energy policy. To meet the CO_2 reduction target, cantons must carry out their mission. An energy action plan beyond 2000 based on a realistic assessment of the results achieved so far is vital as a basis for consolidated efforts.

In most cases, conflict-solving groups have functioned as a useful tool to disseminate information, reach agreement between different parties and adopt measures which may be better accepted and implemented in the long run. This system could continue to function as a good way of achieving consensus on the new action plan beyond 2000. The Government should continue to enhance public awareness by providing relevant information on energy trends and the cost–effectiveness of policy measures.

Energy Efficiency

The Swiss Government has taken several initiatives to improve energy efficiency, including some creative measures in the transport sector. Information given to the public is also well appreciated.

However, the macroeconomic effects of these measures are not very clear. Between 1990 and 1997, the slowing-down in electricity consumption as well as the stabilisation in CO_2 emissions were mainly achieved because of economic stagnation (see Chapter 3). Energy intensity increased slightly although the Plan

17 Reduction in CO_2 emissions will also depend on decisions taken regarding electricity generation (see Chapter 6).

forecast a substantial decrease. Lower than expected funding of the Energy 2000 Action Plan and lower private investments due to economic stagnation may have affected the improvements in energy efficiency. In spite of economic stagnation, consumption of fossil fuels has also continued to increase.

With regard to the increase in energy consumption in the residential/commercial sector, the Federal Government points out the effects of the 4.6% increase in population between 1990 and 1997. Regarding consumption in the industrial sector, the Federal Government explains the increase in energy intensity by the fact that in a period of industrial stagnation, industries use almost the same amount of energy for reduced production.

A deeper understanding of the trend in Swiss energy consumption in relation to GDP would be useful in assessing the energy efficiency policies. The trends in energy consumption of energy-related services versus GDP (see Figures 12, 13 and 14 in Chapter 3), which show that consumption continued to increase during economic stagnation, should be a useful basis for analysis and discussion.

The effectiveness of voluntary measures, on which the Swiss Government puts special emphasis, has not yet been fully demonstrated and could be improved with the right incentives, as stated in several assessments. In particular, the assessment of measures directed towards small and medium enterprises showed their very low cost–effectiveness. Whether funds should be redirected to other areas or whether more effective incentives should be created in this area should be considered. As a first step, energy audits together with voluntary measures could be used. The Swiss Government also foresees establishment of more binding measures. Reform of energy taxation in order to better internalise the environmental costs of using energy would send the right price signal to consumers and thus contribute to making voluntary measures more effective.

Regulatory measures have shown their cost–effectiveness and compare favourably with voluntary measures. They should therefore be encouraged. Since many of the regulatory measures, such as building codes, are the under cantons' responsibility, co-operation with the cantons is vital in this area.

Because of the large number of households who rent their housing, building codes are effective in increasing energy efficiency in residential buildings. Landlords on their own have less incentive to invest in energy savings and "voluntary measures" are difficult to implement in the housing sector. Assessments have shown the cost–effectiveness of such regulations together with individual metering for heating and hot water. The Swiss Government should continue to co-operate with the cantons to improve building codes on energy efficiency for both new and old buildings (when they are retrofitted). Buildings should be audited when they are rented or sold and for the use of individual metering. The Swiss Government could use the annual funding to the cantons allowed by the 1998 Energy Law to reward cantons which have made progress in this area.

The introduction of competition in the gas and electricity sectors, leading to a decrease in prices for final consumers, should not threaten efforts to increase

energy efficiency. Taxes on fossil fuels could be increased to reflect their negative externalities. Increased efforts to improve efficiency standards in buildings and to expand individual metering should also contribute to energy savings.

Progress has been made in the energy efficiency of appliances and office equipment on a voluntary basis. The Swiss Government has considered more binding measures to accelerate the progress. Efficient labelling is necessary to inform consumers about improvements in energy efficiency and could be applied to more appliances and office equipment.

In the transport sector, the Swiss Government has taken original measures, such as promoting businesses and encouraging local authorities which contribute to energy efficiency. In addition, the decision to put greater emphasis on the promotion of public transport is welcome, after years of investments focused on roads. To ensure that the plans for public transport are realised, long-term financing should be made available. The plan to use revenue from the new tax on trucks for railway development may help such investments, as long as the tax level is not so high that trucks would avoid driving through Switzerland[18]. The effectiveness of energy efficiency policies in the transport sector could also be enhanced by more co-operation between the Swiss Government and the cantons and between administrations involved in energy policies and those involved in transport policies. Repealing the 28 tonne limit for trucks could improve the energy efficiency of road transport as it would allow transport of the same amount of goods with larger trucks and less fuel. On the other hand, this repeal might weaken the competitiveness of rail freight if the heavy goods vehicle tax does not make up for the decrease in costs of road transport.

Experiences gained from the Federal Investment Programme should be used for the other energy policy measures. Thus, the Swiss Government could consider another round of policy measures to improve energy efficiency in co-operation with the cantons while upgrading the technological level of these measures. Care should be taken to avoid free riders[19] and to co-ordinate the plan with the other energy policy measures.

Renewables

The Swiss Government and the cantons have put strong emphasis on the promotion of non-hydro renewables by direct subsidies and indirect measures. However, the supply of renewables is not likely to meet all the targets set by the Energy 2000 Action Plan. The reasons may be linked to lower funding than planned. There is also a question whether policy decisions in this area fully reflect the cost-effectiveness of the measures.

18 If this happens, it may have a negative impact on overall CO_2 and other pollutant emissions by increasing the driving distance of trucks.

19 Avoiding free riders means avoiding support to projects which would have been carried out anyway, even in the absence of this support.

Assessment of the measures to promote non-hydro renewables indicates that their average cost-effectiveness does not compare favourably with most of the measures to improve energy efficiency. There are also large differences in the cost-effectiveness of the measures to promote different types of renewables. In the new competitive energy markets, the best way to achieve increased energy production from renewables and make it sustainable in the long term is to ensure that their total cost decreases to a level which makes them competitive. Policy measures should encourage competition among renewables in order to favour the most cost-effective ones.

The price utilities have to pay for electricity from renewables has been set at a high level (SFr 0.16/kWh) which corresponds to the long-term marginal cost of supply as calculated by the SFOE. The 1998 Energy Law states that a compensatory fund can be created by the cantons to reduce the burden put on utilities which have to support renewables (see Chapter 6). In spite of this measure, there may still be an uneven playing field for electricity suppliers. In the context of the introduction of competition in the electricity market, it should be ensured that support for renewables through high pay-back tariffs does not distort competition in favour of those utilities which do not pay for renewables. One option would be to oblige the national grid company, instead of individual utilities, to purchase electricity from non-hydro renewables.

Initiatives by the utilities to use "green pricing" for renewables are valuable, as they promote renewables through consumer choice. "Green pricing" is also a way of making prices of electricity from renewables more transparent. Such marketing of renewables can encourage utilities to reduce the costs of electricity generation from renewables in order to reduce prices and attract more clients. The Swiss Government and the cantons can promote these developments by disseminating accurate information about them.

Energy Taxation

New energy taxes are under serious consideration in Switzerland. Sensible energy tax reform would contribute to energy efficiency and favour the environment. Setting tax levels to better internalise external costs, including environmental costs, would send the right price signals to energy consumers and suppliers, allowing them to take right decisions on fuel choice and investments to increase energy savings. Various improvements in the present tax system are possible.

A particular example is light fuel oil for households, which is favoured by lower taxation than on natural gas. The light fuel oil price is the lowest of all IEA countries (for industry, the price is the lowest in IEA Europe) mainly because of low taxation. On the other hand, natural gas is burdened by several charges at canton and municipal level (see the section on gas in Chapter 5). Increasing taxes on light fuel oil to reflect its CO_2 emissions and other externalities would enhance efforts to improve energy efficiency in buildings.

Natural gas and electricity rent is captured by several charges and taxes at canton and municipal level (see Chapter 6). Local taxes and charges on gas and electricity

should be made transparent and the tax on the use of water should be set at a level to ensure the optimal use of this natural resource.

Revenues from taxes on gasoline and automotive diesel do not internalise the full cost of car use, according to the calculation made for the DETEC. In addition, authorisation for trucks of more than 28 tonnes could increase damage to roads. While taxes on fuels are not a perfect substitute for road pricing, increases in gasoline taxes to a level comparable to neighbouring countries would eliminate "gasoline tourism". These taxes would send a price signal to consumers which would promote efficiency and also help the Swiss Government in its policy of promoting voluntary measures in favour of public transport. These increases would supplement the reform of road pricing for trucks.

The present proposals on energy taxation provide a good opportunity to rectify some of the problems in energy taxation such as mentioned above. In considering the various proposals, assessments should be made of each proposal's capacity to better reflect negative externalities.

Public funding and the choice of projects to be funded should be determined according to cost-effectiveness, using assessments of past policies rather than earmarking a specific share of tax revenue. In this context, the cost-effectiveness of the "Solar Initiative", which proposes earmarking 50% of the tax revenue to finance mainly the promotion of solar energy, should be questioned. In Switzerland, many other energy policies would be more cost-effective than many solar energy projects.

There are also proposals to earmark part of the revenue from taxes to compensate hydro plants for stranded costs, as well as for their maintenance and retrofitting. As stated in Chapter 6, the Swiss Government or an independent body should carefully assess the stranded costs calculated by the companies so that eventual payments do not distort competition between utilities. In the same way, the competitiveness of Swiss hydro plants should be ensured by decreasing local taxes and charges rather than by creating a new subsidy through the financing of their maintenance or retrofitting. Giving subsidies to hydro power while maintaining taxes and charges would be ineffective and expensive.

RECOMMENDATIONS

The Swiss Government should:

The Energy 2000 Action Plan

- ☐ Strengthen public information on the cost–effectiveness of policy measures in the Plan. Cost-effectiveness should be assessed, taking into consideration economic trends.

☐ Review the process of setting voluntary measures to identify whether and how it could be improved and consider setting more binding measures where possible.

☐ Establish a new energy action plan beyond 2000, based on a comprehensive assessment of the Energy 2000 Action Plan. The new plan should be adapted to the development of competition in the energy market.

☐ Further strengthen co-operation between the cantons and the Swiss Government. Promote co-operation among cantons.

Energy Efficiency

☐ Expand labelling for energy efficiency of domestic appliances and office equipment.

☐ Where needed, encourage cantons to adopt more stringent building codes and to make individual metering for heating and hot water compulsory.

☐ Develop public transportation systems and increase their use. Strengthen co-operation between administrations involved in energy policy and those involved in transport policy.

Renewables

☐ Focus on the most cost-effective measures to promote non-hydro renewables and ensure that these measures are designed to increase their competitiveness. Adapt the current system of promoting electricity from non-hydro renewables to make it compatible with the introduction of competition in the electricity sector.

☐ Ensure that the public receives accurate information about renewable energy available on the market.

Energy Taxation

☐ Make local taxes and charges on electricity and natural gas transparent.

☐ Better internalise the external costs of using energy, including environmental costs, through taxation or through more focused approaches, such as road pricing.

5

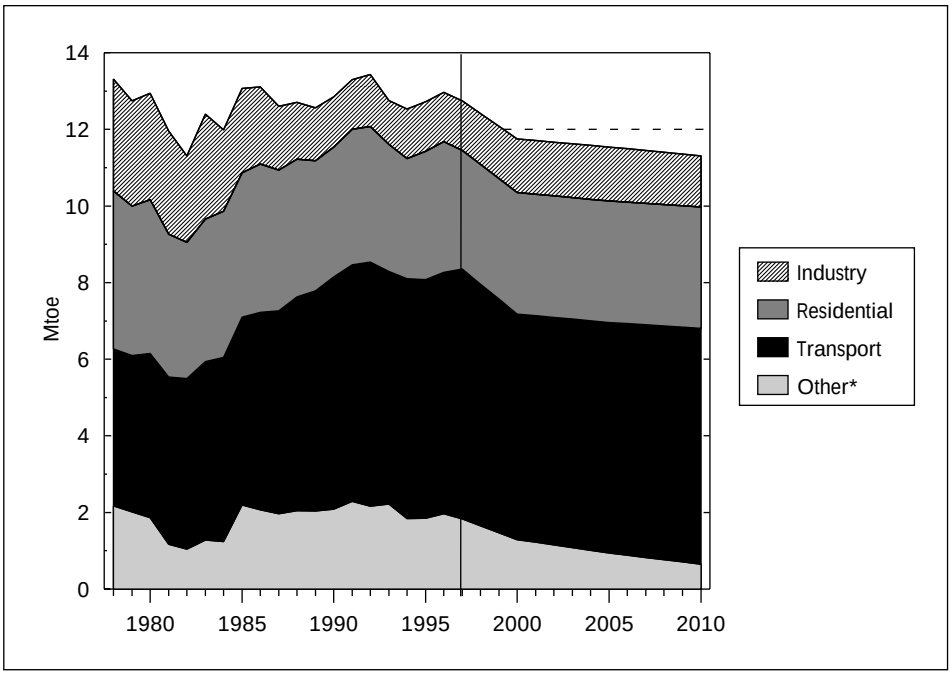
FOSSIL FUELS

OIL

Oil Supply

Total supply of oil was 13.4 Mtoe in 1997, very slightly below the level of 1990. The share of oil in TPES was 51.1%, a substantial decline from the level of 1973 (77.4%). It is however above IEA's Europe average. Oil use for electricity generation is marginal and most of the oil is used in the transport sector, where consumption is increasing. In recent years, oil consumption in the industry sector has stabilised. In the residential/commercial sector, it has been reduced, mainly because of the increase in natural gas consumption and, to a lesser extent, of the increase in electrical heating (see Figures 21 and 22).

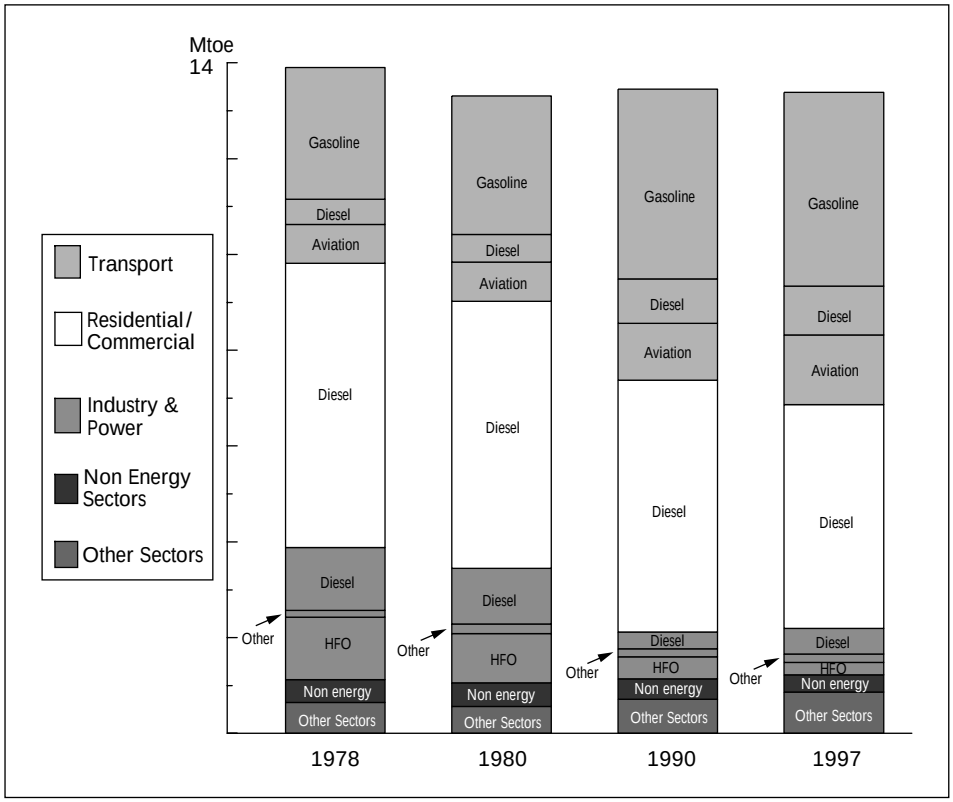
Figure 21
Final Consumption of Oil by Sector, 1978-2010



* Includes commercial, public service and agricultural sectors.

Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 1998, and country submission.

Figure 22
Oil Products Consumption, 1978-1997



Note: HFO = Heavy Fuel Oil.

Source: *Energy Balances of OECD Countries*, IEA/OECD Paris, 1998.

The use of automotive diesel increased by more than 11% between 1990 and 1997 but remained at a low level in comparison with gasoline consumption, which increased by about 2%. The share of unleaded gasoline in total gasoline consumption increased from 51% in 1990 to 91% in 1997. Lower taxes on gasoline than in neighbouring countries have led to lower prices and to "gasoline tourism"[20], which is estimated by the oil industry to account for around 10-15% of total gasoline consumption. Higher taxes on diesel in Switzerland than in neighbouring countries have led to higher prices and are a strong incentive for trucks and diesel cars to refuel outside the country.

Switzerland has no domestic production of fossil fuels and thus is totally dependent on imports. Exploration activities stopped in 1994. In 1997, an agreement was concluded between SEAG, a Swiss company involved in oil and gas exploration,

20 Drivers from neighbouring countries, especially Italy, come to Switzerland to refuel.

Aktiengesellschaft für Schweizerisches Erdöl (Germany) and the US company Anschutz Overseas, to explore further. Depending on the results, SEAG and its partners will decide whether to continue operations.

According to the forecasts made by independent institutes for the Swiss Federal Office of Energy (SFOE), total oil consumption is expected to decrease. The Oil Industry Association forecasts that oil will continue to lose shares in the heat market to natural gas and electricity, but it expects oil sales to grow in the combined heat and power (CHP) market.

Trade and Transport

In 1997, about 37% of oil imports were crude oil and 63% oil products. Crude oil imports are mainly light and low sulphur qualities. In 1997, Nigeria, Libya and Algeria made up 89% of total crude oil imports (see Table 10). Imports from Nigeria have increased substantially in recent years. Products imports are mainly middle distillates (52% of oil products imports) and gasoline (31.5%). Switzerland's two refineries export about 0.5 Mt/year of heavy fuel oil (about two-thirds of their HFO domestic production). Dependence on oil products imports is high, accounting for about 60% of total oil consumption.

Table 10
Crude Oil and Oil Products Imports, 1997*
(million tonnes)

Crude Oil				*Oil Products*				
Nigeria	Libya	Algeria	Other	Netherlands	Germany	Belgium	France	Other
2 064	1 307	946	540	2 117	1 951	1 630	1 612	914

* Provisional.

Source: *Oil Information*, IEA/OECD Paris, 1998.

Switzerland has two crude oil pipelines and one product pipeline, which transported about 38% of total oil supply in 1997:

- The Rhône crude oil pipeline goes to the refinery of Collombey from Italy. The main owners are SNAM (48.9%), Union Bank of Switzerland (UBS, 28.6%) and Crédit Suisse (CS, 14.3%).

