UN Framework Convention on Climate Change

Second national communication of Switzerland 1997

Greenhouse Gas Inventory 1995

SCHWEIZERISCHE EIDGENOSSENSCHAFT
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Overview

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Foreword

The UN Framework Convention on Climate Change was ratified by Switzerland towards the end of 1993. Now, over 3 years later, the shape of Swiss policy on climate change is becoming clearer. The present (second) report shows the considerable efforts which have been made. It also demonstrates that the Swiss people and their government have taken responsibility for this issue, and are prepared to contribute to a global strategy of precaution in the spirit of the Climate Convention.

Two aspects seem particularly worth mentioning. The first concerns achievements in CO2 emissions. At the 1990 Second World Climate Conference held in Geneva, a commitment was made by Switzerland involving the stabilisation of CO2 emissions. This goal seems to be within reach, as 1995 emissions were below the level of 1990, and this tendency is expected to continue in the coming years. A range of measures in the public and private sectors have contributed to this success. The second aspect relates to progress with legislative instruments. There is currently a project for a law to reduce CO2 emissions and it is intended that this should become the cornerstone of the strategy for reducing emissions. This project has already successfully been through a nation-wide consultation process, and it will be debated in parliament during 1997. If passed, this law will enable substantial reductions in CO2 emissions to be made, in a way that is feasible both economically and socially. I am therefore confident that the pragmatic approach which is linked to the Swiss consensus-oriented political structures will ensure that Switzerland will not contribute to any severe disruption of global climate, with the potential implications that such changes could have for the global community.

Although the results of the initial phase of Swiss climate policy have been encouraging, much still remains to be done. The political challenge is to achieve a lasting balance between economic, social and environmental needs, with acceptable living conditions everywhere. Finding ways to reconcile these objectives will be very demanding, and a world satisfying the criteria of sustainability will not be as we know it today. Switzerland is ready to contribute, not only by finding ways and means at the national level to fulfil its international commitments, but also acting in partnership with all who seek solutions to balance the abundant resources of this planet with the basic needs of mankind.

Berne, April 1997

Philippe Roch, Director
Federal Office of Environment, Forests and Landscape

1. Executive Summary

1.1. Introduction and retrospect

This report is Switzerland's second National Communication under the UN Framework Convention on Climate Change. In accordance with Convention guidelines, it documents activities undertaken with a view to meeting commitments under the Convention. Switzerland signed the United Nations Framework Convention on Climate Change on 9th May 1992. A first national communication was submitted on 21st September 1994. The in-depth review of this communication was carried out between August 1995 and January 1996.
A report containing updated inventories for 1990 to 1994 (Swiss Confederation, 1996) was submitted to the UNFCCC in spring 1996.
The most noteworthy recent developments related to climate policy are as follows:

- Within national research programmes, the present knowledge of climate science in Switzerland (climate effects, vulnerability and adaptation) could be improved.
- The national "Energy 2000" Programme has reached its half-way point. A set of evaluation projects have been carried out to monitor the latest developments and to clarify future strategies and the allocation of budgets.
- The Swiss Environmental Protection Law has been revised and now contains the possibility to introduce market based instruments. A special tax on NMVOC emissions is in preparation.
- The Swiss electorate accepted a revised article in the Constitution to promote a sustainable agricultural policy based on ecological principles.
- Several measures addressing climate change are under consideration (e.g. a draft for a CO_2 law, enabling the Swiss Government to introduce a CO_2 tax, a new energy law, a weight and kilometre dependent tax on heavy goods vehicles).
- The Advisory Body on Questions relating to Climate and Climate Change, an advisory body of the Federal Department of Home Affairs on climate change research and policy, was formed under the auspices of the Swiss Academy of Sciences on January 1st 1997.

1.2. National circumstances

The present population of Switzerland is 7.06 million, of which two thirds live in metropolitan areas. The whole area is approximately 41,300 km^2. 30 % are forests, 38 % cropland and permanent pasture, 6 % built up and 26 % unproductive land. Nominal gross domestic product (GDP) for 1995 was CHF 362 billion, which was a 2.6 % increase over the previous year. However, real GDP has been stagnant since 1991. Since then, Switzerland, like other European countries, has faced growing economic problems, with an increasing level of unemployment (0.6 % in 1990; 4.2 % in 1995) and growing deficits in the national budget.
The energy sector in Switzerland produces mainly electricity (61 % hydroelectric power and 37 % nuclear power from five plants), whereas fossil fuels are imported. Regarding the use of primary energy, the proportion of electricity is 37 % and 58 % are fossil fuels. Electricity is traded across Swiss borders on rather a large scale. Amongst the factors affecting the trade volume are hydrological and climatic conditions. Traditionally Switzerland has been a net exporter of electricity.
Emissions of CO_2 from road transport are based on fuel sold in Switzerland. This includes the so-called "tank tourism" which occurs because fuel prices in Switzerland are

at present significantly lower than in neighbouring countries. This leads to an overestimation of emissions released in Switzerland.
Climatic conditions vary significantly across Switzerland, depending mainly on altitude and location (north or south of the Alps). Since there is a considerable yearly variation in weather conditions, heating degree days are an important basis for calculating the effect of variations in weather on energy consumption and CO_2 emissions (climate correction).
The Swiss political system is a Confederation with a Federal government, parliament and court. The territory consists of 26 cantons (states), each of which has its own government, parliament and cantonal courts. Responsibilities are shared between the federal level and the cantons. Subsidiarity plays an important role. This is reflected in constitutional law which states that unless the legislative power is explicitly attributed to the Federal level, the cantons are sovereign, i.e. entitled to legislate in an area of policy. Cooperation (between the different political levels and between the government and the economy) is of considerable importance in Switzerland. It is a representative democracy with strong direct democracy rights, and public participation, through initiatives, referenda and consultation procedures is very important and applied on a regular basis.
Switzerland is a member of several international organisations (e.g. OECD, World Bank Group, and all UN specialised agencies). However, it is not a member of the UN or of the European Union. A governmental proposal to join the European Economic Area, the economic core of the EU, was turned down in 1992. Switzerland has been in bilateral negotiations with the EU since 1992 on major policy areas such as the free movement of persons, and transport by land and air.

1.3. Anthropogenic emissions and removals

Switzerland has provided standardised technical inventories (according to IPCC guidelines) for the years 1990-1994. The present inventory relates to 1995.

1.3.1. 1995 Inventory

Gross CO_2 emissions
In 1995 these emissions amounted to 44,200 Gg i.e. 6.3 tonnes per capita. Three quarters of these emissions were from transportation (33 %) and small-scale combustion (41 %). Industry accounted for 18 % and bunker fuel emissions from international aviation (emitted outside Swiss territory) are estimated at 2,400 Gg, although the latter is not included in national inventory figures. At present, the difference between carbon harvest and carbon uptake (by forests) gives an absorption of the order of 5,100 Gg CO_2. Thus Swiss forests are significant sinks, absorbing a volume corresponding to 11.5 % of gross CO_2 emissions.
Emissions of CH_4
Methane emissions were 235 Gg, with nearly two thirds from agriculture, and 28 % emitted by the waste sector.
Emissions of N_2O
Total emissions amounted to 11.8 Gg, with three quarters emitted by agriculture. Transport is another important source, with about 15 %.

Other greenhouse gases (HFC, PFC and SF_6)
These have been of marginal importance in Switzerland, and detailed inventory data are not yet available. A pilot survey of these substances in 1995 to 1996 led to preliminary data showing that 0.2 Gg HFC, 0.005 Gg PFC and 0.03 Gg SF_6 were emitted in 1995. Improved data will be available for the 1996 greenhouse gas (GHG) inventory.

Precursor gases
Of a total of 134 Gg NO_X emissions, 61 % came from the transport sector. Small-scale combustion (14 %) was the second most important source.
From the total of 510 Gg CO emitted, 63 % were from the transport sector. Equal amounts of about 10 % were emitted by small-scale combustion and the "off road / military" sector.
In 1995 201 Gg NMVOC were emitted. The main sources were solvent use (58 %) and transport (25 %).

SO_2 emissions
Contrary to the above gases, SO_2 is not a greenhouse gas. In fact SO_2 emissions counteract the process of global warming. Nevertheless, SO_2 is a very dangerous air pollutant, causing damage to nature and human health, thus giving good reasons for reducing these emissions. In Switzerland, 34 Gg were emitted in 1995, with small-scale combustion in the lead at 43 %, followed by industry with 23 %.
Table 1-1 gives an overview of emissions in 1995.

IPCC	Source/Sink Category	CO_2 (1,000 Gg)	CH_4 (Gg)	N_2O (Gg)	NO_X (Gg)	CO (Gg)	NMVOC (Gg)	SO_2 (Gg)
1	All Energy Fuel combustion Fugitive emissions	40.2 (40.1) (0.07)	21 (7.8) (12.8)	2.0 (2.0) (0.0)	127 (126.8) (0.15)	488 (488) (0.0)	74 (65.6) (8.2)	28 (28) (0.0)
2	Industrial processes	2.6	0.4	0.31	0.33	10.6	7.6	3.6
3	Solvent use	n.o. 1)	n.o.	0.38	0.04	0.09	117	0.04
4	Agriculture 2)	n.e. 3)	148	8.8	n.e.	5.9	0.3	0.02
6	Waste	1.3	66.5	0.28	6.3	5.5	1.9	2.5
	Total gross emissions	**44.2**	**235**	**11.8**	**134**	**510**	**201**	**34**
5	Land use change and forestry	-5.1	n.e.	n.e.	n.e.	n.e.	n.e.	n.e.
	Total net emissions	**39.1**	**235**	**11.8**	**134**	**510**	**201**	**34**
	International bunkers	(2.4)						

1) n.o. = not occuring
2) Agricultural soils incomplete
3) n.e. = not estimated

Table 1-1: Overview of emissions and sinks 1995 (categories according to IPCC short summary table)

1.3.2. Recent trends in emissions

Compared with the 1990 inventory there is a slight decline (3-5 %) in the emissions of CO_2 and CH_4. The main reasons for this decline can be attributed to the effects of energy-related policies and measures (for CO_2) and stringent prescriptions in the waste sector (in the case of CH_4). Additionally, the recessional trend led to a slow-down in energy use in all sectors. On the other hand N_2O emissions increased slightly (2 %), as a result of the increasing use of catalytic converters, which counteracted the 5 % decrease in the agricultural sector.
Precursor gas emissions declined significantly between 1990 and 1995. The most important reasons are the effect of stringent emission standards in different sectors

(especially transport and small-scale combustion). Emissions of CO and NMVOC declined by 28 % and NO_X emissions by 18 %.
Between 1990 and 1995 SO_2 emissions declined by nearly 20 %. This is due to lower limits for sulphur in heavy fuel oil and in diesel fuel.

1.3.3. Overall emission balance

On the basis of Global Warming Potential (GWP) values for a 100 year time horizon (CO_2 = 1; CH_4 = 21; N_2O = 310), the gross GHG emissions of Switzerland amounted to 52,800 Gg of CO_2 equivalents in 1995. If removals by sinks are considered, this amount is reduced to a net emission of 47,700 Gg of CO_2 equivalents.
In comparison with 1990 there is no significant change.
The contribution by sector is shown in figure 1-1. The largest proportions are from the transport sector with 29 % and from the residential sector with 23 %.

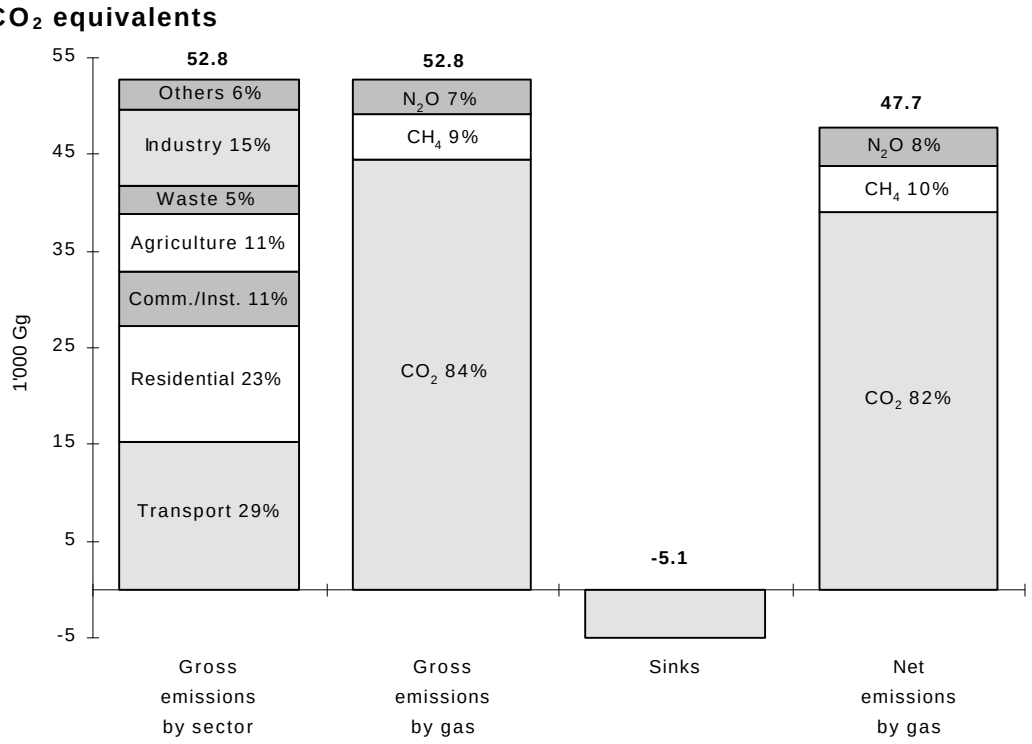

Figure 1-1: CO_2 equivalents by sector and by gas 1995 (without international bunkers)

1.4. Policies and measures

1.4.1. Climate policy issues

Climate policy in Switzerland is incorporated into the policies for different sectors which existed before climate change became an important issue. The following are the most important.

Environmental policy

The Swiss Federal Environment Protection Law focuses on the precautionary principle and the “polluter pays” principle. Moreover, a number of ordinances (e.g. air pollution, waste disposal, hazardous substances) also relate to climate change. The law was revised in 1995 and is also the legal basis for price-oriented measures.

Energy policy

The Decree on Energy Use (1990) sets out the legal basis for several energy-saving measures. The “Energy 2000” Programme was launched in the same year. This programme intends to stabilise CO_2 emissions by the year 2000 and then to reduce them. Other important aims are the stabilisation of electricity demand after 2000 and the increase of the share of renewable energies in energy supply. The total budget for federal promotion measures in the field of energy amounted to CHF 54.3 million in 1996. The programme is based on the cooperation principle, thus integrating

cantonal and communal levels as well as private sector activities. The main principles of the programme are first, increasing incentives for voluntary efforts; secondly, improving the governmental framework to favour sustainable energy supply and demand, and thirdly, mediation and discussion of critical issues at round tables (e.g. the future of nuclear energy).

Transport policy

The Swiss transport policy favours an environmentally friendly transport system and aims to slow down the trend for emissions to increase. The reduction of fuel consumption and the internalisation of external costs are very important aims. At the same time, public transport services are at a very high level and provide the capacity for shifts towards rail. Sustainable Alpine transit traffic is given high priority. The Transit Treaty with the European Union (1994) sets out the obligation to build new transalpine railway infrastructure.

Agricultural policy

Swiss agricultural policy has been undergoing a major reform since the beginning of this decade. The main goal is to obtain sustainable production consistent with market demands, landscape management and the conservation of natural resources. A main element is the separation of price policy from income policy.

Forestry policy

The new forest law, in force since 1993, confirms the long-standing Swiss tradition of preserving the forest area and protects the forests as an ecosystem which is similar to nature.

1.4.2. Implemented measures

Table 1-2 gives an overview of measures which are relevant to climate[1] and have been taken in the various sectors (state of January 1997).

1.4.3. Activities implemented jointly

At COP 2, Switzerland announced its intention to participate in the pilot phase for Activities Implemented Jointly under the UNFCCC. A secretariat to manage the programme began operations in February 1997.

1.4.4. Measures under consideration

Table 1-3 gives an overview of measures which are relevant to climate[1] and are under consideration in the different sectors (state of January 1997).

1 Note: Individual measures may have low or medium mitigation impact while their combination ia a sectoral policy context leads to significant emission mitigation. The classification of expected relative impact is valid within, but not across policy sectors.

Name of policy / measure	Type of instrument	Objective/method of achieving reduction	Sector	Status of implementation	Estimate of mitigation impact short term (2000) long term (2020)	Monitoring and responsibilities
Reduction of specific energy consumption of electric appliances and motorcars	Objective targets Voluntary agreements & regulations	Different targets according to domains and appliances 7 to 19%	Residential and service sector Passenger road transport	Ordinance adopted 1992 (electronic appl.) 1995 (cars)	impact on CO_2 short term - medium long term - high	Continuous evaluation by the Federal Office of Energy
Limit values for energy consumption in the building sector	Regulation	Targets for the energy consumption including hot water installation	Building sector	Ordinance adopted 1992	impact on CO_2 short term - medium long term - high	Continuous Evaluation by the Federal Office of Energy
Individual metering and invoycing of heat and hot water	Regulation price oriented	Prescription that new buildings need installations to enable individual consumption accounting	Building sector	Ordinance adopted 1992	impact on CO_2 short term - low long term - medium	Continuous evaluation by the Federal Office of Energy
VAT on fuels	Fiscal measure	VAT on fuels at 6.5%	All energy sectors	Law adopted 1994	impact on CO_2 short term - medium long term - medium	Continuous evaluation by the Federal Department of Finance
Increase of excise duties on fuel	Fiscal Price oriented	Increase of 20 ct per litre (petrol and diesel)	Road transport	Decree adopted 1993	impact on CO_2 short term - medium long term - medium	Continuous evaluation by the Federal Department of Finance
Energy saving programmes (Energy 2000 Programme)	Voluntary agreements, marketing, support for government measures	Integral programme: Support for new technologies, improved awareness, improved marketing channels	All energy sectors Different programmes in eight sectors	Ongoing programmes since 1990	impact on CO_2 short term - medium long term - high	Specific programme and action monitoring (yearly).
Energy saving measures an incentives for renewable energies on regional/local level	Regulations, financial incentives	Support of national actions, measures in the building sector, public transportation	All energy sectors different programmes in different sectors	Ongoing and initiated measures	impact on CO_2 short term - medium long term - high	Yearly monitoring reports by the Conference of the Cantons

Table 1-2: Overview of implemented measures to mitigate climate change (January 1997)

Name of policy / measure	Type of instrument	Objective/method of achieving reduction	Sector	Status of implementation	Estimate of mitigation impact short term (2000) long term (2020)	Monitoring and responsibilities
Sustainable logging	Regulation	Protection of sink capacity	Forestry	Confirmed in the Forest law 1993	impact on CO_2 medium	Continuous control by forest service
Construction of new transalpine railway axis	Investment in rail infrastructure	Shift from road to rail in transalpine freight and passenger transport	Transalpine transport (freight and passenger transport)	Legislation adopted 1992 Financial schemes under discussion	Impact on CO_2 and Precursors short term - none long term - medium	Evaluation by Federal Office of Transport (Initial construction works)
Agricultural policy reform	Economic instrument	Establishment of land areas for ecological compensation (set-aside areas) Cultivation of energy crops Reduction of nutrient losses by equilibrating the nutrient balance;	Agriculture	Implementation started in 1993 Direct payments are implemented;	Impact on CO_2 short term - low long term - low Impact on N_2O short term - high long term - medium	Continous evaluation by the Federal Office of Agriculture (C-balance, nutrient balance, N_2O emissions)
Regulation concerning milk production	Regulation	Stabilisation of milk production; stabilisation of animal numbers	Agriculture	Implemented since 1977 with several revisions	Impact on CH_4 short term - low long term - low	CH_4 emission balances
Water protection law	Regulation	Limitation of number of animals per surface unit	Agriculture	Revision of the law adopted 1991	Impact on CH_4 short term - medium long term - low	CH_4 emission balances
Waste deposition/ incineration	Regulation	Prescription to incinerate all combustible waste	Waste	Ordinance adopted in 1991	Impact on CH_4 short term - medium long term - medium	Continuous evaluation by the Federal Office of Environment, Forests and Landscape and by the cantons (e.g. inspections)

Table 1-2: Overview of implemented measures to mitigate climate change (continued)

Name of policy / measure	Type of instrument	Objective/method of achieving reduction	Sector	Status of implementation	Estimate of mitigation impact short term (2000) long term (2020)	Monitoring and responsibilities
Air pollution emission standards in the transport sector	Regulation Standards	Emission standards (e.g. adaption of EURO II level)	Road transport	Implemented since 1987 last adaption to EU level 1996 (EURO II)	Impact on precursors short term - high long term - medium	Federal Office of Environment, Forests and Landscape
Air pollution emission standards for combustion	Regulation Standards	Emission standards for combustion installations	Residential, commercial, industry	Ordinance adopted 1985 and revised 1992	Impact on precursors NO_X short term - medium long term - medium	Federal Office of Environment, Forests and Landscape and the cantons
Air pollution emission standards for fugitive emissions	Regulation Standards	Emission limits for fugitive fuel emissions and solvent use	Industry	Ordinance adopted 1985 and revised 1992	Impact on precursors NMVOC short term - high long term - high	Federal Office of Environment, Forests and Landscape and the cantons
NMVOC tax	Fiscal measure	Incentive tax on imported and domestically-produced NMVOC (3 CHF per kg)	Industry	Legal basis adopted 1995, Ordinance in preparation	Impact on precursors (NMVOC) short term - medium long term - high	Federal Office of Environment, Forests and Landscape
Air pollution emission standards for fuels	Regulation Standards	Prescriptions for sulphur content of fuels	Residential, commercial, institutional, industry; transport	Ordinance adopted 1985 and revised 1992	Impact on SO_2 short term - medium long term - medium	Federal Office of Environment, Forests and Landscape and the cantons
Tax on light fuel oil with a sulphur content exceeding 0.1%	Fiscal instrument	Tax of 20 CHF per ton of light fuel oil with a sulphur content of more than 0.1%	Residential, commercial, industry,	Legal basis adopted 1995 Ordinance in preparation	Impact on SO_2 short term - medium long term - medium	Federal Office of Environment, Forests and Landscape

Table 1-2: Overview of implemented measures to mitigate climate change (continued)

Name of policy / measure	Type of instrument	Objective/method of achieving reduction	Sector	Status of implementation	Estimate of mitigation impact short term (2000) long term (2020)	Monitoring and responsibilities
Air pollution measures at cantonal level	Investment Regulations shared cost actions	Additional measures within cantonal action plans (e.g. stringent standards, parking policy and capacity restrictions, speed limits)	All sectors	Ongoing implementation of different measures	Impact on Precursors short term - medium long term - medium Impact on CO_2 & CH_4 short term - low long term - low	Regularly monitoring at cantonal level
Ordinance relating to environmentally hazardous substances	Regulation	Ban of HFCs and PFCs as fire extinguishing agents	Industry, commercial, residential	Implemented since 1996	HFC, PFC preventive measure (high)	Control by the cantons. Yearly monitoring by the FOEFL
Ordinance relating to spray cans	Regulation	Positive list of allowed propellants for domestic use	Residential, commercial	Implemented since 1995	HFC, PFC preventive measure (high)	Control by the cantons
Air pollution emission standards for solvents uses	Regulation, standards	Emission standards	Industry	Implemented since 1996	HFC, PFC preventive measure (high)	Control by the cantons. Yearly monitoring by the FOEFL

Table 1-2: Overview of implemented measures to mitigate climate change (continued)

Name of policy / measure	Type of instrument	Objective/method of achieving reduction	Sector	Status of implementation	Estimate of mitigation impact short term (2000) long term (2020)	Monitoring and responsibilities
Law on the reduction of CO_2 emissions	Institutional voluntary agreements financial incentives	Definition of reduction targets and agreements with the private sector Possibility to introduce a CO_2 tax	All sectors	Draft law (message) to Parliament 1997	Reduction target for CO_2 2010 minus 10% in relation to 1990 level	Elaboration of draft law by Federal Office of Environment, Forests and Landscape
Energy law	Institutional, Voluntary agreements, Regulations financial incentives	Transformation of the Decree of energy use into ordinary law (Coord. with law on CO_2 emissions)	All sectors	Draft law (message) discussed in Parliament 1997	Increase of long term impact of existing energy related measures	Federal Office of Energy
Distance and weight dependent charge for heavy goods vehicles	Fiscal measure	1,6 ct. per km and tonne total weight (2001) 2,5 ct (2005)	Road freight transport	Draft legislation in parliamentary discussion	Impact on CO_2 and precursors short term - medium long term - high	Federal Department of Transport, Communications and Energy
Financing of large infrastructure investments	Fiscal measure	Road-related financing measures to increase competitiveness of rail	Transport	Parliamentary discussion; Implementation earliest 1998	Impact on CO_2 and precursors Short term - low Long term - medium	Elaboration of draft law by interdepartmental group
Implementation of Alpine Initiative	Fiscal Investment	(In addition to above measues) Specific charge for alpine transiting road freight transport	Transalpine freight transport	Draft legislation in consultation process Implementation earliest 2004	Impact on CO_2 and precursors Short term - none Long term - medium	Consultation paper elaborated by the Federal Office of Transport
Air pollution emission standards in the transportation sector	Regulation Standards	Emission standards (e.g. adaption to EURO III) Standards for agricultural and construction vehicles	Road transport Agriculture Construction sector	According to EU (1997/2001)	Impact on precursors short term - medium long term - high	Continous evaluation by FOEFL
Emission-dependent landing tax for air traffic	Fiscal instrument	Landing tax on specific emissions of NO_X and VOC for airplanes	Air transport	Legal basis adopted, Concept elaborated	Impact on precursors short term - low long term - medium	Prep. of consultation paper (Federal Office of Civil Aviation)

Table 1-3: Overview of measures under consideration to mitigate climate change (January 1997)

1.5. Projections

1.5.1. Forecasts for CO_2

The forecasts for CO_2 are based on scenarios using bottom-up model calculations. These models are applied for long term energy perspectives 1990-2030. The results do differ from inventory results, mainly because they contain international bunker fuel emissions and consider climate correction.
Non-energy CO_2 emissions are based on production estimates. Sinks are based on trend extrapolations. For agricultural soils, no data are available at present.
Table 1-4 shows overall emission trends between 1995 and 2010.

CO_2 1,000 Gg	**1995**	**2010**
Energy 1)	43.0 2)	44.6
Industrial processes	2.6	2.6
Solvent use	0.0	0.0
Agriculture	n.e.	n.e.
Land use change/ forestry	-5.1	-5.1
Waste	1.4	1.6
Total	**41.8**	**43.7 (+4,5%)**

1) including international bunkers 1995 2,400 Gg, 2010 3,200 Gg
2) modelled value, climate corrected
n.e. not estimated

Table 1-4: CO_2 emission forecasts (implemented measures)

1.5.2. Other GHG emissions

For the estimation of CH_4 and N_2O emissions from agriculture, the IPCC inventory methodology was used. Emissions from other sources are based on national estimations for air pollutants.

No model-based forecasts are available for HFCs, PFCs and SF_6. However, rapid growth is expected in certain applications. Estimated annual growth rates in HFC emissions are 20 % (5 - 30 %) in refrigeration and air conditioning, 3 to 5 % in insulation foam, and 100 % in aerosol propellants. PFC consumption in the solvent sector may expand at an annual rate of 10 to 50 %.

CH_4 Gg	**1995**	**2010**
Energy	20.6	17.7
Industrial processes	0.4	0.5
Solvent use	0.0	0.0
Agriculture	148	145
Land use change/ forestry	n.e.	n.e.
Waste	66.5	29.3
Total	**235**	**192 (-18%)**

n.e. not estimated

Table 1-5: CH_4 emission forecasts (implemented measures)

N_2O Gg	**1995**	**2010**
Energy	2.03	2.57
Industrial processes	0.31	0.31
Solvent use	0.38	0.41
Agriculture	8.82	7.54
Land use change/ forestry	n.e.	n.e.
Waste	0.28	0.50
Total	**11.8**	**11.3 (-4.2%)**

n.e. not estimated

Table 1-6: N_2O emission forecasts (implemented measures)

1.5.3. Development in terms of GWP

Table 1-7 shows the forecasted values for the aggregate effect of CO_2, CH_4 and N_2O emissions on the basis of IPCC 1996 Global Warming Potential (GWP) figures (see section 1.3.3.).

GWP 1,000 Gg	**1995**	**2010**
Energy 1)	44.0 2)	45.9
Industrial processes	2.7	2.7
Solvent use	0.1	0.1
Agriculture	5.8	5.4
Land use change/ forestry	-5.1	-5.1
Waste	2.8	2.4
Total	**50.4**	**51.4 (+2%)**

1) including international bunkers 1995 2,400 Gg, 2010 3,200 Gg
2) modelled value, climate corrected
n.e. not estimated

Table 1-7: Aggregate emission forecasts (CO_2, CH_4, N_2O) in CO_2 - equivalents

1.5.4. Precursors and SO_2

The estimations are based on overall long term perspectives for air pollutants. Due to measures to reduce air pollution, all emissions are tending to decline. Between 1995 and 2010, the following changes are expected.

- NO_X -18 %
- CO -28 %
- NMVOC -19 %
- SO_2 -12 %

1.5.5. Effects of measures under consideration

Table 1-8 shows the energy-related perspectives for a scenario considering the effects of the implemented measures and a scenario including the effects of the measures under consideration (including a CO_2 tax).

1,000 Gg CO_2	**1990**	**1995**	**2000**	**2010**	**2020**	**2030**
Scenario I (implemented measures)						
Energy transformation	1.5	1.6	1.6	1.6	1.6	1.6
Residential	13.2	12.4	11.9	11.4	10.9	10.3
Commercial / Institutional	5.4	5.1	4.9	4.6	4.2	3.9
Industry	7.2	6.0	5.3	5.9	5.8	6.0
Transport 1)	17.2	17.8	18.9	21.2	22.7	22.9
Total 1)	**44.5** 2)	**43.0** 2)	**42.6**	**44.6**	**45.1**	**44.6**
Scenario II (including measures under consideration)						
Energy transformation	1.5	1.6	1.6	1.5	1.6	1.7
Residential	13.2	12.4	11.6	11.1	10.5	9.8
Commercial / Institutional	5.4	5.1	4.9	4.5	4.0	3.7
Industry	7.2	6.0	5.3	5.6	5.5	5.7
Transport 1)	17.2	17.8	17.5	17.2	17.9	18.1
Total 1)	**44.5** 2)	**43.0** 2)	**40.9**	**39.9**	**39.5**	**39.0**

1) including international bunkers 2) modelled value, climate corrected

Table 1-8 CO_2 forecasts for the two scenarios "implemented measures" and "measures under consideration" (energy-related CO_2 emissions only)

1.6. Impacts and adaptation

Recent research has investigated the effects of climate change in Switzerland. Monitoring and model results indicate that there might be significant effects on ecosystems and hydrological cycles due to climate change. Particular effects are expected in alpine regions, where permafrost reacts immediately to changes in surface temperature.

A comprehensive assessment of climate vulnerability in Switzerland has not been undertaken yet. Nonetheless, the information available points to the following sectors that may be particularly vulnerable to climate change. The **financial service and insurance sector**, which plays an important role in the Swiss economy, faces the risk of increased payments due to extreme weather events. Due to changing weather patterns and a decrease in snowfall in some lower alpine regions, the **tourism sector** might face less customer demand during the skiing season, and a decrease in income. The third important sector is **forestry** where climate change might induce significant shifts in species composition, thus weakening the important protective capacity of forests, especially in alpine areas.
Real measures for adaptation in different sectors are being evaluated. The insurance sector is particularly involved in proactive campaigns and has taken a leading role in studying adaptation strategies. Other actions in alpine regions which may be affected involve looking into alternatives in the areas of tourism and agriculture.

1.7. Technology transfer and financial assistance

Switzerland's involvement consists of the following.

- Contribution to **Global Environment Facility (GEF).** During the pilot phase (1991-1993) the contribution amounted to CHF 80 million. These contributions were extended. Between 1994 and 1996 Switzerland contributed about CHF 60 million to GEF2.
- Bilateral technical cooperation.
- Contributions for technology transfer.

The funding of this international collaboration is mainly secured by three framework credits.

- A credit of CHF 300 million over five years to finance GEF and to fund environment-related bilateral projects in developing countries. The bilateral component, which is managed by the Swiss Agency for Development and Cooperation (SDC) amounts to about CHF 150 million. Between 1991 and 1996, CHF 128 million were committed to funding 60 programmes and projects. In 1995, 31 projects and about CHF 30 million were directly related to climate change issues.
- Two framework credits (in total CHF 1,650 million) are for cooperation with Central and Eastern Europe, with a number of projects addressing improvements in the energy sector.

In addition, a number of individual measures support efforts to reduce GHG emissions. 16 projects in 1994 (CHF 10.4 million) and 24 projects in 1995 (CHF 26.8 million) were carried out. A major part is aiming at improving energy efficiency, by promoting innovative technology, renewable energy sources, and the use of substances which do not deplete the ozone layer. Studies of atmospheric pollution and the planning of appropriate measures are also funded.

1.8. Research and systematic observation

The most important topics of climate research are the physical climate system (e.g. studies on atmospheric processes and dynamics; alpine vulnerability; regional climate; the analysis of time series data; the history of the climate; monitoring). Other important topics are the analysis of biogeochemical processes, the impacts of climate change, and the human dimensions of global change. Two national research programmes are of major importance (National Research Programme 31 "Climate Changes and Natural Disasters" and the Priority Programme "Environmental Technologies and Environmental Research"). These programmes are coordinated with international climate research. In addition, Switzerland contributes significantly to the World Climate Research Programme, the International Geosphere - Biosphere Programme, and to the International Human Dimensions of Global Environmental Change Programme.
Swiss energy research is coordinated by the Federal Office of Energy. A major part of it is related to the development of renewable energy sources and efficient energy use. The research efforts are linked to international research activities (EUREKA, COST and the EU Framework Programmes). In 1995 a total amount of CHF 215 million were allocated to energy research.
The Swiss government coordinates and supports monitoring activities in the climate sector, together with several national and international networks (observation; monitor-

ing; calculations of emissions; forecasts of future emissions etc.).
An Advisory Body to the Federal Department of Home Affairs on climate change research and policy was formed on 1st January 1997. It will make recommendations concerning climate change research priorities and coordination.

1.9. Education, training and public awareness

Activities in education, training and public awareness are carried out through the government, and by private sector activities. The Federal Office of Environment, Forests and Landscape has launched campaigns which address issues of climate change. The most important activity in climate change policy is the “Energy 2000” Programme, where projects and programmes, carried out both by the government and by the private sector, aim to market new technologies and promote energy efficient behaviour.
A number of information activities are undertaken by the Swiss Academy of Sciences Forum for Climate and Global Change (ProClim-). These include an information system with access via the WWW on research in the area of global change, a quarterly newsletter and the organisation of workshops and public forums on global change topics.
A Climate Change Information Centre is at present being set up by the Swiss Meteorological Institute. It will lend collated information material on specific topics, and prepare reviews and background reports upon request.
At the regional level, several networks exist to promote and discuss energy and climate issues with the actors involved. In addition, Swiss environmental NGOs are raising awareness through campaigns and projects.