- The crude oil pipeline of the Jura Neuchâtelois goes to the Cressier refinery from France. It is owned 49% by Shell, 20% by FMN (the largest electricity company of the Canton of Neuchâtel), 15.5% by CS and 15.5% by UBS.

- The oil product pipeline SAPPRO (Société anonyme du pipeline à produits pétroliers sur le territoire genevois) goes to Vernier in the Canton of Geneva from France. Its main shareholders are BP, ESSO and Shell (13.5% each).

- The crude oil CEL pipeline from Geneva to Ingolstadt in Germany was closed in February 1997 because it was not economical[21].

In 1998, 29.3% of oil was transported by barges on the Rhine river, followed by the railways (26.6%) and trucks (6.1%, mainly from Italy).

Oil Industry Structure

There are two refineries in Switzerland[22]: Cressier, owned by Shell, and Collombey, owned by Tamoil (see Table 11). In 1993, desulphurisation plants were installed at the two refineries to comply with the lower limits on the sulphur content of diesel and heavy fuel oil. At Collombey, investments in dewaxing facilities allowed lower output of heavy fuel oil and production of unleaded and high octane gasoline. In 1998, the utlisation ratio was 92.5% in Cressier and 83.4% in Collombey. Shell intended to sell its refinery in 1996 because of the lack of profitability of the refinery but in 1998, it withdrew its decision because there was no suitable buyer.

Table 11
Oil Refineries in Switzerland, 1997
(Mt/year)

	At. Dist.	*Vacuum Dist.*	*Cracking*	*Visbreaking*	*Cat. Reforming*	*HDS/HT*	*Isomerisation*
Cressier	2.5	0.0	0.0	0.0	0.5	1.0	0.2
Collombey	5.7	1.3	1.2	0.5	1.1	3.8	0.4
Total	8.2	1.3	1.2	0.5	1.6	4.8	0.6

Source: IEA Database.

Oil products distribution is quite concentrated, with Shell having a market share of 28.9% in 1997, followed by BP (17.7%) and ESSO (16.4%). Tamoil has a market share of around 15-20%. There are 20 automotive fuel distribution companies. AVIA is the largest distributor (576 service stations in 1997), followed by Shell (546) and BP (393). In 1997, there were 3 655 service stations. Over the past two decades, their number

21 Since the closure of this pipeline, the share of oil transported by pipeline decreased substantially in favour of rail transport.

22 In addition, the refinery of Rheintal owned by Agip re-treats waste oil (in 1997, 44 000 tonnes of recycled middle distillates were re-treated).

has decreased while sales of gasoline per station have increased (from 0.4 million litres per station in 1974 to 1.4 million in 1997). To attract clients, service stations are developing convenience stores. In 1997, their number was 1 073 (30% of the total).

Regulations and Prices

According to the Federal Law on Energy Transport by Pipelines, a concession for the building and operation of transboundary pipelines can be granted only to Swiss companies or to joint ventures which are not unilaterally dominated by foreign investors. This provision is subject to revision by the Parliament and is expected to be abolished.

In January 1997, import taxes on oil products[23] were replaced by the excise tax. Because of the low taxes (see Chapter 4), the price of light fuel oil (LFO) for households is the lowest of all IEA countries, that of LFO for industry is the lowest of all IEA European countries and gasoline prices are lower than in neighbouring countries. In contrast, the prices of automotive diesel are higher than in neighbouring countries because of higher taxes (see Table 12).

Table 12
Oil Products Prices in Switzerland and in Other Selected IEA Countries, 1997
(US$/toe)

	*Automotive Diesel**	*Unleaded Gasoline***	*HFO Industry****	*LFO Industry*	*LFO Households*
Austria	918.0	1 162.2	237.3	259.4	413.7
France	909.8	1 267.6	151.2	329.7	465.0
Germany	822.9	1 194.1	135.9	284.3	327.9
Italy	1 067.9	1 355.6	168.7	815.8	972.8
Switzerland	1 115.8	1 058.2	153.6	228.8	280.3
OECD Europe	964.5	1 196.4	n.a.	356.8	435.3

* Non-commercial use.
** 95 RON.
*** Low Sulphur.

Source: *Energy Prices and Taxes*, IEA/OECD Paris, 1998.

23 Imported products were subject to duties equivalent to excise duties paid by domestic refiners when they delivered products to the domestic market.

Emergency Stocks

Switzerland's compulsory oil stocks policy, which dates prior to the International Energy Programme (IEP) Agreement, is based on the Federal Law on National Economic Supply (1982) as well as on the Ordinance on the Main Principles of Stockpiling (1983) and the Ordinance on Establishing Compulsory Stocks on Fuel Oils and Transport Fuels (1983).

All companies importing oil in quantities greater than 3 000 m^3/year into Switzerland are obliged to apply for an import licence which is conditional upon signing a contract with the Federal Office for National Economic Supply, by which the importer commits itself to hold an amount of stocks in relation to its domestic market share. Although compulsory stocks remain in the ownership of the oil importers, they are under the control of the Swiss authorities who can dispose of them, should the need arise.

Stocks have been maintained well above the 90-day IEA obligation. On 1st January 1998, stocks represented some 171 days of net imports.

COAL

Total coal supply was 0.11 Mtoe in 1997, less than one-third of coal consumption in 1990. Coal supply amounted to 0.4% of TPES. Switzerland has no indigenous production of coal and thus is totally dependent on imports.

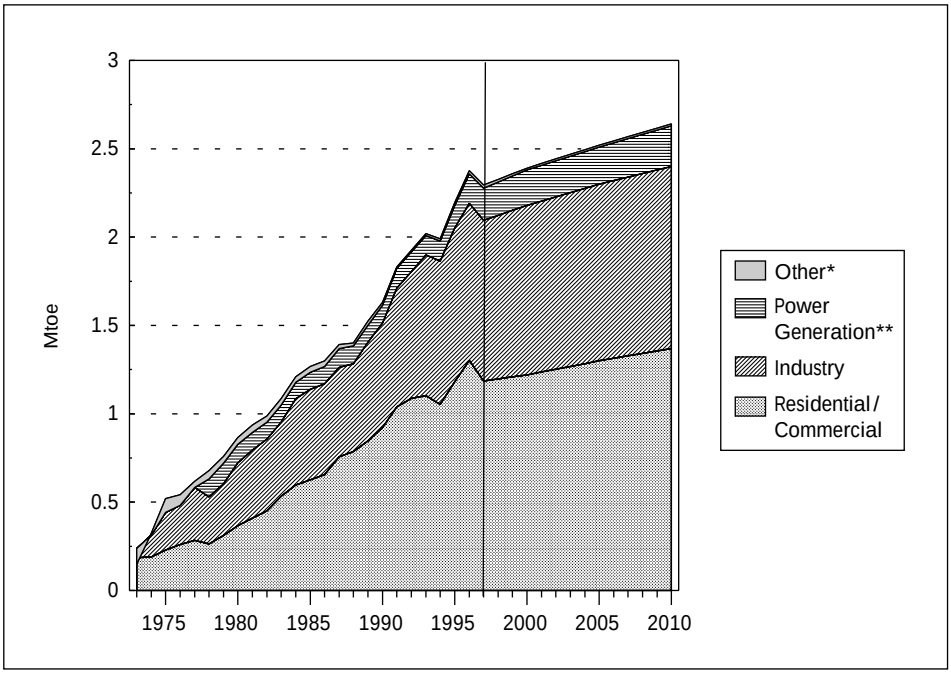
Coal is not used for electricity generation and is mostly consumed in the cement industry. This industry has committed itself to replace coal by waste-derived fuels for 75% of its energy consumption. As a consequence, total coal consumption is expected to decrease further.

NATURAL GAS

Market Trends

In 1997, natural gas accounted for 2.3 Mtoe, i.e. 8.7% of total energy supply. Supply has increased at a rate of more than 12% per year since 1973 (see Figure 23). However, the share of natural gas in total energy supply and total final consumption of energy is still lower than the average of IEA Members in Europe. Natural gas is mostly used in final consumption (2.1 Mtoe in 1997), and to a small degree in electricity generation. Natural gas accounted for 0.9 Mtoe in the industry sector (22.1% of total energy consumption in this sector) and 1.2 Mtoe in the residential/commercial sector (12.6% of total energy consumption in this sector), where consumption has increased at the fastest pace. More than 50% of natural gas is used for heating purposes. In 1997, natural gas had a 22% share in the residential heat market (16% in 1990).

Figure 23
Natural Gas Supply by Sector, 1973-2010



* Includes other transformation and energy consumption and transport.

** Includes district heating.

Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 1998, and country submission.

Switzerland no longer has domestic gas production and has been totally dependent on imports since 1994[24]. According to supply contracts and the Swiss Association of Gas Utilities, natural gas supply sources in 1997 were: Germany 51.7%, the Netherlands 20.9%, Russia 13%, France 12.9%, Italy 1.5%[25]. Some of the gas imported into Switzerland from France and all of the gas imported into Switzerland from Germany originate from Russia.

The forecasts made by independent consultants for the SFOE indicate that the increase in gas consumption will slow down. The gas industry plans to continue gaining market shares in Swiss energy consumption, reaching around 20% of total energy supply by 2010 and leading to increased imports. The gas industry expects to expand in the area of co-generation, possibly by replacing nuclear energy.

24 Between 1985 and 1994, a very small amount of natural gas was produced near Lucerne. There are other small gas deposits which are not economically recoverable. On exploration, see the paragraph on oil supply, above.

25 Non specified: 0.9%.

Structure and Organisation of the Natural Gas Industry

About 100 companies are involved in natural gas distribution. The seven largest companies are owned by cantons and municipalities. They supply 50% of gas consumption[26]. An additional 54 companies supply 10%. Distribution companies have monopolies in exclusive areas. The majority of these companies are partially or totally owned by cantons and municipalities. In some cases, the gas distribution company is not separated from the local administration. Most of these companies are also involved in other activities such as water, electricity and heat supply.

Gas transmission pipelines are owned by 11 companies. They are generally owned by local distribution companies. Some of them are privately owned and there are various cross-shareholdings among these companies (see Table 13). They buy the gas from Swissgas (see below) or directly from abroad, and resell it to distribution companies. They also sell some gas directly to final consumers (around 10% of total gas consumption).

Swissgas, a natural gas transport company, is owned by two major Swiss banks, Union Bank of Switzerland (UBS) and Crédit Suisse (CS), the Swiss Natural Gas Industry Association (ASIG) and four non-profit regional (supra-cantonal) companies: Erdgas Ostschweiz AG (EGO), Gasverbund Mittelland of Arlesheim (GVM), Société pour l'approvisionnement et le transport du gaz naturel en Suisse romande (Gaznat) and Erdgas Zentralschweiz of Lucerne (EGZ).

Swissgas is responsible for about 75% of natural gas imports. It sells its gas to the four regional companies and to AIL, a company situated in the Canton of Ticino. GVM, EGO and Gaznat also have supply contracts with foreign companies for their remaining gas imports. All import negotiations are led by Swissgas[27].

26 Basel (14.9% of total sales), Zürich (10.6%), Geneva (6.6%), Lausanne (5.9%), Soleure (5.8%), Berne (3.5%) and Bienne (2.8%). In 1998, Gasverbund Ostschweiz of Zürich was transformed into a stock company (Erdgas Zürich), owned 100% by the municipality of Zürich.

27 In addition, Swissgas is in charge of handling questions of common interest to the natural gas industry, such as supply and infrastructure, and representing and defending the interests of the Swiss gas industry abroad.

Table 13
Shareholding of the Main Gas Transport Companies
(% of total shareholding)

	Gas Industry (Swiss and Other)	*Cantons and Communes*	*Private Industry, Banks and Other*
Swissgas	EGO, GVM, Gaznat, ASIG (16.45% each) EGZ (4.2%)		UBS (20%) CS (10%)
Transitgas	Swissgas (51%) SNAM (46%) Ruhrgas (3%)		
GVM		100%	
EGO		100%	
Gaznat	20%	40%	Aluminium, Cement and Chemical Industry (40%)
EGZ		100%	
GANSA Neuchâtel		90%	Forces motrices neuchâteloises 10%*
AIL (Chiasso-Lugano)		100%	
EBRAG (Trübbach-Chur)		100%	
GWB Bern		100%	
Unigas	60% Gaznat 40% GVM		

* Public company mainly involved in electricity.

Source: Country submission.

Infrastructure

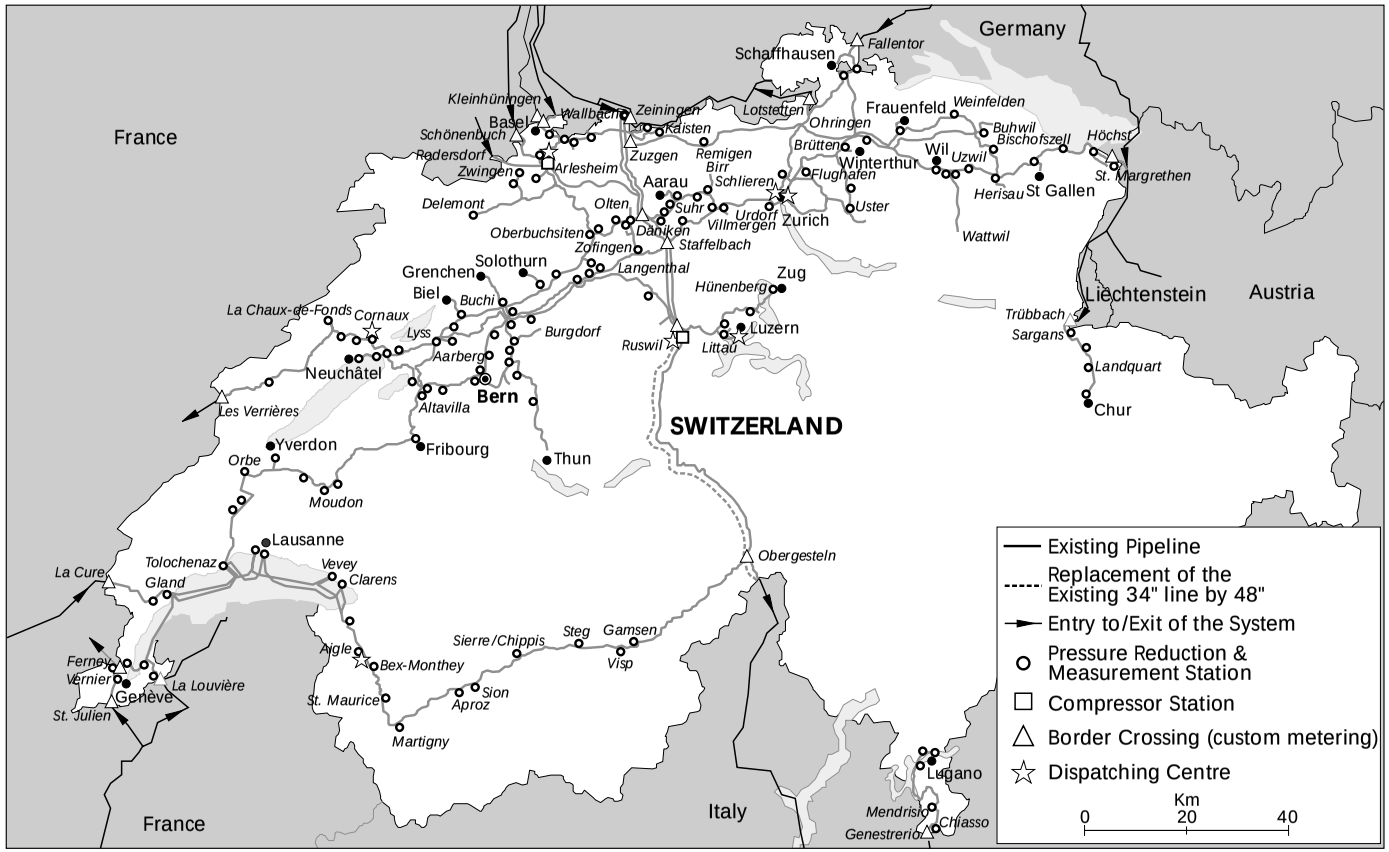
In 1997, the pipeline infrastructure included about 2 000 km of transmission pipelines and 12 500 km of distribution pipelines. About two-thirds of the population live in areas supplied with natural gas. The transmission system is operated by Swissgas and the regional companies, each being responsible for its own part of the network.

There are ten delivery points for natural gas imports (see Figure 24). The most important new development is the work being undertaken by Transitgas[28] and

28 Transitgas transports gas to Italy and imports gas for Swissgas.

Figure 24

Map of the Natural Gas Infrastructure



Source: Swiss Natural Gas Industry Association.

financed by the Italian gas company SNAM to allow Norwegian natural gas to transit Switzerland to Italy. It is expected that in 2001, about 15 bcm of gas, i.e. about five times current Swiss natural gas consumption, will transit Switzerland from Norway to Italy. The gas industry expects that the increase in gas transit will amount to around 1.5% per year as of the beginning of the 21st century. In addition, in 1998 Gaznat completed a new transmission pipeline from Cathoy in France to Vernier near Geneva. In the northwest, Erdgas Ostschweiz AG completed its transmission grid from Zuzgen to Winterthur/Ohringen.

Regulations and Prices

Under the law of 1963, a licence from the Swiss Government is required for the construction and operation of pipelines. The licence has a maximum duration of 50 years and can be renewed.

Like for oil, the federal law stipulates that a concession for construction and operation of transit pipelines can only be granted to Swiss companies or to joint ventures which are not dominated by foreign investors. As mentioned above, this provision is expected to be abolished. Licensing procedures for building pipelines have been streamlined.

There is an obligation for gas distributors to supply gas in their supply area. The law requires the distributor and the transporter to carry gas for third parties under favourable economic and technical conditions, with the third party paying the appropriate fee. However, this provision has never been used.

In most cases, local investments in distribution grids are undertaken by local authorities (cantons or municipalities). Soft loans are also available for the building of the gas grid (federal law on financing investments in mountainous areas). Investments decisions by a local authority are subject to a local referendum when the investment is above a certain amount.

Each distributor sets its own tariff structure and price, based on the structure of its market. However, pricing is mostly done on a netback basis: in industry, gas is priced against heavy fuel oil or light fuel oil, depending on the fuel for which it substitutes. Prices to residential consumers are determined by distribution companies, generally according to the price of light fuel oil, with a premium since natural gas also competes with electricity for cooking. In practice, prices differ between regions since the prices of competing energies, costs and municipal policies differ. In most cases, prices for domestic consumers are subject to approval by local authorities or are set by them. Local authorities also exercise strong influence through their shareholding. Cantons and municipalities may impose extra charges on gas distribution companies. A large number of local gas distribution companies transfer their profits to the municipalities.

The Price Surveillance Authority is in charge of price monitoring in the natural gas sector. Consumers can complain to the Authority. In cases where public authorities approve or set prices, the Surveillance Authority can only issue recommendations, which utilities are not obliged to follow (see also Chapter 6).

The Federal Department for Environment, Transport, Energy and Communication (DETEC) published recommendations on prices and tariffs for grid-based systems in 1989, but an assessment in 1993 showed there had been few improvements. The recommendations included the following:

- Cost-reflective tariffs.
- Fixed price elements should be avoided or reduced as much as possible.
- Rates should differ by customer group only to the extent that costs of supply differ or interruptible contracts are employed.
- Each end-user should be metered and billed individually.

Since 1992-1993, prices for natural gas have decreased steadily, both for households and for industry. However, they remain at a high level in comparison with other IEA European countries (see Figure 25), in particular for industry (see Figure 26). According to ASIG statistics, prices for large industries amounted to SFr 0.027/kWh in 1997. For households, prices are higher than the IEA average (see Figure 26).

In industry, the full price (taxes included) of natural gas is higher than the prices of other fuels (see Table 14). In the household sector, the price of natural gas is higher than light fuel oil (see Table 15). In this sector, natural gas prices are higher than the average for IEA countries in Europe, whereas light fuel oil prices are lower (see Table 12 in section on oil industry).

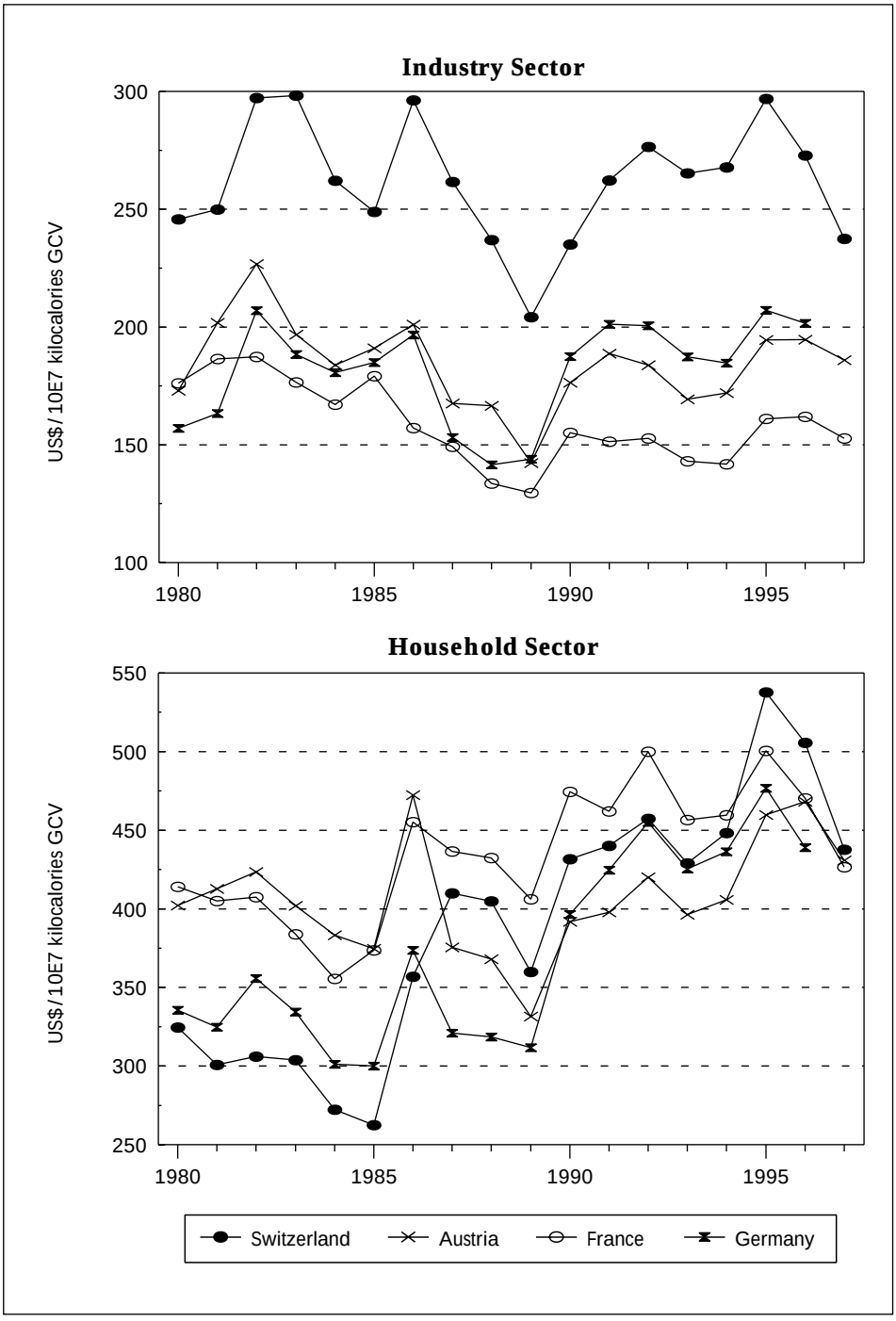
Security of Supply

Swissgas is allowed by law to store gas but no large adequate geological structure has been found. Only local gas storage facilities exist in Switzerland. Some supply contracts are designed to meet seasonal fluctuations in demand. In addition, Gaznat has an agreement with Gaz de France to withdraw a limited amount of gas from the French storage facility of Etrez (northwest of Geneva).

Gas consumption by interruptible consumers amounts to around 80% of total gas consumption by industry. Switch capacity to oil represents about 37% of total gas demand and Switzerland stores heating oil as a backup for interruptible gas supply contracts.

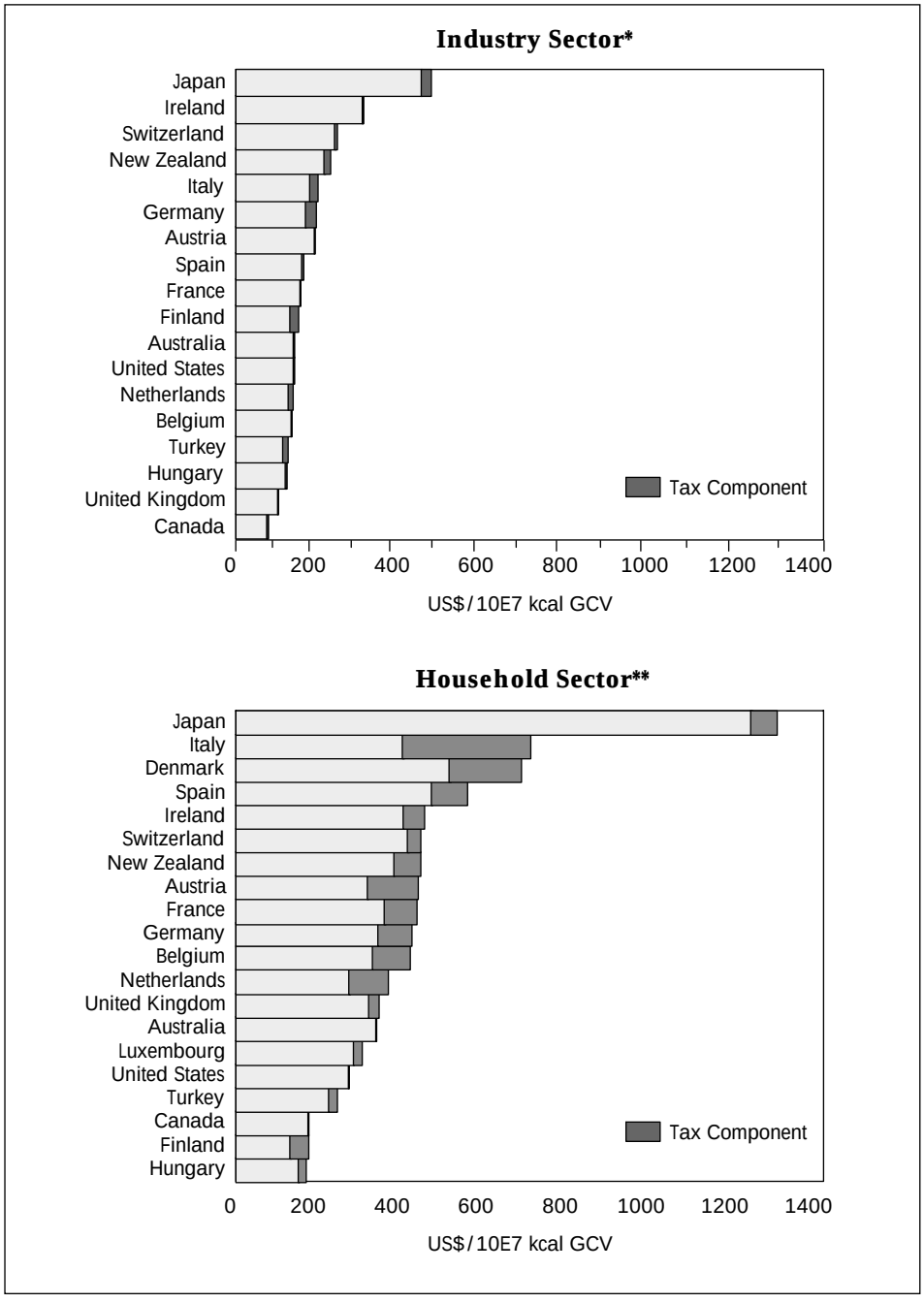
Figure 25

Gas Prices in Switzerland and Other Selected IEA Countries, 1980-1997



Source: *Energy Prices and Taxes*, IEA/OECD Paris, 1998.

Figure 26
Gas Prices in IEA Countries, 1997



* Data not available for Denmark, Greece, Luxembourg, Norway, Portugal and Sweden.
** Data not available for Greece, Norway, Portugal and Sweden.

Source: *Energy Prices and Taxes*, IEA/OECD Paris, 1998.

Table 14
Energy Prices in the Industry Sector, 1996-1997
(SFr/toe)

	Light Fuel Oil		*Low Sulphur Fuel Oil*		*Natural Gas*		*Steam Coal*	
	Incl. Taxes	*Excl. Taxes*	*Incl. Taxes*	*Excl. Taxes*	*Incl. Taxes*	*Excl. Taxes*	*Incl. Taxes*	*Excl. Taxes*
1996	305.6	281.9	221.9	203.5	374.7*	370.2	123.3	120
1997	331.7	312.9	222.7	208.6	382.6*	377.8	122.5	121

*Taxes do not include charges levied at local level.

Source: *Energy Prices and Taxes*, IEA/OECD Paris, 1999.

Table 15
Energy Prices in the Household Sector, 1996-1997
(SFr/toe)

	Light Fuel Oil		*Natural Gas*		*Electricity*	
	Incl. Taxes	*Excl. Taxes*	*Incl. Taxes*	*Excl. Taxes*	*Incl. Taxes*	*Excl. Taxes*
1996	376.6	330.0	694.6*	647.7	2 293.0*	2 152.3
1997	406.4	362.8	705.2*	657.8	2 284.9*	2 145.3

*Taxes do not include charges (and taxes for electricity) levied at local level.

Source: *Energy Prices and Taxes*, IEA/OECD Paris, 1999.

Market Reforms

In February 1997, a report was released on "The Opening of the Gas Market" by a group comprising the Federal Administration, the gas industry and consumer groups. The report recommended reducing prices to revitalise the Swiss economy and make the industry more competitive at international level. The main recommendations of the report were:

- Local monopolies should be eliminated to allow consumers to have a free choice of suppliers. The Swiss gas market should be open to competition when the EU opens its gas market. In this perspective, the gas sector should start to prepare the opening of its market.

- The gas industry should consider the benefits of its "depolitisation" (i.e. separation from political power) and, if possible, increased private ownership. In particular, "hidden profit taxes" in favour of communes should be removed. The industry should focus on business and financing issues to reduce costs.

- Administrative procedures for building infrastructures should be streamlined and speeded up.

- Prices for final consumers should be cost-reflective. Cross-subsidies should be avoided, and prices should be monitored by competition authorities.

- Small consumers should benefit from competition, in particular through price reductions. Public service obligations in favour of small consumers should be maintained.

The gas industry plans to make proposals to the Government on reforms by summer 1999.

CRITIQUE

Oil

Competition in the retail market is increasing although oil supply is still mainly concentrated in the hands of four large suppliers. This has led companies to rationalise distribution in order to cut costs and to develop activities such as sales of non-oil goods to attract clients. Swiss refineries are price takers and had to make large investments to adapt better to growing competition, to environmental regulations and to the structure of the market (i.e. a very small domestic market for heavy fuel oil).

Natural Gas

Switzerland has no indigenous gas production but its gas industry has a well-diversified portfolio of gas imports. In recent years, natural gas consumption has increased rapidly, reducing the share of oil in energy consumption and thus increasing energy diversification and security of energy supply. Switzerland has no natural gas storage depots and needs specific measures for load balancing. For this reason, gas companies have signed storage contracts with neighbouring countries and adapted some gas contracts with suppliers to make up for the annual variation in demand. In addition, the increasing interconnections with the rest of Europe improve security of gas supply. Switzerland will eventually become an important transit country for gas from the North Sea to Italy. Its role as a transit country will increase substantially in the medium term. This will multiply market opportunities and increase security of gas supply.

Further development of the natural gas market would reduce CO_2 emissions to the extent that gas replaces oil products. The share of gas, which is lower than in most other European countries, could be increased by reforms in energy taxation and by addressing pricing and organisational problems of the gas industries.

Average natural gas prices are higher than light fuel oil prices and are also higher than in most other IEA countries. This high average price of gas can be partly explained by high import prices and the cost of building infrastructure. However, this price level is also explained by other factors. Local charges increase prices of natural gas, thus decreasing its competitiveness and slowing down its market penetration. The fact that gas prices are controlled by local governments which own the distribution companies may create conflicts of interest and affect pricing. Local governments have an incentive to set high gas prices in order to maximise revenues. Also, at federal level, taxes on gas for households are comparable to those on light fuel oil. In general, in the other IEA countries, both taxes are higher than in Switzerland and lower for natural gas than for heating oil. Rationalisation of the tax system would favour gas penetration (see Chapter 4).

Other factors have also affected gas penetration. Some distribution companies are not autonomous: profits are often returned to local governments. In some cases, company staff are not separated from local administrations. Many companies are too small to undertake proper investments and some distribution companies have difficulties recovering costs. When local governments make investments, decisions are not always based on commercial grounds.

The Swiss Government is considering the introduction of competition in the natural gas market. Such a decision should allow the gas market to develop in a more efficient manner, with decisions on pricing and investment based on economic criteria. This should lead to a decrease in prices, which would benefit consumers and the economy in general, as mentioned in the 1997 report on "The Opening of the Gas Market". Competition in the natural gas market, together with its development in the European Union, would benefit Switzerland, which is surrounded by EU countries. The creation of a level playing field for all gas industries in Europe would enhance gas trading on a European scale. This would improve energy security and help the environment. The development of competition and reorganisation of the gas industry should be carried out along the lines recommended by the 1997 report and should focus on the issues described below.

Separating gas companies from local administrations and making them separate legal entities should be a first step. The decision, taken after a referendum, to transform the gas distribution company of Zürich into a stock company should serve as an example for the other distribution companies. The city of Zürich expects this reform to improve the management of the company and reduce costs, thereby benefitting consumers and city development.

The corporatisation[29] of all natural gas companies not already privatised, as well as the unbundling of accounts for gas trading (purchases and sales), transmission,

29 Corporatisation of public entreprises means managing companies according to the same rules as private companies, free of political interference in their corporate strategies, investment decisions and daily management.

distribution and non-gas activities, are necessary for effective competition. Ownership and regulatory functions must be clearly separated to ensure fair and adequate regulation and to avoid conflicts of interest. To allow for effective competition, regulation should be unbiased and independent from the parties involved. In addition, the regulator should be endowed with enough powers to develop proper expertise, settle disputes, control tariffs and implement regulatory reforms such as unbundling. The regulator should reveal any anti-competitive practices and its decisions should be enforced.

The probable introduction of competition by the Swiss Government through Third Party Access is a welcome development. Tariffs for access to the grid should be transparent and non-discriminatory. The system should provide the same opportunities and conditions of access to newcomers and incumbents. The introduction of competition may create incentives for cross-subsidies favouring eligible customers over captive customers. Captive customers should be protected against such practices.

Increased competition and corporatisation should improve the management of gas companies. Competition is expected to promote the integration of companies and thus the optimisation of their size, leading to economies of scale and profit-oriented management and investments.

RECOMMENDATIONS

The Swiss Government should:

- ☐ Introduce competition in the natural gas sector as soon as possible.
- ☐ Strongly encourage corporatisation of those gas industries which are not privatised and the unbundling of accounts in order to allow the companies to compete on a level playing field.
- ☐ Establish a regulation to control tariffs and settle disputes in an unbiased manner and ensure that the regulator has enough legal authority and resources to carry out its missions.
- ☐ Introduce Third Party Access to the whole gas grid and make tariffs transparent in order to prevent discrimination between users.

6

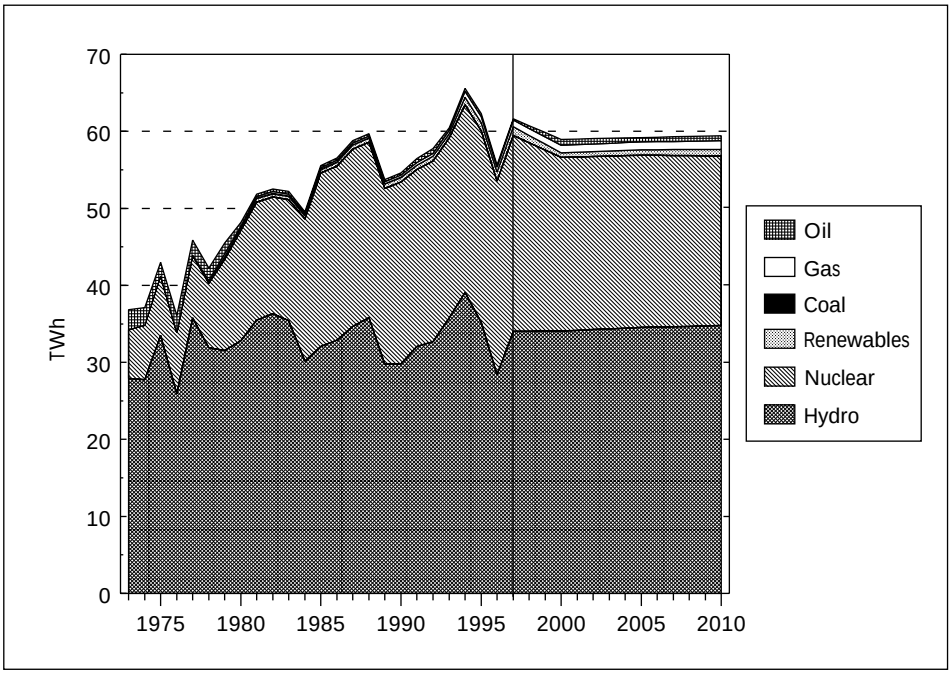
ELECTRICITY

SUPPLY, DEMAND AND TRADE

Supply and Demand

In 1997, electricity generation was 61.6 TWh, a 10.7% increase over 1996, which was a dry year (see Figure 27). Hydro accounted for 55.3% of electricity generation, followed by nuclear energy (41.2%). The mountainous cantons – Glaris, Grisons, Obwald, Schwyz, Ticino, Uri and Valais – supply around 80% of hydro production, including most of peak load. More than 40% of run-of-river power plants are also in mountainous areas.