2. Introduction

2.1. Purpose

This report sets out the Swiss second national communication updating the contents of the first communication and presenting the present state of the Swiss national GHG inventory, emission trends and climate policy. Switzerland signed the United Nations Framework Convention on Climate Change (UNFCCC) on 9th May 1992. In order to meet the commitments (Article 12 of the Convention), a first national communication (Confédération Suisse, 1994) was submitted on 21st September 1994.

2.2. International context

Since the first deadline for submitting national communications in September 1994, three major events have taken place which have had an impact on the implementation of the Convention. These events are the first and the second Conferences of the Parties (COP 1 and COP 2) which were held in Berlin in April 1995 and in Geneva in July 1996 respectively, and the publication of the Second Assessment Report (SAR) of the IPCC in December 1995.

2.2.1. Climate science

The Second Assessment Report of the Inter-governmental Panel on Climate Change (IPCC) was adopted in December 1995 (UNEP/WMO/IPCC, 1996). Its results had been established after an intensive study involving a large number of experts from a vast spectrum of scientific fields and from a wide range of geographical and international origins. The work of these experts was intensively peer-reviewed and the essential conclusions, which were presented in the Summaries for Policy Makers (SPM), were approved by the delegates of the governments. The conclusions of this authoritative and comprehensive work are quite robust and have to be considered as the reference in the field of climate change. The results of the SAR follow three themes, namely first the science of climate change; secondly impacts on physical and ecological systems, on human health and on socio-economic sectors; and thirdly economic and social issues related to climate change. Switzerland supports the process of assessment conducted by IPCC and considers the SAR as a valuable source of information on the three topics mentioned earlier for elaborating climate policy. Among others, some relevant key findings and implications of the SAR are as follows.

- As a result of human activities, the atmospheric concentration of greenhouse gases continue to increase, leading to a net warming of the surface of the earth and other changes in its climate, even taking into account the tendency of man-made aerosols to cause negative radiative forcing.
- Even taking into account the remaining uncertainties, the balance of evidence suggests a discernible human influence on global climate.
- Specific policies are needed to mitigate climate change. IPCC scenarios show that for an atmospheric CO_2 equivalent concentration of 550 ppmv, i.e. twice the value of the pre-industrial era, the global mean surface air temperature could increase by about 2°C relative to 1990, and the average sea level could rise about 0.5 m by 2100.
- Even after the stabilisation of the concentrations of greenhouse gases in the atmosphere, the temperature will continue to increase beyond 2100 because of the thermal inertia of the oceans.

- Environmental, economic and social impacts are expected as a consequence of climate change. Developing countries which may have less capacity to adapt will be particularly affected, as will small island countries which will suffer from the rise in sea level.
- Many low- or no-cost "no regrets" polices to reduce the emissions of greenhouse gases have been identified in numerous sectors world-wide.
- International cooperation can considerably reduce the costs of the policies and measures to prevent climate change and ensure an equitable share of the burden between countries.
- Actions taken to prevent climate change are important means towards sustainable development.

2.2.2. Climate policy

Important decisions concerning the implementation of the Convention were adopted at COP 1. These decisions, called "the Berlin Mandate", concern new commitments for Annex I Parties to reduce their emissions of greenhouse gases. The Berlin Mandate states that these new commitments should contain policies and measures and Quantified Emission Limitation and Reduction Objectives (QELROS) to achieve the goals of the Convention. An Ad hoc Group on the Berlin Mandate (AGBM) has been constituted in the framework of the Convention to negotiate the legal instrument containing the new commitments for the Annex I Parties. This legal instrument should be finalised for signature at COP 3 which will take place in Kyoto in 1997.
The first phase of the work of the AGBM consisted of evaluating the possibilities to adopt internationally harmonised policies and measures. Parties have been helped in this task by the OECD/IEA Annex I Expert Group which has identified possible policies and measures and the way they could be implemented.
At COP 2, which was held in Geneva in July 1996, it was necessary to face the situation that the majority of the Annex I Parties were having difficulties fulfilling their commitments regarding the aim of reducing their emissions of greenhouse gases to 1990 levels by 2000. In order to give a new impulse to the implementation of the Convention, Ministers issued a declaration ("Geneva Declaration") in which they reaffirmed the commitments of Annex I Parties, pointing out the need to make additional efforts. To that purpose, Ministers decided to instruct their representatives to accelerate negotiations on the text of a legally-binding instrument in time for adoption at COP 3. Furthermore, Ministers recognised and endorsed the SAR as currently the most comprehensive and authoritative assessment of the science of climate change. Another issue supported by the Geneva Declaration is the need for a global effort to speed up the development, diffusion and transfer of climate-friendly technologies, practices and processes.

2.3. National developments since the first submission

Switzerland submitted its first national communication to the UNFCCC on 21st September 1994. The in-depth review of this communication was carried out between August 1995 and January 1996 and included a country visit by the review team to Berne from 11th to 14th September 1995. Several developments since the submission of the first communication have already been stated in the in-depth review report. For the time being the following developments are of major importance.

- A report containing updated inventories for 1990 to 1994 (Swiss Confederation, 1996) was submitted to the UNFCCC.
- Within national research programmes, the present knowledge of climate science in Switzerland (climate effects, vulnerability and adaptation) could be improved (see section 7).
- The national “Energy 2000” Programme has reached its half-way point. A set of evaluation projects have been carried out to monitor the latest developments and to clarify future strategies and the allocation of budgets.
- The Swiss Environmental Protection Law has been revised and now contains the possibility to introduce market based instruments. A special tax on NMVOC emissions is in preparation (see section 5.2.5).
- The Swiss electorate accepted a revised article in the Constitution to promote a sustainable agricultural policy based on ecological principles.
- Several measures addressing climate change are under consideration (e.g. a draft for a CO_2 law, enabling the Swiss Government to introduce a CO_2 tax, a new energy law, a weight and kilometre dependent tax on heavy goods vehicles).

- The Advisory Body on Questions relating to Climate and Climate Change, an advisory body of the Federal Department of Home Affairs on climate change research and policy, was formed under the auspices of the Swiss Academy of Sciences on January 1st 1997.

References:

Confédération Suisse, 1994, Rapport de la Suisse 1994, Berne
Swiss Confederation, 1996, Swiss Greenhouse Gas Inventory 1990-1994, Berne
UNEP/WMO/IPCC, 1996, Climate Change 1995, Cambridge

3. National Circumstances

3.1. Geographical and economic context

Location
Switzerland is located between 45°49' and 47°48' north and from 5°57' to 10°30' east. It comprises an area of 41,300 km^2. The location in the heart of Europe and in the centre of the single European market leads to substantial imports and exports of goods and services, and to flows which transit through Switzerland. The main and highest mountain range, the Alps, is a natural barrier to traffic moving in a north-south direction, i.e. between northern Europe and Italy. A number of tunnels enable road and rail traffic to cross the Alps. Two new railway tunnels to facilitate and speed up traffic are currently planned.

Climatic profile
Climatic conditions vary significantly across Switzerland, depending mainly on altitude and location (south or north of the Alps). Figure 3-1 shows the index of heating degree days from 1973 to 1995 (1973 = 100). Since there is a considerable yearly variation in weather conditions, heating degree days are an important basis for calculating the effect of weather variability on energy consumption and CO_2 emissions (climate correction). Climate corrected figures are used to adjust base year figures in emission forecasts (see section 6.1.4) as well as in the retrospective assessment of the effects of the measures.

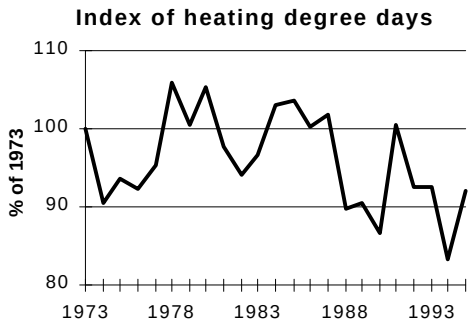

Figure 3-1: Index of heating degree days (1973=100; FOE 1996)

Mean temperatures at 44 meteorological stations in Switzerland increased between 0.3° C and 1.2° C over the period 1961-1990, which is a greater increase than that observed globally. However, average rainfall has not changed significantly over the same period (Gutermann, 1996).

Population
At the end of 1995, the population was 7.06 million. Two thirds of the Swiss live in cities or metropolitan areas. Figure 3-2 shows the change from 1960 to 1995.

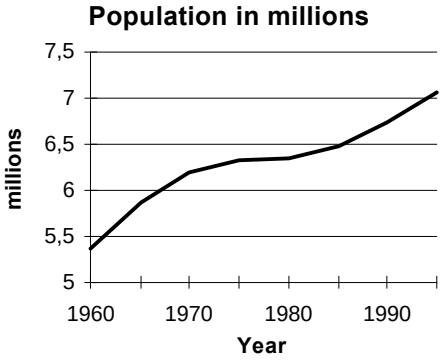

Figure 3-2: Population between 1960 and 1995 (FOS 1994, 1996b)

The population density was 171 persons per km^2 in 1995.

Land use

The area of the country is approximately 41,300 km^2, of which 30 % are forest and woodland, 38 % cropland and permanent pasture, 6 % built up, and 26 % unproductive land. The size of the built-up area more than doubled between 1950 and 1990. Transport infrastructure takes up 2 % of the overall area. Total livestock decreased between 1973 and 1994. The number of farms and of people employed in primary agricultural production have decreased, while the average size and productivity per farm have increased.

Economy: GDP, public debt and balance of payments

Nominal GDP was CHF 362.0 billion in 1995 which is a 2.6 % increase over the previous year. In real terms, GDP has remained level or declined since 1991. Figure 3-3 shows the changes in nominal and real GDP between 1970 and 1995.

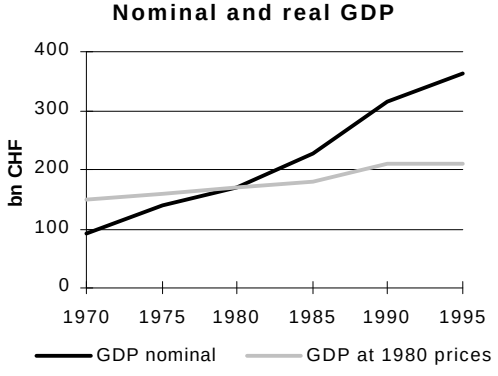

Figure 3-3: Nominal and real GDP (at 1980 prices) between 1970 and 1995 (FOS 1996b, DFEP 1996)

Over the period 1986 to 1995, real GDP in "per capita" terms (i.e. per worker) first increased, then decreased and has been stable since 1994.

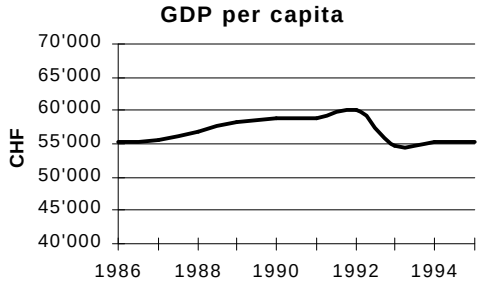

Figure 3-4: Real GDP per capita (at 1980 prices) between 1986 and 1995 (FOS 1994, DFEP 1996)

Unemployment was 4.2 % in 1995 and showed a further rise in 1996. In parallel with rising unemployment, government spending of all three administrative levels together has exceeded revenues since 1990, which has led to increasing debt.

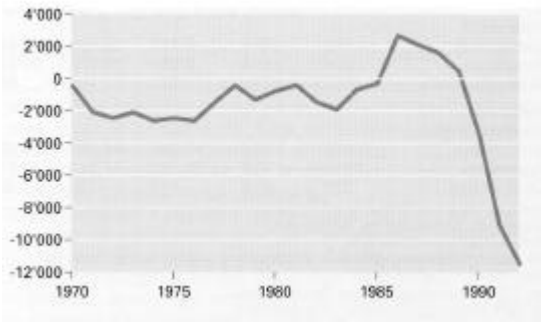

Figure 3-5: Government fiscal statements (in million CHF) between 1970 and 1992 (all administrative levels; FOS 1994)

Typically, the elements of the Swiss balance of payments can be characterised as follows:

- the balance of trade with goods is negative
- the balance of services is positive
- the balance of labour and capital incomes is positive
- the balance of transfers is negative.

Energy supply

Switzerland does not have any fossil energy resources of its own. Almost two thirds (61 % in 1993) of electricity generation is hydroelectric, 37 % is produced in the five domestic nuclear power plants, and the rest in thermal power plants or from "new" renewable sources (solar, wind, biomass).

The contribution of renewable sources to electricity generation is still small (below 1 %), but, supported by the "Energy 2000" programme, it increased by 41 % between 1990 and 1995 (Energie 2000, 1996).

Energy end use by sector

Between 1980 and 1993, aggregate end use of energy increased by 19 %. The largest increase was in the transport sector (+39 %), whereas energy consumption in industry increased by only 7 %, which reflects considerable efforts towards energy efficiency in that sector. In 1993, transport accounted for 31 % of energy end use, whereas in 1950 its share was only 15 %.

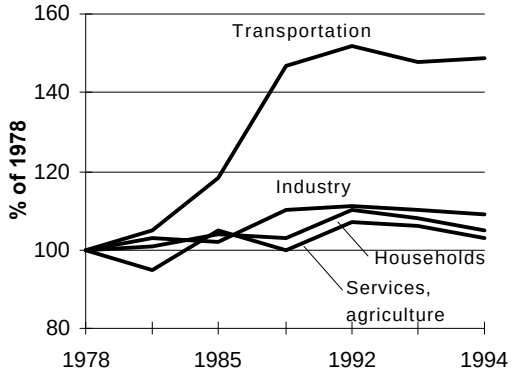

Figure 3-6: Energy end use by sector between 1978 and 1994 (1978=100; total: 811,000 TJ; FOS 1995b)

Energy productivity has increased since 1984, in other words the index of per capita energy use has been below the index of per capita GDP.

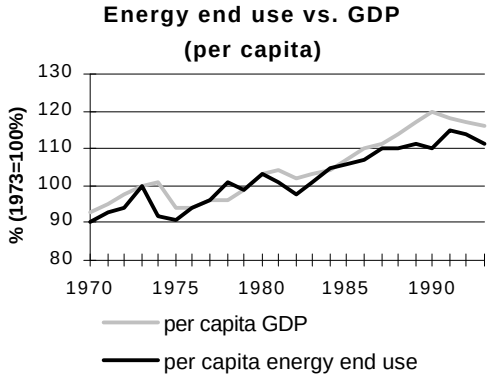

Figure 3-7: Indices of per capita energy end use and per capita GDP between 1970 and 1994 (1973 = 100; FOS 1994)

Energy prices

Between 1970 and 1993, the real prices of energy sources have, in general, decreased and reached a historic low.

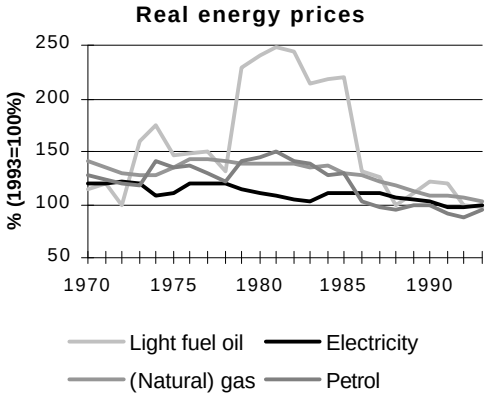

Figure 3-8: Real energy prices of major energy sources at retail and household levels (1993=100; FOE 1996)

Electricity trade

Electricity is traded across Swiss borders on rather a large scale. Amongst the factors affecting the volume traded are hydrological and climatic conditions. Traditionally, Switzerland has been a net exporter of electricity. Exchanges take place with several western and central European countries. Long-term contracts for electricity procurement have been concluded with France and the Czech Republic. Figure 3-9 shows electricity exchanges with neighbouring countries for the year 1995, when exports by Switzerland exceeded imports by some 7,000 GWh.

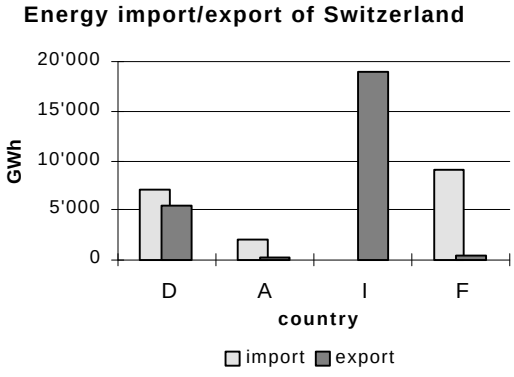

Figure 3-9: Electricity imports and exports by Switzerland to and from some neighbouring countries (UCPTE 1996)

Transport sector
Unlike the road network, Swiss rail infrastructure has not been significantly expanded over the past 50 years. Nevertheless, by international comparison, Swiss railways play an important role in the transport market, especially in passenger transport. Figure 3-10 shows the demand for passenger transport by road; rail; and air & water.

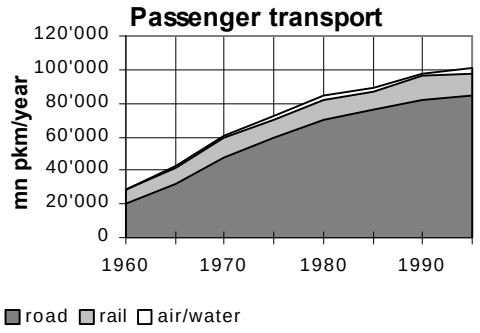

Figure 3-10: Passenger transport 1960 - 1995 (FOS 1996c)

Rail has been losing market share to road in freight transport. Figure 3-11 shows the market shares of road; rail; and air & water freight transport in Switzerland.

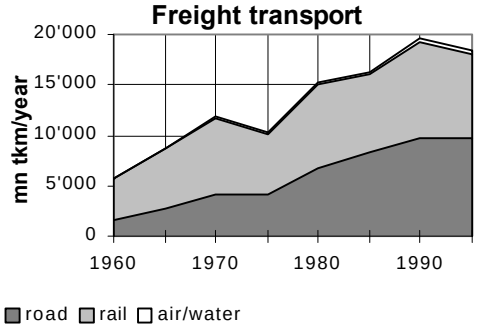

Figure 3-11: Freight transport 1960 - 1995 (FOS 1996c)

Rail has suffered a similar setback in transalpine freight transport, although Swiss rail transport has traditionally had a particularly strong position compared with that in neighbouring alpine countries, because of significant restrictions on road freight transport in Switzerland (28 tonne weight limit, and a ban on lorries at night and on Sundays).

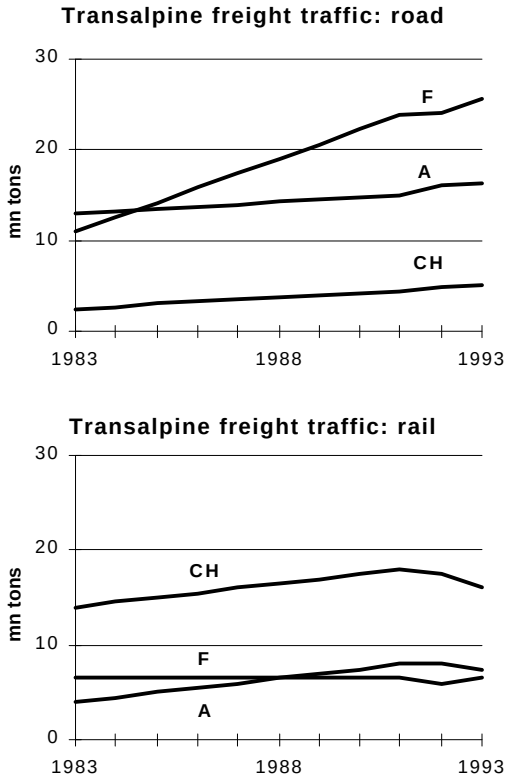

Figure 3-12: Transalpine freight traffic (goods in million tonnes; FOS 1995a)

Car ownership (including minibuses) increased from 510,000 vehicles in 1950 to 3.1 million in 1992 (FOS 1994), so nearly half the inhabitants of Switzerland own a car. Emissions of CO_2 from road transport are based on fuel sold in Switzerland. This includes the so-called "tank tourism" which takes place because fuel prices in Switzerland are at present significantly lower than in neighbouring countries. This leads to an overestimation of emissions within Switzerland.

3.2. GHG emissions 1900 - 1990

Some agricultural data reach back to 1900, but in most other sectors the quality of data is only satisfactory from about 1950 on, when emissions started to soar. Consequently, emission data from the period 1900 to 1950 are rough estimates, and are based on a number of assumptions.

3.2.1. CO_2

Anthropogenic gross CO_2 emissions have increased markedly since 1950. This has

mainly been due to a large increase in fossil fuel consumption.

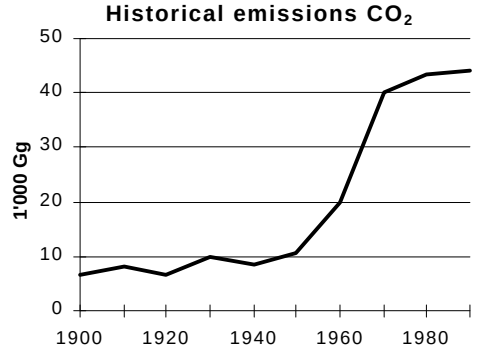

Figure 3-13: Gross CO_2 emissions 1900 - 1990; (FOEFL 1995)

Per capita CO_2 emissions peaked in 1980 and have decreased since then. This partly reflects increased energy efficiency.

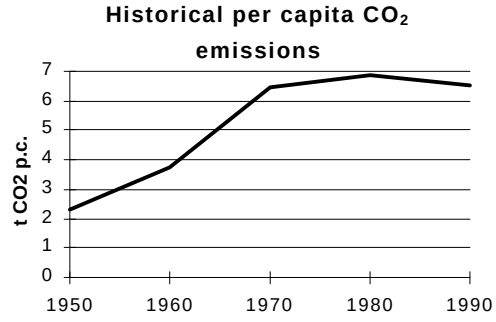

Figure 3-14: Per capita gross CO_2 emissions 1950 - 1990 (FOEFL 1995)

When interpreting Swiss CO_2 emissions a few points should be borne in mind.

- Switzerland has very little heavy industry, which would tend to be particularly energy-intensive.
- Electricity generation in Switzerland (hydroelectric and nuclear) causes relatively little CO_2 emission. This leads to lower CO_2 emissions compared with other countries.
- Since the emissions inventory relates to the Swiss territory, energy embodied in products consumed in Switzerland, but produced abroad, is not included.
- Possible CO_2 emissions from net electricity trade are not included.

The ratio of gross CO_2 emissions per unit of real GDP increased until around 1970, but has decreased since then.

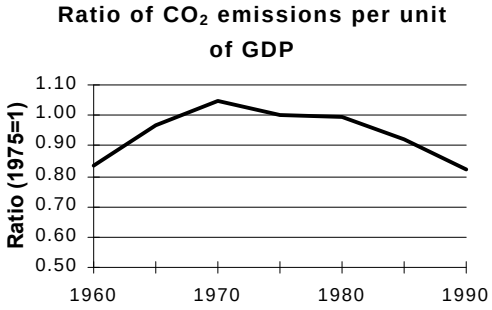

Figure 3-15: Ratio of gross CO_2 emissions per unit of real GDP (at 1980 prices) between 1960 and 1990 (FOE 1996, FOEFL 1995)

3.2.2. CH_4

Total methane emissions increased steadily from 1900, peaked in the 1970s and have since decreased. In 1990 most of the emissions (62 %) were caused by the agricultural sector (mainly cattle), the second most important source was the waste sector (35 %), where emissions were from landfills, wastewater treatment facilities and from leakages of gas supply networks. Quantities from all sources have decreased in recent years (decreasing number of livestock and improved feed quality; technical improvements).

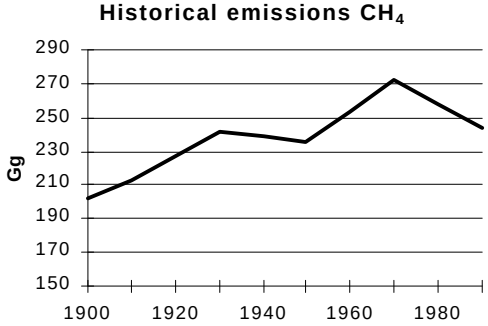

Figure 3-16: CH_4 emissions 1900 - 1990, based on data for selective years (FOEFL 1995, IUL 1996)

3.2.3. N_2O

Emissions of N_2O were already substantial in 1910 (5,300 tons) and increased steadily. The main source is agriculture.

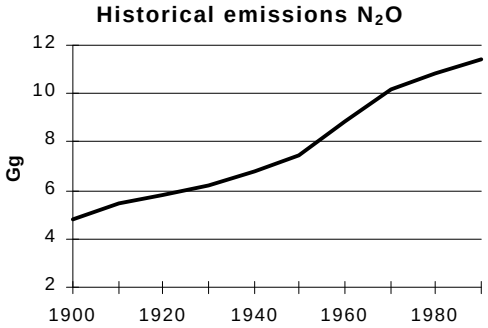

Figure 3-17: N_2O emissions 1900 - 1990, based on data for selected years (FOEFL 1995, IUL 1996)

3.2.4. Precursors (NO_X, NMVOC, CO)

Emissions of NO_X increased gradually between 1900 and 1950. After 1950 they grew rapidly and reached a peak around 1980, where they were six times as high as in 1950. The rapid increase was due to road transport. The decrease from 1985 on has been due to the market penetration of the catalytic converter for passenger cars which has been mandatory for new cars since 1987 and which reduces specific NO_X emissions (emissions per km driven) by 80-90 %.
Emissions of NMVOCs increased by a factor of 3.5 between 1900 and 1950. Between 1950 and 1980 they increased almost fivefold, mainly due to the increased use of solvents in industry, in the small-scale service sector and in private households. A further reason is the rapid growth in transport.
Emissions of CO increased by a factor of 2.8 between 1950 and 1975. Until the 1950s coal and wood-fired heating were the main sources. Since then, transport has taken the leading role.
Figure 3-18 shows emissions of the three precursors between 1900 and 1990 (1900 = 100).

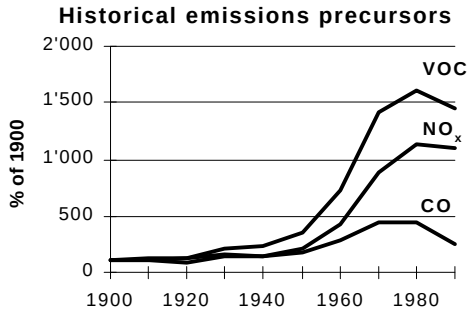

Figure 3-18: Emissions of precursors 1900 - 1990 (1900=100; FOEFL 1995)

3.3. Policy-making in Switzerland

3.3.1. Organisation

Switzerland is a Confederation with a Federal Government, two chambers of Parliament and a Federal Court. The territory consists of 26 cantons (states), each of which again has its own government, parliament and cantonal courts. Responsibilities are shared between the Federal level and the cantons.

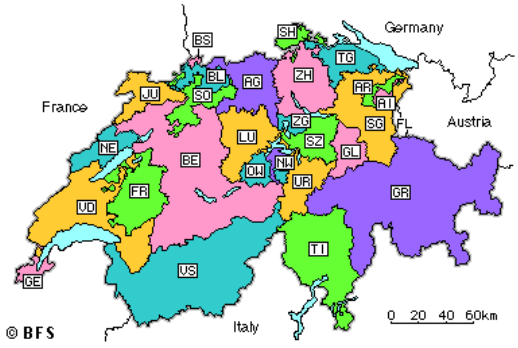

Figure 3-19: The cantons of Switzerland (FOS 1996b)

3.3.2. Decentralisation and subsidiarity

Subsidiarity plays an important role in Switzerland. This is reflected in constitutional law which states that unless the legislative power is explicitly attributed to the Federal level, the cantons are sovereign, i.e. entitled to legislate in a policy area. This fundamental principle helps protect and safeguard minority interests, above all those of the French, Italian and Romansh speaking

parts of Switzerland. Another important aspect is fiscal federalism. Each canton has its own budget and sets its own level of direct taxation. Despite a system of offsetting payments amongst cantons, substantial differences in the level of taxation of both households and companies prevail.

3.3.3. Cooperation

Cooperation is an important principle, both vertically and horizontally. In matters where the Federal level legislates, the cantons' role is to implement (execute) the Federal legislation. Very often, the cantons have a substantial freedom in this endeavour, allowing them to take local or regional conditions into account. At a lower level, an analogous autonomy is granted by the cantons to the municipalities.
On the other hand, cantons cooperate horizontally and have, in a number of policy areas, concluded treaties which facilitate a harmonised and effective implementation.

3.3.4. Legislative hierarchy at the Federal level

The legislative system comprises several hierarchies. All legislation must be ultimately based on the (written) Constitution. Laws of different kinds (Federal Laws, Federal Decrees) implement constitutional matters. Regulation at both levels is open to the influence of the people, which is not the case for ordinances where the Government alone implements the contents of the laws.

3.3.5. Direct democratic rights

Switzerland is a representative democracy with strong formal and informal elements of direct democracy. With a popular initiative citizens can ask for an amendment to the Constitution (at the cantonal level also an amendment to a law). Popular initiatives can comprise a general suggestion or contain detailed regulations. In most cases a majority of the electorate and of the cantons must accept the proposal to make it part of the Constitution. This "double" majority (population and cantons) implies a protection mainly of the interests of less populated rural cantons.
The second formal instrument of direct democracy is the referendum. It allows citizens to veto decisions made by parliament. The referendum may be mandatory or facultative. It is possible to have a referendum concerning regulations at the level of the Constitution, formal laws, international treaties and Federal decrees which are generally-binding and urgent. Both popular initiatives and referenda also exist at the cantonal level.
The petition is an informal instrument of public participation and is non-binding.

3.3.6. Public consultation

Cantons as well as other interested parties (e.g. business, trade unions, NGOs etc.) are included in a consultation process whenever government (the Federal Council) proposes a change in the Constitution, in a law or an ordinance that is of significance to the addressees. Although the outcome of this process is formally non-binding, it is of great importance and reflects an established principle of consensus typical for policy-making and for political culture in Switzerland.

3.3.7. Switzerland and the EU

Switzerland is a member of several international organisations (e.g. OECD, World Bank Group, all UN specialised agencies), however, it is not member of the UN or of the European Union. In the case of the UN, adhesion was proposed by the Government and Parliament, but was turned down in a referendum in 1986. Adhesion to the EU remains a strategic aim of the Federal Council, although a majority of the Swiss turned down adhesion to the European Economic Area (the economic core of the EU treaty) in 1992. Since 1992 Switzerland has been in negotiations with the EU on major policy areas (e.g. free movement of persons; land and air transport; public procurements; research). Although Switzerland is a non-member, most of the new Swiss laws or changes in existing Swiss laws have voluntarily been made compatible with EU law. The aim is to facilitate possible subsequent adhesion to the European Economic Area or to the EU. Due to the strong economic ties with many EU countries (notably Germany), a "virtual" dependency exists, despite the formal political absence of Switzerland in the EU.

3.4. Climate policy in the context of policies for other sectors

Climate policy in Switzerland is incorporated into other policies that existed well before climate change became an important issue. In the legislative programme for 1995-1999 (Swiss Federal Council, 1996) climate change is mentioned under the heading of energy policy. The following policy areas address the issue of climate change.

Area of policy	Aims, highlights
Energy policy	Decree on energy use and coresponding ordinances, "Energy 2000" Programme for the integral implemantation of government and private measures.
Environmental policy	Federal Environmental Protection Law, with a number of important ordinances, e.g. Ordinance on Air Pollution Control, Ordinance relating to Environmentally Hazardous Substances.
Transport policy	Favouring rail in transalpine transport, internalisation of external costs in freight transport.
Land-use planning policy	Protection & conservation of landscapes; Law on Spatial Planning.
Agricultural policy	Incentives for environmentally friendly production methods (agricultural reform).
Forestry policy	Sustainable logging; ban on clearing and clear felling.
Development policy	Fund for global environment projects.
Foreign economic policy	Facilitating direct investment in clean technologies.

Table 3-1: Policy areas that address climate change (overview)

All of these policy areas contain elements of environmental policy which have been reinforced in view of the upcoming threat of climate change. This strategy is mirrored in the organisation of the Federal administration, where existing units in different Departments have been charged with the design and implementation of climate policy.
Apart from these adaptations, the Group IDC-Rio (Interdepartmental Committee Rio) was created in the wake of the Earth Summit in Rio in 1992. It comprises 17 Federal

Government Offices which are obliged to consider sustainability in their policies. Their report "Sustainable development in Switzerland" of February 1996 will be followed by an Action Plan in 1997. To this end, several task force groups have analysed and discussed concrete policy issues. A special group IDC Rio Climate, comprising NGOs, accompanied the process to elaborate the first communication on climate change.
The Federal Office of Environment, Forests and Landscape (FOEFL) is responsible for the implementation of the obligations resulting from the FCCC, in particular the preparation of the second communication.

References:

DFEP (Département fédéral de l'économie publique), 1996, La vie économique, No. 12/96, Berne
Energie 2000, 1996, Jahresbericht Ressort Erneuerbare Energien, Liestal/Berne
FOE (Swiss Federal Office of Energy), 1996, Statistique globale suisse de l'énergie 1995, Berne
FOE (Swiss Federal Office of Energy), 1996, Annual Review of the „Energy 2000“ Programme
FOEFL (Swiss Federal Office of Environment, Forests and Landscape), 1995, Emissions polluantes dues à l'activité humaine en Suisse de 1900 à 2010, Rapport No. 256 des cahiers de l'environnement, Berne
FOS (Swiss Federal Office of Statistics), 1994, Annuaire statistique de la Suisse 1995, Zurich
FOS (Swiss Federal Office of Statistics), 1995a, Statistical data on Switzerland 1995, Berne
FOS (Swiss Federal Office of Statistics), 1995b, Umweltstatistik Schweiz, No. 3, Energiewirtschaft, Berne
FOS (Swiss Federal Office of Statistics), 1996a, Statistical data on Switzerland 1996, Berne
FOS (Swiss Federal Office of Statistics), 1996b, Statistique de la Suisse (publication on the WWW), Berne
FOS (Swiss Federal Office of Statistics), 1996c, Statistique suisse des transports de 1994, Berne
Gutermann T., 1996, Klimarisiken, Extreme Wetterereignisse als Folgen für die Schweiz?, Arbeitsbericht NFP 31, Zurich
IUL, 1996, Estimation of historical GHG emissions in the agricultural sector, Bern-Liebefeld (in preparation)
Swiss Confederation, 1994, Rapport de la Suisse dans la convention-cadre des Nations Unies sur les changements climatiques, Berne
Swiss Federal Council, 1996, Bericht über die Legislaturplanung 1995-1999, Berne
UCPTE (Union pour la coordination de la production et du transport de l’electricité), 1996, Annual Report 1995, Vienna

4. Anthropogenic emissions and removals

Standardised and technical inventory information, as required by the Guidelines for the Preparation of National Communications by Annex 1 Parties and the IPCC Guidelines for National Greenhouse Gas Inventories (UNEP / WMO / IPCC, 1995), is provided in the annex of this report. In this section, inventory data will be presented and commented on more comprehensively, illustrating main sources and sinks (see section 4.1), trends in emissions since 1990 (see section 4.2), and the contributions of CO_2, CH_4 and N_2O to the present Swiss emissions balance based on 100 year GWP values (see section 4.3).