Figure 27
Electricity Generation by Fuel, 1973-2010



Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 1998, and country submission.

Final electricity consumption decreased in 1993 and 1994. Since then, it has increased at a slower pace than in the pre-1993 period (see Figure 28). Overall, electricity demand has continued to grow while GDP has been stable (see Figure 12 in Chapter 3). Electricity is mostly used in the residential/commercial sector, where the increase has been the largest. The share of electricity in total energy consumption of the residential/commercial sector was 27.6% in 1997. The corresponding figure in the industrial sector was 33.9%. Both figures are higher than the IEA Europe average.

Switzerland is a net exporter of electricity (see Figure 29). It exports electricity in the summer and has become a net importer of electricity in winter. The country imports mainly base load and exports mainly peak load. Switzerland imports electricity mainly from France (9.8 TWh in 1997) and Germany (8.7 TWh). It exports electricity mainly to Italy (20 TWh) and Germany (6.1 TWh).

Transport and Trade

The transport grid is designed to transport electricity from the mountains to the valleys as well as from France and Germany to Italy (see Figure 30). There are over-capacities in the north-to-south transport grid but the west-to-east grid needs to be strengthened. In particular, the building of the 380 kV grid section between Galmiz and Verbois is blocked because of environmental objections. A conflict-solving group involving the Swiss Government, the cantons, electricity companies and ecologist organisations agreed in 1998 on criteria for the protection of the environment and new licensing procedures.

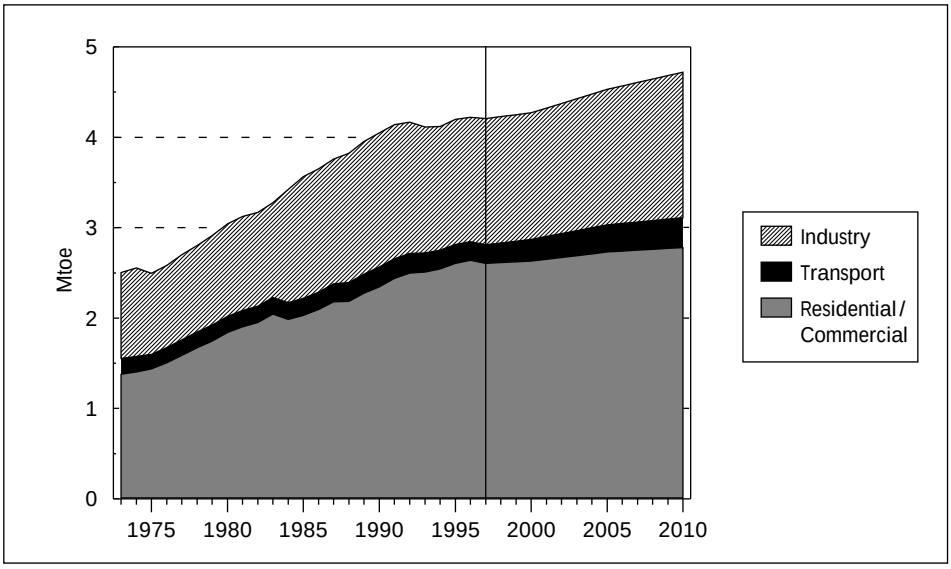
Electricity interconnections with foreign countries are shown in Table 16. There are four large high-voltage synchronous interconnections with Germany, three with France, three with Italy and one with Austria. About 20 companies are involved in international trade. Electrizitäts-Gesellschaft Laufenburg (EGL) (see below) handles about two-thirds of all international electricity trade and plays an important role in trade co-ordination.

Table 16
Electricity Interconnections
(GW)

Switzerland-Germany	10.5
Switzerland-France	5.4
Switzerland-Italy	3.5
Switzerland-Austria	3.2

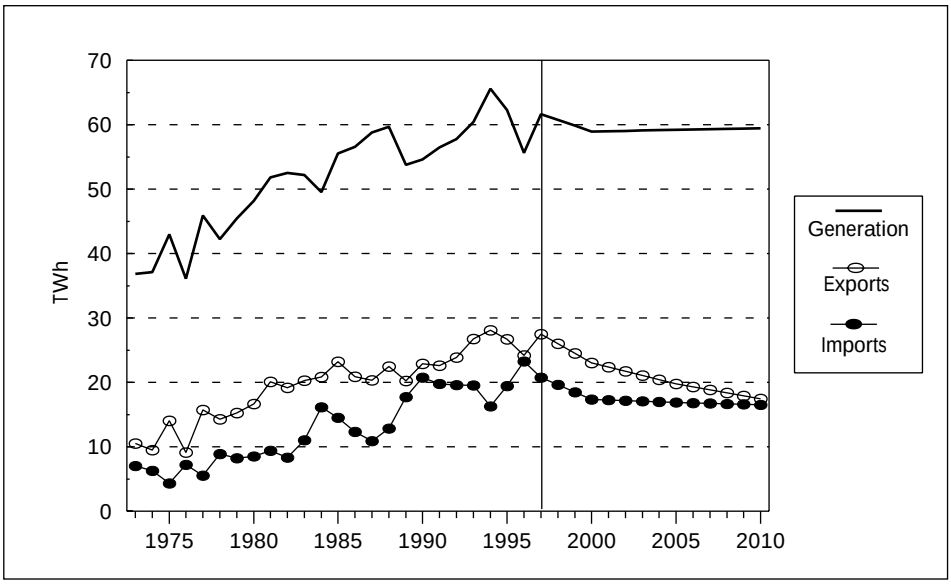
Source: SFOE.

Figure 28
Electricity Consumption by Sector, 1973-2010



Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 1998, and country submission.

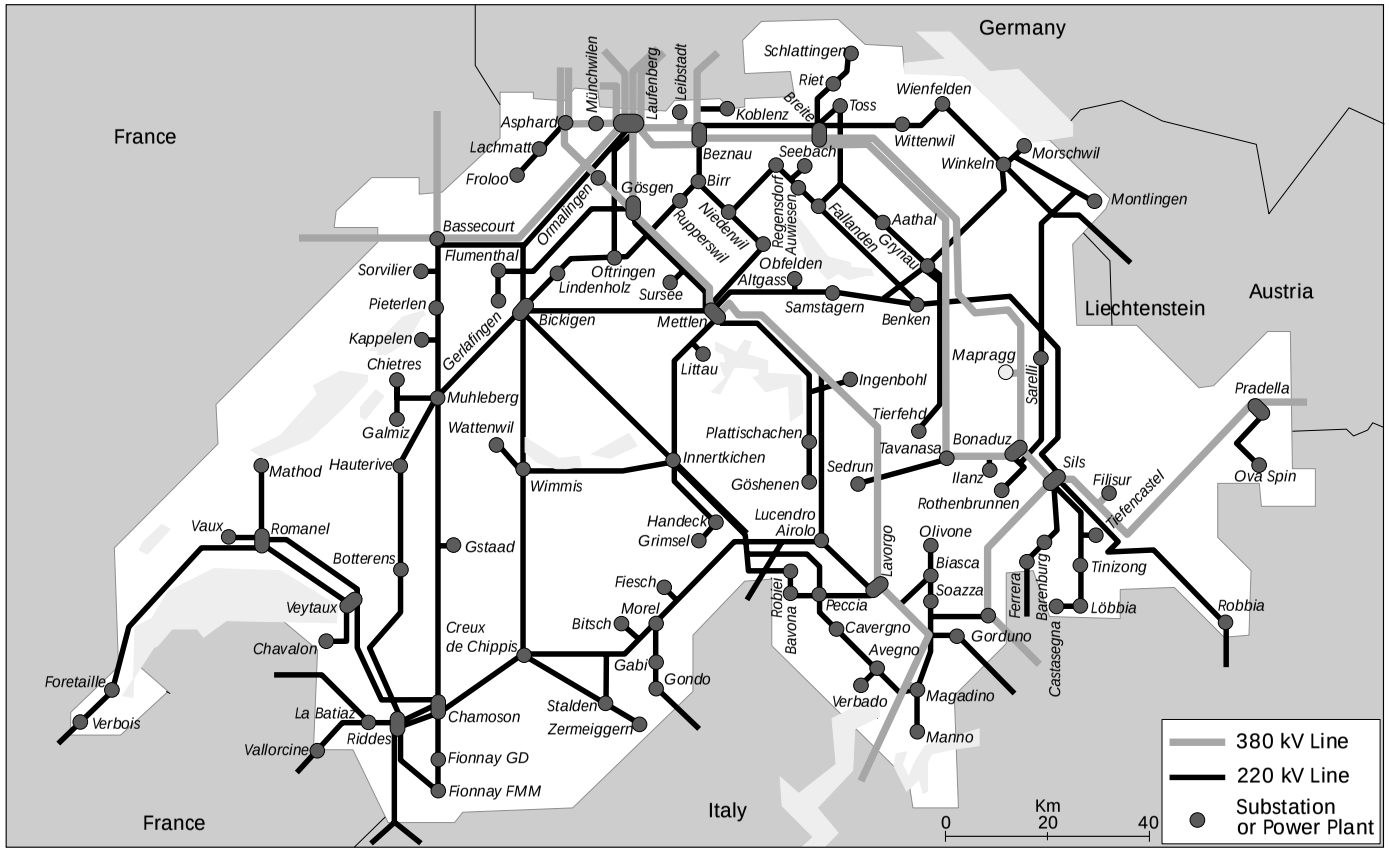
Figure 29
Electricity Generation, Imports and Exports, 1973-2010



Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 1998, and country submission.

Figure 30

Map of the Swiss Electricity Grid



Source: Swiss Electricity Utilities Association.

Forecasts

The Energy 2000 Action Plan aims at increasing hydro production by 5% and at increasing the capacity of existing nuclear power plants by 10% between 1990 and 2000 (see Chapter 4). Major increases in hydro plant capacity were made in the 1950s and 1960s and costs of building new hydro plants have increased. Some projects have been abandoned, the largest one being the upgrading and extension of the 550 MW hydro plant of Mauvoisin. The electricity companies face a moratorium on the construction of new nuclear power plants until 2000 and in October 1998, the Swiss Government decided to start discussions with all parties involved on the date of the closure of the existing nuclear power plants (see Chapter 7).

Several scenarios have been prepared to assess the results of energy policy measures, such as an energy/CO_2 tax and the phasing-out of nuclear power, on the balance of electricity supply and demand as well as on CO_2 emissions. According to most of these scenarios, Switzerland may become a net electricity importer after 2015. This would be the case if nuclear power plants closed after 40 years of operation and if existing supply contracts with France were not renewed. These forecasts also indicate that electricity supply would continue to exceed demand if the operation of nuclear plants were extended beyond 40 years, if the supply contracts with France were renewed, if support to renewables were maintained and if an energy tax were implemented. This energy tax would help to stabilise electricity demand: current forecasts continue to indicate an increase in electricity consumption after 2000.

ELECTRICITY INDUSTRY

Industry Structure

There are about 1 200 electricity companies (excluding independent power producers), which can be classified as follows:

- Six vertically integrated supra-cantonal companies (see Table 17).
- 300 utilities having at least two of the production, transmission and distribution functions. These companies are mostly regional or cantonal companies.
- 200 utilities which are producers only. Most are jointly owned by other utilities.
- About 700 companies that are mainly distributors, operating at cantonal or municipal level. Most of these companies are owned by cantons or municipalities. These local distribution companies distribute about 70% of the electricity supplied to final consumers. They are also often involved in other activities, such as gas and water distribution and district heating. In some cases the utilities are not independent legal entities: staff in these utilities are a part of the local administration. This is mostly true for very small distribution companies at municipal level.

The electricity system is dominated by the six main integrated supra-cantonal companies, three large municipally owned integrated utilities in the cities of Basel, Berne and Zürich and the Federal Railway Company, which owns several electricity plants, mainly for peak load[30].

Table 17
Major Swiss Electricity Companies

Utilities	*Type*	*Domestic Sales in 1995 (TWh)*	*Main Shareholders*
NOK	Production Transmission	20.1	Owned by cantons and cantonal companies
BKW	Production Transmission Distribution	10.3	71% Canton of Berne, 10% PreussenElektra, 5% Canton of Jura, 5% Cantonal Bank of Berne, 9% private
EOS	Production Transmission	7.4	22.7% Geneva, 19.7% Lausanne, 16.7% CVE (Compagnie vaudoise de l'El.), 14.9% EEF (Entreprise El. Fribourg), 10.7% SRE (Soc. Romande de l'El.), 5.9% Forces motrices de Nyon, 5.4% Forces motrices valaisannes, rest: various private shareholders
CWK	Production Transmission Distribution	4.1	66.3% Watt AG, 8.9% Canton of Lucerne, 5.7% NOK, 2.1% various cantons, 17% various shareholders
ATEL	Production Transmission Distribution	22.6*	56.5% Motor-Columbus SA, 10.9% Elektra Birseck, 8.5% Canton of Soleure, 6.2% Elektra Baselland, 3.8% chemical industry (e.g. Novartis), 3.6% Canton of Aargau, 10.5% various shareholders, EDF and RWE each own 20% of Motor-Columbus
EGL	Production Transmission Distribution	17.3*	81.2% Watt AG, 8.3% Kraftwerk Laufenburg, 1.1% WEG (Forces motrices valaisannes), 9.4% various shareholders

* Including international trade.

Sources: VSE, ATEL, EGL, country submission.

Nordostschweizerische Kraftwerke AG (NOK) is the largest domestic supplier. It supplies over two million inhabitants in nine northeastern cantons. It is followed by BKW FMB Energie AG (BKW), Energie Ouest Suisse (EOS) and Centralschweizerische

30 The Railway Company also has shares in some electricity generation companies.

Kraftwerke (CWK). The other supra-cantonal suppliers are Aare-Tessin AG für Elektrizität (ATEL) and Elektrizitäts-Gesellschaft Laufenburg (EGL), which have drawing rights on electricity produced mainly in France but also in Germany (for an amount equivalent to a total capacity of around 2.4 GW). They are responsible for most electricity exports to Italy.

Local public ownership dominates in most electricity utilities. Private shareholding dominates in ATEL and EGL. In recent years, some private shares have been sold to local authorities. Foreign companies have bought shares in Swiss companies. There are also various cross-shareholdings between electricity companies.

According to estimates from the SFOE, in 1997, electricity generation from autoproducers was 3.2 TWh, i.e. around 6% of electricity consumption. Co-generation was below 3% of total electricity consumption. The small number of large energy-intensive industries in Switzerland partially explains this small amount.

Organisation

Electricity companies are grouped into the Verband Schweizerischer Elektrizitätswerke (VSE), the association of Swiss power utilities.

Electricity purchases between electricity companies are based on long-term private contracts. Each utility optimises its dispatch, but there is no national merit order system.

REGULATIONS AND PRICES

Licensing and Regulation

For historical reasons, electricity exports require a federal licence as a precaution against power shortages. Only about 20 utilities are granted this licence on a routine basis. No licence is required for imports.

Siting procedures for electricity plants need approval by the cantons, with the exception of hydro plants situated at the Swiss border and nuclear installations, where the Swiss Government has overall regulatory and administrative power (see Chapter 7). Large new plants and extensions of existing projects are also subject to environmental impact assessment. A code was issued in 1990 on the protection of rivers during the construction and operation of power plants. The law of 1992 on water resources sets maximum limits on the use of naturally flowing rivers in two ways: medium-term measures that cause only minor generation reductions and long-term measures, after renewal of existing licences for the use of water resources[31].

31 Licences for the use of water resources are provided for each generator individually and usually expire after 80 years.

These long-term measures will have differing individual effects on generation reductions (in some cases up to 20% losses). These long-term measures will be applied in most cases in the years 2025 to 2040, since most of the larger hydro plants were constructed between 1945 and 1960.

Distributors have an obligation to supply in their areas. As a consequence of various cantonal and municipal regulations as well as demarcation agreements between companies, distributors operate as supply monopolies in their exclusive areas. Competition in generation is not forbidden by law but is prevented in practice by the absence of Third Party Access obligations. Companies negotiate the tariff for the use of the grid.

Independent Power Producers (IPPs)

The Decree of 1991 on Efficient Energy Use obliged electricity companies to buy electricity from co-generators, small hydro plants and producers using renewables (see Figure 31). The Decree states that electricity from renewables has to be purchased according to the cost of purchase of equivalent energy from new indigenous power plants. In 1996 and 1997, decisions of the Federal Tribunal made the recommended average purchase price of SFr 0.16/kWh compulsory. This price is adjusted to be higher during daily peak periods and lower in summer. Electricity from other sources must be purchased according to the cost of purchase of electricity from the regional distribution grid or based on a contract between the independent producer and the utility.

The 1998 Energy Law (in effect since January 1999) states that:

- In general, the obligation for utilities to purchase electricity from co-generators and producers of electricity from renewables only covers electricity which exceeds the consumption of IPPs (IPPs cannot sell their electricity at a high price and purchase electricity at a lower price at the same time).

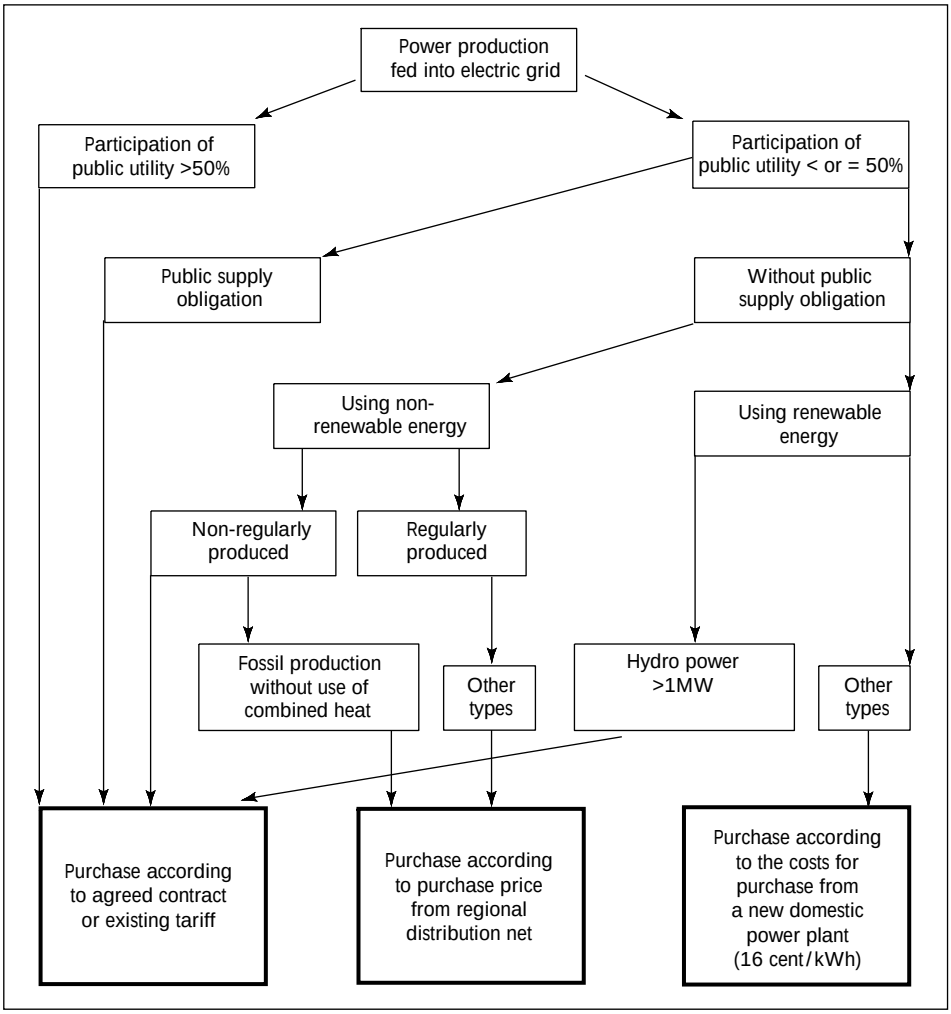
- Non-renewable electricity from independent producers has to be purchased at market prices.