4.1. Overview of sources and sinks (Swiss Greenhouse Gas Inventory 1995)

4.1.1. CO_2

In 1995 gross CO_2 emissions amounted to 44,200 Gg[2] or 6.3 tonnes per capita[3]. Three quarters of these emissions come from transport (33 %) and small-scale combustion (41 %). Industry accounts for 18 % of CO_2 emissions (12 % energy-related emissions; 6 % not energy-related). Other sources are of minor importance.

Bunker fuel emissions from international aviation (emitted outside Swiss territory) are estimated at 2,400 Gg. They are not included in the national emission figures. Bunker fuel emissions emitted within the Swiss territory are included in domestic transport figures. At present, the net result of carbon harvest versus carbon uptake yields an absorption of the order of 5,100 Gg CO_2. Thus, Swiss forests are significant sinks, with an absorption volume corresponding to 11.5 % of gross CO_2 emissions.

2 1 Gg = 1,000 (metric) tonnes

3 without international bunkers

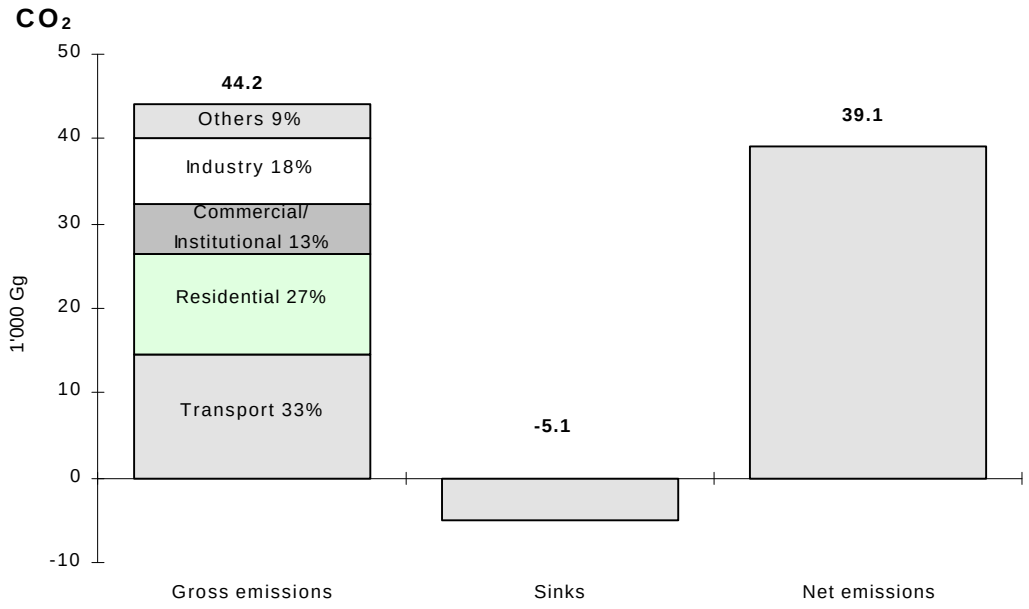

Figure 4-1: 1995 CO_2 emissions by sector (without international bunkers)

4.1.2. CH_4

A total of 235 Gg CH_4 was emitted in 1995. Nearly two thirds of this came from the agricultural sector. About 86 % of agricultural emissions were released by enteric fermentation in ruminants. The second most important source of CH_4 emissions was the waste sector with 28 % of the total. Taken together, these two sectors account for almost 92 % of Swiss CH_4 emissions.

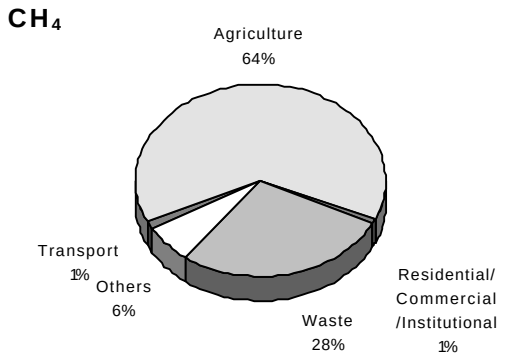

Figure 4-2: 1995 CH_4 emissions by sector

4.1.3. N_2O

N_2O emission data have undergone revision since the first submission in 1994 and the inventories 1990 - 1994. The reason for the lower figures in the present report is the application of the most recent IPCC methodology (method 2) for the calculation of agricultural N_2O emissions.
About three quarters of the 11.8 Gg N_2O emitted in 1995 came from agriculture. Another significant source was transport, which contributed about 15 %.

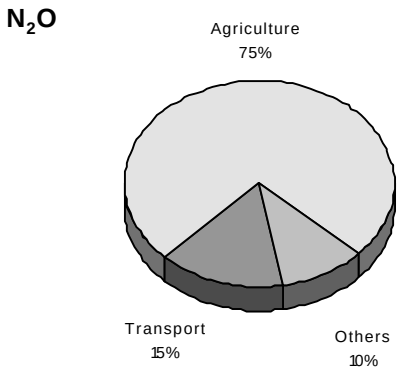

Figure 4-3: 1995 N_2O emissions by sector

4.1.4. Other greenhouse gases

Until recently, HFCs, PFCs and SF_6 were of marginal importance in Switzerland. A pilot survey of these substances in 1995 - 1996 gave preliminary data, showing that 0.2 Gg HFC, 0.005 Gg PFC and 0.03 Gg SF_6 were emitted in 1995.
An in-depth survey of production, consumption and emission was launched in winter

1996 - 1997. Its results will be available for the 1996 greenhouse gas inventory.

4.1.5. Precursor gases

NO_X
Of a total of 134 Gg emitted 61 % came from the transport sector. Secondary sources for NO_X emissions are small-scale combustion (Residential / Commercial / Institutional) (11 %), industry (9 %), agriculture (6 %) and waste (5 %).

CO
From the total of 510 Gg emitted, 63 % originated in the transport sector. Equal proportions of about 10 % were contributed by small-scale combustion, biomass and the category „off road vehicles / military sector“ (included in „others“).

NMVOC
In 1995, 201 Gg of NMVOC were emitted. The main sources of emission were solvent use in industry (53 %) and the transport sector (25 %). Agriculture (incl. machinery) accounted for 8 % of NMVOC emissions. No other source category exceeded 5 %.

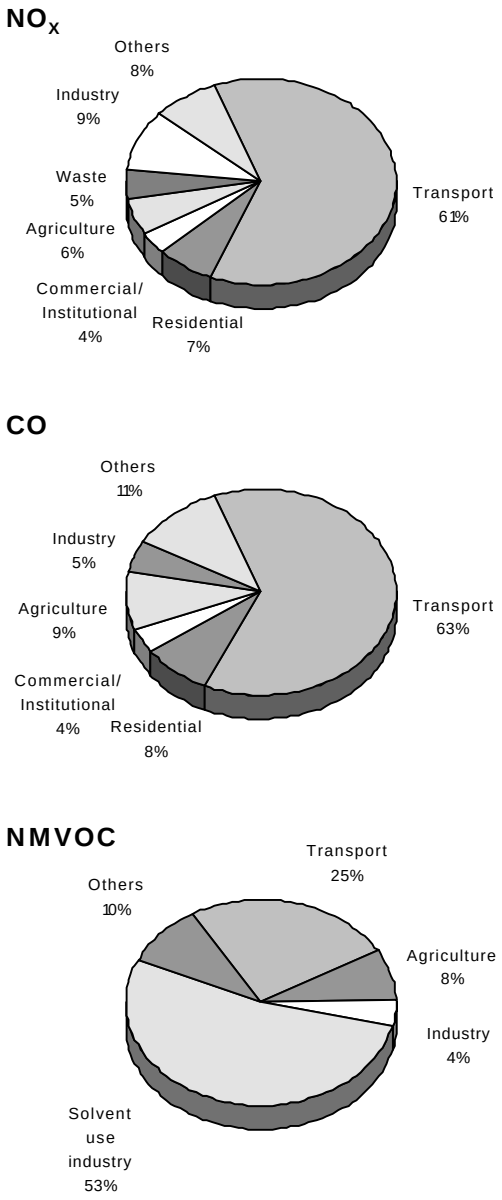

Figure 4-4: 1995 precursor emissions by sector

4.1.6. SO_2

Contrary to the above gases, SO_2 is not a greenhouse gas. In fact SO_2 emissions counteract the process of global warming. Nevertheless, SO_2 is a very dangerous air pollutant, causing damage to nature and human health, thus giving good reasons for reducing these emissions. Emissions of SO_2 amounted to 34 Gg in 1995. Small-scale combustion took the lead with a 43 % share, followed by industry (24 %) and non energy-related industrial processes (11 %). Energy & transformation industries (in Fig. 4-5 included in category „others"), waste and transport each contributed another 6 to 7 % to total emissions.

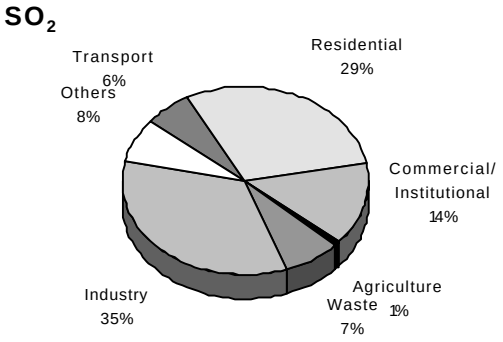

Figure 4-5: 1995 SO_2 emissions by sector

4.1.7. Summary 1995

IPCC	Source / Sink Category	CO_2 (1,000 Gg)	CH_4 (Gg)	N_2O (Gg)	NO_X (Gg)	CO (Gg)	NMVOC (Gg)	SO_2 (Gg)
1	All Energy Fuel combustion 1) Fugitive emissions	40.2 (40.1) (0.07)	21 (7.8) (12.8)	2.0 (2.0) (0.0)	127 (126.8) (0.15)	488 (488) (0.0)	74 (65.6) (8.2)	28 (28) (0.0)
2	Industrial processes	2.6	0.4	0.31	0.33	10.6	7.6	3.6
3	Solvent use	n.o.	n.o.	0.38	0.04	0.09	117	0.04
4	Agriculture 2)	n.e.	148	8.8	0.0	5.9	0.3	0.02
6	Waste	1.3	66.5	0.28	6.3	5.5	1.9	2.5
	Total gross emissions	**44.2**	**235**	**11.8**	**134**	**510**	**201**	**34**
5	Land use change & forestry	-5.1	n.e.	n.e.	n.e.	n.e.	n.e.	n.e.
	Total net emissions	**39.1**	**235**	**11.8**	**134**	**510**	**201**	**34**
	International bunkers	(2.4)						

1) including transport

2) Agricultural soils incomplete

n.e. not estimated

n.o. not occuring

Table 4-1: Overview of 1995 emissions and sinks (categories according to IPCC short summary table)

4.2. Recent trends in emissions

Figure 4-6 shows the trends in the emissions of different greenhouse gases between 1990 and 1995.

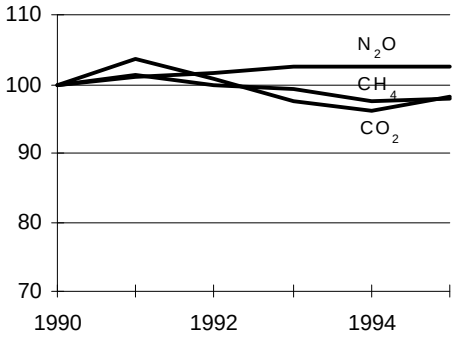

Figure 4-6: Total emissions of CO_2, CH_4 and N_2O between 1990 and 1995 (1990=100)

4.2.1. CO_2

In 1990, CO_2 emissions reached the level of 45,100 Gg. Subsequently, emissions oscillated around this level within a margin of ± 4 %. The yearly variation can largely be attributed to changing seasonal weather conditions (number of heating degree days per year) as well as changes in the price difference for petrol and diesel compared with neighbouring countries ("fuel tourism"). Note that the figures don't include international bunkers.
These natural or intangible factors need to be taken into consideration when assessing emission trends against emission targets. The 1995 level of 44,200 Gg was slightly below the 1990 value. Thus, so far, Switzerland is on track with its stabilisation goal over the 1990 to 2000 period. This situation can be seen as the combination of three effects: policy measures which are relevant to climate, private initiative (see section 5), and the tendency for stagnation in economic development (real GDP declined at an annual rate of 0.5 % between 1990 and 1995).
In 1990, excessive damage to certain forest areas through windthrow led to increased yield, temporarily reducing the net CO_2 absorption of forests by almost 20 %. Under regular conditions, as in 1995, forests absorb CO_2 at a rate of well over 10 % of total CO_2 emissions (see section 4.1.1.).

4.2.2. CH_4

The calculations show that CH_4 emissions have declined from 244 Gg in 1990 to 235 Gg in 1995 with an intermediate peak at 244 Gg in 1991. This trend is above all a reflection of developments in the agricultural sector, because of the strong correlation between the number of livestock and CH_4 emissions. Other sectors also show a tendency to declining emissions, giving an overall decrease of 4 % between 1990 and 1995.

4.2.3. N_2O

The data show a very slight increase in emissions from 11.5 Gg in 1990 to 11.8 Gg in 1995. This relative stability is the result of two opposing trends. While agricultural emissions show a slow decline, the transport and waste sectors tend to emit increasing amounts of N_2O as a consequence of the increased use of catalytic converters in private cars and waste incineration plants.

4.2.4. Other greenhouse gases

Data on emissions of HFCs, PFCs and SF_6 are lacking for the period before 1995. National markets and potential applications for these substances are being monitored by the environmental protection authorities. Observed trends show a sharp increase in the use of HFCs as cooling agents. PFC emissions from the manufacturing of aluminium are decreasing due to the gradual shut-down of production plants. At the same time, there is a tendency towards increased use of PFCs as solvents. No information is available on recent trends in SF_6 emissions. However, there is no indication of major changes since 1990.

4.2.5. Precursor gases

NO_X
An almost constant decline of about 4 % per year has taken place over the period from 1990 to 1995. This decline was mainly due to the increased use of catalytic converters in private cars.
CO
With a yearly reduction rate of about 6 % CO emissions showed a very marked decline between 1990 and 1995. Again, the main reason for this development was the increased use of catalytic converters in private cars.

NMVOC
These substances show the same tendency as CO, with an average yearly reduction in emissions of about 6 %. This development reflects the increased use of catalytic converters in private cars as well as more stringent emission limits for solvent use.

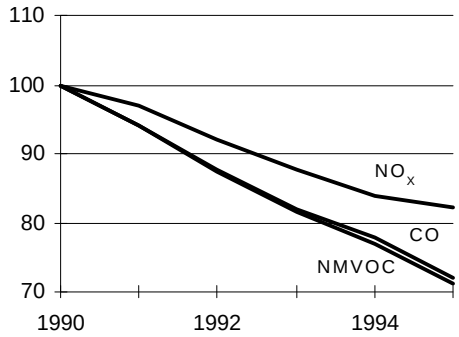

Figure 4-7: Total emissions of precursors between 1990 and 1995 (1990=100)

4.2.6. SO_2

Emissions data for SO_2 are not available on a yearly basis. Overall emissions have declined by nearly 20 % over the 1990 to 1995 period. This reduction is due to the effects of lower limits for sulphur in heavy fuel oil and diesel fuel.

4.3. Overall emissions

4.3.1. CO_2 equivalents by gas[4]

On the basis of 1995 GWP values for a 100 year horizon (UNEP / WMO / IPCC, 1996), in 1995 the gross greenhouse gas emissions of Switzerland amounted to 52,800 Gg of CO_2 equivalents. If removals by sinks are considered, this amount is reduced to a net emission of 47,700 Gg of CO_2 equivalents. In comparison with 1990 data, no significant change in the proportions of CO_2, CH_4 and N_2O with respect to total CO_2 equivalents can be noted.
Emissions of HFC, PFC and SF_6 are not taken into account in the above figures. On the basis of available estimates, their inclusion would raise the 1995 CO_2 equivalent total by roughly 1,000 Gg or 2 %.

4.3.2. CO_2 equivalents by sector[4]

The following sectors are of major importance for their contributions to CO_2 equivalents: transport (29 %, including 2.5 % domestic civil aviation); residential sector (22.5 %); industry (15 %, including 5 % non energy-related emissions); agriculture (11 %); commercial & institutional sector (11 %); waste (5 %). Data for HFC, PFC and SF_6 emissions are not taken into account in the above percentages.
Of the total CO_2 equivalents emitted 78 % are energy-related.
Forests are to be noted as sinks, since the difference between carbon uptake and carbon removal proves to be positive (net absorption of 5,100 Gg of CO_2 equivalents).

4 without international bunkers

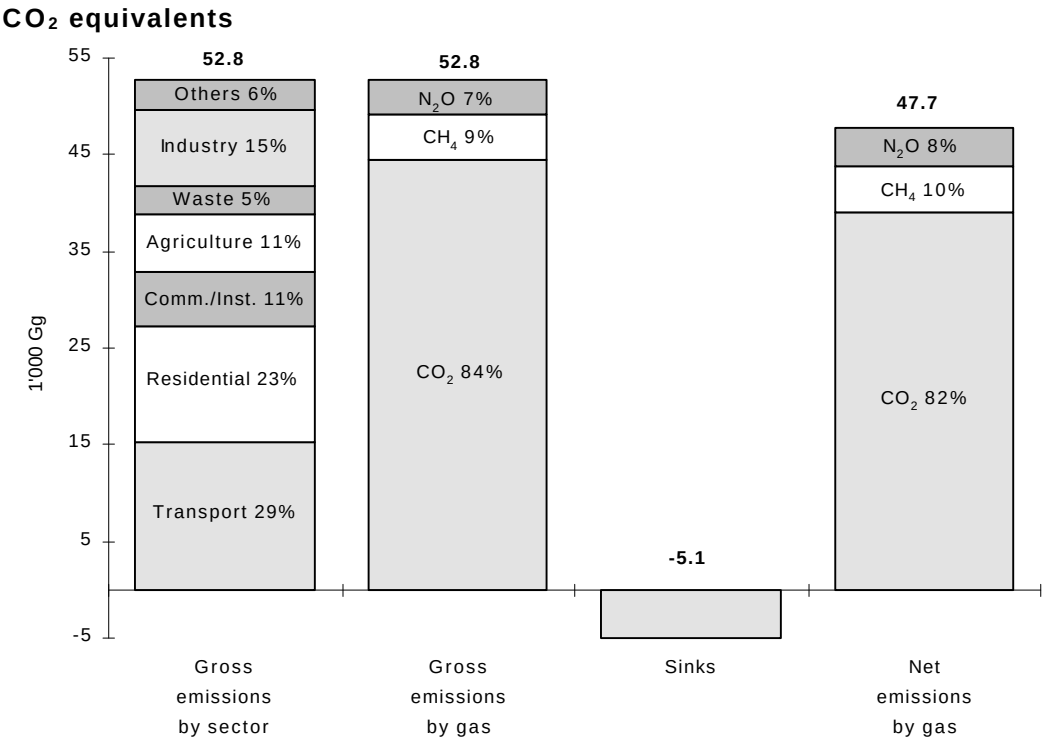

Figure 4-8: CO_2 equivalents by sector and by gas (without international bunkers)

References:

UNEP / WMO / IPCC, 1995, IPCC Guidelines for National Greenhouse Gas Inventories, Vols 1-3

UNEP / WMO / IPCC, 1996, Climate Change 1995, The Science of Climate Change

5. Policies and measures

5.1. General policy context

5.1.1. Environmental policy

The principles and instruments of Swiss environmental policy are formulated in the Environmental Protection Law, adopted in 1985. This modern legislative framework is a comprehensive basis for the national policy on climate and focuses on the following principles.

- **Precautionary principle:**

According to this principle, all detrimental or annoying impacts have to be limited, as far as it is technically feasible and economically acceptable. This principle is related to article 3 of the Climate Convention, taking into account the relevance of the cost-effectiveness of different measures with respect to the effects of climate change.

- **Polluter pays principle:**

This principle allocates the share of costs of measures to reduce environmental damages to the polluters causing it and suggests market-based instruments.

- **Information for the public:**

The national and cantonal Offices have to inform the public regularly about environmental quality, and the measures necessary to improve it (to increase public awareness continuously).

The Environmental Protection Law is the umbrella for a number of important regulations (ordinances) that address climate change. The most important are as follows.

- **Ordinance on Air Pollution Control (1985):**

This contains emission limits to keep air pollution as low as possible (preventive measures) and air quality standards for the protection of man and the environment. Preventive emission limits have to be strengthened when air quality standards are exceeded locally or regionally.

- **National Clean Air Concept (1986):**

This defines national targets and measures to reduce emissions of GHG precursors such as CO, NO_X and VOCs nation-wide. Compared with their maximum levels between 1980 and 1985, NO_X emissions have now been reduced by 25 %, and VOC emissions by 62 %. However, to reach the final goal (emission level of 1960) further reductions are necessary[5] (BUWAL 1996).

- **Technical Ordinance for Waste Disposal (1992):**

This contains the national framework for waste management and introduces a consistent controlling and monitoring system.

- **Ordinance Relating to Environmentally Hazardous Substances (1995):**

This contains measures to avoid emissions of persistent substances with high GWP (HFC, PFC in fire fighting).

The Environmental Protection Law was revised in 1995. The most important aspect is the new legal basis for price-oriented measures (in particular a NMVOC charge, see details in section 5.2). A key element for the future climate change policy is a new law on the reduction of CO_2 emissions (see details in section 5.5).

5.1.2. Energy policy

The goals of environmental protection are disturbed by the generation, distribution and

5 The cantons are also responsible for reaching air quality targets which are set in the Ordinance on Air Pollution Control. Therefore they have to elaborate cantonal action plans.

use of energy. With the Decree on Energy Use („Energienutzungsbeschluss“ ENB) of 14th December 1990, and the planned Energy Law, efforts to decrease the use of electricity and of fossil fuels are intensified, thereby reducing air pollutant emissions, and other adverse environmental effects. The energy policy measures of the Federal Government and of the cantons, including the Action Programme “Energy 2000” are essential components of climate policy.
For the present, the emissions of CO_2 which occur during combustion processes cannot be held back by justifiable technical and economic means. Therefore, a reduction can only be achieved in practise by a decrease in the use of fossil fuels. Swiss CO_2 emissions, either expressed per capita or based on GDP, are relatively low. This can be attributed to several factors especially efforts up until now to save energy, the fact that electricity generation in Switzerland is virtually CO_2-free (60 % hydroelectric power and 38 % nuclear power), and the lack of heavy industry or indigenous fossil fuels.
The Action Programme “Energy 2000” (Federal Council Decree of 6th November 1990) has the goal of stabilising the use of fossil fuels (and thereby CO_2 emissions) by the year 2000, and afterwards bringing about a reduction. The programme also aims for a reduction in the rate of increase in the demand for electricity, and a stabilisation from 2000 onwards. It is intended that the proportion that renewable forms of energy contribute to energy supply will be raised, that hydroelectric power will be moderately increased, and that the performance of existing nuclear power stations will be improved by 10 %.
„Energy 2000“ is based on the following three principles.

1. Voluntary measures for the efficient use of energy and for the use of renewable forms of energy.
2. State framework conditions for a supply of energy which is sufficient, safe, and acceptable economically and environmentally, and also for a non-wasteful, efficient use of energy.
3. Discussion of controversial themes (e.g nuclear energy, measures for saving energy) with interest groups and those affected.

„Energy 2000“ is based on partnership with all spheres affected. Cantons, communes, business and private individuals promote energy efficiency and the use of renewable sources of energy through voluntary measures and with financial contributions.
The measures which have been taken are periodically evaluated to increase their effect, and to bring about a learning process for all participants. The annual reports of Energy 2000 (EVED 1996a) always give information about the latest position with the measures. As far as climatic emissions are concerned, the goals for the year 2000 are within range. In the future activities should above all be aimed at a greater widespread effect. It is also recognised that for the period after 2000 further efforts will be necessary to achieve the long-term goals of a reduction in CO_2 emissions and a sustainable supply of energy.

5.1.3. Transport policy

Environmental concerns are given high priority in Swiss transport policy. Therefore already in the 1970s Switzerland established principles and strategic guidelines for an integrated approach, considering all the different means of transport. There is still a general increase in mobility, so efforts to improve environmental performance in the transport sector have been increased. The following key elements of today’s transport policy are important in order to mitigate climate change.

Reduction of fuel consumption and air pollutants
Based on the Swiss environmental legislative framework and on the Energy Conservation Decree, several ordinances aim at a continuous improvement of the energy and environmental efficiency in the road sector. These specific regulations directly support the reduction of CO_2 emissions and precursors.

Priorities for public transport
The high level of supply and quality in public transport is the backbone of Swiss transport policy and an important precondition for a modal shift from road to rail. The financing of large rail infrastructure projects (Rail 2000 to improve East-West accessibility, and Alpine Transit to raise capacities north-south) is active, long-term support to increase the attractiveness of public rail transport, and to reduce the damaging effects of the road sector.

Internalisation of external costs
According to the polluter pays principle, the different modes of transport are to pay their full costs, including external costs due to environmental damage. Estimating external costs and developing internalisation strategies have a long tradition in Switzerland, and aim to establish measures

to reduce damaging effects and to secure financial means for infrastructure investments. This aspect is very important in the policies to increase excise duty on fuel, and to adopt new taxation schemes in the road freight sector, for which the Swiss electorate accepted the introduction of a distance and weight dependent heavy goods vehicle charge, at the constitutional level, in 1994. This charge directly addresses the internalisation of external costs caused by the road freight sector (see section 5.5.2).

International collaboration

Since Switzerland is situated in the centre of Europe, the international dimension in transport policy is of major importance, especially for transalpine traffic. The Transit Treaty with the European Union includes the construction of new transalpine rail axes, formulates pricing principles, and obliges the partners to establish ideal conditions for an efficient shift from road to rail within the next ten years. This process is supported by a new article in the Swiss Constitution, accepted by the Swiss electorate in 1994 (the so-called Alpine Initiative), which obliges the Swiss Government to introduce concrete measures to shift transalpine freight transport to rail.

5.1.4. Agricultural policy

Swiss agricultural policy has been undergoing major reform since the beginning of this decade. The agricultural policy reform is based on the dual task of agriculture: sustainable production which is consistent with market demands and landscape management, and the conservation of natural resources. The main element of the concept developed to achieve these goals consists of the separation of price policy and income policy. In other words, the prices for agricultural products depend on the market situation and are determined, as far as possible, to optimise the economic return, while production-independent financial compensation for agricultural services which are of public interest, is granted as far as necessary.

In October 1992 the Federal Parliament adopted the revision of the Federal Law of Agriculture, introducing a legal basis for product-independent direct payments to farmers. In 1996 nearly 40 % of these payments were already related to environmentally friendly production methods.

In June 1996 the Swiss electorate accepted a new article at the constitutional level, which will lead to increased efforts to improve ecological performance. The Government is preparing new proposals for a second stage of agricultural policy reform, named "Agricultural Policy 2002".

5.1.5. Forestry policy

Forest protection has a long tradition in Switzerland. The first Federal Forestry Police Act came into force in 1876, but only covered the mountain region. A stricter Forest Policy Act was introduced for the whole country in 1902. Its aim was to put a stop to the depletion of forests, to manage the remaining forest areas sustainably, and to promote afforestation. As a result of this legislation, the forested area in Switzerland has increased by nearly 50 % since the middle of the last century. The new forest law, in force since 1993, confirms the preservation of the forest area and also protects the forest as an ecosystem similar to nature. The increase in the area of forest is the result of afforestation and land use change, mainly from pasture to forest and this is still continuing. Abandoned land, on which a population of trees has grown naturally, automatically comes under the forest law once the trees reach the age of 10 to 20 years.

5.2. Measures at the national level

5.2.1. CO_2

a) Energy

The Decree on Energy Use (of 14th December 1990) and the corresponding Ordinance on Energy Use make up the essential legal basis for the current, established measures of energy policy on the federal level. These legal principles are limited until 1998, but it is accepted that similar measures will be continued, based on an energy law (see section 5.5).

The legal measures are components of the Action Programme "Energy 2000", especially in connection with financial incentives and voluntary agreements, but also through information, training and advice. The various measures complement each other, and in this way reinforce the effect. In addition regulations and measures of the Clean Air Ordinance which are relevant to energy consumption must be considered as an important political starting point. They make

a decisive contribution to reducing the use of energy, and thereby emissions of CO_2.
The following instruments, arranged according to certain categories of measures, play a particularly important part.

Setting target values and registration requirements for installations, equipment and vehicles which use energy

- in the household and service sectors (electrical household appliances, communication equipment and office equipment)
- in the building sector (energy requirement for heating buildings, efficiency of heating installations)
- in the transport sector (motor vehicles)

Regulations for implementation and approval

- for billing heating and hot water based on metering consumption
- for new electrical resistance heating

Financial incentives for the promotion programmes (direct and indirect promotion)

- Voluntary agreements for non-wasteful, efficient use of energy
- Information and advice, education and training programmes

The most important measures are briefly described below.

Reduction in the specific energy consumption of equipment and appliances

Consumption goals for a stepwise reduction in the average energy consumption of equipment and vehicles are established. If the goal is not reached, then binding regulations should be imposed. The reduction in energy consumption aimed for is from 7 to 19 % for household appliances, depending on the appliance category. The objectives are supported by voluntary measures together with the Action Programme “Energy 2000” (e.g. awards for particularly economical appliances).

Minimum standards for new buildings and conversions

Limit values have been fixed at the cantonal level. These have been based on the recommendations of the Association of Swiss Engineers and Architects. Analogous values are valid for ventilation installations and other technical installations in houses.

Individual heating and hot water metering

This measure holds for new buildings (from 1992) and for existing buildings (from 1998) with five or more heating accounts. The actual consumption of heat and hot water is registered using meters and taken into account in calculating the cost of heating. This can lead to energy-saving behaviour which can reduce the consumption of energy in the residential sector by about 5-7 %, and in service sector buildings by about 10 %.

Fiscal measures

In 1995 Switzerland changed over to value added tax (from a previous tax on the turnover of businesses) and at this point the rate of taxation was increased from 6.2 to 6.5 % and tax was imposed on fuel, and electricity, which had both previously been exempt from tax. Since 1st January 1995, based on a Federal Ordinance, tax allowances have been specified towards the costs of investments in existing private buildings for the efficient use of energy and the use of renewable sources.

Promotion programmes

There is indirect promotion through contributions to education and training, research and development, pilot installations, and developing information- and advice points. The so-called Impulse programmes BAU, RAVEL and PACER should be mentioned in particular. These have expired in 1995, but it is foreseen that the most important activities will be continued in the framework of the Action Programme “Energy 2000” or through other supporting organisations. Renewable forms of energy, the use of waste heat and the emergence of innovative uses of new energy techniques (DIANE) will all, as before, be directly promoted in the framework of “Energy 2000”. The total budget of the promotion programme of the Federal Government in the field of energy amounted to CHF 54.3 million in 1996.

b) Transport

Reduction of specific fuel consumption of road vehicles

Based on the Decree on Energy Use, the Swiss Government is entitled to adopt regulations for specific fuel consumption of newly registered road vehicles. Thus the Ordinance on the Lowering of Specific Fuel Consumption for Passenger Cars was adopted in December 1995. It defines a reduction path in specific fuel consumption of the entire fleet of newly registered passenger cars (reduction of 15 % between 1996 and 2001) and the technical and organisational procedures. The reduction path is not a regulation, but an objective. If the car importers do not reach this target within the prescribed schedule, the Government is entitled to adopt a regulation on the fuel consumption of new cars.

Increase in fuel prices
Excise duties on petrol and diesel are an important source of revenue to finance road infrastructure. The last increase was accepted in a referendum in March 1993 and amounted to 0.2 CHF per litre of petrol or diesel. This led (on average) to a 20 % increase in fuel prices. Half of the revenue is earmarked to finance road infrastructure; the other half goes into the general budget.

Energy saving programmes in the transport sector
Within the national "Energy 2000" Programme, several projects and programmes to increase energy efficiency in passenger and freight transport are sponsored by the Government, with an annual budget of around 6 million CHF, co-financed by the private sector. These actions were started in the early 1990s and will continue until the year 2000.

Example
Increase of energy efficiency in the transport sector
- *Eco-Driving. Several actions and simulation techniques promote an eco-efficient driving style. Individual measurements showed an energy saving potential of 10-15 %.*
- *Mobility Management. Together with private organisations, several actions aim at building up new institutions for an efficient use of passenger cars (car sharing, collaboration of public transport operators with car hire firms).*
- *Improvement of fuel consumption awareness. Different actions prepare the labelling and promotion of energy efficient cars in collaboration with car importers and automobile organisations.*
- *Promotion of new technologies and management facilities in the freight sector. Specific actions are the building up of new institutions to organise city logistics and the promotion of combined transport.*

Construction of new transalpine railway axes
In a referendum in September 1992, the Swiss electorate accepted a Federal decree to build two new railway axes at the Gotthard and the Lötschberg. These projects are part of the Transit Treaty between Switzerland and the EU, and it is estimated that they will be completed before 2010. Together with additional measures in the road sector, based on the demand to implement the Alpine Initiative, this improved attractiveness of the rail network will support the saving of CO_2 emissions and precursors. The different measures, as well as the financing schemes and the alignments, are still under discussion (see section 5.5).

c) Agriculture
Environmentally friendly production methods, such as integrated production and organic farming, are supported economically in order to increase the application of ecological principles in agriculture. Important criteria, amongst others, are
- equilibrated nutrient balances, and
- establishment and maintenance of areas for ecological compensation which amount to 5 % of the land area used for agriculture.

This programme, and especially the conversion of arable land to permanent grassland, combined with reduced management intensity in the case of existing meadows, enhances carbon sequestration in soils, in other words the CO_2 sink capacity of agricultural land. This effect is complemented by a limited promotion of the cultivation of energy crops (in conjunction with the "Energy 2000" Programme).

d) Land use change and forestry
Forests, as a carbon reservoir and acting as a carbon sink, are completely protected by the forest law. The main instruments used are as follows.
- Prohibition of deforestation with strong regulations about exceptions which include the obligation to afforest an equal area.
- Obligation of reafforestation of devastated areas or clearings, if natural regeneration is uncertain. During the last ten years CHF 49.9 million of subsidies were paid annually for this purpose and other damages and 67,720 trees were planted annually (the subsidies are unusually high due to the damage caused by cyclone Vivian in February 1990).
- Strictly sustainable forest management. For nearly 100 years felling of timber has only been permitted at a rate no greater than replacement.