- For small hydro-power plants only, if full production costs are much lower than the fixed purchase price of SFr 0.16/kWh, cantonal authorities can reduce the puchase price.

- Cantons can establish alone or in co-operation with other cantons a compensatory fund in favour of enterprises which are obliged to buy electricity from IPPs when the purchase share is "over-proportional" to their turnover[32]. This fund is financed by all producers, transporters and distributors of electricity in the canton.

32 This share has to be determined on a case-by-case basis by the cantons' authorities.

Figure 31
Tariff System for Independent Power Producers



Source: SFOE.

Taxes and Charges

Cantons have jurisdiction over the use of water. They grant rights for the use of water and in return receive royalties based on the gross capacity of the hydro plant (see the section on energy taxation in Chapter 4). In 1997, the upper limit of this levy was increased from SFr 54/kW to SFr 80/kW. Most of the cantons set the levy at its maximum limit. Revenues from this royalty are estimated by the SFOE and the alpine cantons to be around SFr 400 million (SFr 371 million by the VSE).

In addition to this royalty, cantons and municipalities set other different charges which apply to electricity generators, transport companies and distribution

companies. These charges are mainly applied to the distribution business and can amount to more than 10% of the turnover of the utility. Major charges are as follows:

- Contributions to the financing of public infrastructure and public lighting.
- Transfer of resources to the municipalities, including direct transfer of benefits, and interest payments to the communes for capital endowment.
- Diverse fees such as those based on the amount of electricity distributed to final consumers.
- Electricity delivered free of charge to municipalities and cantons.
- The cost of retrofitting elements of hydro plants when they are returned to the municipalities and the cantons[33].

According to the SFOE, total taxes and charges on electricity, including royalties on the use of water, amount to around SFr 0.02 per kWh. The VSE calculates SFr 0.033 per kWh when corporate and capital taxes are not included (when they are included, total taxes and charges amount to SFr 0.038 per kWh). These taxes amount to a large share of the costs of hydro and of the price for final consumers (see box).

Taxes and Charges/Cost of Supply

According to the VSE, in 1996 average production costs of hydro were SFr 0.04 to SFr 0.06/kWh for run-of-river power stations and SFr 0.05 to 0.11/kWh for pumped storage power stations. Some recent hydro plants have costs which are much greater. The average cost is estimated by the VSE to be between SFr 0.06 and SFr 0.08/kWh.

The royalty is up to 15-20% of the total cost of hydro. The VSE calculates that royalties and charges applied to hydro production amount to 20-27% of the total cost of hydro.

According to various sources, the royalty and charges amount to around 15% of the average price for final consumers.

Cantons and municipalities that decide not to exploit their hydro-power capacity in order to protect the environment in areas such as landscapes under national protection, are paid by the Swiss Government SFr 1 per kW avoided every year. For example, the Canton of Grisons and its two municipalities receive SFr 1.3 million per year for the protection of the Greina Plateau. To finance these compensation payments, the Swiss Government is entitled to collect up to SFr 1/kW in royalties from all the cantons.

33 Hydro plants are built under a Build Operate Scheme and some elements are given back to the communes or cantons after 80 years.

Price Levels

On average, in 1997 electricity prices for industry as shown in published tariffs were the second highest in the IEA (see Figures 32 and 33). For the household sector, electricity prices are higher than the IEA Europe average.

According to the VSE, large industries such as chemical and paper industries receive special tariffs for electricity. Other consumers, such as small and medium enterprises and services, pay much higher prices. In 1997, the average electricity price for households was estimated by the VSE to be SFr 0.19/kWh; for large industry: SFr 0.15/kWh; for small and medium industries and services: SFr 0.21/kWh.

Prices may differ widely between municipalities or cantons. After a substantial increase in the beginning of the 1990s, prices for households and industry edged down slightly in 1997 (see Table 18).

Table 18
Electricity Prices for Households and Industry in Switzerland, 1990-1997*
(SFr/kWh)

	1990	*1995*	*1996*	*1997*
Households				
Total Price	0.1538	0.1954	0.1972	0.1965
Ex-Tax	0.1538	0.1835	0.1851	0.1845
Industry	0.1238	0.1479	0.1487	0.1476

* Ex-tax prices include royalties on hydro plus other taxes and charges.

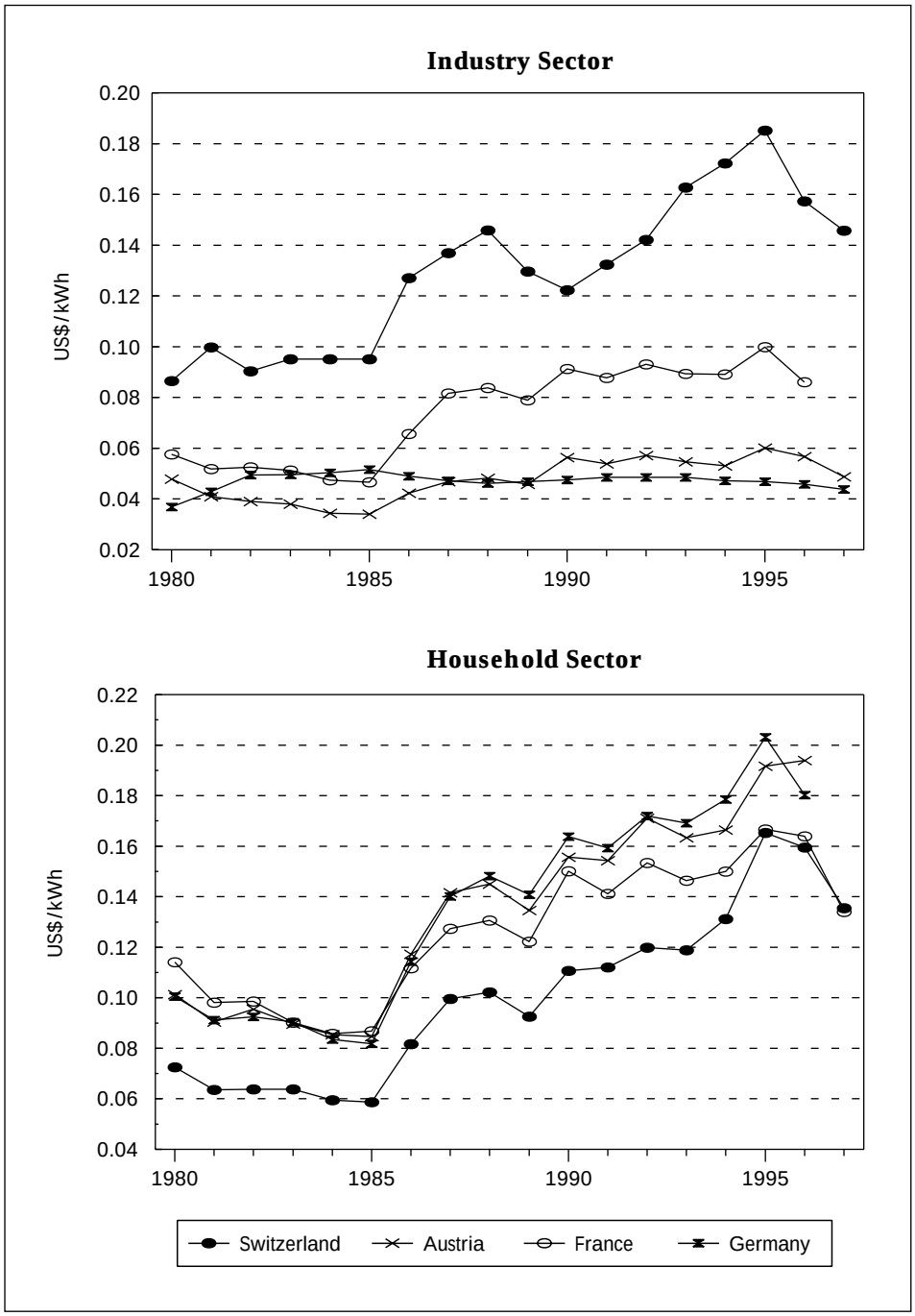
Source: *Energy Prices and Taxes*, IEA/OECD Paris, 1998.

Price Regulations

Prices for large industries are set by utilities, are confidential and are not subject to price controls. Electricity prices for other consumers are set by the utilities or by local authorities. When prices are set by utilities, formal approval by local authorities is needed in most cases. In some municipalities, electricity prices are approved by popular referendum. Municipalities and cantons also influence price setting through their shareholdings.

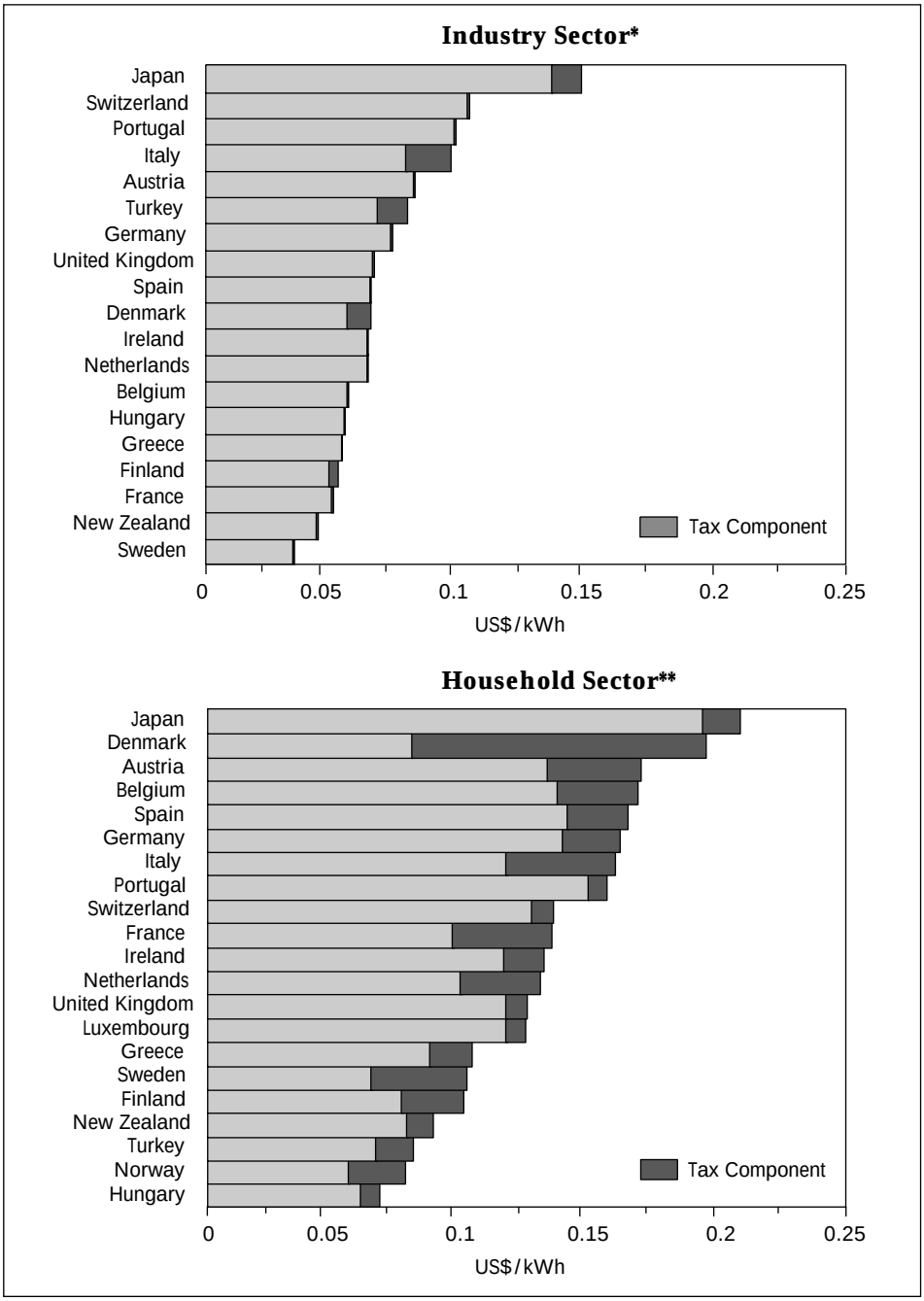
At federal level, the Price Surveillance Authority is in charge of price monitoring in sectors with little competition. Consumers can complain to the Authority about abusive prices. When the price is set by a company without an approval by any local authority, the Surveillance Authority can forbid a price increase or decide on a reduction. However, this has never happened. If a public authority decides on or has to approve a price increase (which is the case for most electricity prices),

Figure 32
Electricity Prices in Switzerland and Other Selected IEA Countries, 1980-1997



Source: *Energy Prices and Taxes*, IEA/OECD Paris, 1998.

Figure 33
Electricity Prices in IEA Countries, 1997



*Data not available for Australia, Canada, Luxembourg, Norway and the United States.
**Data not available for Australia, Canada and the United States.

Source: *Energy Prices and Taxes*, IEA/OECD Paris, 1998.

the Surveillance Authority can only issue recommendations, which utilities are not obliged to follow.

The Price Surveillance Authority

At federal level the Price Surveillance Authority is in charge of price monitoring in sectors with little competition, such as natural gas and electricity. The Authority comprises 14 members. The head of the Authority is nominated by the Government.

In 1989 the SFOE published principles for price setting in grid-based industries. The SFOE particularly recommended setting cost-reflective tariffs and metering and billing each end-user (for more detailed information, see section on gas in Chapter 5). A survey of electricity prices in 1993 showed only some compliance with these recommendations.

Cantons decide which body is in charge of settlement of disputes with IPPs: the cantonal government, the energy department of the cantonal administration or an authority appointed by the cantons.

MARKET REFORM

In February 1998, the Swiss Government released a draft law for public consultation, aimed at liberalising the electricity sector. The main features of the proposed law are described below.

The proposed system is regulated Third Party Access. The operators of electricity grids would be required to transport electricity on behalf of eligible customers on a non-discriminatory basis with a published tariff.

When the law enters into force, consumers of more than 20 GWh annually will be allowed to choose their suppliers. Three years later, the ceiling will be reduced to 10 GWh, and three years later to 5 GWh. Nine years after the entry into force of the law, all consumers will be allowed to choose their suppliers. Distribution companies will have access to suppliers in an amount equal in the first stage to 10% of the consumption of their captive consumers, then 20% and then 50%.

Electricity distributors have an obligation to supply electricity to captive consumers in their area. Utilities have obligations regarding the security of electricity supply. Utilities must set an identical price in their supply area for all captive consumers in a given category. In case of an abuse of monopoly, the Price Surveillance Authority can refuse a price increase or reduce the price.

The Swiss Government has issued principles for setting tariffs for use of the grid. The managers of the grid will have to agree on a uniform way of calculating costs.

If necessary, the Government can issue regulations on tariffs. An Arbitration Commission would be created to settle disputes over tariffs and access to the grid. The Commission would comprise five to seven members, including a president and vice president nominated by the Swiss Government. The Commission would be independent from the Swiss Government and local authorities. Decisions of the Commission would be subject to recourse in the Federal Court.

Accounts of electricity companies should be unbundled for generation, transmission and distribution as well as for non-electricity activities. Utilities would have to agree on the same accounting method. Three years after publication of the law, utilities should create a joint independent company to manage the transmission grid. If the company is not created, the Swiss Government will take the necessary steps to create it. Electricity from renewables should have priority in the merit order system.

The draft law would allow electricity companies to charge all electricity consumers prices high enough to recover their stranded costs for plants built before 1990 (see box)[34]. Stranded costs would be calculated by the owners of the plants[35]. The extra charges to consumers would also be used for accelerated depreciation of hydro and nuclear plants and for modernisation and maintenance of existing hydro-power plants. Consumers would pay for stranded costs no longer than 10 years. Electricity in transit and exports should not count in the calculation. The Federal Council can issue instructions on the calculation.

A foreign company would be allowed to supply electricity to a consumer in Switzerland if the consumer has the same rights in the foreign country and if the foreign country allows reciprocity according to the rules in the EU Directive.

Stranded Costs in Switzerland

The SFOE, in co-operation with the electricity industry, has issued a report estimating the stranded costs in generation according to different scenarios. According to this report, two-thirds of the 44 most recently refurbished or built run-of-river power plants (in particular those with a capacity below 10 MW) and five out of the 10 most recently built storage power stations will not be totally amortised. Stranded costs also involve some nuclear capacity.

Total costs will depend on the evolution of electricity prices, interest rates, the schedule for introduction of competition in the electricity sector in Switzerland and the evolution in electricity over-capacities in Europe. In the two most probable scenarios, the average stranded costs are estimated at between SFr 1.5 and SFr 2.5 billion.

The VSE has estimated the total of stranded costs to be SFr 4.8 billion.

34 There are other proposals to pay for the stranded costs. An energy tax proposal from the National Council includes the partial earmarking of the revenue of this tax as compensation for stranded costs (see Chapter 4).

35 The law sets some criteria.

The SFOE expects that the introduction of competition will lead to a decrease of SFr 0.02-0.03/kWh in generation costs and a tendency towards investments with short amortisation periods, such as combined cycle gas turbines. Competition will also lead to restructuring and mergers, and growing pressures to reduce the high royalties and taxes. The Swiss Government wishes to reach consensus before presenting the law to Parliament. Further discussions are needed and the Government plans to have the law discussed in Parliament in summer 1999.

CRITIQUE

Prices for final consumers are among the highest of all IEA countries in Europe. The relatively high prices are mostly for small and medium enterprises and services. In contrast, large industries have more negotiating power and can get lower power prices.

This high price level can be explained as follows:

- There is no competition between electricity companies which would favour cost reduction and improved management. In addition, only the six supra-cantonal utilities optimise electricity generation. Each utility can favour its own generation over others' regardless of costs.

- The total amount of charges and taxes on utilities is high. Local authorities allow utilities to cover the extra costs resulting from increases in charges by increasing prices for their clients. Some segments of the population have advocated high electricity prices to promote energy savings.

- The Swiss electricity sector is characterised by a large number of electricity companies, many of them below the optimal business size. Most of them do not need to give priority to commercial management methods for cost minimisation.

- In some cases, the policy of giving generous dividends to shareholders has led to an increase in electricity prices.

- The power of the Price Surveillance Authority is very limited.

Against this background, the initiative by the Swiss Government to introduce competition in the electricity sector is a timely and welcome move. It is important to increase the efficiency of the electricity sector and to reduce the price level through competition. Lower electricity prices should stimulate economic growth.

Harmonisation of rules in the electricity market between Switzerland and the European Union would be beneficial for Switzerland, which is surrounded by EU countries. Now that the European electricity market is expected to emerge, the best way for Switzerland to achieve security of supply is to enter this large market. Swiss hydro plants, in particular peak load plants, already contribute to the electricity

supply/demand balance at supra-national level. Energy policy-makers should be fully aware of this reality and make the necessary adjustments through measures which include abolishing the system of federal licences for electricity exports. This approach would be better than focusing on national self-sufficiency, which, in the case of electricity, can encourage actions to protect domestic industry from competition. A protectionist approach would reduce the competitiveness of Swiss generators, which actually have good potential to compete in Europe if they are not disadvantaged by high taxes and charges (see below).

Discussions are under way among all parties involved on the date of the closure of existing nuclear power plants (see Chapter 4). The new regulation on the use of water by hydro plants is expected to reduce electricity generation from hydro. Decisions on nuclear and hydro generation need to take into account the fact that both of them produce a large amount of CO_2-free and economic energy. Different scenarios have been worked out in order to see how future electricity demand can be met while reducing CO_2 emissions. According to these scenarios, a reduction in hydro production and an accelerated phasing-out of existing nuclear power plants would make Switzerland a net importer of electricity. Compensation for this loss in electricity generation by using fossil fuels would increase CO_2 emissions.

The regulated Third Party Access system foreseen in the draft law should allow for transparent prices for access to the grid, with the Swiss Government setting the principles. Ancillary services and back-up should be adequately priced. In addition, tariffs for final consumers should be cost-reflective and cross-subsidies should be avoided, as stated in the recommendations of the SFOE in 1989. In particular, since the introduction of competition may create incentives for cross-subsidies between the competitive part (generation) and the monopolistic part (network) as well as between eligible customers and captive customers, prices for access to the network and for captive customers should be strictly regulated.

In order for the Swiss people to take full advantage of the competitive electricity market, the market should be adequately supervised. The new authority proposed by the law, the Arbitration Commission, together with the Federal Price Surveillance Authority, should have adequate powers and means to function efficiently to settle disputes, control tariffs, control the implementation of regulatory reforms such as unbundling, and reveal any possible anti-competitive practices. In particular, decisions by the authorities should be mandatory for all parties. These authorities should develop the proper expertise about competition issues to track down and deal with any discrimination as soon as possible.

Ownership and regulatory functions must be clearly separated to ensure fair and adequate regulation. One of the primary requirements is for utilities to be independent legal entities, separate from local administration. In case privatisation is not possible or enforceable, corporatisation[36] of utilities would be a minimum solution

36 Corporatisation of public entreprises means managing the utilities according to the same rules as private companies, free of political interference in their corporate strategies and daily management.

to conflicts of interest between the owners of utilities and regulations such as tariff setting for captive consumers. In addition, corporatisation enhances efficient management, and allows utilities to compete on a level playing field. As the proposed law states, to ensure efficient competition, accounts for generation, transmission, distribution and non-electricity activities need to be unbundled and accounting methods should be harmonised. Cost calculations and methods of amortisation should be included in this process. Eventually, competition is expected to promote mergers of utilities, thus optimising their size. Competition should further enhance management efficiency and bring benefits to consumers and local governments.

Creating a single national company for transmission is a good proposal to facilitate Third Party Access by eliminating discrimination, increasing transparency and setting fair tariffs for transmission. The management of the company should be unbiased and to prevent any bias, the management should be independent from the utilities or other commercial parties. The creation of a single transmission company can also lead to increased rationalisation of the transmission system and make it easier to establish a nationwide main grid tariff and operate interconnections to neighbouring countries. A single transmission company could encourage better dispatching for all of Switzerland, optimised at the national level. The national electricity market in Switzerland is smaller than the supply areas of many European utilities and maintaining a transmission system owned and managed by separate companies would be inefficient. Regulation of such a company would be easier than regulating six vertically integrated companies. Lastly, ownership of transmission lines cannot be a strategic goal in a competitive market. Opinions vary among utilities regarding benefits of such a reform, but all parties, including the Federal Government, local governments, utilities and electricity consumers, should work together to create a national grid company.

The different studies on stranded costs show a large variance in total expected costs. This issue was highly disputed in the consultation process. In general, when the introduction of competition has led to problems of stranded costs, owners of the generation plants have tended to overestimate the amount of these costs. The Swiss Government or an independent body should carefully assess the amount of stranded costs calculated by the companies. The amount to be paid should not be decided by these companies. These payments should not distort competition with the other electricity generators at national or international level.

Taxes and charges on electricity generators differ from canton to canton and create an uneven playing field for generators. The introduction of competition in the electricity sector is expected to oblige local authorities to reduce taxes and charges. This will lead to a large decrease in the revenue of some municipalities and cantons, for which they will have to be compensated. This compensation would be preferable to supporting hydro power by subsidising the retrofitting and maintenance of hydro plants. Collecting taxes and charges from hydro-power plants with one hand while providing subsidies with the other hand would not be efficient.

There are several opinions on the timetable for opening the electricity market. The mountain cantons would like the market to open to competition as soon as

possible, at least at the same pace as in the EU because of business opportunities. Large electricity utilities would prefer a slower pace in order to reduce stranded costs. Since the opening of the electricity market is a generally accepted goal, a consensus should be reached quickly on the timetable.

One concern is the long-term security of supply and reliability. As the electricity market becomes a "normal" commodity market, the same kind of dynamic business cycles as for other commodities can be expected. Prices will move above and below the long-run marginal cost average. This kind of cyclicality benefits end-users when the system is in over-capacity because prices, i.e. short-run marginal costs, will be as low as the variable costs of running the marginal power plant. However, consumers could face extremely high prices, or worse, brown-outs or black-outs during the part of the business cycle when there is under-capacity.

In the case of Switzerland, which is well connected to the electricity grids of the neighbouring countries, such a concern about the business cycle must be considered in the context of the wide European electricity market, which currently has over-capacity. In future, if new capacity is needed, price signals could be used to ensure that such investments are made. Security should be reflected in electricity prices, and each user should pay a security premium according to his needs. When electricity is not supplied, an agreed-upon financial penalty should be paid by the supplier. This approach would be consistent with a competitive market. The Government's role is to ensure that end-users are well informed (contracts can be easily "compared") and that suppliers' assurances are backed by adequate financial guarantees.

RECOMMENDATIONS

The Swiss Government should:

- Seriously consider the future of electricity supply, taking into account probable future developments (i.e. introduction of competition, CO_2 emissions reduction) and the merits of the different production options from the point of view of economy and environment.

- Continue to work on the introduction of effective competition in the electricity sector, based on regulated Third Party Access, with the eventual aim of ensuring a high level of competition among utilities, and consumer choice.

- Strongly encourage corporatisation of utilities when they are not privatised.

- Strongly encourage unbundling of accounts and regulate prices in the non-competitive segments of the electricity sector. Ensure that prices for captive consumers are cost-reflective and that there are no cross-subsidies.

☐ Ensure that regulatory authorities have enough legal competence and resources to carry out their mission.

☐ Set up a national grid company in order to facilitate Third Party Access and tariff setting in a transparent and non-discriminatory manner.

☐ Carefully assess the stranded costs calculated by the electricity companies and take measures to ensure that payments for these costs do not distort competition with the other electricity generators at national or international level.

7

NUCLEAR

NUCLEAR POWER PLANTS

Five nuclear units[37] are in operation in Switzerland, representing a total capacity of 3 077 MWe (see Table 19), i.e. nearly 20% of the total generation capacity in the country. In 1997, these plants generated 23.97 TWh (41.2 % of total electricity generation). The Beznau and Gösgen units produced some 976 TJ of process and district heat. In 1997, electricity from nuclear power was more than 25% of total energy supply.

Table 19
Operating Nuclear Power Plants in Switzerland

Name	*Type*	*Net Capacity (MWe)*	*Operator*	*Commissioning Date*	*Electricity Generation in 1997 (TWh)*	*Availability Factor in 1997 (%)*
Beznau 1	PWR	365	NOK*	1969	2.69	88.3
Beznau 2	PWR	357	NOK*	1971	3.08	99.7
Mühleberg	BWR	355	BKW**	1972	2.56	87.6
Gösgen	BWR	970	KKG***	1979	7.85	93.7
Leibstadt	BWR	1 030	KKL****	1984	7.79	89.8
Total		**3 077**			**23.97**	**91.8**

* Nordostschweizerische Kraftwerke.
** BKW FMB Energie AG.
*** Kernkraftwerk Gösgen-Daeniken AG.
**** Kernkraftwerk Leibstadt AG.
Source: Country submission.

The performance of the Swiss nuclear units is very good, with an average lifetime availability factor exceeding 80% for all units. In 1997, the availability factors of the five units ranged between 88% and more than 99%, with an average over 91%. The occupational exposure accumulated by workers ranged in 1997 from 0.08 man.Sv at Beznau 2 (no outage in 1997) to 1.8 man.Sv at Leibstadt. The average in Switzerland is comparable to that of the other OECD countries.

The ages of the Swiss nuclear units range from 15 to 30 years. Three of the units, Beznau 1, Gösgen and Leibstadt, have unlimited operating licences. In 1994,

37 Two nuclear power plant projects, Kaiseraugst and Graben, were cancelled.

Beznau 2 was granted a licence for operation until the end of 2004. In 1998, the Swiss Government authorised a 15% capacity upgrade of the Leibstadt unit. In 1992, Mühleberg was issued a ten-year operating licence after refurbishment and a 10% capacity upgrade, and in October 1998, its licence was extended to 2012 (see below).

The owners are responsible for funding the decommissioning of the power plants they operate. The total estimated cost of decommissioning the five units in operation is SFr 2.7 billion. In 1984, a decommissioning fund was established to cover this cost in due course and the nuclear utilities pay contributions to this fund on an annual basis.

NUCLEAR FUEL CYCLE AND WASTE MANAGEMENT

Switzerland has no domestic nuclear fuel cycle industry, except for two companies offering services for the transportation of fresh nuclear fuel. Uranium is procured from partnerships or joint venture production abroad, long-term contracts and spot market acquisitions. Enrichment, fabrication and reprocessing services are purchased from foreign companies.

The owners and operators of nuclear power plants are responsible for the planning and decision-making relative to the fuel cycle, including its back-end, i.e., spent fuel storage and/or reprocessing. They have signed contracts with Cogéma and BNFL (British Nuclear Fuel Ltd) for the reprocessing of about one-third of the spent fuel expected to be unloaded during the 40-year planned lifetime of the five reactors in operation. No decision has been taken yet on the remaining two-thirds of spent fuel arisings. The plutonium issued from reprocessing is recycled in three reactors, Beznau 1 and 2 and Gösgen, that are currently using MOX (mixed uranium-plutonium oxide) fuel and it is expected that Leibstadt will load MOX fuel after the turn of the century.

According to Swiss law, the safe handling and disposal of radioactive waste is the responsibility of the waste producers. In 1972, the utilities operating nuclear power plants and the Federal Government, which is responsible for radioactive waste from research activities and radioisotope production and uses, founded NAGRA (the National Co-operative for the Disposal of Radioactive Waste). NAGRA is responsible for the disposal of all categories of radioactive waste and for the research and development associated therewith. For construction and operation of centralised waste management facilities, it is foreseen that dedicated companies will be created.

The expenditures associated with the management and disposal of radioactive waste from nuclear power plants are financed by waste producers (nuclear utilities) and charged to consumers as a component of electricity prices. The funds set aside to cover future financial liabilities (costs that will be supported in the future) are maintained by utilities and the level of these funds is documented in their annual reports. One of the objectives of the revised Nuclear Energy Act (see below)

currently in preparation is to provide prescriptions about guaranteeing the funds for radioactive waste management.

Until final repositories become operational, all categories of radioactive waste are held in interim storage facilities at the nuclear power plants. A centralised interim storage facility (ZWILAG), located near the site of the Paul Scherrer Institute (PSI) at Würenlingen, is under construction and is expected to start operation in 1999. A specific low- and intermediate-level waste (LILW) repository project has been worked out for site selected by NAGRA at Wellenberg in the Canton of Nidwalden (central Switzerland). However, in spite of Swiss Government approval for preliminary work on the site, the project is on stand-by because of local opposition. A stepwise procedure is being considered, aiming at obtaining, in a first phase, cantonal concession for an exploratory tunnel only. For high-level waste (HLW) a repository will not be required before 2020. NAGRA is pursuing a comprehensive programme based on the concept of a deep geological repository and focusing on the crystalline bedrock of northern Aargau and the opalinus clay of the Zürcher Weinland in the northern part of the Swiss plateau.

A conflict-solving group including members of the Federal Administration, the nuclear industry and environmental organisations was set up to find a common solution for reprocessing and/or direct disposal of spent fuel. However, in 1998, this conflict-solving group ended its work without any common solution.

NUCLEAR REGULATIONS AND POLICY

Regulatory Authorities and Regulations

The Swiss Government has the overall regulatory and administrative power in the field of nuclear energy and radiation protection. The Federal Department for Environment, Transport, Energy and Communication (DETEC), which includes the Swiss Federal Office of Energy (SFOE), and the Federal Department of the Interior (including the Federal Office of Public Health and the Federal Office of Education and Science) are responsible for implementing the provisions adopted by the Swiss Government.

The Federal Nuclear Safety Inspectorate, which reports to the SFOE, acts as an advisory body on nuclear safety issues. Its main tasks are to formulate safety requirements and guidelines and to review, assess and control the safety of nuclear installations. The Inspectorate has expressed concerns regarding its effectiveness and independence and has asked the International Atomic Energy Agency (IAEA) to provide advice in this regard through an International Regulatory Review Team mission carried out in December 1998. Greater independence for the Inspectorate is envisaged in the new draft Atomic Law (see below).

The Federal Commission for Protection against Radiation and the Federal Commission for the Monitoring of Radioactivity, which come under the Federal

Department of the Interior, are responsible for advising on questions relating to radiation protection and monitoring, respectively.

The use of nuclear energy in Switzerland is regulated by an amendment to the Constitution approved by the Parliament and all the cantons (by referendum) in 1957, stipulating that nuclear legislation should fall within the sole jurisdiction of the Swiss Government. Cantons have residual jurisdiction concerning the licensing of nuclear installations.

The Federal Act of 1959 on the Peaceful Use of Atomic Energy, as amended by the Federal Order of 1978, provides the basic regulations currently in force regarding licensing for the construction, operation, modification and decommissioning of nuclear installations. The Radiation Protection Act of 1991 lays down the broad principles for protection against radiation. The Act gives the Swiss Government power to promulgate detailed implementation regulations such as the Radiation Protection Ordinance of 1994, based largely on the most recent recommendations of the International Commission on Radiological Protection (ICRP).

Nuclear Policy

In 1990, the Swiss population adopted by referendum a ten-year moratorium on the construction of any new nuclear power plant. Following the referendum, the Federal Act on transitional dispositions (approved in 1990) stipulates that for a period of 10 years no licences for building new nuclear power plants will be issued. However, the Energy 2000 Action Plan included in its goals a 10% increase in the capacity of nuclear power plants between 1990 and 2000 (see Chapter 4). In 1997, 51% of the target had been reached.

In 1998, two popular initiatives were under consideration regarding nuclear power policy beyond 2000 (see box).

Also in 1998, a revision of the Atomic Energy Law was being considered by the Federal Government. The main objectives of the new law are to:

- Enhance further the safety of operating nuclear units.
- Ensure long-term options for new nuclear power technologies.
- Establish prescriptive regulations regarding decommissioning and radioactive waste management.
- Establish prescriptive regulations for guaranteeing the financing of radioactive waste disposal.
- Grant nuclear licences exclusively at the federal level (this is already the case, but cantons have residual responsibilities).

New Popular Initiatives on Nuclear Energy

"Moratorium Plus – For an extension of the nuclear power plant construction moratorium and a limiting of atomic risks"

For ten years, no more licences should be issued for new nuclear energy installations, the upgrading of the thermal power of nuclear power plants or reactors for nuclear technical research and development, except for medical purposes.

After a period of operation of 40 years, a decision from Parliament subject to optional referendum should be required for an extension of the operating licence, which should be limited to a period of 10 years.

"Electricity without Atoms – For a change in the way energy is obtained and the stepwise closure of nuclear power plants"

The nuclear power plants should be closed down in a stepwise manner. The reprocessing of spent fuel should be stopped. The plants of Beznau 1 and 2 and Mühleberg should be shut down at the latest two years after the acceptance of the initiative. The plants of Gösgen and Leibstadt should be closed after 30 years of operation.

- Make it possible to appeal in court against a nuclear licence.
- Make the granting of a general licence subject to an optional referendum.
- Enhance the independence of the safety authority (Nuclear Safety Inspectorate).
- Furthermore, the new law might establish prescriptive regulations on reprocessing.

In October 1998, the Federal Government took the following decisions:

- Operators of nuclear plants, environmental organisations, and interested cantons and municipalities should seek consensus on the elimination of spent fuel and propose a timetable for the closure of the nuclear power plants. If they do not agree, the Swiss Government will decide.
- The DETEC is in charge of drafting a new Atomic Law. The law shall include the provision that the construction of a new nuclear power plant should be submitted to facultative referendum (see Chapter 3).
- The Swiss Government has granted licences to increase the nuclear capacity of Leibstadt and to operate Mühleberg until 2012.

R&D

Research and development activities in nuclear fission are carried out mainly by the Paul Scherrer Institute (PSI). Funds for nuclear fission and fusion have decreased since the late 1980s (see Chapter 8).

CRITIQUE

The Swiss nuclear power plants are efficiently run and contribute significantly to Swiss electricity supply. In addition, because nuclear power is carbon-free, it contributes largely to making Switzerland one of the lowest emitters of CO_2 among developed countries. The performance and safety records of the five nuclear units in operation are excellent. The legal framework that regulates the use of nuclear energy and makes the Federal Government responsible has so far proven effective in ensuring the safe operation of nuclear facilities. For these reasons, the nuclear option should be kept open.