Other carbon reservoirs like bogs, rare forest communities, hedges, coppices and other natural habitats functioning as ecological balance areas are fully protected by the 1996 revised Federal Law relating to the Protection of Nature and Natural Heritage. Several hundreds of landscapes and

biotopes have been declared as protected objects by the Confederation and listed in inventories. They cover about 2 % of the area of Switzerland.
The laws concerning nature and landscape protection also demand that areas acting as ecological balance like coppices, hedges and natural vegetation on lake shores and river banks are to be established within areas used intensively by man. The duty to extend ecological potential has been supported by the promotion of more ecological agricultural practices over the past few years. Financial support for these activities is several million Swiss Francs per annum.

5.2.2. CH_4

a) Waste management

Based on the Technical Ordinance for Waste Management, since 1991 all kinds of waste have to be treated in an ecological manner. Landfill has to be avoided if possible, and most combustible waste has to be burnt in special waste incineration plants. The cantons are responsible for implementation (planning capacity, installing, monitoring). This measure considerably reduces the CH_4 emissions created by landfill sites.

b) Agriculture

The Federal Water Protection Law with its revision in 1991 defines the guidelines for the quality of surface waters and groundwater. To ensure high water quality, a limit of 3 cattle manure units per hectare has been set to control stocking densities. This requirement leads to a limitation of the total number of farm animals in the country. Regulations fixing the milk delivery quota for individual dairy farms were first introduced in 1977 and later revised (e.g in 1988). These regulations limit the overall amount of milk produced, which in turn, has a limiting effect on the number of animals.

c) Fugitive fuel emissions

The CH_4 emissions in the sector "Fugitive fuel emissions" are mainly CH_4 losses from the gas distribution network in Switzerland. Based on the revised Ordinance on Air Pollution Control (1992), the emission standards for fuel distribution were tightened, asking for vapour-recovery units for petrol distribution. This also has a positive impact on CH_4 emissions.
The foreseen NMVOC tax will also have a positive impact on the future level of emissions (see section 5.2.5).

5.2.3. N_2O

a) Agriculture

Since 1992, different measures have been taken partially or completely for the first step of the agricultural policy reform. These measures mainly affect the emission of N_2O. In October 1992, the Federal Parliament adopted articles 31a and 31b of the Federal Law on Agriculture as the legal basis for product-independent direct payments. This enabled the system based on financially guaranteed prices and benefits to be replaced by a system based on direct payments.
The reduction in the financial support for agriculture and the adaptation of the Swiss price level to the level of the European Union both reduce economic returns and change the relationship between the costs of production factors, such as fertilisers, and returns. To support agriculture, compensation by direct payments for services of public interest and of special ecological importance is granted provided that specific ecological sound practices are being applied.
Direct payments for ecological compensation are the only part of the Federal budget for agriculture which should increase markedly over the next few years, while other aspects, such as subsidies related to specific products will remain constant, and others will decrease. The recent increase in the number of farms participating in the eco-programmes demonstrates that farmers respond positively to these measures. In 1996 environmentally friendly production systems had already been applied to 60 % of the agricultural land area. It is expected that the process will be completed within a few years.

b) Others

The increased N_2O emissions in the sectors "transport" and "waste" are a result of the use of the catalytic converter to reduce NO_X emissions; there are as yet no measures to compensate for this effect.

5.2.4. Other GHGs (HFC, PFC, SF_6)

No particular policies or measures are in place in the energy and transformation industries or in the industrial sector. In the use of solvents and other products several areas are subject to regulation.
Fire protection

The 29th November 1995 modification of the Ordinance relating to Environmentally Hazardous Substances, annex 4.16, forbids the supply and importation, from 1st January 1996 on, of extinguishing agents made of gases (e.g. HFCs and PFCs) with a half-life of more than five years other than carbon dioxide, nitrogen, and the inert gases, as well as the supply and importation of appliances or stationary equipment containing such agents.

Aerosol propellants

The Ordinance relating to Spray Cans of 26th June 1995 forbids the use of HFCs or PFCs in most spray cans. It only allows the use of HFC 152a as propellant in spray cans containing cosmetic and household products.

Other products

The Ordinance relating to Environmentally Hazardous Substances of 9th June 1986, art. 26, establishes that the marketing of all types of environmentally hazardous substances (including HFCs, PFCs and SF_6), or of products containing such substances, is subject to the self supervision requirement. According to Annex 2 of the Ordinance on Movements of Toxic Wastes, wastes containing HFCs and PFCs qualify as special wastes (code 1215). Thus, movements of such wastes are controlled, and wastes must be treated by licensed enterprises in an environmentally sound manner.

Announcement No 2 (1994) concerning the Ordinance relating to Environmentally Hazardous Substances and the Ordinance on Clean Air recommends that, according to the Clean Air Ordinance, the use of HFCs and PFCs as solvents shall meet the emission reduction requirements applicable to the most stringent class of solvents (Class 1). It also states that the Federal Office of Environment, Forests and Landscape relies on the economic sectors concerned to refrain on a voluntary basis from using such substances. However, if the desired effects are not achieved, the Federal Office of Environment, Forests and Landscape is prepared to propose appropriate measures.

5.2.5. Precursors

Emission standards for stationary and mobile sources

Based on the revised Ordinance on Air Pollution Control (1992), the emission standards were tightened for heating installations and incineration plants, industrial high temperature processes (cement and steel industry) and vapour recovery units for fuel distribution. As a result of these more stringent standards the following effects have been observed.

- NO_X emissions decreased in the residential, commercial, institutional and industry sectors; the emission limit values of combustion installations run with light fuel oil and gas were about halved.
- NMVOC emissions in the sectors of "Fugitive fuel emissions" and "Solvent use" decreased.

Within the road transport sector, emission standards were adapted to the EU level. In 1995, the EURO II level was introduced. This leads to a further reduction of NO_X, VOC and CO emissions.

NMVOC tax

While revising the Environmental Protection Law in December 1995, the Swiss Parliament approved the introduction of an incentive tax on volatile organic compounds. In view of the large number and the small size of pollution sources in Switzerland, this incentive tax is the best suited policy instrument for restraining NMVOC emissions. The new tax is to be levied on both imported and domestically produced NMVOCs and is introduced gradually. The tax rate will be in the first stage 1 CHF per kilo NMVOC. This rate will be doubled after two years (second stage) and tripled after four years (third stage). The revenues from the tax on NMVOC will be redistributed to the population. The subsequent ordinance relating to the tax on NMVOCs will enter into force on 1st July 1997.

5.2.6. SO_2

According to the revision of the Ordinance on Air Pollution Control (1992), SO_2 emissions decrease due to the lower limits for sulphur content. The most important are the decrease in the sulphur limit of diesel fuel (0.2 % to 0.05 % by weight in 1994) and the decrease in the sulphur limit of heavy fuel oil (1.5 % to 1 % by weight in 1991). In addition, the Swiss petroleum industry lowered the sulphur content of light fuel oil in a permanent manner (voluntary effort). Additionally, based on the revised Environmental Protection Law, a tax on the sulphur content of light fuel oil will promote a shift to even lower sulphur grades, without establishing a stringent mandatory limit value. The ordinance relating to this tax will enter into force on July 1st 1997.

5.2.7. Activities implemented jointly

At COP 2, Switzerland announced its intention to participate in the pilot phase for Activities Implemented Jointly under the UNFCCC. A secretariat to manage the programme began operations in February 1997.

5.3. Private sector activities

5.3.1. Commercial sector

Within the **Energy 2000 Programme**, the activities of the private sector are of major importance. The whole programme is focused on shared cost actions to integrate private companies and to create incentives to multiply the effects in the longer run. Concrete financial data to illustrate the level of involvement of the private sector are not available, but it exceeds by far the annual budgets at the national level which are more than 80 million CHF. The approach of creating voluntary agreements to save energy is very fruitful, as different evaluation projects have pointed out. Table 5-1 points out an illustrative sample of several voluntary actions of the private sector, especially of several branch associations. The insurance sector is directly affected by an increased risk of catastrophic events due to climate change. Swiss Re, for example, is involved in a number of internationally co-ordinated precautionary efforts. The reinsurance company has signed the UNEP Statement of Environmental Commitment by the Insurance Industry and is a member of the Steering Committee. This statement affirms the principle of sustainable development. In this context, several projects were initiated (e.g. seminars, international networking, energy and environmental concepts, etc.).

5.3.2. Non-commercial sector

Environmentally oriented non-governmental organisations are also taking part in the "Energy 2000" Programme and report regularly on their activities. Besides activities in environmental education, information and public awareness (see Section 10), several NGOs are directly involved in energy-saving actions. The green transport association, for example, promotes car sharing and pedestrian-friendly town centres in test areas. WWF Switzerland is involved in local activities to build up a dense network of knowledge on how to save energy in smaller towns and in other projects promoting solar energy production for smaller electricity facilities. Greenpeace Switzerland has promoted new technical concepts of energy-efficient cars, together with Germany (SmILE car) to halve fuel consumption. Swiss environmentally oriented NGOs have traditionally been involved in the lobbying and promotion of sustainability and climate policy.

At the national level, different NGOs launched three popular initiatives to reduce GHG emissions.

- **Energy - Environment Initiative.** This initiative aims at reducing the consumption of all non-renewable sources of energy. Consumption should be stabilised within eight years, and then be reduced by 1 % p.a. To achieve this an energy tax is proposed, leading to a considerable increase in energy prices.
- **Solar Initiative.** This initiative proposes a small tax on non-renewable forms of energy to raise funds to promote solar energy and energy efficiency. The tax level should amount to 0.005 CHF per kWh.
- **Initiative to halve road transport**. This initiative requests a reduction of the vehicle kilometres of road transport by 50 % within 10 years.

The Swiss Government is obliged to prepare messages for the parliament. It is foreseen that these initiatives will be discussed in parliament in 1997-98. In 1998-1999 the Swiss electorate will have the final say. The Swiss Government has, however, already recommended rejection of the Energy - Environment Initiative and the Solar Initiative.

Name of firm or cooperation	Sector	Activities (Examples)	Effect	Evaluation Future activities
Coop Switzerland	Retail commerce	Environment information system. Integrated energy management. Several specific actions (e.g. heating).	Increased awareness. Development of monitoring tools. Energy savings in selected fields.	Improvement of installed energy saving tools and information systems. Technological investments and pilot projects.
Migros	Retail commerce	Optimisation of logistics. Voluntary agreements within “Energy 2000” programme.	Increased motivation. Less increase in energy consumption.	Strengthening of activities.
Swiss farmers association	Agriculture	Pilot and demonstration plants to produce biofuels.	Increase of area for rapeseed and Miscanthus	Strengthening of activities and further investment.
Swiss cooperation of architects and engineers (SIA)	Building sector	Several action groups to provide information and networking capacity. Establishment of standards to reduce energy consumption in the building sector.	Establishment of objective targets for the use of different building materials.	Coordination and preparation of European standards. Implementation of the energy guidelines and standards in practice.
Cooperation of Swiss small-scale service sector	Small scale service sector	Assignment of Swiss Energy Charter.	Improved awareness.	Strengthening of activities.
Federation to promote solar energy	Solar energy	Network and institution building. Market information systems in solar energy.	Increased market share of solar energy (present volume 62 million CHF), especially active solar heating.	Strengthening of activities.
Association of Swiss gas industry	Fossil fuels (gas)	Enlargement of gas supply infrastructure. R & D. Pilot actions to promote new technologies.	15 % of Swiss building sector are supplied with gas.	Strengthening of activities.
Swiss Petrol Industry Association	Fossil fuels (oil)	Marketion for enhanced oil burners. R & D fund for new oil relating projects.	Increase of efficiency in the oil sector	Strengthening of activities.
Swiss Society of Chemical Industries	Industry	Responsible care. Performance indicators.	Improvement of energy efficiency 10 % between 1980 and 1995	Strengthening of activities.
Association of Swiss machine industry	Industry	Training courses. Environmental management systems. Energy statistics in industrial sector.	Specific increase of energy efficiency in industry of 7 % p.a.	Strengthening of activities.

Table 5-1: Illustrative examples of private sector activities

5.4. Measures at regional and local levels

5.4.1. CO_2-related measures

National and cantonal Governments together established a national and cantonal Energy programme in 1985. This programme was the basis for the Decree on energy use (setting the legislative framework for the national energy policy) and the "Energy 2000" Programme. Nearly every canton has adopted additional legislation fully coordinated with the national level. On the one hand, these pieces of legislation contain implementation guidelines, since the cantons are broadly responsible for the implementation of energy related measures; on the other hand, cantons adopted the legislative basis for additional measures, especially related to energy saving in the building sector.
Both the cantonal and the local level are taking part in the "Energy 2000" Programme. There are several actions addressed to these levels or initiated by cantonal and local authorities, partly supported by national funds. Some examples are given below (EVED 1996b).

- Development of specific cantonal energy programmes.
- Adjustment of energy standards to the present state of technology, especially for insulation in buildings.
- Incentives for renewable forms of energy, establishment of specific programmes, in addition to the national level.
- Investment and restoration programmes in the building sector.
- Incentives for energy-saving measures in the transport sector. Several actions are linked to the national energy-saving programmes. The canton of Lucerne, for example, introduced a differentiation of cantonal vehicle taxes, according to specific fuel consumption.
- Initiatives and initiation of actions at the communal level. Several bigger cities (e.g. Zurich, Basle, Lausanne, St. Gallen, Winterthur) established their own activities and programmes and are monitoring them regularly.

Example: Environmental Policy of the City of Zurich (local Agenda 21)
In 1995 the City of Zurich established a local agenda which is in line with the goals and the principles of sustainability according to Agenda 21 of the UNCED Conference in Rio 1992 (City of Zurich, 1995). The agenda contains guidelines of local policy in different areas related to climate and other environmental problems, such as air pollution or noise abatement and relations to the cantonal and national level.
The agenda serves as a local position paper in order to follow up a process of integrating the different sector policies towards sustainable development.

Several networks at the communal level strengthen local power in order to increase synergy at the political level and to improve implementation. The following networks are used to build up an institutional platform for sustainable development at the local level.

- "Klimabündnis" (climate alliance) of European Cities. Eleven Swiss cities are members of this network. It is a platform to exchange information and political experience, simultaneously supporting indigenous people in rain forest areas.
- "Stadt-Gemeinde-Charta" (town and commune charter). In order to implement the aims of the UNCED conference in Rio 1992, the charter is a general agreement to support voluntary actions at the local level.
- "Energiestadt" (energy town). This network of smaller cities in Switzerland is embedded in the actions of the "Energy 2000" Programme. It aims to support the energy planning sector and organises several events for the exchange of experience in the field of energy saving. "Energiestadt" is also engaged in continuously providing information material.
- ICLEI (International Council of Local Environmental Initiatives). Zurich as the biggest city in Switzerland is a member of ICLEI and supports activities at the international level for climate change mitigation in cities.

5.4.2. Air pollution control to reduce precursors

Based on the Federal Ordinance on Air Pollution Control (adopted in 1985) the cantons are responsible for the implementation of the ordinance at the regional

level. Thus every canton submitted an action plan which identified the measures to reduce emissions of the different pollutants below a critical level. Most critical are the levels of NO_2 in urban areas and ozone (O_3) in rural areas within bigger metropolitan areas. The reduction of the precursors (NO_X and VOCs) is therefore a major concern. The implementation of these action plans is in progress and regularly monitored. The most important additional measures implemented at the cantonal level are:

- Heating installations. Regulations for different types of combustion installations, at least according to national levels. In several cantons specific standards are more stringent.

According to these regulations, low- NO_X burners and DENOX technology are requested for all buildings within a specifically appointed time.

- Transportation. Each canton has implemented different measures to favour public transport and to reduce the volume of traffic in urban areas (e.g. promotion of public transport and additional measures to reduce the amount of urban road transport; restrictive parking measures by increasing prices and reducing parking areas for public and private purposes; Speed reduction on motorways[6] and major road network; traffic and speed reductions in residential areas).

Several cantons have recently updated their plans (originally adopted mainly before 1994) in order to adjust the implementation to the present situation or air quality. Although progress is visible and concentrations show a significant downward trend, further measures are necessary to fulfil the prescribed national air quality targets.
Together with the measures at the national level related to air pollution (according to the clean air concept) the aforementioned measures especially reduce the emission of precursors.

6 The Federal level has transferred the competence to the cantonal level to introduce lower than usual speed limits on the national motorway system, but cantonal requests for lower speed limits have to be approved by national authorities.

5.5. Policies and measures under consideration

5.5.1. Implementation of Agenda 21

Action plan for sustainable development

The Swiss Government has mandated the Federal administration to prepare a national action plan for sustainable development as a contribution to the implementation of Agenda 21 and other agreements and initiatives related to the Earth Summit.
The Federal Office of Environment, Forests and Landscape, jointly with the Federal Office of Foreign Economic Affairs and the Swiss Agency for Development and Cooperation, have appointed seven eminent people in Switzerland with the responsibility of advising the Government on key issues for sustainable development. The Action Plan will define the main issues which deserve high priority. One of the priority issues regards the energy sector. The expert panel will make recommendations for action by Government and others, reflecting both the national and international responsibilities of Switzerland.

5.5.2. CO_2

a) Law on the reduction of CO2 emissions

A key element of the future Swiss climate policy is the Law on the Reduction of CO_2 Emissions. In the autumn of 1996, the Swiss Government presented a draft of this law and carried out a consultation process.
The law on the reduction of CO_2 emissions has the following main features (DFI 1996).

- The law sets a specified objective for the reduction of CO_2 emissions by the year 2010: 10 % reduction, compared with the year 1990.
- Implemented and planned measures are taken into consideration to achieve this objective. They include the new Federal energy law, a mileage-related tax on heavy vehicles, and a surcharge on motor fuel excise duty to finance important new constructions for public transport.
- The contribution of voluntary measures is taken into consideration as well. These measures should also help curb CO_2 emissions. The possibility of joint implementation is included in the law.
- As a supplementary measure, the legislation also foresees a CO_2 tax. This tax will

only be introduced if, after a period of monitoring and evaluation, it becomes clear that the other measures are inadequate to reach the specified objective. Because of this strategy, the CO_2 tax will be introduced in 2002 at the earliest. Any revenues from the CO_2 tax will be entirely redistributed to the population and to the business community.
- If the introduction of the CO_2 tax becomes necessary, enterprises will be able to free themselves from paying the tax if they engage in voluntary limitations of their CO_2 emissions.

The strategy of the CO_2 law guarantees the adequate integration of the CO_2 tax in the context of energy, transport and fiscal policies. The strategy matches the international efforts to set specific reduction targets for the period after 2000. After the consultation process the draft law will be passed to the Swiss Parliament.

b) Energy law

The draft of the Energy Law presented by the Federal Council to the Parliament is the main focus of the measures intended for reducing energy consumption (DFTCE 1996a). This law is to supersede the Decree on Energy Use, which is limited to the end of 1998. The draft underlines the principles of coordination, of cooperation and of subsidiarity. The Federal Council can therefore bring in appropriate private organisations and business for carrying it out, and transfer certain tasks to them. The proposed Energy Law plans measures in the following fields.

- Guidelines and regulations to ensure the economic and environmentally-friendly supply of energy (responsibility of the energy industry for the supply of energy, the use of waste heat in power stations which run on fossil fuels, regulations on independent power stations)
- Regulations about stating the energy consumption of installations, vehicles and equipment, and about reducing their consumption
- Legal instructions for the attention of the cantons in the building sector (heat insulation, individual metering and billing of heating and hot water)
- Promotion measures (information, advice, education, training, research, pilot installations, demonstration installations) and financial incentives for the efficient use of energy, renewable sources of energy and waste heat.

The following measures are particularly important.

Reduction in specific energy consumption
This measure follows the same concept as in the Decree on Energy Use. It acts above all on the electricity consumption of private households and the service sector and on the specific fuel consumption of cars.

Limit values for consumption in the building sector
The legal instruction obliges the cantons to enact regulations. The measure includes buildings in all sectors.

Individual metering and billing of heating and hot water

In accordance with the draft Energy Law, the legal instruction passes to the cantons. No changes are expected compared with the arrangement in the Decree on Energy Use.

Further development of the Action programme „Energy 2000“ Programme

The programme, which is limited to ten years is to be further developed after the year 2000. Actually arranging this is the subject of present discussions on energy policy between political parties, cantons and the Swiss NGOs which are affected.

Electricity supply

In Switzerland electricity generation is based on 60 % hydroelectric power and 38 % nuclear power. The supply from abroad, which is ensured by contracts, and is of a similar amount to the capacity of domestic nuclear power stations, comes for the most part from power stations in France. If after the year 2010 the supply from existing nuclear power stations or purchases from abroad should be replaced by power stations running on fossil fuels, either due to technical reasons, or as a result of the duration of contracts, then the question would arise of compensation for the additional emissions of CO_2 through more extensive measures on the demand side. The question of long-term electricity supply is at present being considered in the framework of the discussions on energy policy, which were mentioned above. Central aspects are the efficient use of electricity, the supply from nuclear power stations, electricity generation by fossil fuel-thermal processes in large installations or in decentralised coupled, heat and power

installations, the increased use of renewable sources of energy in the long term and the increase in electricity importation, at best linked to an opening of the market.

c) Measures in the transport sector

New taxation of heavy goods vehicles

In February 1994 the Swiss electorate accepted a new article at the constitutional level[7] enabling the national Government to introduce a new distance and weight dependent charge on heavy goods vehicles (above 3.5 tonnes of total weight) to replace the existing flat rate tax. Based on this article, the Government has now elaborated draft legislation and a message for the parliament (DFTCE 1996b). The aim of this charge is the internalisation of the full costs of road freight transport. These full costs comprise infrastructure costs, external accident costs and external environmental costs (e.g. air pollution, noise). The proposed new charge will rise steadily from 0.016 CHF in 2001 to 0.025 CHF in 2005 per km tonne of gross weight. Thus a transalpine journey through Switzerland for a 40 tonne lorry would amount to 300 CHF[8], which is similar to the tolls which are at present paid at foreign alpine transit routes (e.g. Brenner, Mont Blanc). The tax will internalise external costs in order to favour rail freight transport and to prevent an increase in lorry transport, if Switzerland should adjust its existing weight regulation (28 tonnes) to EU standards.
The existing proposal will be discussed in parliament early in 1997. It is expected that a referendum vote of the Swiss electorate will be necessary. Thus the new charge is unlikely to be adopted prior to 2001.

Decree on Financing Large Infrastructure Investments

Although the Swiss electorate accepted the construction of two new transalpine railway axes, the financing of the major investment (more than 15 billion CHF) has not yet been secured. The Swiss Government therefore elaborated a comprehensive concept for the funding as a draft decree and a message for the parliament as follows.

- Re-dimensioning of the rail infrastructure projects with priority for the two base tunnels at Gotthard and Lötschberg without new access tracks.
- Earmarking of part of the revenue (maximum 400 million CHF) from the proposed new heavy duty vehicles tax.
- Temporary increase in excise duty on petrol of 0.10 CHF per litre which will lead to a rise in fuel prices of 5 to 8 %.

This decree will be discussed early in 1997. A national referendum is again expected.

Implementation of the Alpine Initiative

The Alpine Initiative (amendment to the Swiss Constitution) requests a shift of total transalpine lorry traffic (from border to border) from road to rail. The initiative relates to 600,000 lorries per year. The strategy to implement this aim is embedded in the general strategy of transalpine transport, constructing new rail base tunnels to increase rail capacity, introducing new financial schemes, preparing railway reform favouring combined transport, and introducing the above distance and weight dependent tax on heavy goods vehicles.
In order to achieve the aims in modal shift, an additional alpine charge for transalpine lorries is foreseen. Thus a draft for a legislative basis is in preparation for a nation-wide consultation procedure. Implementation can be expected by 2005 at the earliest, following the expiring of the Transit Treaty. The implementation of such a charge must be fully consistent with EU law, i.e. respecting the principle of non-discrimination.

5.5.3. CH_4

Agricultural policy reform is still taking place. A reduction of CH_4 emissions is expected as a result of this reform. Before additional measures are taken these effects have to be assessed.

5.5.4. N_2O

It is planned to increase the competitiveness of the entire nutritional sector based on an economic reform of the agricultural market, which should take place as part of a second step of the agricultural policy reform. Revised legislation based on the new article 31 section 8 of the Federal Constitution is being prepared which requires that farmers document the positive effects of applying ecological farming principles in order to

7 Together with this article, the existing motorway highway charge for passenger vehicles was increased to 45 CHF p.a.

8 The existing flat rate tax for lorries amounts to 25 CHF per transit.

collect direct payments. Trends in the development of prices and of direct payments (until 2002) should also favour the implementation of integrated production (DFEP 1996). Research and education, together with increasing costs for mineral fertilisers, will also lead to a more efficient utilisation of resources. Finally, regulations concerning low input farming and water protection are expected to further reduce nitrogen losses.

5.5.5. Other GHGs (PFC, HFC, SF_6)

Announcement No 2 (1994) concerning the Ordinance relating to Environmentally Hazardous Substances and the Ordinance on Clean Air states that the Federal Office of Environment, Forests and Landscape relies on the economic sectors concerned to refrain from using environmentally hazardous substances, such as HFCs, PFCs or SF_6, on a voluntary basis. If the desired effects are not achieved, the Federal Office of Environment, Forests and Landscape is prepared to propose appropriate measures.

5.5.6. Precursors

More stringent exhaust gas limits for motor vehicles (EURO III) will be introduced in Switzerland at the same time as in the European Union.
Emission limits for agricultural vehicles and construction machines are necessary because these sources emit about 25 % of the total NO_X emissions in Switzerland. Up until now there have been no limitations for these categories.
In order to reduce NO_X and NMVOC emissions from air transport, a landing tax on Swiss airports, dependent on specific aeroplane emissions is being elaborated by the Federal Department of Transport, Communications and Energy.

5.6. Summary tables

5.6.1. Implemented measures (all greenhouse gases; state as of January 1997)

Name of policy / measure	Type of instrument	Objective/method of achieving reduction	Sector	Status of implementation	Estimate of mitigation impact short term (2000) long term (2020)	Monitoring and responsibilities
Reduction of specific energy consumption of electric appliances and motorcars	Objective targets. Voluntary agreements. Regulation.	Different targets according to domains and appliances 7 to 19% (passenger car fleet 15% between 1996 and 2001). If the targets are not met, Government is entitled to introduce regulations.	Residential and service sector. Passenger road transport.	Ordinance adopted 1992 (electronic appliances) 1995 (cars)	impact on CO_2 short term - medium long term - high	Continuous evaluation by the Federal Office of Energy
Limit values for consumption in the building sector	Regulation	Targets for energy consumption including hot water installation beginning in 1997. Stringent targets after 2010.	Building sector	Cantonal regulations implemented	impact on CO_2 short term - medium long term - high	Continuous evaluation by the Federal Office of Energy
Individual metering and invoycing of heating and hot water	Regulation Price oriented	Prescription that new buildings need installations to enable individual consumption accounting	Building sector	Ordinance adopted 1992	impact on CO_2 short term - low long term - medium	Continuous evaluation by the Federal Office of Energy
VAT on fuels	Fiscal measure	VAT on fuels of 6.5%	All energy sectors	Law adopted 1994	impact on CO_2 short term - medium long term - medium	Continuous evaluation by the Federal Department of Finance

Note: Individual measures may have low or medium mitigation impact while their combination in a sectoral policy context leads to significant emission mitigation. The classification of expected relative impact is valid within, but not across policy sectors.

Name of policy / measure	Type of instru-ment	Objective/method of achieving reduction	Sector	Status of implementation	Estimate of mitigation impact short term (2000) long term (2020)	Monitoring and responsibilities
Increase of excise duties on fuel	Fiscal Price oriented.	Increase of CHF 0.2 per litre (petrol and diesel) for financing road infra-structure and related environmental measures.	Road transport	Decree adopted 1993	impact on CO_2 short term - medium long term - medium	Continuous evaluation by the Federal Department of Finance. Increase of tax revenues +17%
Energy saving programmes of the Energy 2000 Programme	Voluntary agreements, fiscal support, marketing, support for government measures	Integral programme with support for new technologies, improved awareness, improved marketing channels	All energy sectors. Different programmes in eight sectors.	Ongoing programmes since 1990	impact on CO_2 short term - medium long term - high	Yearly monitoring of specific programmes. Progress indicators within impact estimations. Government funding CHF 55 million p.a.
Energy saving measures and incentives for renewable energies at regional and local levels	Regulations, financial incentives.	Support for national actions. in the building sector and public transport.	All energy sectors. Different programmes in different sectors.	Ongoing and initiated measures	impact on CO_2 short term - medium long term - high	Yearly monitoring reports by the Conference of the Cantons
Construction of new transalpine railway axes	Investment in rail infrastructure	Shift from road to rail in transalpine freight and passenger transport.	Transalpine transport (freight and passenger).	Legislation adopted 1992. Financial schemes under discussion	impact on CO_2 and precursors short term - none long term - medium In combination with additional measures high	Evaluation by Federal Office of Transport (initial construction work).

Implemented measures (continued)

Name of policy / measure	Type of instrument	Objective / method of achieving reduction	Sector	Status of implementation	Estimate of mitigation impact short term (2000) long term (2020)	Monitoring and responsibilities
Agricultural policy reform	Economic instrument	Establishment of areas of land for ecological compensation. Cultivation of energy crops. Reduction of nutrient losses by equilibrating the nutrient balance.	Agriculture	Implementation started in 1993. Direct payments implemented. Decisions concerning measures for a market reform expected in 1998.	impact on CO_2 short term - low long term - low impact on N_2O short term - high long term - medium	Continous evaluation by the Federal Office of Agriculture (C-balance, nutrient balances, N_2O-emissions).
Regulation concerning milk production	Regulation	Stabilisation of milk production; stabilisation of animal numbers	Agriculture	Implemented since 1977 with several revisions	impact on CH_4 short term - low long term - low	CH_4-emission balances
Water protection law	Regulation	Limitation of number of animals per surface unit	Agriculture	Revision of the law adopted 1991	impact on CH_4 short term - medium long term - low	CH_4-emission balances
Waste deposition/ incineration	Regulation	Prescription to incinerate all combustible waste	Waste	Ordinance adopted in 1991	impact on CH_4 short term - medium (40 Gg until 2010) long term - medium	Continuous evaluation by the Federal Office of Environment, Forests and Landscape and by the cantons (e.g. inspections).
Sustainable logging, ban on clearing and clear felling	Regulation	Protection of sink capacity of the forests and its increase	Forestry	Confirmed in the Forest Law 1993	impact on CO_2 short term - medium long term - medium	Continuous controlling by the forestry service

Implemented measures (continued)

Name of policy / measure	Type of instrument	Objective / method of achieving reduction	Sector	Status of implementation	Estimate of mitigation impact short term (2000) long term (2020)	Monitoring and responsibilities
Air pollution emission standards in the transport sector	Regulation Standards	Emission standards (e.g. adaption to EURO II level).	Road transport	Implemented from 1987. Last adapted to EU level in 1996 (EURO II).	impact on precursors short term - high 1990-2000 NO_X 3.8 Gg p.a. NMVOC 6.0 Gg p.a. CO 29 Gg p.a. long term - medium 2000-2010 NO_X 0 Gg p.a. NMVOC 0.8 Gg p.a. CO 3.5 Gg p.a.	Air quality monitoring and emission control by the Federal Office of Environment, Forests and Landscape.
Air pollution emission standards for combustion	Regulation Standards	Emission standards for combustion installations.	Residential, commercial, industry	Ordinance adopted 1985 and revised 1992	impact on precursors NO_X short term - medium long term - medium (1990 - 2010 about 6 Gg)	Air quality monitoring and emission control by the Federal Office of Environment, Forests and Landscape and the cantons.
Air pollution emission standards for fugitive emissions	Regulation Standards	Emission limits for fugitive fuel emissions and solvent use.	Industry	Ordinance adopted 1985 and revised 1992	impact on precursors NMVOC short term - high long term - high (1990 - 2010 about 60 Gg)	Air quality monitoring, emission control by the Federal Office of Environment, Forests and Landscape and the cantons.

Implemented measures (continued)

Name of policy / measure	Type of instrument	Objective/method of achieving reduction	Sector	Status of implementation	Estimate of mitigation impact short term (2000) long term (2020)	Monitoring and responsibilities
NMVOC tax 1)	Fiscal measure	Incentive tax on imported and domestically-produced NMVOCs (3 CHF per kg)	Industry	Legal basis adopted 1995. Ordinance in preparation.	impact on precursors (NMVOC) short term - medium (2000 - 10 Gg p.a.) long term - high (2010 - 30 Gg p.a.)	Preparation and monitoring by the Federal Office of Environment, Forests and Landscape.
Air pollution emission standards for fuels	Regulation Standards	Prescriptions for sulphur content of fuels	Residential, commercial, institutional, industry; transport	Ordinance adopted 1985 and revised 1992.	impact on SO_2 short term - medium long term - medium (1990 - 2010 about 12 Gg)	Air quality monitoring, emission control by the Federal Office of Environment, Forests and Landscape and the cantons.
Tax on light fuel oil with a sulphur content of more than 0.1% 1)	Fiscal instrument	Tax of 20 CHF per ton of light fuel oil with a sulphur content of more than 0.1%	Residential, commercial, industry	Legal basis adopted 1995. Ordinance in preparation.	impact on SO_2 short term - medium (2000 - 3.5 Gg) long term - medium (2010 - 3.2 Gg)	Preparation and monitoring by the Federal Office of Environment, Forests and Landscape.
Air pollution measures on cantonal level	Regulations shared cost actions	Additional measures within cantonal action plans (e.g. stringent standards, Parking policy and capacity restrictions, speed limits)	All sectors	Running implementation of different measures	impact on precursors short term - medium long term - medium impact on CO_2 and CH_4 short term - low long term - low	Regular monitoring at the cantonal level.