Public opinion remains divided on the need for nuclear power and on its risks. The proposed revisions of the Atomic Energy Act address several concerns of the public and the policy-makers, e.g. guidelines for decommissioning and waste management, the possibility of appealing against a nuclear licence, and increased independence of the safety authorities.

The decision of October 1998 to start discussions on the phasing-out of the existing nuclear power plants does not actually impede the building of new nuclear power plants. In the process of setting a date for phasing out nuclear power plants, the Government should develop the best timetable, taking into account the costs and the consequences for CO_2 emissions and the electricity supply/demand balance (see Chapter 6). In this respect, the atomic law being prepared by the Government should aim to ensure that a viable and democratic process exists for choosing long-term options for nuclear power. In particular, decisions to build new nuclear power plants should be taken in a democratic process, with sufficient information provided to the public. Once a decision is taken, licensing procedures should be streamlined so that investments can be made without delay.

Switzerland has a comprehensive policy framework for radioactive waste management, including conditioning and interim storage of all types of waste. Concepts and technical feasibility studies for the final disposal of radioactive waste have been carried out. The Swiss Government plans to create a fund to better guarantee financing for decommissioning and radioactive waste management. Decisions have not yet been taken for the implementation of repositories, mainly because of public acceptance issues. The Swiss Government will have to seek a common view among the different groups involved. A democratically accepted decision-making process is necessary.

The Federal Nuclear Safety Inspectorate has adequate technical competence and autonomy to fulfil its role. However, its independence could be enhanced and it is

welcome that such enhancement is planned by the Swiss Government. Findings from the IAEA International Regulatory Review Team mission will be helpful in this regard.

Although the government budget for nuclear fission R&D has been reduced significantly, efforts continue, with emphasis on safety and radioactive waste disposal issues. The Swiss Government should consider whether lowering further the level of R&D on advanced nuclear technologies might jeopardise the long-term viability of the nuclear option and reduce its potential role in sustainable, carbon-free energy mixes (see Chapter 8).

RECOMMENDATIONS

The Swiss Government should:

- ☐ Take measures to ensure the implementation of radioactive waste repositories.
- ☐ Continue actions aimed at strengthening the legal framework for the use of nuclear energy and at enhancing the independence of safety authorities.
- ☐ Ensure that decisions on nuclear issues are reached in a democratic process accepted by the public.
- ☐ Maintain a sufficient level of technological competence to keep nuclear energy as a viable option.

8

ENERGY TECHNOLOGY, RESEARCH AND DEVELOPMENT

ADMINISTRATIVE ORGANISATION

The Swiss Federal Office of Energy (SFOE) co-ordinates research and development activities related to energy, co-finances projects and ensures the monitoring of programmes. It also ensures links with the private sector and with international energy research projects. Within the SFOE, three sections are responsible for three different R&D programmes (efficient use of energy, renewables and special issues). These three sections ensure that each project is followed up, from the research stage to deployment and marketing.

In 1986, the Federal Commission for Energy Research (CORE) was established as an advisory body within the SFOE. CORE comprises representatives from industry, universities, cantons and other organisations involved in energy efficiency, science and technology, and economics.

OBJECTIVES

Since 1984, the SFOE has issued guidelines for R&D policy. These guidelines are developed with the advice of CORE. The Concept of Swiss Federal Energy Research 1996-1999 is the fourth such document issued since 1984. The aim of R&D is to contribute to meeting the objectives of the Energy 2000 Action Plan (see Chapter 4) and, more broadly, the basic objectives of Swiss energy policy.

The R&D strategy of the 1996-1999 Concept is to increase R&D activities in *conservation*, particularly by promoting pilot and demonstration (P+D) projects. Two fields, "fossil fuels" and "supporting techniques"[38] should be funded constantly. Funding for "nuclear fission" and "nuclear fusion" should be reduced.

The Concept of Swiss Federal Energy Research 2000-2003 is expected to be adopted in 1999. The aim of the new concept is to improve the rational use of energy, to further promote renewable energies and to increase Switzerland's environmental performance. The long-term strategy is to greatly reduce CO_2 emissions.

PUBLIC EXPENDITURE

In 1997, the public budget for energy R&D was SFr 197 million. The budget for public and private R&D on energy was about 10% of total R&D in Switzerland,

38 According to the Swiss definition: generation, transport and transformation of electricity and cross-cutting activities.

i.e. more than SFr 1 billion. About 80% of these expenditures were from the private sector. In 1997, the Board of the Swiss Federal Institutes for Technology financed 51% of public research, the SFOE 19%, the cantons and municipalities 14%[39], and other federal administrations and funds 16%. About 80% of public funding is directly supervised by the SFOE, which thus influences the programmes. About 15% public funding is devoted to demonstration, and 85% to research.

Expenditure from the SFOE in 1997 was SFr 38 million and included SFr 11 million for pilot and demonstration projects. The breakdown of the funding was 40% for renewable energy, 30% for energy savings, 12% for new techniques, 6% for nuclear safety and 12% for other activities.

The three main technology institutes, the Swiss Federal Institutes for Technology at Lausanne and Zürich and the Paul Scherrer Institute (see box), receive about two-thirds of government funding.

About 20% of government funding is devoted to the private sector, on the basis of subsidiarity: the Government participates in the financing of private projects when private funding is insufficient. Since the beginning of the 1990s, as a result of the economic downturn, demand for public funding from private enterprises has increased. Public funding for private sector projects is dedicated to applied research or to improving processes. Most of the funding goes to pilot and demonstration projects. In this field, private funding has to finance the major part of the investment (the cost of a comparable conventional project plus 60% of the rest). About 11% of government funding goes to cantonal and municipal institutions and the remaining 70% goes to the federal research institutes.

Funding by the private sector is dedicated to development (80%) and to applied research (20%). More than 50% of private funding goes to "supporting techniques", mostly electricity.

Public expenditure on energy R&D has decreased since 1993 in nominal terms, and since 1992 in real terms and also in comparison with GDP (see Figure 34). However, Swiss government expenditure related to GDP remains the third highest among IEA countries, after Japan and Finland.

The evolution in public expenditures (in nominal terms) by sector is as follows (see Table 20):

- Between 1990 and 1997, the total share of expenditures for conservation and renewables increased; the share for nuclear and for power and storage decreased.

39 Cantons and municipalities mostly finance pilot and demonstration installations.

Paul Scherrer Institute (PSI)

PSI is the largest national research institute and the largest energy research centre (including nuclear research) in Switzerland. Over the last few years, emphasis has shifted from the earlier priorities of particle physics and nuclear energy towards materials sciences and solid state physics as well as general energy research and environmental sciences.

The missions of PSI are:

- To conceive, design, build and operate large, complex research facilities for the scientific community.
- To carry out fundamental and applied research in solid state physics and materials sciences, in particle physics, life sciences and nuclear and non-nuclear energy and energy-related environmental areas (reactor safety, safety studies on the disposal of radioactive wastes, new methods for energy production and storage, energy systems analysis).

PSI began construction of an advanced Swiss Synchrotron Light Source (SLS), which should be operational in 2001.

For 1998, PSI had a budget of SFr 161 million (down from SFr 166 million in 1997) plus SFr 30 million of external funds, and a staff of about 1 200 employees, including 240 scientists and technicians paid by external funds.

PSI invests almost 16% of its budget in nuclear energy-related activities. The reduction in public funding for nuclear energy could be compensated for, to a large extent, by external funding (i.e. utilities, safety authorities).

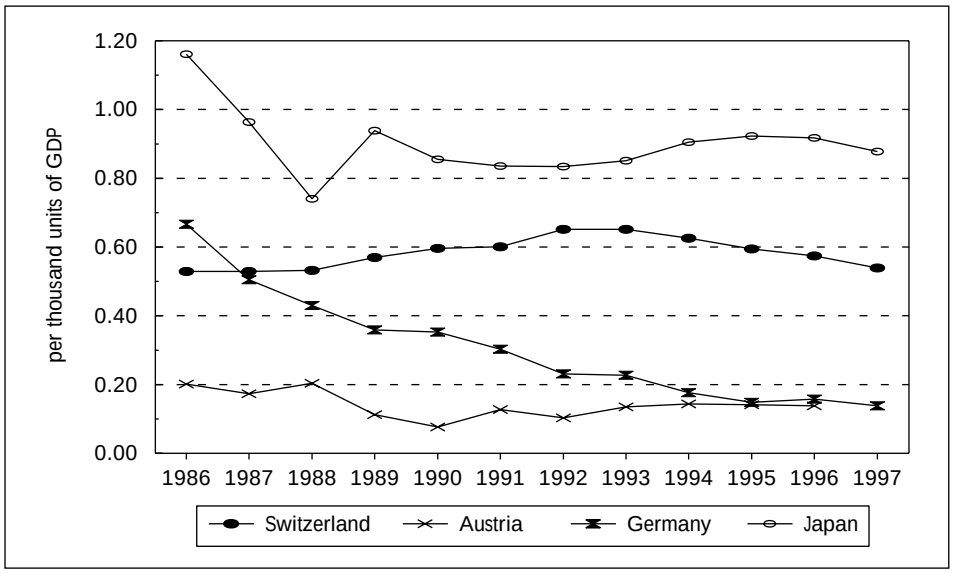
One-third of the overall costs of nuclear energy research is externally funded. This funding is provided by the Swiss Utilities and NAGRA, the Nuclear Safety Inspectorate (HSK) and other research-supporting agencies. A substantial share is provided by foreign nuclear industry.

Nuclear energy research at PSI will concentrate for the next few years on reactor safety and safety-related operational problems of Swiss nuclear power plants and on nuclear waste disposal. At the same time, PSI will continue to investigate safety features of advanced reactor concepts and fuel cycles.

- Between 1993 and 1997, expenditures in all sectors except non-solar renewables (such as mini hydro) decreased[40].

40 Some R&D programmes initially used to promote renewable energies have been phased out. These include the "START" programme, which ran from 1992 to 1995 and promoted a particular renewable energy application/technology over a short period of time (e.g. photovoltaic systems in school buildings). The DIANE programme (1992-1996) was mainly used to encourage wood energy and small-scale hydro power in addition to energy efficiency.

Figure 34
Energy R&D Public Spending per GDP in Switzerland and Other Selected IEA Countries, 1986-1997



Sources: *IEA Energy Technology R&D Statistics*, IEA/OECD Paris, 1997, and country submissions.

Table 20
Public R&D Budget for Energy, 1990-2003
(SFr million)

	1990	*1991*	*1992*	*1993*	*1994*	*1995*	*1996*	*1997**	*2003***
Conservation	24.4	29.0	33.4	36.4	42.1	40.5	38.0	30.0	42
Fossil fuels	13.0	16.7	17.4	17.8	17.4	16.8	12.7	13.9	15
Renewables	38.0	43.0	52.5	56.2	53.9	53.2	50.9	53.7	58
Solar	*27.9*	*31.4*	*35.1*	*36.3*	*36.6*	*33.5*	*30.0*	*33.5*	*43*
Other	*10.1*	*11.6*	*17.4*	*19.9*	*17.3*	*19.7*	*20.9*	*20.2*	*15*
Nuclear	73.6	70.3	67.5	67.9	63.5	60.3	60.6	61.3	45
Fission	*38.6*	*37.8*	*35.5*	*35.7*	*35.4*	*35.1*	*30.9*	*30.6*	*20*
Fusion	*35.0*	*32.5*	*32.0*	*32.2*	*28.1*	*25.2*	*29.6*	*30.6*	*25*
Power & Storage	27.3	28.1	34.8	30.0	26.5	27.0	28.8	22.6	24
Other	10.9	11.9	15.0	15.0	17.4	17.3	15.7	15.5	18
Total	**187.2**	**199.0**	**220.6**	**223.3**	**220.8**	**215.1**	**206.7**	**196.9**	**202**

* Provisional.
** Proposed, in real terms.
Source: Country submission.

- In 1990, R&D on nuclear energy amounted to 41% of total energy R&D. In 1997, expenditures on nuclear energy amounted to 31% (50% fission and 50% fusion), followed by renewables (27.2%, mostly solar energy) and energy conservation (15.2%).

The SFOE made proposals on future funding for the Concept of Swiss Federal Energy Research 2000-2003. According to these proposals, government funding for R&D should be stabilised in real terms. More funding should be devoted to energy efficiency and solar. For wind energy, only pilot and demonstration projects would be funded and no funds would be devoted to research. R&D on nuclear should continue to decrease and should concentrate on safety issues for fission. Additional funding should be dedicated to pilot and demonstration installations (SFr 10 million more) and funding for applied research should decrease by the same amount. Overall funding for applied research would decrease slightly and pilot and demonstration projects would account for around 20% of total R&D expenditure.

INTERNATIONAL CO-OPERATION

Most of the projects involve international co-operation. In 1997, 25% of the funding went directly to international co-operation, mainly within the IEA and the EU. Switzerland participates in 22 IEA Implementing Agreements as well as several EU research programmes, but Swiss access to EU programmes is still limited. The Federal Council has recommended increasing co-operation with Central and Eastern European Countries and with developing countries, particularly in limiting greenhouse gas emissions.

ASSESSMENT AND DEPLOYMENT

CORE regularly reviews Swiss energy R&D objectives and priorities. Thus, Swiss industry is involved in these evaluations. In 1995, CORE indicated that there were two kinds of pressure on R&D policy: pressure from private industries for short-term projects and pressure from the public for R&D on particular technologies.

The SFOE also assesses programmes annually. The methodology used to evaluate the effectiveness of projects is designed to make comparisons posssible with similar projects in the private sector.

In 1992/1993, an international group of experts assessing Swiss R&D policy found several areas for improvement: programmes were split into too many small projects, there was a lack of co-ordination between the projects, and deployment needed improvement. There were also cases of dual functions (expert and manager) which were not compatible. The SFOE addressed these issues and in 1996 it undertook an administrative reform to improve deployment. Before 1996,

two separate bodies did research and marketing for the same project. In 1996, the separation between research and marketing was removed and three SFOE sections were put in charge of following the projects from beginning to end (see above).

Other reforms to improve co-operation between public research and the private sector include associating private enterprises with research as soon as possible and increasing industrial involvement in special groups to evaluate the potential of different projects.

CRITIQUE

Switzerland has a comprehensive and efficiently managed R&D programme. In addition, efforts have been made to improve the evaluation and efficiency of R&D. Priorities are clearly defined and the reallocations of R&D funds aim to be in line with the energy policy objectives.

The Swiss Government should continue to ensure that the R&D programmes are in line with Swiss energy policy. This is becoming increasingly important as Switzerland is committed to making large efforts to reduce CO_2 emissions. The following areas need special attention:

- With multiple sources of funding and reduced funding by the SFOE, coherence in funding and in choosing new projects should be maintained. Where possible, there should be competition among projects to ensure that the most effective ones are funded.

- Part of the government funding is dedicated to private projects on the grounds of subsidiarity. Because demand from private enterprises for public funding has increased, it should be ensured that public funding to private R&D and the goals for R&D programmes are consistent. Public or political pressures to redirect funds to new technologies regardless of their cost-effectiveness should not be allowed to threaten the consistency of R&D programmes.

- Programmes should continue to be evaluated on a regular basis and the results of these evaluations should be used to redirect funds in a more efficient way. In particular, funding for short-, medium- and long-term R&D should support energy policy goals and contribute to the reduction of CO_2 emissions. In this regard, projects to be supported by the proposed increase in budget for energy efficiency are consistent with the goals of the Energy 2000 Action Plan. These projects should be critically examined on the basis of past assessments to achieve the best results.

R&D funding aims to lower the cost of new technologies and increase their effectiveness, particularly renewables. For improved efficiency, R&D funding for pilot and demonstration projects should include requirements for technical characteristics.

Some government efforts, such as the promotion of public acceptance, might be needed to facilitate the introduction of newly developed technologies into the market. Internalisation of external costs like environmental costs also helps the introduction of new technologies, such as those related to renewables and energy efficiency.

Co-operation between the public and the private sector is essential for market deployment of new technologies. Participation by the private sector in public programmes should be encouraged.

The choice of new projects should take into account the results of research in foreign countries. It is welcome that Switzerland is actively involved in international programmes. This is a very effective way to avoid duplication of work and to further strengthen national R&D.

RECOMMENDATIONS

The Swiss Government should:

- ☐ Continue to fund R&D sufficiently to contribute to the objectives of Swiss energy policy.
- ☐ Strengthen the assessment of R&D programmes and fully reflect the results of these assessments to ensure maximum efficiency of future programmes.
- ☐ Further strengthen co-operation with industry in order to better disseminate R&D results into the market.
- ☐ Maintain strong participation in international R&D programmes.

A

ANNEX

ENERGY BALANCES AND KEY STATISTICAL DATA

Unit: Mtoe

SUPPLY

		1973	1990	1996	1997	2000	2005	2010
TOTAL PRODUCTION		**4.28**	**9.72**	**10.48**	**10.99**	**10.24**	**10.29**	**10.28**
Coal[1]		–	–	–	–	–	–	–
Oil		–	–	–	–	–	–	–
Gas		–	0.00	–	–	–	–	–
Comb. Renewables & Wastes[2]		0.24	0.98	1.45	1.41	1.40	1.45	1.49
Nuclear		1.64	6.18	6.57	6.64	5.89	5.84	5.76
Hydro		2.40	2.56	2.44	2.93	2.93	2.97	2.99
Geothermal		–	–	–	–	–	–	–
Solar / Wind / Other[3]		–	–	0.02	0.02	0.02	0.03	0.04
TOTAL NET IMPORTS[4]		**15.23**	**15.16**	**15.15**	**15.02**	**14.20**	**14.34**	**14.37**
Coal[1]	Exports	0.02	0.01	–	–	–	–	–
	Imports	0.24	0.35	0.11	0.07	0.05	0.04	0.02
	Net Imports	0.22	0.34	0.11	0.07	0.05	0.04	0.02
Oil	Exports	0.23	0.16	0.65	0.51	–	–	–
	Imports	15.38	13.54	13.40	13.74	–	–	–
	Bunkers	–	0.02	0.01	0.01	–	–	–
	Net Imports	15.16	13.36	12.74	13.22	12.25	12.03	11.79
Gas	Exports	–	–	–	–	–	–	–
	Imports	0.15	1.63	2.38	2.29	2.39	2.52	2.64
	Net Imports	0.15	1.63	2.38	2.29	2.39	2.52	2.64
Electricity	Exports	0.90	1.97	2.08	2.37	1.98	1.70	1.50
	Imports	0.60	1.79	2.00	1.78	1.49	1.45	1.42
	Net Imports	–0.30	–0.18	–0.08	–0.58	–0.49	–0.25	–0.08
TOTAL STOCK CHANGES		**0.22**	**0.12**	**–0.00**	**0.21**	**–**	**–**	**–**
TOTAL SUPPLY (TPES)		**19.72**	**25.00**	**25.62**	**26.22**	**24.44**	**24.63**	**24.65**
Coal[1]		0.33	0.36	0.14	0.11	0.05	0.04	0.02
Oil		15.26	13.46	12.70	13.39	12.25	12.03	11.79
Gas		0.15	1.63	2.38	2.29	2.39	2.52	2.64
Comb. Renewables & Wastes[2]		0.24	0.99	1.46	1.41	1.40	1.45	1.49
Nuclear		1.64	6.18	6.57	6.64	5.89	5.84	5.76
Hydro		2.40	2.56	2.44	2.93	2.93	2.97	2.99
Geothermal		–	–	–	–	–	–	–
Solar / Wind / Other[3]		–	–	0.02	0.02	0.02	0.03	0.04
Electricity Trade[5]		–0.30	–0.18	–0.08	–0.58	–0.49	–0.25	–0.08
Shares (%)								
Coal		*1.7*	*1.4*	*0.6*	*0.4*	*0.2*	*0.2*	*0.1*
Oil		*77.4*	*53.8*	*49.6*	*51.1*	*50.1*	*48.8*	*47.8*
Gas		*0.8*	*6.5*	*9.3*	*8.7*	*9.8*	*10.2*	*10.7*
Comb. Renewables & Wastes		*1.2*	*4.0*	*5.7*	*5.4*	*5.7*	*5.9*	*6.0*
Nuclear		*8.3*	*24.7*	*25.6*	*25.3*	*24.1*	*23.7*	*23.4*
Hydro		*12.2*	*10.2*	*9.5*	*11.2*	*12.0*	*12.1*	*12.1*
Geothermal		–	–	–	–	–	–	–
Solar / Wind / Other		–	–	*0.1*	*0.1*	*0.1*	*0.1*	*0.2*
Electricity Trade		*–1.5*	*–0.7*	*–0.3*	*–2.2*	*–2.0*	*–1.0*	*–0.3*

0 is negligible. – is nil. .. is not available.