1) not included in the “with measures” projections (see Section 6)

Implemented measures (continued)

Name of policy / measure	Type of instrument	Objective/method of achieving reduction	Sector	Status of implementation	Estimate of mitigation impact short term (2000) long term (2020)	Monitoring and responsibilities
Ordinance relating to environmentally hazardous substances	Regulation	Ban of HFCs and PFCs as fire extinguishing agents	Industry, commercial, residential	Implemented since 1996	HFC, PFC preventive measure (high)	Control by the cantons. Yearly monitoring by the FOEFL
Ordinance relating to spray cans	Regulation	Positive list of allowed propellants for domestic use	Residential, commercial	Implemented since 1995	HFC, PFC preventive measure (high)	Control by the cantons
Air pollution emission standards for solvents uses	Regulation, standards	Emission standards	Industry	Implemented since 1996	HFC, PFC preventive measure (high)	Control by the cantons. Yearly monitoring by the FOEFL

Implemented measures (continued)

5.6.2. Measures under consideration (state as of January 1997)

Name of policy / measure	Type of instrument	Objective/method of achieving reduction	Sector	Status of implementation	Estimate of mitigation impact short term (2000) long term (2020)	Monitoring and responsibilities
Law on the reduction of CO_2 emissions	Institutional voluntary agreements. financial incentives.	Definition of reduction targets and agreements with the private sector. Possibility to introduce a CO_2 tax.	All sectors	Draft law (message) to Parliament 1997.	Reduction target for CO_2 in 2010 is 10% less than 1990 level.	Elaboration of draft law by Federal Office of Environment, Forests and Landscape
Energy law	Institutional voluntary agreements Regulations and financial incentives	Transformation of the Decree on the efficient use of energy into ordinary law (coordination with law on CO_2 emissions).	All sectors	Draft law (message) discussed in Parliament 1997.	Increase in long-term impact of existing energy related measures	Federal Office of Energy.
Distance and weight dependent charge for heavy goods vehicles (HGVs)	Fiscal measure	CHF 0.016 per km tonne total weight in 2001; CHF 0.025 in 2005.	Road freight transport	Draft legislation under parliamentary discussion Implementation 2001 at the earliest.	impact on CO_2 short term - medium long term - high impact on precursors short term - medium long term - high	Elaboration of draft law by Federal Department of Transport, Communications and Energy.
Financing of large infrastructure investments	Fiscal measure	Financial measures for roads to increase competitiveness of rail. HGV charge dependent on distance and weight. Temporary increase of CHF 0.1 on petrol excise duty.	Transport Freight (see above) and passenger transport.	Draft decree in parliamentary discussion. Implementation 1998 at the earliest.	In addition to the above measures impact on CO_2 and precursors short term - low long term - medium	Elaboration of draft law by interdepartmental group

Name of policy / measure	Type of instrument	Objective/method of achieving reduction	Sector	Status of implementation	Estimate of mitigation impact short term (2000) long term (2020)	Monitoring and responsibilities
Implementation of Alpine Initiative	Fiscal. Investment.	(In addition to the above measures) specific charge for trans-alpine road freight transport	Trans-alpine freight transport	Draft legislation in process of consultation. Implementation 2004 at the earliest.	(In addition to the above measures) impact on CO_2 and precursors short term - none long term - medium	Consultation paper elaborated by the Federal Office of Transport.
Air pollution emission standards in the transportation sector	Regulation. Standards.	Emission standards (e.g. adaption to EURO III level for motor vehicles) Emissions standards for agricultural and construction vehicles	Road transport Agriculture Construction	According to EU (1997/2001)	impact on precursors short term - medium long term - high (2010) NO_X 22 Gg p.a. VOCs 9 Gg p.a.	Continous evaluation by FOEFL.
Emission-dependent landing tax for air traffic	Fiscal instrument.	Landing tax on specific emissions of NO_X and VOC from aeroplanes	Air transport	Legal basis adopted. Concept elaborated	impact on precursors short term - low long term - medium	Preparation of consultation paper (Federal Office of Civil Aviation)

Measures under consideration (continued)

5.7. Conflicting areas

Abolition of 28 tonne limit for road freight vehicles
In 1992, the Swiss electorate rejected a decree to join the European Economic Area. Since then, Switzerland has sought to integrate its policy through bilateral negotiations with the Commission of the European Union. Although Switzerland has been adjusting its recent legislation in most areas to EU law, there are two major obstacles to a successful termination of the negotiations. The first is the liberalisation of the labour market, allowing foreign labour to live and work in Switzerland without further registration. The second is the abolition of the present limit of 28 tonnes per lorry for road freight, allowing lorries of 40 tonnes or more. The latter issue has a direct connection with the Swiss policy of mitigating the effects of climate change in the transport sector. Switzerland fears negative impacts due to an increase of lorries on Swiss roads, weakening the competitiveness of the rail sector, which might also have negative impacts on GHG emissions. Final decisions have not yet been made. Intensified research on this problem has revealed that these fears are justified, even if a higher weight per HGV makes it possible to carry more goods per vehicle, improving the ecological performance per tonne transported. To overcome this delicate situation, Switzerland favours a step-wise liberalisation of the freight transport sector, introducing market-oriented measures (e.g. the distance and weight dependent charge which is planned for HGVs).

Liberalisation of the energy markets
According to the schedule of the European Union, the energy markets, especially the electricity market, should be liberalised by 1999 and should for instance provide third party access for electricity in Europe. Since Switzerland has a high proportion of low emission hydroelectric power and nuclear energy, it is estimated that liberalisation could have adverse effects on the environmental performance of electricity production. The only approach to overcome this situation would be an increased effort to save energy and to increase energy efficiency. On the other hand, liberalisation with free trade of electricity in Europe will lower energy prices, thereby reducing incentives to save energy on the consumer side. Switzerland has not yet decided upon the final schedule, knowing that rapid liberalisation would also affect the competitiveness of the Swiss electricity market, with a negative effect on ecological performance. A positive step to combine the advantages of liberalisation with the policy of saving energy is to strengthen the energy-saving measures using pricing measures.

Economic situation and fiscal policy
Since the beginning of the 1990s, Switzerland has been facing a stagnating economic performance with a considerable increase in unemployment and an increasing deficit of public budgets. This has been felt at the national, cantonal and communal levels. This situation could have an influence on the time scale of the introduction of new and more stringent environmental measures, with temporarily more emphasis on structural measures to improve the economic situation. Nevertheless, Switzerland is aware of the positive argument for a first-mover role concerning environmental performance based on economic incentives in this context. Therefore, fiscally oriented environmental measures, such as incentive taxes like the HGV tax, are under consideration.

Technical trade-offs between air pollution control and energy saving
In most cases energy saving measures have a positive impact on air pollution and vice versa, but there are several sectors where one-sided promotion will cause problems. The following examples can be mentioned.

- The promotion of diesel cars in passenger transport saves energy but leads to increased emissions of particulates which can cause health problems.
- The promotion of catalytic converters, substantially reduces precursor emissions, but has a negative impact on nitrous oxide.
- The promotion of combined cycle turbine plants to produce electricity is a very energy efficient method, but increases air pollutant emissions and CO_2 emissions compared with nuclear energy.

Swiss environmental policy clearly aims to find best overall solutions to overcome these trade-offs. In such situations, a very effective measure is to set strict standards, such as emission standards, and to establish an information policy so that the public is made aware of these trade-offs.

References:

BUWAL (Swiss Federal Office of Environment, Forests and Landscape), 1996, Luft-

reinhaltekonzept des Bundesrates, Stand der Realisierung und Ausblick, September 1996
City of Zurich, 1995, Environmental Policy of the City of Zurich, Zurich October 1995
DFEP (Swiss Federal Departement of Economic Affairs), 1996, Message concernant la réforme de la politique agricole: Deuxième étape (Politique agricole 2002) 26th June 1996
DFI (Swiss Federal Departement of Home Affairs), 1996, Loi sur la réduction des emissions de CO_2 rapport explicatif, 23th October 1996
DFTCE (Swiss Federal Departement of Transport, Communications and Energy), 1996b, Message relatif à une loi fédérale concernant la redevance sur le trafic des poids lourds liée aux prestations, 11th September 1996
EVED (Swiss Federal Departement of Transport, Communications and Energy), 1996a, 6. Jahresbericht des Aktionsprogrammes Energie 2000 inkl. Beilagen, Bern
EVED (Swiss Federal Departement of Transport, Communications and Energy), 1996b, Konferenz der kantonalen Energiedirektoren: Stand der Energiepolitik in den Kantonen, Bern, July 1996

6. Projections

6.1. CO_2

6.1.1. Energy

In order to be able to estimate the changes of energy consumption and CO_2 emissions with time up until 2030, taking account of existing established and additional measures, the FOE had extensive forecasting studies carried out (BEW / Prognos 1996).
In the energy forecasts two variants are calculated. Variant 1 extends the present structure of electricity provision to the future, i.e. nuclear energy and purchase. Variant 2 considers a gradual switch to coupled heat & power generation and fossil-thermal generation after 2020. The forecasts shown in this section are based on variant 1.
The results show that in the field of fossil energy sources the goals of the Action Programme Energy 2000, namely stabilising demand and CO_2 emissions at the level of 1990 by the year 2000 are within range. Through efficient implementation and continuation of existing and established measures the demand for fossil fuels and therefore CO_2 emissions should remain stable within the period 2010 to 2020. Electricity demand would however continue to rise as before, but at a slower rate than in the past.
These forecasts are based on three essential assumptions.

- The economic and demographic framework develops as expected (rapid upswing in the economy: average yearly GDP growing at 1.7 % from 1990 to 2010, and afterwards at 1.3 %; population increase of 600,000 by 2010). The process of substituting with low-CO_2 or CO_2-free sources of energy (renewables) continues.
- The energy policy is rapidly, efficiently and widely implemented. In particular it is assumed that voluntary measures such as target consumption values for equipment are as effective as regulations made by the state. If voluntary solutions do not reach their targets then measures will immediately be introduced by the state.
- The present domestic nuclear power capacity remains in existence, and electricity purchasing agreements with France are renewed. Otherwise, the stepwise replacement of the existing domestic nuclear power capacity by modern gas-fired power stations or coupled heat and power installations by the year 2030 would increase emissions of CO_2 by about 12 % and the importation of natural gas would be more than doubled compared with nowadays.

In view of the prolonged recession and the structural crisis in the Swiss economy the real change in GDP is likely to be below that assumed in both scenarios. This will also have a dampening effect on energy consumption and CO_2 emission.
The scenario calculations[9] are based on bottom up models. Equilibrium models were used to determine the effects of energy policy on economic and demographic framework data. Energy demand is determined in the partial models household, commercial industry and traffic. Cost analyses are worked out in all the partial models, enabling the economic aspect of individual measures to be assessed for different energy prices and in view of the assumptions concerning the degree of implementation of measures and

9 In the energy forecasts a distinction is made between scenario I: implemented measures
scenario II: measures under consideration

instruments. The individual partial models are as follows.

Household

Factors which are particularly considered are the number of flats and households; size of flats; type, age and use of building; type and technical standard of heating installations and equipment for heating up water; the provision of households with electrical appliances and their energy properties and useful life.

Services

Various domains were investigated (trade; banking and insurance; hotel trade, schools; hospitals and homes; buildings in the transport sector; retail trade; wholesale trade; agriculture; culture and sport; other public buildings; auxiliary buildings). The energy code number (energy consumption index) for electricity is differentiated according to 32 sectors.

Industry

Thirteen sectors of industry and 24 sub-sectors were studied, including the number of employees, the net industrial production, the various surfaces using energy, installations etc. For each sub-sector a large number of production processes were investigated (type, replacement cycles, energy consumption etc.).

Transport

A distinction was made between transporting people and transporting goods, as well as between transport by road, rail, air and water. Tonne-kilometres, person-kilometres, and vehicle kilometres were all included. For vehicles other criteria were capacity, number, category, size, age, local trips, regional trips, motorway trips, transit, border traffic etc.

Table 6-1 shows the most important assumptions concerning the framework data. Table 6-2 shows the development of energy consumption according to the source of energy. Figure 6-1 shows graphically the historical and expected development of the most important parameters.

	1990	2000	2010	2020
World oil prices (US$/bbl)				
real	18	19	21	28
nominal	18	24	41	80
Domestic energy prices	(1992)			
Fuel Residential (CHF/t)	458	393	418	491
Fuel Industrial (CHF/t)	395	329	353	421
Electricity (CHF/kWh)	0.146	0.161	0.165	0.173
GDP bn CHF, Prices 1990	314	356	444	520
Population (millions)	6.8	7.4	7.6	7.5
New vehicle efficiency (litres/100km)	9.5	8.6	7.8	7.0
Primary Energy demand (Petajoules)	1048	1059	1112	1133

Table 6-1: Key variables and assumptions in the analyses of energy projections ("with measures" scenario)

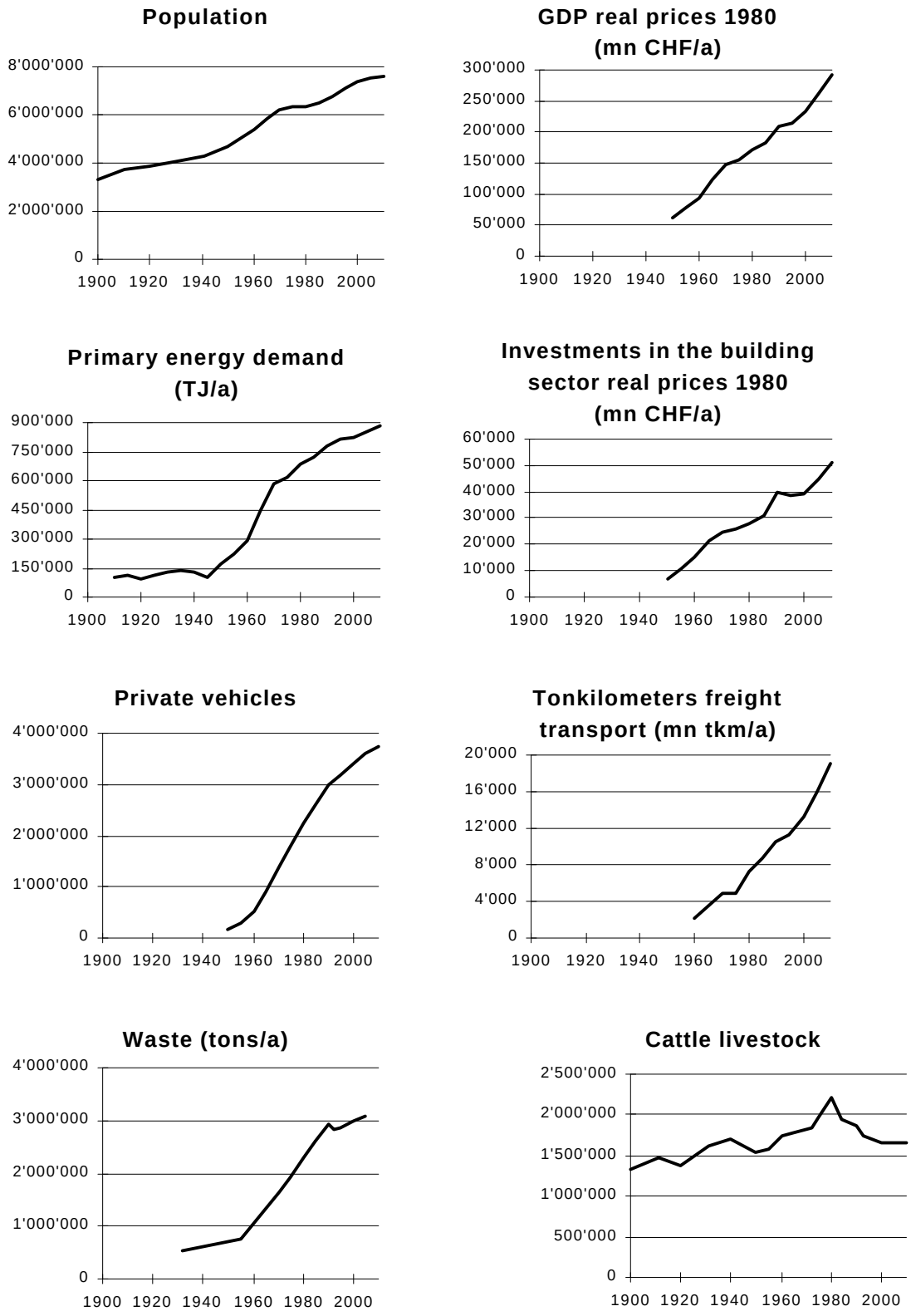

Figure 6-1: Changes in the most important key variables (FOEFL 1995)

in PJ p.a.	1995 1) (energy statistics)	1995 (model values)	2000	2010	2020	2030
hydroelectric	160.2	150.3	153.5	156.8	159.4	161.9
nuclear	256.2	248.5	246.6	241.1	246.6	246.6
coal	8.0	5.6	2.1	2.1	1.9	2.0
petroleum	510.3	522.7	517.4	535.0	538.8	527.3
natural gas	92.9	94.7	100.9	114.5	120.8	126.5
biomass 2)	50.3	55.5	58.9	62.5	63.2	62.7
wind, solar	0.0	0.0	0.1	0.4	0.9	1.2
electricity 3)	-26.2	-25.2	-20.1	-1.0	1.2	4.4
Total	**1060.9**	**1052.2**	**1059.4**	**1111.5**	**1132.8**	**1132.5**

1) differences between the official statistics and the model values are explained in section 6.1.4
2) including landfill gas and biogas
3) export surplus

Table 6-2: Forecasts for gross energy consumption ("with measures" scenario)

6.1.2. Non-energy and other sources

The results presented here are from the official forecast for all pollutants (FOEFL 1995). The assumptions are fully in line with those of the energy perspectives (BEW / Prognos 1996), described in section 6.1.1.
Most of the CO_2 emissions in the sector of industrial processes come from the cement industry. The rapid decline in CO_2 emissions between 1990 and 1995 is the result of a reduction in the production of cement (20 % decrease). The 1995 production level is expected to remain constant until 2010.
Most of the CO_2 emissions in the waste sector are from waste incineration plants. The continuous increase in CO_2 emissions is the result of the increasing amount of waste being burnt.
No data are yet available for agricultural soils. Detailed inventories and forecasts taking account of the change in agricultural land use, and the change in soil carbon stocks are being developed and the first results should be available at the end of 1997. Since the contribution of agriculture to CO_2 emissions is fairly low, it has been neglected in the following carbon balances.

6.1.3. Removals by sinks and reservoirs

The oldest afforestations are now more than 100 years old. According to the IPCC guidelines, this would mean that there is no longer a net carbon sequestration in these areas. However, growth is slower in higher zones and therefore the lifetime of a tree in the alpine region, where most of the afforested areas are situated, may be several centuries. For this reason yield tables and the site classification of the National Forest Inventory are used to calculate the present carbon sequestration. The second National Forest Inventory will enable this to be verified. These data are expected at the end of 1998.
As a consequence of Swiss forest policy (see section 5.1) forest area and growing stock are still increasing. At least a constant sink of 5,100 Gg CO_2 p.a. can be expected during the next few decades. No carbon enrichment in the soil is included in this figure, because abandoned pastures have rather a high carbon content, so an increase as in the guidelines is rather unlikely. It will be difficult to get reliable data on this point.
The contribution of the strategies in nature and landscape protection to CO_2 sequestration is difficult to assess. It is estimated to be 1 to 2 % of those in the Swiss forests.

6.1.4. Summary

Table 6-4 gives an overview of the CO_2 forecasts for 1990 to 2010.
Most of the CO_2 emissions in Switzerland are emissions from combustion installations (about two thirds of total CO_2 emissions in 1990). The rest is mainly CO_2 from transport. The figures clearly show that the contribution of transport to CO_2 emissions is constantly increasing (contribution of traffic was 38 % in 1990; in 2010 it will be about 49 %), while emissions from combustion installations remain about constant.

Further Explanation

Link between inventories and projections of energy-related CO_2 emissions, 1990

The Swiss greenhouse gas inventories are based on official Swiss energy statistics. The final energy consumption in the statistics is split into four sectors: residential; commercial, institutional, services, agriculture; industry; transport. Additional divisions in the inventories refer to these sectors.

The CO_2 emission projections are based on a bottom-up model (BEW / Prognos 1996) with four main sectors 1-residential; 2-commercial, institutional & agriculture; 3-industry & services; 4-transport. This sector classification differs from the IPCC classification and the official statistics.

Table 6-3 gives an approximate relation between inventory data and model data. Note that only energy-related CO_2 emissions are dealt with in the table. 1990 is the base year for modelling. Thus inventories and model results have to be compared in 1990. The model differs from the inventory in three important ways: 1) the grouping of sectors differs, 2) international bunker fuel emissions are included, and 3) data are climate corrected. In columns 1 and 2 of table 6-3 the model definitions are applied to data from the 1990 inventory. The remaining difference between column 2 and 3 shows the error left between model and reality, after the inventory is matched with the model structure as closely as possible.

Considering the overall energy-related CO_2 emissions for 1990, the difference between the adapted inventory and the model is very small (about 1 %). The same is true for the 1995 data.

CO_2 (1,000 Gg)		(1)	(2)	(3)
Sector	**IPCC Category**	**1990 Inventory (adaptation of sectors to model)**	**Adapted 1990 Inventory: Climate correction**	**1990 model projection**
Residential	1A4b	**11.48**	**12.35**	**13.20**
Commercial, Institutional, Agriculture		**5.95**	**6.02**	**5.40**
Comm./Inst.	1A4a	6.19		
Industrial trade 1)		-0.73		
Building trade 1)		-0.15		
Agriculture & Forestry	1A4c	0.64		
Industry, Trade		**6.87**	**6.88**	**7.20**
Industry	1A2	5.41		
Industrial trade 1)		+0.73		
Building trade 1)		+0.15		
Machinery	1A5	0.52		
Fugitive emissions	1B	0.06		
Transport		**17.28**	**17.28**	**17.20**
Transport	1A3	14.67		
Military	1A5	0.21		
Industry, cars	1A5	0.12		
Gardening	1A5	0.12		
Int. bunkers		2.16		
Total		**41.58**	**42.53**	**43.00**

1) Data according to retrospective analysis Prognos (1996)

Table 6-3: Comparison between inventory and model results (CO_2 emissions 1990 1,000 Gg)

CO_2 1,000 Gg p.a.	1990 2)	1995 2)	2000	2005	2010
Energy	44.5	43.0	42.6	43.6	44.6
Energy/ and Transformation	1.5	1.6	1.6	1.6	1.6
Industry	7.2	6.0	5.3	5.6	5.9
Residential	13.2	12.4	11.9	11.6	11.4
Commercial and Institutional	5.4	5.1	4.9	4.7	4.6
Transport 1)	17.2	17.8	18.9	20.1	21.2
of which internat. bunkers	*(2.1)*	*(2.4)*	*(2.7)*	*(3.0)*	*(3.2)*
Industrial Processes	3.4	2.6	2.6	2.6	2.6
Solvent Use	n.o.	n.o.	n.o.	n.o.	n.o.
Agriculture	n.e.	n.e.	n.e.	n.e.	n.e.
Waste	1.3	1.4	1.4	1.5	1.6
Total gross emissions 1)	**49.2**	**46.9**	**46.6**	**47.7**	**48.8**
Land Use and Forestry	-4.4	-5.1	-5.1	-5.1	-5.1
Total net emissions 1)	**44.8**	**41.8**	**41.5**	**42.6**	**43.7**

1) including international bunkers
2) energy related emissions from modelled data, not fully consistent with GHG inventory
n.o. not occuring
n.e. not estimated

Table 6-4: CO_2 forecasts for 1990-2010 by sector, in 1,000 Gg per year (model results, for "implemented measures")

6.1.5 Energy-related CO_2 emissions with intended measures included

The effects of the new CO_2 and Energy Laws which are to be introduced, together with additional measures are simulated in a further energy scenario (scenario IIT with the implementation of a CO_2 tax on fuels, according to BEW / Prognos 1996). If the intended measures are translated into reality the CO_2 emissions for 2010 and 2020 could be reduced by 10 % and 11 % respectively compared with 1990. Electricity demand is expected to increase, but considerably less rapidly than in the 1980s. For this scenario the same prerequisites are valid as for scenario I. Therefore the replacement, where appropriate, of nuclear power by fossil fuels based on natural gas would diminish the CO_2 reduction for 2020 compared with 1990 by 3 %.

Table 6-5 shows the changes with time for both scenarios: I - implemented measures and II - measures under consideration. In the traffic sector, even taking intended measures into account, growth is to be expected. However, the growth rate decreases from 29 % (scenario I) to 15 % (scenario II).

1,000 Gg CO_2	1990 2)	1995 2)	2000	2010	2020	2030
Scenario I (Implemented measures)						
Energy transformation	1.5	1.6	1.6	1.6	1.6	1.6
Residential	13.2	12.4	11.9	11.4	10.9	10.3
Commercial and	5.4	5.1	4.9	4.6	4.2	3.9
Institutional	7.2	6.0	5.3	5.9	5.8	6.0
Industry	17.2	17.8	18.9	21.2	22.7	22.9
Transport 1)	**44.5**	**43.0**	**42.6**	**44.6**	**45.1**	**44.6**
Total						
Scenario II (Measures under consideration)						
Energy transformation	1.5	1.6	1.6	1.5	1.6	1.7
Residential	13.2	12.4	11.6	11.1	10.5	9.8
Commercial and	5.4	5.1	4.9	4.5	4.0	3.7
Institutional	7.2	6.0	5.3	5.6	5.5	5.7
Industry	17.2	17.8	17.5	17.2	17.9	18.1
Transport 1)	**44.5**	**43.0**	**40.9**	**39.9**	**39.5**	**39.0**
Total						

1) including international bunkers
2) energy-related emissions from modelled data, not fully consistent with GHG inventory

Table 6-5: Comparison of changes in CO_2 emissions for scenarios I and II (energy related CO_2 emissions only, in 1,000 Gg)

6.2. CH_4

6.2.1. Agriculture

Emissions of methane (CH_4) from agriculture for the years 1990-2020 were calculated using the IPCC methodology (method 2) and input parameters given in Table 6-6. To determine these parameters for the selected years, it is assumed that the level of production, i.e. the amount of milk and meat produced, remains approximately constant after 1990.
The future energy demand of animals is based on the size of the population and the energy demand determined for 1993. For cattle, the IPCC default value of 6 % for methane production relative to gross energy consumption is used. The corresponding values for sheep and goats are 5 %, and for pigs 0.54 %. For horses and poultry, values of 3.5 % and 0.16 % of digestible energy respectively were used. These values were kept constant for all years. The trend in the number of livestock is derived from the change in the animal population between 1990 and 1994, assuming a relative increase in milk production per animal of 0.5 % p.a. after 1995 due to biological and technical improvements. This leads to a reduction in the number of livestock (e.g. cattle).
Emissions from manure management are calculated using the IPCC guidelines with some parameters adapted to specific Swiss conditions.

Parameter	1990	1995	2000	2005	2010	2020
Mature cows	795	765	751	732	714	714
Non-dairy cattle	1,060	991	976	988	1,000	1,000
Pigs	1,787	1,453	1,430	1,400	1,400	1,400
Poultry	6,530	6,099	6,500	6,500	6,500	6,500
Sheep	395	427	440	440	440	440
Goats	68	57	57	57	57	57
Horses and Mules	42	47	55	55	55	55

Table 6-6: Livestock input data (1,000 head) for the calculation of projected CH_4 emissions from Swiss agriculture (source Federal Office of Agriculture)

Calculated annual methane emissions for selected years are summarised in Table 6-7. Methane emissions show only a slight decrease over the observed period. The expected reduction in the number of animals is partly counteracted by a larger food intake (i.e. energy intake) per animal, which results in a higher emission rate per animal. The projected decrease by the year 2010 is 4 % relative to 1990.

	1990	1995	2000	2005	2010	2020
Enteric fermentation	130.2	127.7	128.0	126.6	125.3	125.3
Manure management	20.7	19.9	19.6	19.4	19.2	19.2
Agriculture tot.	**150.9**	**147.6**	**147.6**	**146.0**	**144.5**	**144.5**

Table 6-7: Projection of annual agricultural emissions of CH_4 (Gg) (Three year averages)

6.2.2. Other sources

The results presented here come from the official forecasts for all pollutants (FOEFL 1995). The assumptions are fully in line with those of the energy forecasts (BEW / Prognos 1996), described in Section 6.1.1.

The emissions of CH_4 in Switzerland are dominated by the emissions of the agriculture sector (62 % in 1990, 76 % in 2010). Fugitive emissions from fuels are mainly losses from the gas distribution network (at present about 6 % of the total methane emissions in Switzerland). This distribution network is constantly being upgraded; so despite the rapid increase in gas

consumption a decrease in fugitive emissions of 23 % is expected for the period 1990 to 2010.

6.2.3. Overview

Table 6-8 shows the forecasts of methane emissions. Methane emissions will decline in the future. Between 1995 and 2010, a decline of 18 % is expected. The decline in the energy sector due to the effect of air pollution measures, and in the waste sector, due to the regulations about waste incineration are particularly relevant.

CH_4 Gg	1990	1995	2000	2005	2010
Energy	23.56	20.61	19.27	18.32	17.73
Fuel combustion	8.92	7.83	6.97	6.52	6.43
of which					
Energy and Transformation	*0.05*	*0.08*	*0.11*	*0.11*	*0.10*
Industry	*0.32*	*0.36*	*0.35*	*0.36*	*0.38*
Transport	*4.47*	*3.52*	*2.74*	*2.31*	*2.15*
Small-scale combustion	*3.71*	*3.48*	*3.37*	*3.31*	*3.34*
Other	*0.37*	*0.39*	*0.40*	*0.42*	*0.46*
Fugitive emissions	14.64	12.78	12.30	11.80	11.30
Industrial Processes	0.43	0.40	0.44	0.47	0.50
Solvent Use	n.o.	n.o.	n.o.	n.o.	n.o.
Agriculture 1)	150.90	147.60	147.60	146.00	144.50
Land Use/Forestry	n.e.	n.e.	n.e.	n.e.	n.e.
Waste	68.61	66.53	61.60	46.30	29.30
Total	**244**	**235**	**229**	**211**	**192**

1) without agriculture soils (values not yet available)
n.o. not occuring
n.e. not estimated

Table 6-8: CH_4 forecasts for 1990-2010 by sector, in Gg per year (including "implemented measures" only)

6.3. N_2O

N_2O emission data have undergone revision since the first submission in 1994 and the inventories of 1990 - 1994. The reason for the lower figures in the present report is the application of the most recent IPCC methodology (method 2) for the calculation of agricultural N_2O emissions.

6.3.1. Agriculture

Emissions of nitrous oxide (N_2O) from agriculture for the years 1990-2020 were calculated using the IPCC methodology (method 2) and input parameters given in Table 6-9. To determine these parameters for the selected years, it is assumed that the level of crop production remains nearly constant after 1990. Input data for livestock are given in Table 6-6.

Parameter	1990	1995	2000	2005	2010	2020
Mineral N-fertliser use	75	67	54	42	30	30
Legumes	10	15	20	22	24	25
Cereals	1,279	1,336	1,300	1,250	1,200	1,200
Root crops	2,074	1,425	1,700	1,700	1,700	1,700
Vegetables	360	380	380	380	380	380
Fruits	510	520	490	460	460	460
Wine (hl)	1,334	1,181	1,200	1,200	1,200	1,200
Tobacco	1	2	2	2	2	2
Energy crops	0	2	2	3	4	5

Table 6-9: Mineral fertiliser input (kt) and crop production (in kt harvested biomass) used to calculate projected N_2O emissions from Swiss agriculture

Projections of the amount of mineral fertilisers used are based on measures adopted to reduce their use. An important goal of these measures is to balance the nutrient budgets of individual farms. This should reduce excess nitrogen application and thus nitrogen losses (see adopted measures in section 5.2.3.) until the majority of farms apply the guidelines for either integrated or organic farming. The trend can thus be estimated by assuming a steady increase in the proportion of farms applying these guidelines until 2005, and the known use of fertiliser associated with organic and integrated farming. The values for 1990 and 1995 indicate that these assumptions are realistic.

However, the values for 2000 and beyond reflect best-guess estimates, and those used for the years beyond 2005 are highly uncertain. As shown in table 6-6, the number of cattle decreases, which in turn leads to a reduction in the amount of N excreted by animals.

Projected emissions of nitrous oxide (N_2O) are given in Table 6-10. Nitrous oxide emissions show a marked decrease over the observed period, which is chiefly due to the decline in the use of mineral N-fertilizers. Relative to 1990, the reduction by the year 2010 would be about 18 %.

	1990	1995	2000	2005	2010	2020
Direct	3.93	3.72	3.43	3.21	3.00	3.00
Animals	2.04	2.03	2.01	2.02	2.02	2.02
Indirect	3.23	3.07	2.84	2.68	2.52	2.52
Agriculture tot.	**9.20**	**8.82**	**8.28**	**7.91**	**7.54**	**7.54**

Table 6-10: Projections of agricultural emissions of N_2O (Gg) (Three year averages)

6.3.2. Other sources

The results presented here come from the official forecasts for all pollutants (FOEFL 1995). The assumptions are fully in line with those of the energy forecasts (BEW / Prognos 1996), described in section 6.1.1. The main source of N_2O emissions is the agricultural sector (80 % of total N_2O emissions in 1990; 67 % in 2010). Due to the increasing market penetration of the catalytic converter in private cars, the contribution of the transport sector to total N_2O emissions is expected to rise from 10 % in 1990 to 21 % in 2010.

6.3.3. Overview

Table 6-11 shows the forecasts of N_2O emissions. Emissions will slightly decline in the future. Between 1995 and 2010 a decline of nearly 5 % is expected. Most relevant is the decline in the agricultural sector due to agricultural reform, whereas in the energy sector (transport) emissions are expected to rise.

N_2O Gg	1990	1995	2000	2005	2010
Energy	1.39	2.03	2.38	2.51	2.57
Fuel combustion	1.39	2.03	2.38	2.51	2.57
of which					
Energy and Transformation	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*
Industry	*0.03*	*0.03*	*0.03*	*0.03*	*0.03*
Transport	*1.13*	*1.78*	*2.13*	*2.26*	*2.32*
Small-scale combustion	*0.19*	*0.18*	*0.18*	*0.18*	*0.18*
Other	*0.03*	*0.03*	*0.03*	*0.03*	*0.03*
Fugitive emissions	0.00	0.00	0.00	0.00	0.00
Industrial Processes	0.32	0.31	0.31	0.31	0.31
Solvent Use	0.35	0.38	0.39	0.40	0.41
Agriculture	9.20	8.82	8.28	7.90	7.54
Land Use and Forestry	n.e.	n.e.	n.e.	n.e.	n.e.
Waste	0.22	0.28	0.33	0.46	0.50
Total	**11.5**	**11.8**	**11.7**	**11.6**	**11.3**

n.e. not estimated

Table 6-11: N_2O forecasts for 1990-2010 by sector, in Gg per year (including "implemented measures" only)

6.4. Other GHG (HFC, PFC, SF_6)

HFC
If not restricted, a very rapid growth is expected in certain applications.
Foreseeable annual growth rates in emissions are

20 % (5 - 30 %)	in refrigeration and air conditioning
3 to 5 %	in insulation foam
100 %	in aerosols propellants.

PFC
If not restricted, consumption in the solvent sector is expected to grow at an annual rate of 10 to 50 %. The plans of the metal industry (aluminium) to stop production in Switzerland will eventually lead to the elimination of PFC emissions in this sector.
SF_6
As yet insufficient information is available to define a trend.

6.5. Precursors

The results presented here come from the official forecasts for all pollutants (FOEFL 1995). The assumptions are fully in line with those of the energy forecasts (BEW / Prognos 1996), described in section 6.1.1.
The emissions of precursors in the energy sector were calculated with energy consumption data of the prognostic model described in chapter 6.1.1. The sector splitting was done in the same manner as in the inventories (based on the official Swiss energy statistics). Only total consumption data for the different fuels come from the model.
The emissions of the sectors of industrial processes and solvent use were calculated with product quantities and the corresponding emission factors.
In the sector of waste different approaches were used. Emissions of waste incineration plants were calculated in the same manner as fuel combustion emissions in the energy sector, emissions of landfill sites were calculated with a sophisticated formula for degassing (similar to 1995 IPCC guidelines).
Table 6-12 shows the predicted trends for 1990 to 2010. Due to air pollution measures, all emissions of precursors will decline. However, the reduction rate will also decline because the effect of certain technological changes (e.g. catalytic converter in the transport sector) will slow down and traffic growth will counterbalance the positive long-term effect. The overall reductions will be as follows between 1995 and 2010:

- NO_X emissions:18 % down
- CO emissions: 28 % down
- NMVOC emissions: 19 % down.

NOx emissions are dominated by transport emissions (66 % in 1990; 63 % in 2010). The sector of small-scale combustion (residential and commercial or institutional) is expected to contribute about 15 % from 1990 until 2010.
Three sectors are chiefly responsible for CO emissions, namely transport, small-scale combustion and other i.e. transport (73 % in 1990 and 49 % in 2010), small-scale combustion (15 % in 1990; 26 % in 2010) and other (7 % in 1990; 16 % in 2010). The sector “other” covers off-road vehicles and military activities.
Emissions of NMVOCs are dominated by the sectors of solvent use and transport. Solvent use contributes 52 % in 1990 and 67 % in 2010, whereas the transport sector gives 32 % in 1990 and 13 % in 2010. Note that the expected effects of the proposed NMVOC tax have not yet been included (see section 5.2.5).

Precursors Gg	**1990**			**1995**			**2000**			**2005**			**2010**		
	NO_X	CO	NMVOC	NO_X	CO	NMVOC	NO_X	CO	NMVOC	NO_X	CO	NMVOC	NO_X	CO	NMVOC
Energy	156	678	123	127	488	74	109	388	52	105	349	45	107	349	45
Fuel combustion	156	678	105	127	488	66	109	388	45	105	349	39	107	349	38
of which															
Energy and Transformation	*2*	*0.3*	*0.0*	*2*	*0.3*	*0.1*	*2*	*0.5*	*0.1*	*2*	*0.6*	*0.1*	*1*	*0.5*	*0.1*
Industry	*16*	*16*	*0.4*	*12*	*14*	*0.4*	*10*	*14*	*0.4*	*9*	*14*	*0.4*	*9*	*14*	*0.4*
Transport	*107*	*509*	*90*	*82*	*318*	*50*	*69*	*217*	*30*	*66*	*186*	*23*	*69*	*182*	*22*
Small-scale combustion	*23*	*104*	*8*	*21*	*104*	*8*	*19*	*102*	*8*	*17*	*92*	*8*	*17*	*95*	*8*
Other	*9*	*49*	*7*	*9*	*52*	*7*	*9*	*54*	*8*	*10*	*56*	*8*	*11*	*58*	*8*
Fugitive emissions	0.1	0.0	18	0.2	0.0	8	0.0	0.0	7	0.1	0.0	6	0.1	0.0	6
Industrial Processes	0.5	14	8	0.3	11	8	0.3	10	8	0.3	11	8	0.3	12	8
Solvent Use	0.0	0.1	147	0.0	0.1	117	0.1	0.1	101	0.1	0.1	105	0.1	0.1	109
Agriculture	n.e.	6	n.e.	n.e.	6	n.e.	n.e.	6	n.e.	n.e.	6	n.e.	n.e.	6	n.e.
Land Use and Forestry	n.e.	n.e.	n.e.	n.e.	n.e.	n.e.	n.e.	n.e.	n.e.	n.e.	n.e.	n.e.	n.e.	n.e.	n.e.
Waste	7	8	3	6	6	2	5	3	1	3	3	0.8	3	2	0.6
Total	**163**	**707**	**281**	**134**	**510**	**200**	**115**	**407**	**162**	**108**	**369**	**159**	**110**	**370**	**163**

n.e. not estimated

Table 6-12: Forecasts of precursor emissions 1990-2010 by sector, in Gg per year (including "implemented measures" only, without NMVOC tax)

6.6. SO_2

The results presented here come from the official forecasts for all pollutants (FOEFL 1995). The assumptions are fully in line with those of the energy forecasts (BEW / Prognos 1996), described in section 6.1.1. Calculations were done in the same manner as the calculations for precursors (see section 6.5.). Calculations of SO_2 emissions in the energy sector are directly influenced by energy consumption and the sulphur content of the fuels. Since 1980 the sulphur content of fossil fuels has decreased constantly. The mean values of sulphur contents of heavy fuel oil fell from 2 % to under 1 % in 1995, and for light fuel oil decreased over the same period from 0.4 % to about 0.13 % in 1995.
Fuel combustion (small-scale combustion and industry) is the main source of SO_2 emissions in Switzerland.
Table 6-13 shows the trends in emissions. Emissions in the energy sector will decline due to air pollution measures. Thus a decline of 29 % in total is expected between 1990 and 2010. Note, that the expected effects of the tax on the sulfur content of light fuel oil have not yet been included (see section 5.2.6).

References:

BEW / Prognos, 1996, Bundesamt für Energiewirtschaft (Federal Office of Energy)/Prognos: Energieperspektiven der Szenarien I bis III 1990 - 2030, Synthese-bericht, Bern November 1996
FOEFL (Federal Office of Environment, Forests and Landscape), 1995: Emissions polluantes dues à l'activité humanie en Suisse de 1900 à 2010. Rapport no. 256 des Cahiers de l'environnement, Berne
Prognos, 1996, Expost-Analyse der Energie-perspektiven, Basel

SO_2 Gg	1990	1995	2000	2005	2010
Energy	30.85	27.62	23.95	24.04	24.15
Fuel combustion		27.62	23.95	24.04	24.15
of which					
Energy and Transformation		*2.33*	*1.75*	*1.5*	*1.32*
Industry		*7.90*	*8.43*	*8.89*	*9.32*
Transport		*2.11*	*2.34*	*2.60*	*2.86*
Small-scale combustion		*15.04*	*11.20*	*10.80*	*10.40*
Other		*0.24*	*0.23*	*0.25*	*0.25*
Fugitive emissions		0.00	0.00	0.00	0.00
Industrial Processes	7.70	3.61	3.52	3.11	3.13
Solvent Use	0.04	0.04	0.04	0.04	0.04
Agriculture	0.02	0.02	0.02	0.02	0.02
Land Use and Forestry	0	0	0	0	0
Waste	3.41	2.54	2.21	2.27	2.31
Total	**42**	**34**	**30**	**29**	**30**

Table 6-13: Forecasts of SO_2 emissions 1990-2010 by sector, in Gg per year ("implemented measures" without sulphur tax)

7. Impacts and adaptation

7.1. Expected impacts of climate change

Within the framework of the National Research Program "Climate Changes and Natural Disasters", a concerted effort has been made to develop an internally consistent set of climate change impact assessments. An analysis of data on climate (49 stations) and precipitation (135 stations) for the period 1961-1990 shows that the average temperature over Switzerland increased by 1°C over this 30-year period, with spring and early summer becoming colder and late summer and autumn showing above average warming. Precipitation increased by 1 % over the same period, whereas the length of periods of sunshine decreased, particularly in the spring and summer (Beck 1996).
Modelling simulations under double pre-industrial CO_2 conditions (2 x CO_2 experiment) suggest an average increase in surface temperature for Switzerland of 2-4°C in summer (July) and of 0.5-1.5°C in winter (January), (Ohmura et al. 1996). However, simulations of precipitation are less certain, and the predicted changes in temperature and precipitation are smaller than, or of the same order of magnitude as, the model bias (i.e. the difference between the current climate simulation and actual climatological data). In view of this background, recent research indicates the following impacts of climate change.

7.1.1. Ecosystems

Recent Swiss research using static equilibrium and dynamic forest succession models indicates that the potential natural vegetation type of Swiss forests will change under warmer conditions, because the fraction of poorly adapted forest inventory points will increase, depending on the degree of warming. With a warming of 1ºC to 1.4ºC, between 30 and 55 % of inventory points would be expected to have a different vegetation type (15 vegetation types in total). As a result of these warmer conditions, plant communities in some zones would be replaced by others (mountain / subalpine belt - replacement of conifers by broad-leaved species; colline / submontane belt - replacement of beech-dominated by oak & hornbeam-dominated communities). However, under warmer and wetter conditions, the shifts in vegetation may not be as drastic. Under warmer temperatures, but the same level of precipitation, overall species richness is expected to increase, whereas no significant change in species richness is expected if conditions are also wetter.
Actual observations in undisturbed colline to submontane forests in Switzerland for the period 1961 - 1995 have shown unexpectedly large changes in species composition (Klötzli et al. 1996). Over this period temperatures increased by 1ºC, resulting in mild winters and hot summers, and the appearance of exotic broad-leaved evergreen species in north and south Switzerland and palms in southern Switzerland.
Despite a great deal of research it remains difficult to make general statements concerning the direct effects of increasing CO_2 concentrations on plants and ecosystems. Recent Swiss research indicates two main points for high alpine sites. First, there is no change in plant biomass, even when nitrogen is not limited. Secondly, fast-growing plants out-compete more robust, slow-growing species, leading to reduced resistance of the vegetation. In meadows, an increase in the root mass is documented, but it is not known whether more carbon is being stored in the soil. It also appears that the effects of elevated CO_2 concentrations are non-linear,

with little or no additional effect above 420 ppm. (Bader 1996a).

7.1.2. Hydrological cycle and cryosphere

There seems to be a consensus that a global increase in average temperature will lead to an intensified hydrological cycle and more precipitation in the form of heavy precipitation (>30 mm/day) in Switzerland, in particular during the winter and on the south side of the Alps (NFP / SPP-Pressestelle, 1996). Such heavy precipitation events may lead, in turn, to more frequent flooding and landslides.
The risk of floods has been greatly reduced through civil engineering projects and other measures taken during the second half of the 19th century. One study, for example, demonstrated the importance of dams, which had been built to create artificial reservoirs for hydroelectric power generation, in reducing the maximum runoff resulting from extreme events (LHG, 1991). However, more recently the claim and damage sums for flood events have begun to climb again, primarily due to land use pressure, rather than climatic changes in the alpine region (Bader 1996a).
Effects on aquifers, including on the chemistry and quality of groundwater resources, are expected to be negligible for a doubling of atmospheric CO_2, and most of the major porous aquifers in Switzerland appear to be relatively insensitive to climatic variations (Bonzelboudjen, Kimmeier and Kunz, 1996). Since 1950 the surface temperature of lakes and rivers in Switzerland has in some cases increased by more than 2°C. A fraction of this warming can be attributed to the enhanced greenhouse effect.
One study concluded that it is not possible to estimate the future development of hail and winter storms on the basis of the assumptions made concerning average temperature and precipitation changes in Switzerland. Such estimates require more precise information on changes in the mesoscale circulation over the north Atlantic and European regions (Bader, 1996b).
Snow and ice in the Alps exist near the melting point and are thus particularly sensitive to climate change. Since 1850 the area covered by glaciers has decreased by about 40 %, and about 50 % of glacier volume in the Alps has been lost (VAW-Mitteilungen 108, 1990). Permafrost reacts immediately to surface temperature changes. At a depth of 10 m, the average rate of temperature increase in permafrost has been more than 0.1°C per year since 1987, (NFP / SPP-Pressestelle, 1996). Such changes have been shown to lead to slope instability in both consolidated and unconsolidated material.
One study of the Valais village of Saas Balen highlighted the risks associated with a sudden failure of high alpine lakes that have begun to form and enlarge as a result of glacier retreat, and it suggested protection measures to reduce these risks. Such events have frequently led to the destruction of alpine villages. Studies are underway to assess the extent to which other communities are also at risk from such events (Bader, 1996a).

7.1.3. Selected economic sectors

Financial services and insurance

The insurance business and government insurance (and relief) schemes are directly affected by any changes in climate, in particular those that occur unexpectedly, because of their involvement in property insurance against weather events such as storms, flooding or drought. Claims due to natural disasters have risen sharply over the past decade, although direct attribution to climate change is not possible. Insurers will attempt to manage the increased risk of a changing climate by applying the precautionary principle and the best scientific information available about the expected damages, so the impacts are difficult to estimate. (ProClim–, 1996)
The banking divisions that would be acutely affected by climate change are project finance, real estate finance, corporate banking and corporate finance services related to the sectors of the economy that would be the most heavily impacted, and asset management. Economic impacts on the banking transactions of individual sectors of the economy such as ski tourism and insurance are already visible today. (ProClim–, 1996).

Tourism

The analysis indicates that if the altitude at which adequate snow exists on 100 days per year were to increase by 300 m (from 1,200 m to 1,500 m, which would be the case, if the temperature were to increase by 2ºC), then only 9 % of small ski lifts and 63 % of ski areas would have adequate snow cover, as compared with 40 % and 85 % today (Abegg, 1996). For comparison, the average

temperature in Switzerland has risen by 1ºC over the past 30 years.

Agriculture

Swiss agriculture is in a difficult situation because of factors such as the challenge of more open markets, pressure for best environmental practice (BEP; production level according to PARCOM / OSCOM - Northsea Conference) and more environmentally sound products, loss of income from secondary occupations (winter tourism) and decreasing demand for some products. Crop yields and grassland productivity may increase in response to climate change and increased atmospheric CO_2, but climate change could contribute to structural changes, accelerating the shift from hill agriculture to agriculture in valley areas. Thus the livelihood of people living in mountainous areas would be threatened. (ProClim–, 1996).

7.1.4. Energy supply and demand

There has been no systematic analysis of the impacts of climate change on energy supply and demand in Switzerland (VSE / FEO, 1996). In general, the expected fluctuations are believed to be small in comparison with natural variability between years, and not currently a high priority for the utilities.

7.1.5. Infrastructure

One recent sensitivity study indicates that increased river flow due to climate change can affect the geometry of river beds in such a way that erosion is enhanced (Musy, Boillat and Kunz, 1996). This situation would represent a risk for the stability of structures anchored in river channels, such as bridges and water pipelines. Reduced flow, on the other hand, would lead to enhanced sedimentation and more flooding.

7.1.6. Indirect effects

No comprehensive analysis has been conducted on the indirect effects of climate change for Switzerland. One example of such effects would be an increase of tropospheric ozone and other air pollutants as a result of rising temperatures.
Another category of indirect effects are those impacts that take place elsewhere, but which nonetheless have repercussions for Switzerland. Such impacts might include aggravation of the North-South conflict (due to inadequate food and water supplies in developing countries); an increase in "environmental refugees" seeking asylum in Switzerland; losses to the insurance industry due to drought, sea-level rise and storms in other regions of the world; or increasing demands for financial support from developed countries for disaster relief and adaptation measures in less developed countries. Thus the indirect effects of the impacts of climate change outside the geographic boundaries of Switzerland could prove to be quite significant for Switzerland in the medium- to long-term.

7.2. Vulnerability assessment

Vulnerability depends on the sensitivity of a system to changes in climate variables and the degree to which the system can adapt, either autonomously, in the case of pristine ecosystems, or purposefully, through concerted actions (UNEP / WMO / IPCC, 1996). A comprehensive assessment of the climate vulnerability of various ecological and human systems in Switzerland has not been undertaken in a systematic way to date. In particular, the adaptive capacity of ecological and socio-economic systems and the potential for adaptation strategies to reduce the vulnerability of the various systems to climate change have not been adequately and systematically assessed. There is a need to consolidate the available information on biophysical and socio-economic impacts, to assess likely autonomous adjustments, and to evaluate the various adaptation options. Nonetheless, the available information points to the following systems that may be particularly vulnerable to climate change.

7.2.1. Sensitive ecosystems

In general, plant and animal communities which are already living at their ecological limits (maximum temperature, precipitation requirements) would tend to be vulnerable to climate change. Vulnerability also depends on other pressures on ecosystems, such as pollution levels, habitat fragmentation, soil and water quality and many other natural and human factors.

Mountain ecosystems

It is likely that the most vulnerable would be the cryosphere, which is already showing a response to the 1°C warming over the past

30 years (see section 7.1), and also plant communities at high altitude.

Forests

Recent research indicates that under warmer conditions beech-dominated communities in the colline-submontane belt are vulnerable to replacement by oak-hornbeam communities and that the dominance of conifers in the montane and subalpine belt would be seriously threatened by the invasion of broad-leaved species from the current low montane and submontane belt (Kienast, 1997).

Freshwater ecosystems

Temperature increases have a major impact on the partial pressure of gases and on the activity of organisms. This can reduce the oxygen concentration to levels which lead to conditions that are toxic to aquatic plants and animals. The maximum temperature that can be tolerated by local species of trout in Swiss rivers will soon be exceeded in some stretches of the larger lowland rivers (Jakob, Liechti and Schädler, 1996).

7.2.2. Sensitive economic activities and sectors

Tourism

In 1994 tourism contributed CHF 21.6 billion in income for Switzerland (about 4 % of GNP) and accounted for 13 % of export income, making tourism the third most important export sector in Switzerland (Abegg, 1996). Activities related to tourism provide 9 % of all jobs (300,000 jobs) and a much higher fraction in mountain regions. Important factors for the success of tourism have been the availability of snow for skiing (snow cover and length of season) and the scenic value of glacial landscapes. Global warming will lead to more winters with little snow, with low-lying ski resorts particularly vulnerable. Recent analyses indicate that only 9 % of small ski stations and 65 % of larger ski areas could operate economically if temperatures were to increase by 2ºC.

Agriculture & Forestry

Swiss agriculture is practised at elevations ranging from 300 to 2,500 m above sea level, with large differences in meteorological, topographical and pedological conditions.
Climate change may affect agriculture by increasing or decreasing crop productivity, and by altering the need for weed and pest control. These effects are likely to show regional differences, and this may in turn lead to changes in the pattern of production. The frequency and intensity of storms that have affected Swiss forests have increased over the past 100 years. Forest damage due to storms in 1990 was the most severe on record and resulted in the following monetary and non-monetary damages (FOEFL, 1994): 4.9 million m^3 of timber felled (compared with a normal annual harvest of 4.5 million m^3); approximately CHF 200 million paid out in indemnities by the Federal Government; and estimated restoration costs of CHF 100 to 200 million. Such events could become more commonplace under warmer climatic conditions. Indirect consequences of any change in the effectiveness of forests in protecting against soil erosion and slope instability are difficult to predict.

Insurance & banking

Property insurance and reinsurance are vulnerable to extreme climatic events. The insurance industry is currently under stress from a series of billion dollar storms since 1987, resulting in dramatic increases in losses, reduced availability of insurance, and higher costs. Higher losses strongly reflect increases in infrastructure and economic worth in vulnerable areas as well as a possible shift in the intensity and frequency of extreme weather events. (UNEP / WMO / IPCC, 1996)
The financial services sector and institutional investors are sensitive to the impacts of both climate change and response strategies on the various economic sectors in which they invest. One analysis has shown that climate change represents major long-term risks to the carbon fuel industry and perhaps other economic sectors, because of the anticipated need for policy measures to limit greenhouse gas emissions (Mansley, 1995). Such measures would reduce the demand for energy, reduce the upside potential for producer energy prices, and decrease the prospect of a long-term rise in energy prices. The risks to the carbon fuel sector have not yet been adequately discounted by the financial markets, so that investors are vulnerable, in particular if drastic measures should become necessary.

7.2.3. Sensitive regions

High alpine villages

The increasing potential for natural disasters due to melting of permafrost, glacial retreat, heavy precipitation events, and shifts in the form of precipitation will contribute to the vulnerability of alpine settlements and infrastructure (e.g. roads, bridges, railway lines and ski-lifts) to climate change.

Low altitude ski areas

Economic hardship from negative impacts on both winter tourism and mountain agriculture, as well as other pressures related to structural changes, could make communities that are dependent on these two economic bases particularly vulnerable to climate change (small single lifts and ski areas in the Jura mountains, Ticino and the eastern & central Swiss Alps) (Abegg, 1996; ProClim–, 1996).

River valleys and floodplains

In the alpine environment of Switzerland the major damage is not usually caused by flooding in the floodplains. Valleys are much more vulnerable because, in addition to the villages, infrastructure such as roads, railways and motorways with many bridges is frequently situated parallel to the river on the small space in the bottom of the valley. Floods are primarily hazardous in four ways (Petrascheck and Schädler, 1992).

1. Vertical and lateral erosion of riverbanks, together with subsequently collapsing embankments which can lead to the collapse of structures well above the water level.
2. Flooding by water with deposits of river bed-load, and blockages due to timber or bed-load (at outlets, bridges etc.) and natural narrow passages.
3. River bed aggradation due to a rising river bed forcing the river to divert to a new bed, causing flooding at unexpected places.
4. Debris flow, a high density mixture of water and solids, which often causes severe damage due to the enormous quantities of solid material.

7.3. Actions with regard to adaptation

Estimates of the regional impact of climate change are difficult, for the climate models do not offer the necessary information at the regional scale. As a consequence it is difficult to work out appropriate and reliable adaptation strategies. Beside the primary effects, secondary effects on the natural and socio-economic system are to be expected. However, there is still a lack of knowledge about impacts and necessary adaptation strategies. As a first step a paper distinguishing sensitive processes and sectors is in preparation. Key questions have to be identified in these fields, in order to assess the impacts, the natural abilities of ecosystems and economic sectors to adjust, and the necessity for adaptation measures. It is expected that these questions will be, at least partly, integrated in the forthcoming priorities of Swiss research programmes.
It is said that the Alps, like mountainous regions in general, are sensitive to environmental deterioration and therefore vulnerable to climate change. Adverse effects are expected to arise, for instance from more frequent storms and heavy precipitation, from the replacement of high altitude snowfall by rainfall, and from a decrease in snow cover during the winter. This means that adaptation measures are of special importance in the following fields:

- natural hazards,
- forests and forestry,
- economic sector.

7.3.1. Natural hazards

Natural hazards are a common threat in the mountains. Reliable data on the frequency and intensity of landslides, mud-slides, flooding and other hazards caused by climate in the Alpine region are lacking. The forest law and the law on flood protection have the purpose of protecting human life and objects of value against the damaging effects of natural hazards. These objectives have to be achieved in three steps.

1. Assessment of hazards. Recognition of hazard situations and jeopardising situations and their impacts (establishing danger zone maps).
2. Differentiation of the objective of protection.
3. Planning of measures using
   a) land use planning
   b) protection forests and structures, monitoring stations etc.

The total financial support from the Confederation between 1986 and 1995 was CHF 53.8 million per year for protection against avalanches, landslides, erosion and rockfalls. It was CHF 72.3 million per year

from 1988 to 1995 for flood protection. This amount has increased from CHF 41.4 million per year between 1984 and 1987 due to extreme flood events in 1987. The costs of repairing properties damaged by floods are not included in these amounts.
The main uncertainty is how the protective structures will fulfil their functions under the changed circumstances, and whether melting permafrost and glaciers will destabilise moraines and rocks and so cause more frequent rockfalls, mud-slides and landslides. Serious investigations in this field are necessary.

7.3.2. Forests and sylviculture

The history of vegetation, and models suggest that forests will be affected, though the mode of transition is uncertain. Damage must be expected from storms, drought, interactions with atmospheric pollution, and (according to the level of warming) new or intensified pests and diseases. During the 20th century, increasing forest damage through extreme climatic events has been reported. There is no adaptation strategy to prevent such effects but forest policy (see section 5.1.1) includes measures to preserve forests.

1. Addressing ecological imperatives through sylviculture.
   - Ban on clear-felling.
   - Regeneration practices imitating the natural behaviour of a forest left to itself.
   - Natural sylviculture with financial support for forest management, logging and hauling the timber, since total costs of nature protection are high (CHF 39.4 million average annual subsidy for 1986 - 1995).
2. Maintaining the vitality of the forests (CHF 49.9 million average annual subsidies for 1986 - 1995), using the following measures.
   - Measures to prevent and combat pests and parasites.
   - Repairing damage where forest conservation might be threatened.
3. Conservation of the genetic resources of forests (CHF 0.6 million average annual subsidy for 1986 - 1995) using the following measures.
   - National register of seed tree stands on the basis of internationally defined parameters.
   - Launching a gene conservation network.
   - Creation of seed orchards to improve the supply of indigenous reproductive material.

All these measures are intended to improve the stability and autonomous adjustment of forest stands to changing natural conditions.

7.3.3. Economic sector

In the economic sector, planning periods are hardly more than ten years. As a consequence, leadership and planning in business is more flexible, which leads to a certain continuous adaptation to short-term fluctuations under normal business practice. At the same time there is a growing tendency to sustainable production. However, there is no long-term strategy for adapting to the effects of climate change, so the increasing frequency of extreme events or long-term shifts could be particularly damaging.
Winter tourism is especially affected because it is highly dependent on the presence of the "climatic resource" of snow cover. Winter sports resorts at lower altitudes may be threatened by warmer winters. The most common adaptive responses are to install artificial snow equipment, to move ski stations to higher altitudes or glaciers (where this is practical), or to diversify the type and seasonal focus of the activities offered. Summer tourism could also be affected by damage to the Alpine landscape resulting, for example, from the retreat of glaciers. In general, there is a tendency to create equipment for alternative activities; but there is no long-term strategy for adapting to climate change.

References:

Abegg, B., 1996, Klimaänderung und Tourismus: Klimaforschung am Beispiel des Wintertourismus in den Schweizer Alpen. Schlussbericht NFP 31. Zürich: Hochschulverlag AG an der ETH Zürich, 222 pp

Bader, S., 1996a, Auf dem Prüfstand der Praxis. NFP 31 Info 8:5

Bader, S., 1996b, Klimatologie der Stürme und Sturmsysteme anhand von Radar- und Schadendaten. NFP 31 Info 9:9

Beck, M., 1996, Klimadatenauswertung 1961-90 in der Schweiz: Temperaturzunahme knapp 1 Grad. NFP 31 Info 8:10

Bonzelboudjen, M., F. Kimmeier, et P. Kunz, 1996, Impact des changements climatiques sur le comportement des systèmes aquifères. PNR 31 Info 10, in prep.

FOEFL (Federal Office of Environment, Forests and Landscape), 1994, Global Warming and Switzerland: Foundations for a National Strategy. Report of the Inter-departmental Working Group on the Evolution of the Climate System. Bern: OFEFP, 112 pp
Kienast, F., 1997, Personal Communication, 13th January 1997
Klötzli, F., Walther G.-R., Carraro G. und Grundmann A., 1996, Anlaufender Biom-wandel in Insubrien. Verhandlungen der Gesellschaft für Ökologie 26: 537-550
Jakob, A., P. Liechti, und B. Schädler, 1996, Temperatur in Schweizer Gewässern – Quo vadis? gwa:4, 288-294
LHG (Swiss Geological & Hydrological Survey), 1991, Ursachenanalyse der Hoch-wasser 1987. EVED/EDI, 47 pp
Mansley, M., 1995, Long Term Financial Risks to the Carbon Fuel Industry from Cli-mate Change. London: The Delphi Group, 26 pp
Musy, A., J.-L. Boillat, and P. Kunz, 1996, Influence des changements climatiques sur le régime hydrologique des bassins-versants et sur le comportement hydraulique des cours d'eau: Implications sur le dimensionnement des structures hydrauliques. PNR 31 Info 10, in prep.
NFP / SPP - Pressestelle, 1996, Klima-entwicklung und Naturkatastrophen im Alpengebiet: Signale des Treibhauseffekts? NFP 31 Info 8:9-10
NRP 31 (National Research Programme "Climate Changes and Natural Disasters"), 1996, Newsletter of the NRP 31, NRP 31 Info. Berne: NRP 31
Ohmura, A., M. Beniston, M. Rotach, P. Tschuck, M. Wild, and M.R. Marinucci, 1996, Simulation of Climate Trends over the Alpine Region: Development of a Physically-Based Modelling System for Application to Regional Studies of Current and Future Climates. Final Report NRP 31. Zürich: Hochschulverlag AG an der ETH Zürich, 197 pp
Petrascheck, A. and B. Schädler, 1992, Flood hazards. In: G.I. Lumsden (ed.), Geology and the Environment in Western Europe. Types of Hazards and Regional Characteristics. Clarendon Press, Oxford, pp 187-190
ProClim– (Forum for Climate and Global Change, Swiss Academy of Sciences), 1996, Climate Risks – Challenge for the Swiss Economy. Summary of the Proceedings of a forum organized by ProClim–, NRP 31 and Swiss Re (29-31 January 1996, Rüschlikon). Berne: ProClim–, 21 pp
UNEP / WMO / IPCC, 1996, Climate Change 1995, Summary for Policymakers, Geneva
VAW-Mitteilungen (Versuchsanstalt für Wasserbau, Hydrologie und Glaziologie), 1990, Internationale Fachtagung über Schnee, Eis und Wasser der Alpen in einer wärmeren Atmosphäre (11th May 1990), VAW Mitteilungen 108, D. Vischer (ed.), 135 pp
VSE / FEO (Association of Swiss Electric Utilities / Federal Energy Office), 1996, Personal communications, November and December 1996

8. Technology transfer and financial assistance

8.1. Introduction

The increase in levels of greenhouse gases in the earth's atmosphere over the last hundred years has been due almost exclusively to the activities of the industrialised countries. Nevertheless, since the developing countries are likely to account for an increasingly large proportion of world-wide emissions in the future, their help will be essential in solving global environmental problems.
To be able to solve these problems, the developing countries are dependent on financial resources provided by the industrialised countries over and above the funds already being contributed for Overseas Development Assistance (ODA). This fundamental fact was underlined by all the heads of government participating in the United Nations Conference on Environment and Development (the Rio "Earth Summit") held in Rio de Janeiro in June 1992.
Switzerland contributes funds as follows.

- Cooperation in the framework of the Global Environment Facility (GEF).
- Cooperation in the field of technology transfer.
- Bilateral technical and financial cooperation.

Table 8-1 gives a list of the Swiss financial contributions to multilateral institutions and programmes. Concerning the multilateral programmes, the list presented here is not exhaustive. More details are given in section 9 on the scientific programmes.

8.2. Switzerland's contribution to the Global Environment Facility (GEF)

The Global Environment Facility (GEF) is a mechanism for financing environmental projects of global importance in developing countries (and to some extent in Central and Eastern Europe). Since mid-1991, the GEF has financed projects in the fields of climate, biodiversity and the protection of international waters and of the ozone layer.
To mark the 700th anniversary of the founding of the Swiss Confederation, the Swiss Federal Parliament granted a five-year credit facility of CHF 300 million to finance environmental programmes and projects of global importance in the developing countries (Federal Decision of 13th March 1991). With this credit facility Switzerland made resources available for global cooperation in the area of environmental protection over and above the funds already earmarked for development aid. The CHF 300 million credit facility has enabled Switzerland to play a major role in the GEF and to set up a programme of bilateral cooperation in the global environment field. During the pilot phase (1991-1993) Switzerland contributed CHF 80 million to the GEF, of which 64 million went to the core fund and 16 million were co-financing. Thanks to co-financing, Switzerland has (for specific projects) the right to a certain say in the operations of the GEF. Switzerland became the sixth biggest donor country, accounting for 5.9 % of total contributions. The contributions extending the GEF to the 1994-1996 period are now directed at more equitable distribution. Switzerland has contributed some CHF 60 million to the core fund, making it the tenth biggest donor.

8.3. Technology transfer

As a co-signatory to the United Nations Framework Convention on Climate Change, Switzerland is committed to the following.

- Providing new and additional financial resources to meet the agreed full costs incurred by developing country Parties to

the Convention in complying with their obligations under article 12, paragraph 1 (national communications).
- Providing such financial services, including resources for the transfer of technology, as are needed by the developing country Parties to meet the full incremental costs of implementing measures covered by article 4.1 (national inventories, national programmes on climate change, etc.).
- Taking all practicable steps to promote, facilitate and finance, as appropriate, the transfer of, or access to, environmentally sound technologies and know-how to other Parties, particularly developing country Parties, to enable them to implement the provisions of the Convention.

8.3.1. Principles underlying Swiss policy on technology transfer

The following principles and goals play an important role in Swiss policy on the transfer of environmentally sound technology to developing and to Central and Eastern European countries.
- Consideration of preferences and structures of the partner countries.
- Utilisation and coordinaton of experience.
- Long-term cooperation between competent partners.
- Local capacity building.
- Creation of suitable conditions for private enterprises.
- Least cost and cost-effective solutions.

8.3.2. Bilateral measures aimed at developing countries

In the field of technology transfer to developing countries, Switzerland acts above all as a catalyst between private investors and potential target countries for the transfer of capital and know-how. The following instruments are used.

Financing
Mixed financing arrangements are composed of a government component (a grant) and a bank component (a commercial credit facility). Their purpose is to mobilise additional financial resources on preferential terms in order to finance investments and priority services in developing countries. Basically, mixed financing arrangements promote the transfer to developing countries of technology that is capable of substantially reducing emissions of greenhouse gases and other atmospheric pollutants under specific circumstances. As far as the instruments described below are concerned, the connection with climate change is not immediately apparent; it may, however, be the case with individual projects.

Match making
Match making is aimed at establishing contacts between small and medium-sized Swiss companies on the one hand and similar companies in developing countries and/or Central and Eastern Europe on the other. Such exchanges help promote the transfer of technology and know-how in industry between these companies.

8.3.3. Bilateral measures aimed at Central and Eastern Europe and the CIS

The countries of Central and Eastern Europe require enormous financial resources to pay for the cost of adapting, renewing and rebuilding their industries and infrastructures. Swiss cooperation with Central and Eastern Europe is based on two framework credits approved by the Federal Parliament. From the framework credit of CHF 250 million (Federal Decision of 13th March 1990), CHF 200 million has been earmarked for financial aid on the part of the Federal Office for Foreign Economic Affairs and CHF 50 million for technical cooperation under the aegis of the Federal Department of Foreign Affairs. This first credit has been allocated and the projects have, in part, been implemented. From the second framework credit facility of CHF 800 million (Federal Decision of 28 January 1992) CHF 600 million has been set aside for financial aid and CHF 200 million for technical cooperation. The bulk of these resources has been allocated to specific projects. In 1992, this second credit facility was increased by CHF 600 million (450 mn for financial assistance and 150 mn for technical cooperation) to extend it to the Commonwealth of Independent States (CIS).
Bilateral cooperation between Switzerland and the countries of Central and Eastern Europe is based primarily on two instruments: grants and credit guarantees.

Grants
Switzerland uses grant financing to support non-profit-making projects in, for instance, the field of environmental protection. As far as most countries in Central and Eastern

Europe are concerned, the contribution envisaged and the field of application are defined in bilateral agreements. The priority fields of application are the environment, energy, infrastructure and the health sector. Generally speaking, the projects are proposed by the partner countries. The evaluation of the projects, the decision and the financing fall under the competence of the Swiss side. As a rule, the equipment provided must be of Swiss origin. In addition, the partner country is expected to bear the costs of the project to the extent that it is able to do so, especially with regard to local cost components.

Credit guarantees
Credit guarantees are used to finance projects in which the return on investment is expected to allow the payment of interest and the reimbursement of the debt. Credit guarantees are granted when hedging of export risks with the official Export-Risk Guarantee Agency is prevented by economic or political instability. Credit guarantees are used to finance Swiss goods and services, particularly machinery, precision instruments and spare parts. The environmental dimension is taken into account at the application stage. These mechanisms have sometimes promoted the importation of goods impacting directly on air quality.

8.3.4. Multilateral activities

Multilateral financial institutions of which Switzerland is a member country (for instance the World Bank, International Monetary Fund and regional development banks,) play an important role in technology transfer. Indeed, almost all the investments made by development banks concern the transfer of environmentally sound technology.
The projects submitted to these organisations are systematically screened for their environmental impact, and a growing number of projects in the environmental field are financed in this way. Switzerland attaches importance to the integration of environmental questions into the projects.

World Bank
The World Bank's activities in the field of sustainable development are supplemented by issuing political guidelines, and by research work and technical collaboration.