Please note: Forecast data for electricity and heat generation are IEA Secretariat estimates.

Unit: Mtoe

DEMAND

FINAL CONSUMPTION BY SECTOR

	1973	1990	1996	1997	2000	2005	2010
TFC	**17.57**	**19.59**	**20.61**	**20.23**	**19.53**	**19.75**	**19.83**
Coal[1]	0.29	0.35	0.14	0.11	0.05	0.04	0.02
Oil	14.30	12.85	12.97	12.74	11.75	11.54	11.31
Gas	0.24	1.52	2.19	2.10	2.18	2.30	2.40
Comb. Renewables & Wastes[2]	0.24	0.60	0.74	0.73	1.01	1.05	1.07
Geothermal	–	–	–	–	–	–	–
Solar / Wind / Other	–	–	0.02	0.02	0.02	0.02	0.02
Electricity	2.50	4.04	4.21	4.20	4.26	4.52	4.71
Heat	–	0.25	0.33	0.34	0.26	0.28	0.30
Shares (%)							
Coal	*1.6*	*1.8*	*0.7*	*0.5*	*0.3*	*0.2*	*0.1*
Oil	*81.4*	*65.6*	*62.9*	*63.0*	*60.2*	*58.4*	*57.0*
Gas	*1.3*	*7.7*	*10.6*	*10.4*	*11.2*	*11.6*	*12.1*
Comb. Renewables & Wastes	*1.4*	*3.0*	*3.6*	*3.6*	*5.2*	*5.3*	*5.4*
Geothermal	–	–	–	–	–	–	–
Solar / Wind / Other	–	–	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*
Electricity	*14.2*	*20.6*	*20.4*	*20.7*	*21.8*	*22.9*	*23.8*
Heat	–	*1.3*	*1.6*	*1.7*	*1.3*	*1.4*	*1.5*
TOTAL INDUSTRY[6]	**4.78**	**3.93**	**4.08**	**4.11**	**4.32**	**4.49**	**4.57**
Coal[1]	0.08	0.33	0.13	0.10	0.04	0.03	0.02
Oil	3.70	1.31	1.29	1.29	1.40	1.41	1.34
Gas	0.05	0.59	0.89	0.91	0.96	1.00	1.03
Comb. Renewables & Wastes[2]	–	0.16	0.32	0.34	0.47	0.50	0.52
Geothermal	–	–	–	–	–	–	–
Solar / Wind / Other	–	–	–	–	–	–	–
Electricity	0.95	1.48	1.38	1.40	1.40	1.50	1.61
Heat	–	0.05	0.07	0.08	0.05	0.05	0.05
Shares (%)							
Coal	*1.6*	*8.4*	*3.2*	*2.4*	*0.9*	*0.7*	*0.4*
Oil	*77.4*	*33.4*	*31.7*	*31.4*	*32.4*	*31.4*	*29.3*
Gas	*1.1*	*15.1*	*21.8*	*22.1*	*22.2*	*22.3*	*22.5*
Comb. Renewables & Wastes	–	*4.1*	*7.9*	*8.3*	*10.9*	*11.1*	*11.4*
Geothermal	–	–	–	–	–	–	–
Solar / Wind / Other	–	–	–	–	–	–	–
Electricity	*19.9*	*37.7*	*33.8*	*33.9*	*32.4*	*33.4*	*35.2*
Heat	–	*1.2*	*1.7*	*1.8*	*1.2*	*1.1*	*1.1*
TRANSPORT[7]	**4.29**	**6.29**	**6.51**	**6.73**	**6.13**	**6.32**	**6.49**
TOTAL OTHER SECTORS[8]	**8.49**	**9.38**	**10.02**	**9.39**	**9.08**	**8.94**	**8.77**
Coal[1]	0.21	0.02	0.01	0.01	0.01	0.01	–
Oil	6.48	5.47	5.38	4.93	4.46	4.11	3.81
Gas	0.19	0.92	1.30	1.19	1.22	1.30	1.37
Comb. Renewables & Wastes[2]	0.24	0.44	0.42	0.39	0.54	0.55	0.55
Geothermal	–	–	–	–	–	–	–
Solar / Wind / Other	–	–	0.02	0.02	0.02	0.02	0.02
Electricity	1.37	2.34	2.63	2.59	2.62	2.72	2.77
Heat	–	0.20	0.26	0.26	0.21	0.23	0.25
Shares (%)							
Coal	*2.5*	*0.2*	*0.1*	*0.1*	*0.1*	*0.1*	–
Oil	*76.3*	*58.3*	*53.6*	*52.5*	*49.1*	*46.0*	*43.4*
Gas	*2.2*	*9.8*	*13.0*	*12.6*	*13.4*	*14.5*	*15.6*
Comb. Renewables & Wastes	*2.8*	*4.7*	*4.2*	*4.1*	*5.9*	*6.2*	*6.3*
Geothermal	–	–	–	–	–	–	–
Solar / Wind / Other	–	–	*0.2*	*0.2*	*0.2*	*0.2*	*0.2*
Electricity	*16.1*	*24.9*	*26.2*	*27.6*	*28.9*	*30.4*	*31.6*
Heat	–	*2.2*	*2.6*	*2.8*	*2.3*	*2.6*	*2.9*

Unit: Mtoe

DEMAND

ENERGY TRANSFORMATION AND LOSSES

	1973	1990	1996	1997	2000	2005	2010
ELECTRICITY GENERATION[9]							
INPUT (Mtoe)	**4.48**	**9.35**	**9.97**	**10.47**	**9.58**	**9.59**	**9.60**
OUTPUT (Mtoe)	**3.17**	**4.70**	**4.78**	**5.30**	**5.07**	**5.09**	**5.11**
(TWh gross)	36.82	54.62	55.64	61.62	58.95	59.19	59.42
Output Shares (%)							
Coal	–	*0.1*	–	–	–	–	–
Oil	*7.1*	*0.5*	*0.5*	*0.3*	*1.3*	*1.0*	*1.1*
Gas	–	*0.6*	*1.2*	*1.4*	*1.6*	*1.7*	*1.9*
Comb. Renewables & Wastes	–	*1.0*	*2.1*	*1.8*	*1.0*	*1.0*	*1.1*
Nuclear	*17.1*	*43.3*	*45.2*	*41.2*	*38.2*	*37.8*	*37.1*
Hydro	*75.8*	*54.6*	*51.0*	*55.3*	*57.8*	*58.4*	*58.5*
Geothermal	–	–	–	–	–	–	–
Solar/Wind/Other	–	–	*0.0*	*0.0*	*0.0*	*0.2*	*0.3*
TOTAL LOSSES	**2.17**	**5.05**	**5.65**	**5.61**	**4.91**	**4.88**	**4.82**
of which:							
Electricity and Heat Generation[10]	1.32	4.38	4.82	4.81	4.23	4.20	4.17
Other Transformation	0.14	0.01	0.02	–0.02	0.07	0.07	0.04
Own Use and Losses[11]	0.72	0.66	0.81	0.83	0.61	0.61	0.61
Statistical Differences	**–0.02**	**0.36**	**–0.63**	**0.37**	**–**	**–**	**–**

INDICATORS

	1973	1990	1996	1997	2000	2005	2010
GDP (billion 1990 US$)	182.31	228.41	227.57	231.53	237.84	251.21	260.12
Population (millions)	6.44	6.80	7.11	7.11	7.24	7.39	7.44
TPES/GDP[12]	0.11	0.11	0.11	0.11	0.10	0.10	0.09
Energy Production/TPES	0.22	0.39	0.41	0.42	0.42	0.42	0.42
Per Capita TPES[13]	3.06	3.68	3.61	3.69	3.38	3.33	3.31
Oil Supply/GDP[12]	0.08	0.06	0.06	0.06	0.05	0.05	0.05
TFC/GDP[12]	0.10	0.09	0.09	0.09	0.08	0.08	0.08
Per Capita TFC[13]	2.73	2.88	2.90	2.85	2.70	2.67	2.67
Energy-related CO_2 Emissions (Mt CO_2)[14]	45.9	44.2	42.9	44.8	41.4	41.0	40.5
CO_2 Emissions from Bunkers (Mt CO_2)	–	0.1	0.0	0.0	–	–	–

GROWTH RATES (% per year)

	73–79	79–90	90–96	96–97	97–00	00–05	05–10
TPES	0.2	2.1	0.4	2.3	-2.3	0.2	0.0
Coal	–6.3	4.5	–14.1	–23.6	–23.1	–4.4	–12.9
Oil	–2.2	0.1	–1.0	5.5	–2.9	–0.4	–0.4
Gas	31.0	7.2	6.5	–3.5	1.4	1.1	0.9
Comb. Renewables & Wastes	11.2	7.3	6.6	–2.8	–0.3	0.7	0.5
Nuclear	11.0	6.5	1.0	1.1	–3.9	–0.2	–0.3
Hydro	2.1	–0.5	–0.8	19.9	0.0	0.3	0.1
Geothermal	–	–	–	–	–	–	–
Solar/Wind/Other	–	–	–	5.6	1.7	8.4	5.9
TFC	–0.6	1.3	0.8	–1.8	–1.2	0.2	0.1
Electricity Consumption	2.6	3.0	0.7	–0.3	0.5	1.2	0.8
Energy Production	6.5	4.1	1.3	4.9	–2.3	0.1	–0.0
Net Oil Imports	–1.6	–0.3	–0.8	3.8	–2.5	–0.4	–0.4
GDP	–0.4	2.3	–0.1	1.7	0.9	1.1	0.7
Growth in the TPES/GDP Ratio	0.6	–0.2	0.5	0.6	–3.2	–0.9	–0.7
Growth in the TFC/GDP Ratio	–0.3	–0.9	0.9	–3.5	–2.1	–0.9	–0.6

Please note: Rounding may cause totals to differ from the sum of the elements.

Footnotes to Energy Balances and Key Statistical Data

1 Includes lignite and peat.

2 Comprises solid biomass and animal products, gas/liquids from biomass, industrial waste and municipal waste. Data are often based on partial surveys and may not be comparable between countries.

3 Other includes tide, wave and ambient heat used in heat pumps.

4 Total net imports include combustible renewables and waste.

5 Total supply of electricity represents net trade. A negative number indicates that exports are greater than imports.

6 Includes non-energy use.

7 Includes less than 1% non-oil fuels.

8 Includes residential, commercial, public service and agricultural sectors.

9 Inputs to electricity generation include inputs to electricity, CHP and heat plants. Output refers only to electricity generation.

10 Losses arising in the production of electricity and heat at public utilities and autoproducers. For non-fossil-fuel electricity generation, theoretical losses are shown based on plant efficiencies of 33% for nuclear, 10% for geothermal and 100% for hydro.

11 Data on "losses" for forecast years often include large statistical differences covering differences between expected supply and demand and mostly do not reflect real expectations on transformation gains and losses.

12 Toe per thousand US dollars at 1990 prices and exchange rates.

13 Toe per person.

14 "Energy-related CO_2 emissions" specifically means CO_2 from the combustion of the fossil fuel components of TPES (i.e. coal and coal products, peat, crude oil and derived products and natural gas), while CO_2 emissions from the remaining components of TPES (i.e. electricity from hydro, other renewables and nuclear) are zero. Emissions from the combustion of biomass-derived fuels are not included, in accordance with the IPCC greenhouse gas inventory methodology. TPES, by definition, excludes international marine bunkers. INC-IX decided in February 1994 that emissions from international marine and aviation bunkers should not be included in national totals but should be reported separately, as far as possible. CO_2 emissions from bunkers are those quantities of fuels delivered for international *marine* bunkers and the emissions arising from their use. Data for deliveries of fuel to international *aviation* bunkers are not generally available to the IEA and, as a result, these emissions have not been deducted from the national totals. Projected emissions for oil and gas are derived by calculating the ratio of emissions to energy use for 1996 and applying this factor to forecast energy supply. Future coal emissions are based on product-specific supply projections and are calculated using the IPCC/OECD emission factors and methodology.

B

ANNEX

INTERNATIONAL ENERGY AGENCY
"SHARED GOALS"

The Member countries* of the International Energy Agency (IEA) seek to create the conditions in which the energy sectors of their economies can make the fullest possible contribution to sustainable economic development and the well-being of their people and of the environment. In formulating energy policies, the establishment of free and open markets is a fundamental point of departure, though energy security and environmental protection need to be given particular emphasis by governments. IEA countries recognise the significance of increasing global interdependence in energy. They therefore seek to promote the effective operation of international energy markets and encourage dialogue with all participants.

In order to secure their objectives they therefore aim to create a policy framework consistent with the following goals:

1 Diversity, efficiency and flexibility within the energy sector are basic conditions for longer-term energy security: the fuels used within and across sectors and the sources of those fuels should be as diverse as practicable. Non-fossil fuels, particularly nuclear and hydro power, make a substantial contribution to the energy supply diversity of IEA countries as a group.

2 Energy systems should have **the ability to respond promptly and flexibly to energy emergencies.** In some cases this requires collective mechanisms and action: IEA countries co-operate through the Agency in responding jointly to oil supply emergencies.

3 The environmentally sustainable provision and use of energy is central to the achievement of these shared goals. Decision-makers should seek to minimise the adverse environmental impacts of energy activities, just as environmental decisions should take account of the energy consequences. Government interventions should where practicable have regard to the Polluter Pays Principle.

4 More environmentally acceptable energy sources need to be encouraged and developed. Clean and efficient use of fossil fuels is essential. The development of economic non-fossil sources is also a priority. A number of IEA Members wish to retain and improve the nuclear option for the

* Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Japan, Luxembourg, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, United Kingdom, United States.

future, at the highest available safety standards, because nuclear energy does not emit carbon dioxide. Renewable sources will also have an increasingly important contribution to make.

5 Improved energy efficiency can promote both environmental protection and energy security in a cost-effective manner. There are significant opportunities for greater energy efficiency at all stages of the energy cycle from production to consumption. Strong efforts by governments and all energy users are needed to realise these opportunities.

6 Continued **research, development and market deployment of new and improved energy technologies** make a critical contribution to achieving the objectives outlined above. Energy technology policies should complement broader energy policies. International co-operation in the development and dissemination of energy technologies, including industry participation and co-operation with non-Member countries, should be encouraged.

7 Undistorted energy prices enable markets to work efficiently. Energy prices should not be held artificially below the costs of supply to promote social or industrial goals. To the extent necessary and practicable, the environmental costs of energy production and use should be reflected in prices.

8 Free and open trade and a secure framework for investment contribute to efficient energy markets and energy security. Distortions to energy trade and investment should be avoided.

9 Co-operation among all energy market participants helps to improve information and understanding, and encourage the development of efficient, environmentally acceptable and flexible energy systems and markets worldwide. These are needed to help promote the investment, trade and confidence necessary to achieve global energy security and environmental objectives.

(The Shared Goals were adopted by IEA Ministers at their 4 June 1993 meeting in Paris.)

C

ANNEX

GLOSSARY AND LIST OF ABBREVIATIONS

In this report, abbreviations are substituted for a number of terms used within the International Energy Agency. While these terms generally have been written out on first mention and abbreviated subsequently, this glossary provides a quick and central reference for many of the abbreviations used.

bcm — billion cubic metres.

CHP — combined production of heat and power; sometimes, when referring to industrial CHP, the term "co-generation" is used.

DETEC — Federal Department for Environment, Transport, Energy and Communication.

EU — The European Union, whose members are Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, Sweden and the United Kingdom.

GDP — gross domestic product.

GW — gigawatt, or 1 watt $\times 10^9$.

IEA — International Energy Agency whose Members are Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Japan, Luxembourg, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, United Kingdom, United States.

LDC — local distribution companies.

LPG — liquefied petroleum gas; refers to propane, butane and their isomers, which are gases at atmospheric pressure and normal temperature.

Mt — million tonne.

Mtoe — million tonne of oil equivalent; see toe.

MW — megawatt of electricity, or 1 Watt $\times 10^6$.

MWh — megawatt-hour = one megawatt $\times$ one hour, or one watt $\times$ one hour $\times 10^6$.

NAGRA — Swiss National Co-operative for the Disposal of Radioactive Waste.

NEA — the Nuclear Energy Agency of the OECD.

OECD	Organisation for Economic Co-operation and Development.
PJ	Petajoule = 10^{15} joules.
PPP	Purchasing power parity: the rate of currency conversion that equalises the purchasing power of different currencies, i.e. estimates the differences in price levels between different countries.
R&D	research and development, especially in energy technology; may include the demonstration and dissemination phases as well.
SAEFL	Swiss Federal Agency for the Environment, Forests and Landscape.
SB	Single Buyer.
SFOE	Swiss Federal Office of Energy.
SLT	Standing Group on Long-Term Co-operation of the IEA.
TFC	total final consumption of energy; the difference between TPES and TFC consists of net energy losses in the production of electricity and synthetic gas, refinery use and other energy sector uses and losses.
TJ	Terajoule = 10^{12} joules.
toe	tonne of oil equivalent, defined as 10^{7} kcal.
TPA	Third Party Access.
TPES	total primary energy supply.
TW	terawatt, or 1 watt $\times$ 10^{12}.
TWh	terawatt $\times$ one hour, or one watt $\times$ one hour $\times$ 10^{12}.