Global Environment Facility (GEF)
The GEF, an innovative global financing mechanism, has been successful in operationalising a major restructuring process, which it was mandated to carry out at the 1992 Rio Conference: The developing countries accepted GEF financing for the major environmental conventions, provided it would become more transparent and open (still subject to a permanent agreement). The OECD countries on the other hand obtained satisfaction in their demand, that multilateral „additionalities“ for environmental objectives would be administered by the World Bank, and not by UN agencies. As a consequence, the GEF is now a very dynamic and flexible linkage between the UN system - through the inclusion of UNDP and UNEP - and the Bretton Woods institutions. So far, about 40 % of GEF funds were directed to projects under the UNFCCC.

Asian Development Bank
A division of the Asian Development Bank is devoted entirely to the environment, thereby ensuring the integration of environmental concerns into all its activities.

Inter-American Development Bank
An Environment Management Committee systematically examines all IADB projects for their environmental impact. To link granting of the credits to improvements in the environment, six specialists have been appointed by the IADB to the regional agencies to monitor projects for compliance with agreed environmental standards.

African Development Bank
In the course of the 1990s, the African Development Bank has formulated several objectives aimed at resolving the serious environmental problems of the African continent (desertification, destruction of tropical forests, etc.). The main objectives are as follows.

- Evaluation of the state of the environment in Africa.
- Application of an environmental policy to all regions at risk.
- Assistance to African countries in formulating their national policies on the environment.

8.3.5. Involvement in international task forces

Switzerland participates in various technology transfer task forces in a number of international bodies such as the OECD, GATT,

UNIDO, UNCTAD and the Commission on Sustainable Development (CSD). It is therefore well placed to help improve general conditions at both national and international levels. Such conditions promote the transfer of technology and know-how, especially by strengthening the institutional infrastructure and supporting programmes of education, training and information.

8.4. Bilateral technical cooperation

8.4.1. Bilateral component

In March 1991 the Swiss Federal Parliament approved a framework credit facility of CHF 300 million over five years to finance global environment programmes and projects in developing countries (see section 8.2). The multilateral component (accounting for about 45 % of the credit) comprises Switzerland's contributions to the Global Environment Facility and the Multilateral Fund of the Montreal Protocol. The bilateral component, which is managed by the Swiss Directorate of Development and Cooperation, amounts to some CHF 150 million. Within the first five years (1991-1996) of the credit's being approved, CHF 128 million have been committed to funding 60 programmes and projects, not counting smaller-scale activities. The funds will continue to be disbursed until 2000.

8.4.2. Climate change projects

Climate change is one of the priority fields, and its current share of the financial resources allocated is 28 %. In 1994, 16 projects coming under this category received a total of CHF 10.4 million and involved 13 countries. In 1995, 24 projects received CHF 26.8 million and involved 15 countries.
In the field of energy, 9 projects in 1994 (CHF 8.7 million) and 14 projects in 1995 (CHF 19.6 million) were aimed at improving energy efficiency by promoting the innovative use of technology. In 1994 two projects (CHF 1.1 million) and in 1995 five projects (CHF 2.7 million) were for promoting renewable energy resources, particularly solar energy.
Tables 8-2 and 8-3 give a detailed comparison of the projects funded by Switzerland which are relevant to climate change.

	Contributions (Million CHF)	
	1994	1995
Global Environment Facility	16	16
Multilateral institutions		
1 World Bank	55.4	58.0
2. International Finance Corporation	5.3	5.1
3. African Development Fund	49.1	23.3
4. Asian Development Fund	12.0	16.6
5. European Bank for Reconstruction and Development	22.3	21.1
6. Inter-American Development Bank	2.2	8.2
7. United Nations Development Programme	56.0	62.0
8. International Bank for Reconstruction and Development	55.4	55.2
9. International Development Association	14.5	43.7
Multilateral scientific programmes		
1. Consultative Group on International Agricultural Research (CGIAR)	11.6	14.0
2. International Fund for Agricultural Development (IFAD)	9.5	3.3
3. International Union for the Conservation of Nature and Natural Resources (IUCN)	0.7	0.7
4. WMO Programmes	0.9	0.8
5. European Co-operation in the Field of Scientific and Technical Research (COST)	7.8	9.8
6. OECD-Environment Directorate	0.5	0.7
Multilateral technology programmes		
1. UNIDO	1.8	1.8
2. Ozone Fund UNEP	2.7	2.0
3. UNEP	5.4	3.8
Multilateral training programmes		
1. UNITAR	0.7	0.6
2. UNESCO	0.6	0.5
3. Capacity 21 UNDP		3.0

Table 8-1: Financial contributions to the operating entity or entities of the financial mechanism, regional or other multilateral institutions and programmes

1994:
Type of project:
E=Energy / T=Transport / F=Forest / A=Agriculture / W=Waste management / I=Industry / C=Capacity building

	Country	Type	Project	Duration	CHF *)
1.	Albania	E	Renewal hydroelectric plant	1994-1998	2.125
2.	Albania	E	Power loss energy project	1994-1998	0.74
3.	Bulgaria	E	Renewal hydroelectric plant Tzarevetz	1993-1995	0.625
4.	Bulgaria	E	Renewal hydroelectric plant Peshtera	1994-1997	2.75
5.	China	T	City of Kunming : Masterplan Public Transport	1994	0.09
6.	Colombia	I	Coke production improvement	1994	0.195
7.	Costa Rica and other central american countries	I	Reduction of emissions from motors	1992-1995	1.0
8.	Hungary	C	Ecological plan for Szombathely	1994-1995	0.193
9.	India	E	Development of the market of PV plants	1992-1997	1.0
10.	Marocco	E	Photovoltaic technology transfer	1994-1995	0.120
11.	Marocco	E	Water desalinisation using solar enegy	1994	0.20
12.	Romania	E	Renewal hydroelectric plant Latu	1994-1996	0.96
13.	Slovak Rep.	C	Energy Efficiency Institute	1994-1995	0.2
14.	Czeck and Slovak Rep.	C	Capacity building in forestry	1992-1994	0.155
15.	Tunisia	E	Water desalinisation using solar enegy	1994	0.180
16.	Western Africa	F	Bush fire control using radio alert system	1994-1996	0.08
			Total for 1994		10.413

*) For many-year projects, the annual contribution is obtained by dividing the total cost of the project (million CHF) by the number of years.

Table 8-2: Bilateral financial contribution related to the implementation of the Convention, 1994

1995:

Type of project:
E=Energy / T=Transport / F=Forest / A=Agriculture / W=Waste management / I=Industry / C=Capacity building

Country	Type	Project	Duration	CHF *)
1. Albania	E	Renewal hydroelectric plant	1994-1998	2.125
2. Albania	E	Power loss energy project	1994-1998	0.74
3. Bielorus	F	Forest information system	1995-1997	0.966
4. Bulgaria	E	Renewal hydroelectric plant Tzarevetz	1993-1995	0.625
5. Bulgaria	E	Renewal hydroelectric plant Peshtera	1994-1997	2.75
6. Colombia	I	Coke production improvement	1995	0.071
7. Costa Rica and other central american countries	I	Reduction of emissions from motors	1992-1998	2.27
8. Costa Rica	E	Warm water production with solar energy	1995-1998	0.75
9. Hungary	C	Ecological plan for Szombathely	1994-1995	0.193
10. India	E	Development of the market of PV plants	1992-1997	1.0
11. India	E	Energy efficiency improvement in industry	1995-1997	0.63
12. Macedonia	E	Renewal hydroelectric plant	1995-1997	1.66
13. Marocco	E	Photovoltaic technology transfer	1994-1995	0.120
14. Marocco	E	Water desalinisation using solar enegy	1995-1996	0.50
15. Romania	E	Renewal hydroelectric plant Latu	1994-1996	0.96
16. Romania	I	Reduction of air pollution in Baia Mare	1995-1996	1.5
17. Russia	I	National Pollution Abatement Facility	1995-2002	1.5
18. Slovak Rep.	C	Energy Efficiency Institute	1994-1995	0.2
19. Slovak Rep.	E	Reduc. air pollution from electrical plant	1995-1996	3.75
20. Slovak Rep.	E	Renewal electrical plants	1995-1996	1.44
21. Tunisia	E	Integrated solar energy production	1995-1996	0.227
22. Ukraine	E	Renewal hydroelectric sector	1995-2000	2.33
23. Ukraine	I	Air pollution monitoring	1995	0.410
24. Western Africa	F	Bush fire control using radio alert system	1994-1996	0.08
		Total for 1995		26.797

*) For many-year projects, the annual contribution is obtained by dividing the total cost of the project (million CHF) by the number of years.

Table 8-3: Bilateral financial contribution related to the implementation of the Convention, 1995

9. Research and Systematic Observation

9.1. Non-specific and targeted research on climate science and response strategies

The Forum for Climate and Global Change (ProClim–) of the Swiss Academy of Sciences recently completed a series of three reports that provide an overview of research and monitoring in the field of global change and to summarise research needs in relevant fields of study. Part I of the study focuses on the physical climate system (ProClim– and CCA, 1995) and the other two parts address the biogeochemical aspect (Part II; ProClim– and Swiss National IGBP Committee, 1996) and the human dimension of the climate issue (Part III; ProClim– and Swiss National IHDP Committee, 1996).
An Advisory Body to the Federal Department of Home Affairs on climate change research and policy (Advisory Body on Questions relating to Climate and Climate Change) was formed under the auspices of the Swiss Academy of Sciences on 1st January 1997. The Advisory Body will make recommendations on research priorities concerning climate change, on coordination, and on climate change mitigation measures. The Body will also evaluate the state of knowledge on the issue of climate change and serve as a discussion platform.
The results presented below refer generally to research on global change, and not specifically to climate research (cases where the focus is the physical climate system are indicated explicitly).

9.1.1. Basic study characteristics

For research related to biogeochemical processes, projects generally focused on local to regional-scale processes and were conducted in 63 % of cases in Switzerland. The time scales of processes most frequently studied ranged from seasonal to century.
Over 70 % of human dimension research addresses socio-economic or political aspects of global environmental change. The methodological emphasis of Swiss human dimension research is on policy analysis and improvements in assessment, scenario and predictability methodologies, as well as social scientific modelling. The geographical focus of research projects is as follows: Switzerland (38 %); non-EU (for the most part developing countries) (20.5 %); EU countries (10 %); global (1.9 %); unknown or unspecified (29.6 %).

9.1.2. Research emphasis

Physical climate system

Over half of the ongoing research effort is focused on process studies. The other major areas of emphasis with regard to the projects currently underway are the development of new techniques or instruments and the detection of trends via monitoring and the analysis of existing time-series data. Few projects focus on determining the causes of variability and change.
Two thirds of the projects that involve process studies focus on atmospheric processes, dynamics and chemistry (including air pollution). A key area of study is the role of the Alps with regard to atmospheric circulation and regional climate and the feedback between atmospheric general circulation patterns and regional climatology. Ongoing research also addresses the hydrological cycle, the energy and/or moisture balance and cryospheric processes. Switzerland makes a large contribution to the development of new techniques, instruments and technologies. A great deal of attention is paid to developing methods to ensure the quality of data and to analysing and archiving existing data; developing new laboratory,

field and monitoring instruments; developing techniques to link General Circulation and regional climate models; and developing internationally agreed upon scales and standard measurement instruments.
Substantial effort also goes into the analysis of existing time-series data and monitoring activities to obtain new data (atmospheric concentrations of trace gases, aerosols and particulates; direct, diffuse, terrestrial and global irradiance; incident UV radiation levels; meteorological and snow cover conditions).
Research on the impacts of climate change on hydrology and water resources takes both a retrospective and a simulation approach to estimating the impacts of climatic changes and extreme weather events on hydrological systems (runoff, sensitivity of stream systems, feedback with the cryosphere, groundwater aquifers). Several studies address water resources management and land-use planning.
Relatively few projects focus primarily on determining the causes of climate variability and change or on the development of future climate scenarios.

Biogeochemical processes

Studies of earth system processes and the impacts of global change were the most prevalent. Lesser, but still quite significant, emphasis (20-40 % of projects) was placed on the development of new techniques and instruments, the detection of recent trends (time-series data, indicators, monitoring) and past global changes.
Approximately half of the projects that involve process studies (and impacts analyses) focus on the biosphere, in particular issues such as vegetation change, population dynamics and ecosystem structure and function. There is also significant effort with regard to hydrosphere processes and impacts and large-scale coupled systems and biogeochemical cycles.
As indicated above, substantial effort goes into monitoring, and developing new methods and instrumentation. In this context, "monitoring" encompasses the use and development of (paleo-) indicators of global change, systematic monitoring and remote sensing, and the analysis of existing time-series data. The development of new methods includes a wide range of subjects from the interpretation of paleoindicators to the development of statistical down scaling methods. Research on the causes of global change and variability covers the full spectrum of anthropogenic, external and internal dynamic causes.

Human dimensions of global change

Swiss social science and humanities research addresses all major aspects of the human dimension of global environmental change, with a strong emphasis on social processes and institutions (65.5 %), in particular, the study of public perception, assessment and behaviour. Numerous studies also address responsive policy formation and implementation and the major human driving forces of global environmental change.
Research on the major human driving forces of global environmental change focuses on land use and land cover change (42 %), industrial and economic transformation, and issues related to the role of world views in driving change.
The main focus of research is on socio-economic / political and psychological / social / educational aspects of global environmental change. Nearly 30 % of studies involve policy analysis or the development of planning tools, instruments or methods.

9.1.3. Current funding

Based on the available data, total Swiss funding for physical climate system research amounted to CHF 8.7 million for 1995.
Research on biogeochemical processes in global change (not limited to climate change) was funded at a level of CHF 30.8 million for 1995 and CHF 16.1 million were provided for human dimensions of global environmental change (including climate change) research.
Two coordinated research programmes currently provide substantial funding for climate research, the National Research Programme 31 "Climate Changes and Natural Disasters" and the Priority Programme "Environmental Technology and Environmental Research".
Over half of all climate research is funded via grants to individual researchers by the Swiss National Science Foundation. The Priority Programme "Environmental Technology and Environmental Research" plays a predominant role in disbursing funds for research related to the human dimensions of climate change. Other important funding sources are Federal Government offices, Federal research institutes and the cantons.
The numbers cited above for total research funding generally neglect or underestimate both indirect research support over university

and institute budgets (salaries, equipment) and projects financed and / or conducted directly by Federal offices such as the Federal Office of Environment, Forests and Landscape.

9.1.4. International cooperation

International research and monitoring programmes

Switzerland contributes to the World Climate Research Programme through individual research projects, research conducted at Federal institutes and within coordinated programmes (e.g., NRP-31) and by operating monitoring stations and networks, as well as calibration and data centres. It also plays a leading role in several regional climate research programmes.
Current research and monitoring of the physical climate system is judged to be adequate to fulfil Swiss obligations in this field of study, as required by the UN Framework Convention on Climate Change. Switzerland also contributes significantly to the International Geosphere-Biosphere Programme (IGBP), both directly and through relevant research activity. The Core Project Office for the IGBP Past Global Changes project is located in Bern and is jointly financed by Switzerland and the USA. Swiss scientists are heavily engaged in GCTE and PAGES and participate in most other Core Projects, as well. Swiss participation is also significant in the DIVERSITAS programme. Switzerland has also contributed significantly to the International Human Dimensions Programme (IHDP) on Global Environmental Change. During its initial phase (1993-1996), Switzerland cofinanced the IHDP Secretariat, which was located in Geneva. Swiss researchers are active in fields relevant to the IHDP and have also made important contributions to the United Nations University over the years.
Swiss participation in COST and the EU's Specific Programme on Environment and Climate is healthy and growing.

International assessment activities

The involvement of Swiss scientists in international assessment activities is varied. Swiss scientists (and the Swiss government) are very active in the Intergovernmental Panel on Climate Change, but participation in the International Ozone Assessment is limited to a few individuals and no Swiss scientists played a role in the Global Biodiversity Assessment.

9.2. Energy research

Publicly-funded energy research in Switzerland is focused on the energy research concept of the Federal Government. The Federal Office of Energy (FOE) is responsible for coordinating, accompanying, implementing and establishing research work at the international level. The FOE has funds available to promote research, and these are used to supplement the efforts of private and public research establishments. The FOE also promotes the implementation of research results in practise. The FOE consults with the Swiss Federal Commission for Energy Research (CORE) about these matters.
Energy research has the long-term goal of reducing emissions of CO_2 in Switzerland. In the concept of energy research of the Federal Government for 1996-1999 a reduction of CO_2 emissions to the level of 1 tonne per person per year within the next 50 years is proposed.
Above all the following research strategy is used.

- Contributing to reducing the use of energy through more efficient end use; the domains of buildings and traffic, but also equipment and motors can be mentioned.
- Improving the energy aspect of existing techniques for the production, transformation, storage and distribution of heat and electricity.
- Continuing the efforts for clean and efficient techniques of combustion and heating, also with regard to new chemical fuels.
- Providing low-CO_2 techniques for process heat, heating, and internal combustion engines.
- Developing new, environmentally-compatible, efficient techniques for producing and storing heat and electricity, especially using biomass (wood and organic waste), solar energy and ambient heat.
- Continuing safe generation of nuclear power and carrying on with work in the domain of nuclear fusion as a long-term option (but abandoning research into breeder reactors).
- Considering the integrated context, e.g. global flows of matter (grey energy), questions of risk and sustainability.
- Including the framework conditions of society and of the economy.

The research studies are closely linked to international activities, especially in the framework of the International Energy Agency (IEA) and in the context of European Programmes (EUREKA, COST, EURATOM, EU Framework Programme). An attempt is being made to reinforce collaboration with Eastern European countries and developing countries.
In 1995 the total expenditure on publicly-funded energy research projects amounted to about 215 million CHF, of which about 29 million CHF were used for pilot- and demonstration- installations. The contribution of the FOE was about 44 million CHF.
Publicly-financed energy research in Switzerland was able to continue pursuing its goals throughout 1995. By international comparison Swiss research in this field is amongst the leaders, and in certain domains even in the lead (for instance integration of solar cells into buildings, solar chemistry, and light vehicles). The development of new technologies is at the centre of research. Gratifying results were also obtained in the domain of the economic optimisation of components and systems. Another main focus of energy research deals with the security and reliability of installations.
Several research studies have shown the way and helped towards the efficient use of energy. The forecasts for energy and CO_2 presented in this report were developed in the framework of the research programme "basis of energy economy".

9.3. Monitoring

Although a significant fraction of projects involve monitoring, only a few Swiss scientists are involved directly through individual research projects in the major global change monitoring activities (Global Ocean Observing System, Global Terrestrial Observing System, Global Climate Observing System). However, monitoring activities supported directly by the Federal government (e.g., FOEFL, SMI) and research institutions supported through indirect sources contribute significantly to world-wide monitoring efforts.
Main monitoring activities are supported by Federal (FOEFL, NHGS, SMI) and cantonal administrations and / or research institutions (VAW, EMPA, PSI, WLS, EAWAG, IUL).
Observation networks are particularly well-developed in Switzerland compared with other European countries. Long-term monitoring has many goals relating to protection and evaluating measures which have been taken, forecasts, prevention, management, collecting data to understand cycles and processes, determining changes and their causes. Although these networks focus on specific problems such as meteorology, and the quality of air, water and soil, most of them can contribute to determining climate change or the impacts of climate change on environment and society. The following aspects should be noted.

Physical climate system
- meteorological, precipitation, and climatological network, phenological, frost warning network
- snow cover monitoring network
- UV-B monitoring network
- longwave radiation network
- stratospheric and tropospheric ozone network
- stable isotopes network
- inventory of air emissions (CORINAIR)
- aerosol concentrations monitoring network
- ambient levels in air monitoring network
- glacier monitoring network
- permafrost monitoring network
- storm and avalanche monitoring network

Impact of climate change and environmental quality
- river discharge monitoring network
- groundwater level monitoring network
- radioactivity control network (CENAL)
- air quality network (NABEL)
- soil quality network (NABO)
- water quality network (NADUF)
- hydrological network
- concept of biodiversity monitoring (in prep.)
- groundwater quality network (in prep.)
- fauna, flora, forest, forest damage, ecosystems inventories
- biomonitoring (cantonal level only)
- socio-economic inventories (transport, traffic, demography, agriculture, industry etc.
- monitoring of certain infectious diseases of man.

Switzerland supplies data and maintains reference measurement stations, and thereby participates actively in international surveillance programmes such as OECD, EEA, CORINAIR, WMO, GCOS, GTOS, GAW, IAEA, WCRP/GEWEX, GEMS, FRIENDS, ERB, GRDC, WCMC, CORINAIR.
At the international level Switzerland participates in the work of the OECD, the European Environment Agency (EEA), and

the Alp Observatory along the lines of a model “state - pressures - human activity - environmental problems”. At the national level the IKUB is involved in information and coordination with regard to environmental monitoring. These different activities will allow the observation networks to be better coordinated together and to fill in any gaps as a function of priority problems. In this way it will also be possible to encourage interdisciplinary work and the integrated assessment of the state of (or changes in) the climate, the environment and society.

9.4. Contributions from NGOs

Swiss NGOs are involved in climate-related research. A project jointly financed by different environmental organisations elaborated visions for a sustainable Switzerland in the long term. This study showed that within 50 years, a reduction of CO_2 emissions to 1 ton per person is possible.
Greenpeace is promoting and financing research related to the development of new technical concepts, for example for renewable resources and new car technologies.

References:

CORE (Federal Energy Research Commission), 1995, Konzept der Energieforschung des Bundes 1996-1999. Bern, Federal Office of Energy, 50 pp
Office fédéral de l’énergie, 1996, Recherche, développement et démonstration en matière d’énergie, Liste des publications
ProClim- and CCA (Commission on Climate and Atmosphere Research), 1995, Research and Monitoring of Climate and Global Change in Switzerland: Part I - Physical Climate System. A. Arquit Niederberger for ProClim-, Berne, 49 pp
ProClim- and Swiss National IGBP Committee, 1996, Research and Monitoring of Climate and Global Change in Switzerland, Part II - Biogeochemical Processes. A. Arquit Niederberger for ProClim-, Berne, 78 pp
ProClim- and Swiss National IHDP Committee, 1996, Research and Monitoring of Climate and Global Change in Switzerland, Part III - Human Dimensions of Global Environmental Change. M. Jochimsen for ProClim-, Berne, 91 pp

10. Education, training and public awareness

10.1. National level

10.1.1. Federal Office of Environment, Forests and Landscape

Media Service: Environment Switzerland
Since 1992, in the context of the UNCED conference in Rio, the Federal Office of Environment, Forests and Landscape has provided a media service, comprising facts and trends in the field of environment and development. This service is addressed to journalists, and facilitates access to information. Most important is information on climate problems, biodiversity, depletion of the ozone layer and sustainability.

Communication campaign: Mund auf statt Augen zu! (Open your mouth, don t close your eyes!)
This campaign is a cornerstone of the communication strategy of the Federal Office of Environment, Forests and Landscape (FOEFL). Its aim is to motivate especially the younger generation towards environmentally friendly actions, to initiate learning processes, and to increase environmental awareness. The topics change every year (1994: climate change; 1995: biodiversity). Since 1996, an exhibition about sustainability north-south named “save our planet” has been shown at different places in Switzerland. The annual budget of the campaign is about CHF 1.5 million. It is co-financed by the Swiss Agency for Development and Cooperation and FOEFL.

Training programme Climate protection in municipalities
Since 1995 FOEFL has been sponsoring a three-year education programme offering information seminars and workshops to political parties at the regional and local level. This programme aims to improve knowledge about the climate issue and about options for reducing greenhouse gas emissions locally.

Information material
At present an information brochure on climate and climate change for the general public is in preparation at FOEFL (to be published in summer 1997). Its main purpose is to raise awareness of the importance of a stable climate for society, and to provide arguments for an active climate policy at the national as well as the international level. This publication will be complemented by a checklist-type guide for policy-makers and environmental activists at the regional and local level.

10.1.2. Energy sector

Energy 2000 Programme
Marketing and information is one of the issues of the “Energy 2000” Programme in order to create sustainable effects of the programme activities amongst the public. Thus the Federal Office of Energy is leading a special information division, where a specific strategy was developed comprising the following different actions and information channels.

- Media service of the programme to offer facilities to journalists.
- Own journals and magazines; articles in energy-related magazines.
- Specific media service for pilot and demonstration installations.
- Specific publications, newspapers and marketing activities of each part of the programme (e.g. information events, presentations at exhibitions).
- Provision of different media instruments (abstracts, transparencies, posters, etc.).

Many projects within different sectors (residential sector, public sector, industry, services, hospitals, transport, renewable

resources) are directly related to marketing activities (e.g. television advertising, energy saving weeks in firms).
In 1995 the programme reached its half-way point. This occasion was used for special activities to present and promote the activities of the whole programme. Therefore, specific activities in all regions were carried out during a whole week in September 1995.

Other energy saving programmes
Some of the energy saving programmes at the national level mentioned in section 5 aim to increase public awareness and provide specific courses, publications, information events, seminars and educational material. The impulse programmes of the Federal Office for Economic Policy raise awareness concerning possibilities for a more rational use of electricity and a sustainable building sector. These programmes are addressed to professionals and it is hoped that they will be self-replicating.

10.1.3. Other related activities

Parliamentary Group Climate Change
A parliamentary group on climate change was founded on 19th September 1996. The group meets regularly (usually once during each parliamentary session) to encourage the flow of information about the impacts of climate change and about science, and also to open debate on the issue. The first meeting in December 1996 addressed the evidence for impacts of climate change in the Swiss Alps. The second session in March 1997 will focus on the impacts of climate change on the financial services sector (banking and insurance), a very important component of the Swiss economy.

Swiss Academy of Sciences Forum for Climate and Global Change (ProClim-)
ProClim- was established by the Swiss Academy of Sciences in 1988 to support interdisciplinary and international research collaboration in the field of global environmental change and to facilitate cooperation between the scientific community and decision makers. ProClim- runs an information system with access via the WWW, publishes abstracts of papers published by Swiss authors in refereed journals, and distributes a quarterly newsletter including a listing of relevant seminars at universities throughout the country. ProClim- also serves as the voice of the global change research community in government bodies, organises workshops and public forums on global change topics and encourages participation of scientists in the decision-making process. ProClim- serves as the secretariat of the parliamentary group “Climate Change” (see above) and of the Advisory Body on Questions relating to Climate and Climate Change (see section 9).

Climate Change Information Centre
The Climate Change Information Centre of the Swiss Meteorological Institute (SMI-MeteoSwiss) will begin operations in January 1998. The information centre will lend collated information material on specific topics and prepare reviews and background reports on the functioning of the climate system as requested. The information centre will collaborate closely with ProClim- (see above). Whenever possible requests will be answered and information prepared in German, French or Italian, depending on the needs of the user. This is achieved through scientists at the Geneva Meteorological Centre, the Locarno-Monti Meteorological Centre and the Swiss Meteorological Institute, which are all part of the Climate Change Information Centre Network coordinated by the SMI.

Swiss Centre for Training in the Protection of Nature and the Environment (SANU)
SANU is coordinating education in the field of environment and regularly provides additional documentation about education offers in private und public schools, universities etc.

10.2. Regional level

Since cantons and communes are involved in the national activities, the remarks made above are also valid at the regional level. In addition, there are several other activities within the context of the cantonal energy policy.
The several networks at the regional level which are mentioned in section 5, for example “Klima-Bündnis” (climate alliance), “Stadt/Gemeinde-Charta” (town and commune charter), “Energiestadt” (energy town) are also active in raising the awareness of climate issues at the communal level, organising public discussion events, and providing specific publications and information. For example the City of Lucerne launched an awareness campaign in 1995, with posters and performances, in order to promote sustainable development at the local level. Since Swiss cities are severely affected by air pollution, campaigns to increase awareness of this issue also have a positive impact in the context of climate change. The city of Zurich, for example, launches regular awareness campaigns about measures to reduce ozone concentrations at ground level.

10.3. Contributions from NGOs

Those NGOs involved in climate issues are involved in several governmental actions and programmes. They also play an important role in raising public awareness. Consequently numerous actions and campaigns are taking place. The following may serve as examples.

- Greenpeace is involved in several activities in schools, organising workshops and competitions to raise awareness amongst students and teachers. A special multivision performance was shown for two years at several places in Switzerland.
- At the international level, WWF launched an international Climate Change Campaign which started in September 1996. The goals of this campaign are to secure a binding international agreement, that is ratified by each country to reduce the causes and effects of global warming by reducing carbon dioxide emissions by 20 % by the year 2005 in industrialised countries. Several actions, such as issuing papers and holding symposia, are being prepared.

Abbreviations

ADB	African Development Bank
AGBM	Ad hoc Group on the Berlin Mandate
AsDB	Asian Development Bank
BEW	Bundesamt für Energiewirtschaft (Federal Office of Energy, FOE)
BfS	Bundesamt für Statistik (Federal Office of Statistics)
billion	US billion i.e. thousand million
CFCs	chlorofluorocarbons
CH_4	methane
CHF	Swiss francs
CIS	Commonwealth of Independent States
CO	carbon monoxide
CO_2	carbon dioxide
COP	Conference of the Parties
CORE	Swiss Federal Commission for Energy Research
CORINAIR	Coordination d'information environnementale projet partiel air
COST	European Cooperation in the Area of Scientific and Technical Research
CSD	Commission on Sustainable Development
EAWAG	Federal Institute for Water Supply, Sewage Treatment and Water Pollution Control
EEA	European Economic Area
EMPA	Swiss Federal Laboratories for Materials Testing and Research
FAO	United Nations Food and Agriculture Organisation
FOA	Swiss Federal Office of Agriculture
FOE	Swiss Federal Office of Energy
FOEFL	Swiss Federal Office of Environment, Forests and Landscape
FOS	Swiss Federal Office of Statistics
FRIENDS	Flow Regimes from International Experimental Aand Nuclear Data Sets
GATT	General Agreement on Tariffs and Trade
GAW	Global Atmosphere Watch
GCOS	Global Climate Observing System
GDP	gross domestic product
GEF	Global Environment Facility
GEMS	Global Environment Monitoring System
GEWEX	Global Energy and Water Cycle Experiment
Gg	gigagram (1,000 tonnes)
GHG	greenhouse gas
GNP	Gross National Product
GOOS	Global Ocean Observing System
GTOS	Global Terrestrial Observing System
GRDS	Global Runoff Data Centre
GWP	Global Warming Potential
HCFC	partially hydrogenated chlorofluorocarbon
HFC	partially hydrogenated fluorocarbon
HGV	heavy goods vehicle
IAEA	International Atomic Energy Agency
IEA	International Energy Agency
IGBP	International Geosphere-Biosphere Programme
IHDP	International Human Dimensions Programme on Global Environmental Change
INC	Intergovernmental Negotiating Committee
IPCC	Intergovernmental Panel on Climate Change
ISM	Institut suisse de météorologie (Swiss Meteorological Institute)
IUL	Institut für Umweltschutz und Landwirtschaft IUL-Liebefeld, Bern
NABEL	National Air Pollutant Observation Network

NABO	National Soil Observation Network
NADUF	National Programme for Analytical Long-term Monitoring
n.e.	not estimated
NEFF	Swiss National Fund for Energy Research
NGO	non-governmental organisation
NMVOC	non-methane volatile organic compounds
n.o.	not occuring
NOEC	National Emergency Operations Centre
NO_2	nitrogen dioxide
NO_X	oxides of nitrogen
N_2O	nitrous oxide
ODA	Overseas Development Assistance
OECD	Organisation for Economic Cooperation and Development
p.a.	per annum
PJ	Petajoule
ProClim-	Swiss Forum for Climate and Global Change
PSI	Paul Scherrer Institute
QELROS	Quantified Emission Limitation and Reduction Objectives
SANW	Schweizerische Akademie der Naturwissenschaften
SAR	Second Assessment Report (of IPCC)
SAS	Swiss Academy of Sciences
SDC	Swiss Agency for Development and Cooperation
SF_6	sulphur hexafluoride
t	(metric) tonne i.e. 1,000 kg
UNCED	United Nations Conference Environment and Development
UNCTAD	United Nations Conference on Trade and Development
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNIDO	United Nations Industrial Development Organisation
VAT	Value Added Tax
VOC	volatile organic compounds
WCMC	World Conservation Monitoring Centre
WCRP	World Climate Research Programme
WMO	World Meteorological Organisation
WSL	Swiss Federal Institute for Forests, Snow and Landscape Research
WWW	- World Weather Watch - World Wide Web

Documentation

The following documents are submitted together with Switzerland's second national communication 1997.

- Département fédéral de l'intérieur: Loi sur la réduction des émissions de CO_2, Rapport explicatif, 23 octobre 1996
- Département fédéral des transports, des communications et de l'énergie: Perspectives d'évolution du trafic en Suisse, Berne 1995
- Département fédéral des transports, des communications et de l'énergie: Mobilité en Suisse, Berne 1994
- Federal Departement of Transport and Energy: 6th Annual Report of the Energy 2000 action programme, Period under review: July 1995 to June 1996, Berne 1996
- Merk Mietta B., Sustainable development of Switzerland's forests. Federal Office of Environment, Forests and Landscape, Berne 1995
- Office fédéral de l'énergie, 1996, Statistique globale suisse de l'énergie 1995, Berne
- Office fédéral de la statistique, 1995, Statistique Suisse de l'environnement No 3, L'économie énergétique, Berne
- ProClim: Research and monitoring of climate and global change in Switzerland

Part I - Physical climate system
Part II - Biogeochemical processes
Part III - Human dimensions of global environmental change

- Union Pétrolière, 1996, rapport annuel 1995, Zurich

Relevant documentation supplied to the UNFCC Secretariat on earlier occasions.

- Coefficients d'émission des sources stationnaires, Manuel, edition 1995, Federal Office of Environment, Forests and Landscape, Berne
- Emissions polluantes du trafic routier de 1950 à 2010. Rapport No. 255 des Cahiers de l'environment, Federal Office of Environment, Forests and Landscape, Berne
- Emissions polluantes dues à l'activité humaine en Suisse de 1900 à 2010. Rapport No. 256 des Cahiers de l'environnement, Federal Office of Environment, Forests and Landscape, Berne
- Global Warming and Switzerland: Foundations for a National Strategy, Report of the Interdepartmental Working Group on the Evolution of the Climate System, Federal Office of Environment, Forests and Landscape, Berne, January 1994
- Inventaire forestier national suisse.

- Résultats du premier inventaire 1982 - 1986
- Cartes thématiques 1:800'000

Federal Institute of Forestry Research, Birmensdorf

- Statistique globale suisse de l'énergie 1990, 1991, 1992, 1993, 1994, Federal Office of Energy, Berne
- The State of the Environment in Switzerland, Report on the Environment 1993, Federal Office of Environment, Forests and Landscape, Berne, 1994
- Union Pétrolière: Rapport annuel 1990, 1991, 1992, 1993, 1994, Swiss Petroleum Industry Association, Zürich

Annex — Swiss Greenhouse Gas Inventory 1995

(including updated time-series 1990-1994)

Title of Inventory	Swiss Greenhouse Gas Inventory 1995
Contact Person	Mr. Andreas Liechti
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Contents

Introduction

1 Compliance with IPCC 1995 reporting instructions

The present 1995 Greenhouse Gas Inventory is based on the IPCC Guidelines for Greenhouse Gas Inventories, Vol.I - III, 1995 as well as the Revised Guidelines for the Preparation of National Communications by Parties included in Annex I to the Convention, adopted at CoP2. Calculations of N_2O emissions from agricultural soils were based on Phase II methodology (1996 IPCC guidelines). Reporting recommendations have been followed to the greatest extent possible.

Where the information contained in the inventory does not reach the degree of detail or transparency envisaged by IPCC guidelines, accompanying documentation (which has in part been submitted together with the 1990-1994 inventories) will provide additional insights.

Inventory tables are complemented by technical comments which should help the user in understanding and interpreting the data. These comments will also guide to related documents where more detailed information is available.

2 General quality assessment

Data quality:

- **CO_2**: Data on CO_2 emissions generally have a very high level of reliability (uncertainty range ± 5 percent), with the exception of the Land Use Change and Forestry segment, where data quality is somewhat lower.
  With regard to CO_2 from fossil fuel combustion, emissions are generally calculated as if all carbon in the fuel would be oxidised. The variability of carbon content in the fuels is much higher than the resulting fault of 1 to 2 percent in emission figures.

- **CH_4**: From a statistical point of view, data quality is medium. Major uncertainties exist with respect to emissions from agriculture (manure management). Additional efforts aiming at the improvement of present data quality are not planned.

- **N_2O**: Considerable uncertainty remains as far as emissions from agricultural soils are concerned. Substantial improvements in data quality are not expected in the short run.

- **Precursors and SO_2**: Data quality is medium. At present, no data quality improvement projects are foreseen. For SO_2, the same calculation approach was applied as to the precursor gases. Details can be found in FOEFL reports no. 255 and no. 256, which were submitted along with the 1990-1994 inventories.

The most noteworthy data improvement vis-à-vis the 1990-1994 inventories issued in 1996 concerns **CH_4 and N_2O emission data from the agricultural sector** where new methodologies have been applied. A detailed description of the approaches used is given in the annotations to Standard Table 4 (Agriculture). The overall data quality remains medium (CH_4) to low (N_2O).

Uncertainty ranges:

The following uncertainty ranges are valid for the present inventory (cf. Table 8):
H = high quality:
values are considered accurate with an uncertainty range of ± 10 percent
M = medium quality:
values are considered accurate with an uncertainty range of ± 20 percent
L = low quality:
values are considered accurate with an uncertainty range of ± 50 percent

Data completeness:

Generally, data are provided at the same level of completeness as in the previous inventories. However, no **emissions or removals** are reported in the present inventory for **agricultural soils**, with the exception of N_2O. This gap is due to the lack of reliable data and/or methodologies. With respect to CO_2 and CH_4, these omissions are not likely to affect the overall emission balance to a significant extent.

Limitations concerning data completeness exist in the field of substances which have been newly added to the list of GHG to be reported, too. Available data on **HFC, PFC and SF_6** emissions are considered complete but still too preliminary to be integrated in the inventory. Indicative figures of emissions are given in section 4.1.4. of the national communication.

Verification:

Verification activities are not documented in the inventory proper. In most instances, verification has taken place at the level of background studies or reports which are contained in the inventory documentation (cf. also documentation provided along with 1990-1994 inventories).

3 Major forthcoming improvements

Integration of additional greenhouse gases in the inventory (HFC, PFC, SF_6):

Up to now, only preliminary data are available on the consumption of fluorocarbons (HFC + PFC) and SF_6 (cf. section 4.1.4. of the national communication). More detailed and validated findings are expected in time for reporting in the 1996 GHG inventory.

Ongoing or planned projects relevant to inventory data:

- **Emissions/removals of CO_2 in the forestry sector**:
  The second national forest inventory will be completed in 1998. By then, it will be possible to verify and update presently used figures relevant to the emission balance of Swiss forests. Furthermore, a first approach in assessing carbon fixation in forest soils is planned.

- **Emissions from agricultural soils**:
  Experimental research is under way which should provide the basis for improved estimates. Estimates for CH_4, NO_x and NMVOC and net CO_2 fluxes from agricultural land will be reported as soon as feasible.

- **Update of base data (all gases except CO2 and persistent volatile substances):**
  An update of the present base report (FOEFL report no. 256) is planned for the end of this decade.

1A1 Energy and Transformation Industries

Data base for energy consumption are the annually revised Swiss energy statistics [1] and the Annual Report of the Swiss Petroleum Association [2].

Data base for combustion emission factors is the handbook "Coefficients d'émission des sources stationnaires" [3]. Emission factors are a mix of measured, calculated and default values; details are described in the aforementioned handbook. For CO_2, default emission factors of CORINAIR are applied since these are practically identical to values measured in Switzerland.

The emission factors for LFO and gas are a mix of different types of energy use (fuel burned in combustion installations and stationary motors).

Splitting of energy consumption into electricity and heat production is based on FOEFL report no. 256 "Emissions polluantes dues à l'activité humaine en Suisse de 1900 à 2010" [4].

Waste incineration plants in Switzerland are normally equipped with energy recovery appliances. Since the main purpose of waste incineration is eliminating the waste, all waste incineration plants are considered in Table 6 (Waste).

Greenhouse Gas Inventory 1995																
1A1	**Energy/Transformation**															
IPCC	**Source/Sink Categories**	**Consump.**	**CO2**	**CH4**	**N2O**	**NOx**	**CO**	**NMVOC**	**SO2**	**CO2**	**CH4**	**N2O**	**NOx**	**CO**	**NMVOC**	**SO2**
		TJ	1'000 Gg	Gg	Gg	Gg	Gg	Gg	Gg	t/TJ	kg/TJ	kg/TJ	kg/TJ	kg/TJ	kg/TJ	kg/TJ
1A1	**Energy/Transformation**	19,543	**1.15**	**0.08**	**0.01**	**1.76**	**0.34**	**0.05**	**2.33**							
1A1 a	Electricity/Heat	8,548	0.536	0.059	0.003	1.058	0.175	0.030	1.210							
1A1 ai	Electricity	3,759	0.259	0.023	0.002	0.501	0.064	0.015	1.017							
	LFO	210	0.015	0.001	0.000	0.076	0.015	0.003	0.015	73	5	0.6	360	70	14	70
	HFO	2,255	0.171	0.009	0.002	0.282	0.009	0.009	0.992	76	4	0.8	125	4	4	440
	Gas	1,277	0.070	0.013	0.000	0.140	0.038	0.003	0.001	55	10	0.1	110	30	2	0.5
	Coal	17	0.002	0.000	0.000	0.003	0.002	0.000	0.009	98	9	1.6	200	100	9	550
1A1 aii	Heat	4,789	0.278	0.036	0.001	0.557	0.111	0.016	0.193							
	LFO	335	0.024	0.001	0.000	0.141	0.027	0.006	0.023	73	4	0.6	420	80	18	70
	HFO	305	0.023	0.001	0.000	0.038	0.005	0.001	0.146	76	4	0.8	125	15	4	480
	Gas	4,110	0.226	0.033	0.000	0.370	0.103	0.008	0.002	55	8	0.1	90	25	2	0.5
	Coal	39	0.004	0.000	0.000	0.008	0.004	0.000	0.021	98	9	1.6	200	100	9	550
1A1 b	Petroleum Refining	10,995	0.616	0.024	0.002	0.705	0.165	0.024	1.124							
	HFO	1,825	0.139	0.005	0.001	0.201	0.027	0.005	0.894	76	3	0.6	110	15	3	490
	Gas	9,170	0.477	0.018	0.001	0.504	0.138	0.018	0.229	52	2	0.1	55	15	2	25

1A2 Industry

Data base for energy consumption are the annually revised Swiss energy statistics [1] and the Annual Report of the Swiss Petroleum Association [2].

Data base for combustion emission factors is the handbook "Coefficients d'émission des sources stationnaires" [3]. Emission factors are a mix of measured, calculated and default values; details are described in the aforementioned handbook. For CO_2, default emission factors of CORINAIR are applied since these are practically identical to values measured in Switzerland.

The emission factors for LFO and gas are a mix of different types of energy use (fuel burned in combustion installations and stationary motors).

Fuel combustion emissions in industry are not calculated separately for each industrial category. Data on fuel consumption on branch level are not very reliable and incomplete. Thus, calculations rely mostly on global sectoral data from [1] and emission figures are reported collectively.

In the cement/lime/glass category a mix of LFO, HFO, gas, coal, biomass and waste is used as combustion energy input.

Greenhouse Gas Inventory 1995

1A2 Industry

IPCC	Source/Sink Categories	Consump	CO2	CH4	N2O	NOx	CO	NMVOC	SO2	CO2	CH4	N2O	NOx	CO	NMVOC	SO2
		TJ	1'000 Gg	Gg	Gg	Gg	Gg	Gg	Gg	t/TJ	kg/TJ	kg/TJ	kg/TJ	kg/TJ	kg/TJ	kg/TJ
1A2	**Industry**		**5.17**	**0.36**	**0.03**	**12.30**	**13.81**	**0.43**	**7.90**							
1A2 a	Iron and Steel		0.084	0.005	0.000	0.136	1.810	0.004	0.212							
1A2 f	Other (Combustion)	77,395	5.082	0.359	0.028	12.167	12.003	0.431	7.691							
	LFO	11,670	0.852	0.012	0.007	0.689	0.128	0.023	0.817	73	1	0.6	59	11	2	70
	HFO	9,790	0.744	0.039	0.008	1.224	0.147	0.039	4.699	76	4	0.8	125	15	4	480
	Gas	33,950	1.867	0.204	0.003	1.698	0.475	0.068	0.017	55	6	0.1	50	14	2	0.5
	Coal	1,270	0.124	0.011	0.002	0.254	0.127	0.011	0.699	98	9	1.6	200	100	9	550
	Biomass	2,705	0.000	0.057	0.004	0.379	1.760	0.019	0.019	0	21	1.6	140	650	7	7
	Cement/Lime/Glass	18,010	1.495	0.036	0.004	7.924	9.365	0.270	1.441	83	2	0.2	440	520	15	80

1A3 Transport

Data base for the calculation of emissions from road transportation is FOEFL report no. 255: "Emissions polluantes du trafic routier de 1950 à 2010" [5].

Data base for the calculation of emissions from civil aviation, railways and navigation is [6].

Domestic emissions from civil aviation are calculated by a territorial approach (including LTO-cycles of international flights and overflights). Thus, available data cannot be split into domestic and international aviation according to guideline requirements. The difference of domestic consumption (as defined above) to the total amount of fuel sold in Switzerland are, by definition, "international bunkers". Domestic emissions are a combination of kerosene and gasoline emissions. The share of gasoline consumption in domestic civil aviation is less than 1 percent.

Emissions from road transportation are calculated within a sophisticated traffic model which contains detailed emission factors related to different vehicle types and traffic situations (see FOEFL report no. 255 [5]). This model is not based on fuel consumption but on distances travelled. As a result, only the emissions from fuel used within Swiss borders are known. The difference between the total amount of fuel sold in Switzerland and the amount calculated is not negligible and is, by definition, interpreted as "fuel tourism" or "bunker". This assumption is justified on the grounds of a significant price difference (gasoline being cheaper and diesel fuel being more expensive) between Switzerland and the surrounding countries. The net effect of this price difference is an export of gasoline sold in Switzerland.

Emissions of transports within Switzerland for which diesel fuel was bought abroad are considered "domestic" and make part of the inventory. The non-CO_2 emissions of gasoline bought within Switzerland and used abroad cannot be calculated and thus do not appear in the inventory. To best respect the IPCC guidelines, the CO_2 emissions of the traffic model are corrected by adding the sub-category "bunker" to "Road Transportation".

Due to the circumstances described above, fuel consumption reported under 1A3b "Road Transportation" only encompasses fuel sold within Switzerland. The "bunker" fraction, even though reported in terms of CO_2 emissions, is not contained in the consumption figure given.

Passenger cars (PC) and light duty trucks (LDT) are a mix of diesel- and gasoline-driven vehicles. The share of gasoline consumption is about 95 percent and 70 percent, respectively.

Domestic navigation includes passenger ships and boats; used fuels include diesel as well as gasoline.

Greenhouse Gas Inventory 1995

1A3 Transport

IPCC	Source/Sink Categories	Consump TJ	CO2 1'000 Gg	CH4 Gg	N2O Gg	NOx Gg	CO Gg	NMVOC Gg	SO2 Gg	CO2 t/TJ	CH4 kg/TJ	N2O kg/TJ	NOx kg/TJ	CO kg/TJ	NMVOC kg/TJ	SO2 kg/TJ
1A3	**Transport**		**14.58**	**3.52**	**1.78**	**82.36**	**318.33**	**50.33**	**2.11**							
1A3 a	Civil Aviation		1.245	0.267	0.000	7.020	6.430	0.278	0.324							
1A3 ai	(Bunker)	[34'210]	[2.43]							71						
1A3 aii	Domestic	17,540	1.245	0.267	0.000	7.020	6.430	0.278	0.324	71	15		400	367	16	18
1A3 b	Road Transportation	183,000	13.237	3.183	1.775	74.220	308.450	48.730	1.700							
1A3 bi	PC		9.520	2.580	1.570	39.900	249.000	36.500	0.758							
1A3 bii	LDT		0.925	0.131	0.111	4.230	23.100	2.450	0.136							
1A3 biii	HDT/Bus		2.440	0.118	0.094	29.700	7.750	3.800	0.781							
1A3 biv	Motorcycles		0.182	0.354	0.000	0.390	28.600	5.980	0.012							
	"Bunker"		0.170													
1A3 c	Railways	396	0.029	0.001	0.001	0.485	0.109	0.046	0.009	73	2	2.4	1,200	270	120	23
1A3 dii	Navigation (Domestic)	1,002	0.073	0.070	0.002	0.631	3.337	1.273	0.080	73	70	1.9	630	3,330	1,270	80

1A4 Small Combustion

Data base for energy consumption are the annually revised Swiss energy statistics [1] and the Annual Report of the Swiss Petroleum Association [2].

Data base for combustion emission factors is the handbook "Coefficients d'émission des sources stationnaires" [3]. Emission factors are a mix of measured, calculated and default values; details are described in the aforementioned handbook. For CO_2, default emission factors of CORINAIR are applied since these are practically identical to values measured in Switzerland.

The emission factors for LFO and gas are a mix of different types of energy use (fuel burned in combustion installations and stationary motors).

Data base for calculations within the category "Machinery of Agriculture/Forestry" is [6].

1A5 Other Fuel Combustion Activities

Data base for calculations within the category "Off Road and Military" is [6].

Greenhouse Gas Inventory 1995

1A4 Small Combustion
1A5 Other

IPCC	Source/Sink Categories	Consump	CO2	CH4	N2O	NOx	CO	NMVOC	SO2	CO2	CH4	N2O	NOx	CO	NMVOC	SO2
		TJ	1'000 Gg	Gg	Gg	Gg	Gg	Gg	Gg	t/TJ	kg/TJ	kg/TJ	kg/TJ	kg/TJ	kg/TJ	kg/TJ
1A4	**Small Combustion**	284,375	**18.29**	**3.48**	**0.18**	**21.48**	**104.00**	**7.54**	**15.04**							
1A4 a	Commercial/Institutional	89,520	5.736	1.043	0.053	4.827	20.149	0.714	4.812							
	LFO	66,510	4.855	0.067	0.040	3.326	1.131	0.399	4.656	73	1	0.6	50	17	6	70
	Gas	15,970	0.878	0.128	0.002	0.799	0.687	0.032	0.008	55	8	0.1	50	43	2	0.5
	Coal	20	0.002	0.006	0.000	0.001	0.080	0.002	0.008	98	300	1.6	65	4,000	100	400
	Biomass	7,020	0.000	0.842	0.011	0.702	18.252	0.281	0.140	0	120	1.6	100	2,600	40	20
1A4 b	Residential	185,640	11.887	2.191	0.108	9.246	42.520	1.498	9.967							
	LFO	135,440	9.887	0.135	0.081	6.907	2.302	0.813	9.481	73	1	0.6	51	17	6	70
	Gas	35,540	1.955	0.213	0.004	0.889	1.457	0.071	0.018	55	6	0.1	25	41	2	0.5
	Coal	460	0.045	0.138	0.001	0.030	1.840	0.046	0.184	98	300	1.6	65	4,000	100	400
	Biomass	14,200	0.000	1.704	0.023	1.420	36.920	0.568	0.284	0	120	1.6	100	2,600	40	20
1A4 c	Agriculture/Forestry	9,215	0.667	0.250	0.023	7.412	41.331	5.326	0.257							
1A4 ci	Drying of Grass	1,500	0.104	0.003	0.001	0.083	0.750	0.003	0.080	69	2	0.7	55	500	2	53
1A4 cii	Machinery	7,715	0.563	0.247	0.022	7.329	40.581	5.323	0.177	73	32	2.8	950	5,260	690	23

1A5	**Other**	13,469	**0.94**	**0.39**	**0.03**	**8.87**	**51.80**	**7.27**	**0.24**
	Off Road incl. Military	13,469	0.936	0.388	0.028	8.870	51.800	7.270	0.244

1B Fugitive Emissions from Fuels

Data base for emission factors is the handbook "Coefficients d'émission des sources stationnaires" [3].

Data base for the calculation of emissions is FOEFL report no. 256 "Emissions polluantes dues à l'activité humaine en Suisse de 1900 à 2010" [4].

The NMVOC emissions under 1B2av ("Distribution of Oil Products") are a combination of emissions from storage tanks and filling-stations.

The CH_4 emissions of gas distribution are calculated by the Swiss gas industry (losses per km pipeline). Calculations are done for different pipeline materials and pressure levels.

Greenhouse Gas Inventory 1995

1B Fugitive Emissions Fuels

IPCC	Source/Sink Categories	Product. 1'000 t	CO2 1'000 Gg	CH4 Gg	N2O Gg	NOx Gg	CO Gg	NMVOC Gg	SO2 Gg	CO2 t/t	CH4 kg/t	N2O kg/t	NOx kg/t	CO kg/t	NMVOC kg/t	SO2 kg/TJ
1B	**Fugitive Emissions Fuels**		**0.07**	**12.78**	**0.00**	**0.15**	**0.03**	**8.19**	**0.00**							
1B 2a	Oil			0.225				6.850								
1B 2aiv	Refining/Storage			0.225				2.530								
1B 2av	Distribution of Oil Prod.	3,590						4.320								
1B 2bii	Transm./Distribution Gas		0.031	12.500		0.146	0.028	1.240								
1B 2ci	Venting/Flaring (Oil)	5,000	0.042	0.050				0.100		0.008	0.010				0.02	

2 Industrial Processes

Data base for the calculation of emissions is FOEFL report no. 256 "Emissions polluantes dues à l'activité humaine en Suisse de 1900 à 2010" [4]. Emission factors will be found in [3].

Category 2F "Other" is mainly contained of emissions from the processing of food and wood. SO_2 emissions include Claus-processing emissions from the two Swiss refineries.

Greenhouse Gas Inventory 1995

2 Industrial Processes

IPCC	Source/Sink Categories	Product.	CO2	CH4	N2O	NOx	CO	NMVOC	SO2	CO2	CH4	N2O	NOx	CO	NMVOC	SO2
		1'000 t	1'000 Gg	Gg	Gg	Gg	Gg	Gg	Gg	t/t	kg/t	kg/t	kg/t	kg/t	kg/t	kg/t
2	**Industrial Processes**		**2.62**	**0.40**	**0.31**	**0.33**	**10.63**	**7.62**	**3.61**							
2A	Iron and Steel	730	0.073			0.178	1.100	0.261	0.095	0.10			0.24	1.51	0.36	0.13
2B	Non-Ferrous Metals		0.020			0.003	0.603	0.033	0.097							
2B 1	Aluminium	12	0.019			0.002	0.480	0.008	0.096	1.60			0.20	40	0.65	8
2B 2	Other	52	0.001			0.001	0.123	0.025	0.001							
2C	Inorganic Chemicals		0.013		0.312	0.033			0.495							
2C 1	Nitric Acid Production	65			0.312	0.033						4.80	0.51			
2C 3	Other		0.013						0.495							
2D 2	Organic Chemicals			0.365			1.090	0.277								
2E	Cement/Lime		2.515	0.021		0.013	2.530	0.210	2.730							
2E 1	Cement	4,200	2.480	0.021		0.013	2.530	0.210	2.730	0.59	0.005		0.003	0.60	0.05	0.65
2E 2	Lime	94	0.035							0.37						
2F	Other		0.001	0.016		0.103	5.310	6.840	0.191							

3 Solvent and Other Product Use

Data base for the calculation of emissions is FOEFL report no. 256 "Emissions polluantes dues à l'activité humaine en Suisse de 1900 à 2010" [4]. Emission factors will be found in [3].

Category 3D "Other" is contained of emissions from the health and hygiene sectors as well as glue applications.

Greenhouse Gas Inventory 1995

3 Solvent Use

IPCC	Source/Sink Categories	Product.	CO2	CH4	N2O	NOx	CO	NMVOC	SO2	CO2	CH4	N2O	NOx	CO	NMVOC	SO2
		1'000 t	1'000 Gg	Gg	Gg	Gg	Gg	Gg	Gg	t/t	kg/t	kg/t	kg/t	kg/t	kg/t	kg/t
3	**Solvent Use**				**0.38**	**0.04**	**0.09**	**116.98**	**0.04**							
3A	Paint Application							32.400								
3B	Degreasing/Dry Cleaning							9.780								
3C	Chem. Prod./Processing							21.500								
3D	Other				0.383	0.043	0.086	53.300	0.036							

4 Agriculture

With the 1995 inventory, agricultural data are brought more in line with inventory guidelines by reporting three-year average values.

• CH_4 emissions from agriculture

The main agricultural production of methane is due to enteric fermentation in ruminants, and in the associated manure. Earlier estimates of CH_4 emissions from Swiss agriculture were derived on the basis of the IPCC 'Tier 1' methodology. For the present inventory, the IPCC 'Tier 2' approach was used assuming a cool climate with an annual mean temperature of <15°C. This change in methodology resulted in major improvements mainly in the case of the estimates of emissions from manure management. The following Table contains the Swiss-specific values used for the calculation. In contrast to earlier inventories, no CH_4 emissions from agricultural soils are given since no IPCC methodology is proposed in this area and the reliability of available data and methods is considered too weak. Field burning of crop wastes is not usually practised and the corresponding emissions are negligible (<0.5 Gg yr^{-1}).

Country-specific values used for IPCC method Tier 2 .
Symbols are according to the Guidelines, numbers in parenthesis are references.

	Cattle		Sheep	Goats	Horses/Mules	Swine	Poultry
	Dairy	Non-Dairy					
Feed energy requirement	NELI(1)	NELI,NEGI(1)	NELI,NEGI(1)	NELI(1)	DEI(1)	DEI(1)	MEI(1)
Gross energy intake (GEI)	NELI/0.318 (3)	NELI/0.318(3) NEGI/0.307(3)	NELI/0.318(3) NEGI/0.307(3)	NELI/0.318(3)		DEI/14.5(5)*18.45	
Methane conversion rate	0.06GE(7)	0.06GE(7)	0.05GE	0.05GE (7)	0.035DE(4)	2.5 l/kg DM(8)	0.0016ME(9)
Dry matter intake (DMI)	GEI/18.45	GEI/18.45	GEI/18.45	GEI/18.45	DEI/10.6(4)	GEI/18.45	MEI/10.3(6)
Digestibility of energy (D_E)	0.65	0.65	0.65	0.65	0.57(4)	0.84(9)	
Ash content of manure (A_M)	0.18(10)	0.18	0.18	0.18	0.2(11)	0.17(12)	
Organic matter digestibility (D_{OM})							0.82(13)
Ash content of feed (A_F)							0.085(13)
Volatile solids production	DMI(1-D_E)(1-A_M)	DMI(1-D_E)(1-A_M)	DMI(1-D_E)(1-A_M)	DMI(1-D_E)(1-A_M)	DMI(1-D_E)(1-A_M)	DMI(1-D_E)(1-A_M)	DMI(1-D_{OM})(1-A_F)
Liquid/slurry: usage(2)	0.603	0.525	0	0	0.093	0.925	0
Solid storage: usage(2)	0.325	0.21	0.315	0.795	0.838	0.075	1
Pasture: usage(2)	0.072	0.265	0.685	0.205	0.069	0	0

References
(1) SBV (Secretariat of the Swiss Farmer's Association (1996). Statistische Erhebungen und Schätzungen über Landwirtschaft und Ernährung, 1995. Brugg, Switzerland. (For 1995 energy requirements are estimated according to average population published in (2)).
(2) Menzi, H.; Frick, R. (1996). Kaufmann, R. Fachtechnischer Bericht. Ammoniak-Emissionen in der Schweiz (in preparation)
(3) Daccord, R. (1996). Forschungsanstalt für Viehwirtschaftliche Produktion. Pers.Communication.
(4) Kirchgessner, M. (1985). Tierernährung; DLG-Verlag, Frankfurt.
(5) Buchmann, M.; Ackermann, T.; Scheidegger, R. (1994). Daten Schweine. In: Daten Tierproduktion (LBL Ed.), Lindau, Switzerland
(6) Brugg, Schweizerischer Bauernverband (1996). Futterbedarf des schweizerischen Tierbestandes 1993. Unpublished.
(7) IPCC (1994). IPCC Greenhouse Gas Inventory Reference Manual.
(8) Christensen, K.; Thorbek, G. (1987). Methane excretion in the growing pig. British Journal of Nutrition 57, 355-361.
(9) Hadorn, R. (1994). Einfluss unterschiedlicher Nahrungsfaserträger (Soja- und Hirseschalen) im Vergleich zu Weizenquellstärke auf die Nährstoff-und Energieverwertung von wachsenden Schweinen und Broilern. PhD Dissertation ETH Zürich.
(10) Besson, J. M.; Lehman, V.; Roulet, M.; Edelmann, W. (1982). Comparaison de trois traitements des lisiers en conditions expérimentales contrôlées: stockages, aération et méthanisation. Revue suisse Agric. 14, 327-335.
(11) Hasler, A.; Hofer, A. Düngungslehre (1975). Verlag Wirz, Aarau, Switzerland.
(12) Anonymous (1984). Biogas-Handbuch. Verlag Wirz, Aarau, Switzerland.
(13) Hadorn, R. (1996). Schweizerische Geflügelzuchtschule Zollikofen. Pers. Communication.

The number of animals and the corresponding annual CH_4 emission in 1995 are listed for each category in the following Table.

CH_4 emission from agriculture by category (1995)

Category	CH_4 (Gg)	Animal population (x 1000)
Agriculture (animals)	149.1	
Enteric fermentation	129.2	
Mature cows	81.3	765
Non-dairy cattle	42.0	991
Pigs	1.5	1453
Poultry	0.1	6099
Sheep	2.8	427
Goats	0.5	57
Horses/Mules	1.0	47
Manure management	19.9	
Mature cows	12.2	765
Non-dairy cattle	4.0	991
Pigs	3.4	1453
Poultry	0.1	6099
Sheep	0.1	427
Goats	0	57
Horses/Mules	0.2	47

Agricultural CH_4 emission in 1995 (3-year average in Gg CH_4)
(IPCC Method 2, Tier 2)

	1995
Enteric fermentation	127.7
Manure management	19.9
Total	147.6

Compared to the earlier estimates, methane emission from enteric fermentation presented here is of similar magnitude. This is in spite of the fact that IPCC Method 2 (Tier 2) was applied which is not based on specific mean emission factors for each category. However, emissions from manure management are considerably lower. The discrepancy is caused by the application of the IPCC Method 2 using emission factors adapted to the conditions of a cold/humid climate (mean annual temperature <15###C). Using the factor for maximum potential methane emission capacity for each manure storage system given for this climate region lowers the rate of methane emission compared to the calculation without consideration of the climate factor. However, it should be noted that a large uncertainty is attached to these factors, and their temperature-dependence.

- **N_2O from agricultural soils**

Nitrous oxide (N_2O) is produced by the conversion of nitrogen (N) in the soil, mainly by the process of denitrification. For N_2O, the Phase II methodology (IPCC Guidelines for National Greenhouse Gas Inventories, 1996) was adopted for calculating the Swiss national emissions from agriculture. The input data used for this methodology are available in the

Swiss Farmers Association data base (Yearly agricultural statistics and evaluation) for synthetic fertiliser use, edible crop production of N-fixing and non N-fixing crops and the number of livestock. The dry biomass production of each crop was obtained by multiplying the annual production with the dry matter content of each crop according to the dry biomass contents reported by Souci et al. (1981). The area of histosols was available in Presler and Gysi (1989). The method described by Menzi et al. (1996) was used to determine the total amount of N excretion by farm animals, and the relative proportions of the different waste management system. The amount of N excretion was calculated from the number of animals and from animal-specific excretion factors (Walther et al., 1994). Relative proportions of N excretion by different animal waste management systems were determined according to estimates for Switzerland given by Menzi et al. (1996). The input data used proved to be more accurate than the FAO data base. The IPCC method ignores inputs of nitrogen from non-agricultural sources via atmospheric deposition.

Default values were used for all calculations with the exception of the value for the crop fraction burned on fields ($Frac_{BURN}$); the value used here was 0.05 kg N/ kg crop N.

Agricultural N_2O emissions in 1995 (3-year average in Gg N_2O)

	1995
Direct	3.719
Animals	2.030
Indirect	3.074
Total	8.823

Earlier estimates have been based on an emission factor for the conversion of fertiliser nitrogen and other nitrogen inputs to N_2O ranging between 2-3%. For the present inventory, the revised IPCC methodology was used which differs considerably form the method used earlier. Estimated agricultural emission is lower than the earlier estimate in the national inventory which was based on an conversion factor of 3%, but very close to the value obtained with a factor of 2%. Hence, the present estimate is within the range of uncertainty presented before. It should also be noted, that in the present estimate the input of nitrogen from non-agricultural sources, such as NO_x-emissions from traffic, is ignored, which contributed about 10% to the earlier estimate.

References:

Walther, U., Menzi, H., Ryser, J.P., Flisch, R., Jeangros, B., Kessler, W., Maillard, A., Siegenthaler, A.F. und Vuilloud, P.A. (1994). Grundlagen für die Düngung im Acker- und Futterbau. Landwirtschaftliche Beratungszentrale, Lindau.

IPCC/OECD (Intergovernmental Panel on Climate Change/Organisation for Economic Cooperation and Development) (1996). IPCC Guidelines for National Greenhouse Gas Inventories. OECD/OCDE, Paris.

Menzi, H., Kaufmann, R. and Frick, R. (1996). Die Ammoniak-Emissionen in der Schweiz: Ausmass und technische Beurteilung des Reduktionspotentials. Fachtechnischer Bericht der Arbeitsgruppe “Emissionen” zuhanden der Projektgruppe Ammoniak-Emissionen Schweiz. In preparation.

Presler, J. und Gysi, C. (1989).Organische Böden des schweizerischen Mittellandes. Bericht 28 des Nationalen Forschungsprogramms “Boden”. Liebefeld-Bern.

SBV (Sekretariat des Schweizerischen Bauernverbandes), 1911-1995. Statistische Erhebungen und Schätzungen über Landwirtschaft und Ernährung. Brugg.

Greenhouse Gas Inventory 1995

4 Agriculture

IPCC	Source/Sink Categories	Product.	CO2	CH4	N2O	NOx	CO	NMVOC	SO2	CO2	CH4	N2O	NOx	CO	NMVOC	SO2
		1'000 p.	1'000 Gg	Gg	Gg	Gg	Gg	Gg	Gg	t/t	kg/p.	kg/t	kg/t	kg/t	kg/t	kg/t
4	**Agriculture**			**147.7**	**8.82**	**0.03**	**5.88**	**0.25**	**0.02**							
4A	Enteric Fermentation			127.6												
4A 1	Cattle			121.5												
4A 1a	Dairy	765		80.1												
4A 1b	Non-Dairy	991		41.4												
4A 3	Sheep	427		2.8												
4A 4	Goats	57		0.5												
4A 6/7	Horses/Mules	47		1.1												
4A 8	Swine	1,453		1.6												
4A 9	Poultry	6,099		0.1												
4B	Manure Management			19.9												
4B 1	Cattle			15.9												
4B 1a	Dairy	765		12.0												
4B 1b	Non-Dairy	991		3.9												
4B 3	Sheep	427		0.1												
4B 4	Goats	57		0.0												
4B 6/7	Horses/Mules	47		0.2												
4B 8	Swine	1,453		3.6												
4B 9	Poultry	6,099		0.1												
4D	Agricultural Soils *				8.82											
4F 1	Field Burning of Residues			0.2		0.03	5.88	0.25	0.02							

*) Values not yet available
(with the exception of N2O)

5A - 5C Land Use Change and Forestry

Preliminary Remarks:

The main data base for calculations is the Swiss National Forest Inventory (Inventaire forestier national Suisse, 1988 [7]).

"Abandonment of Managed Lands" (Table 5C) is not separately calculated, even though the Swiss forest area has increased by nearly 50 percent over the last 100 years. The carbon uptake on this surface is included in the carbon uptake increment of forests (Table 5A, Sheet 1: Annual Growth Increment, Column B). The abandoned land has become forest and is now part of forest statistics.

No carbon enrichment in soils is included. Alpine pastures, e.g., already have a high soil carbon content, so that an enrichment according to the Guidelines is unlikely. An IPCC method based calculation of a fifty year period with a constant abandonment rate resulted in four to five times higher carbon uptake than the calculation on Switzerlands own data base. The present assessment is considered to be a rather conservative estimate of carbon sequestration in Swiss forests.

5A1 Changes in Biomass Stocks: Annual Growth Increment

Site quality classification (Keller, 1978 [8]) and yield tables are used to calculate the dry matter increment of wood. Subsequently, the following factors are applied to determine the "Total Carbon Uptake Increment":
- Expansion factor: 1.45 (Burschel et al., 1993 [9])
- Conversion factor dry matter to carbon content: 0.5 (Holz Lexikon, 1988 [10]).

Greenhouse Gas Inventory 1995

5A (Sheet 1) Changes in Forest and Other Woody Biomass Stocks - Annual Growth Increment

SOURCE AND SINK CATEGORIES			ACTIVITY DATA	UPTAKE ESTIMATES	AGGREGATE UPTAKE FACTOR
Sector Specific Data (units) Land Type			A Area of Forest/Biomass Stocks (kha)	B Total Carbon Uptake Increment (Gg C)	C Carbon Uptake Factor (t C/ha) C = B/A
Temperate Forests	Commercial	Evergreen	780	1838.5	2.36
		Deciduous	281	949	3.38
	Other		143	0	0
Other Ecosystem Types: moor			26	~ 0.5	0.02
Non-Forest Trees			Number of Trees (1000)	Annual Carbon Uptake (Gg C)	Carbon Uptake Factor (t C/tree) C = B/A
fruit trees (1992)			4250	?	?
hedges, small groups of trees			113 kha	?	?
growth of stock of wooden goods and buildings				~150	

5A2 Changes in Biomass Stocks: Annual Harvest

For the calculation of dry matter and carbon content of biomass from timber volume the following factors are used:

- Expansion factor: 1.45 (Burschel et al., 1993 [9])
- Wood density: hardwood 1 m^3 = 556 kg dm
  softwood 1 m^3 = 384 kg dm
  weighted average 1 m^3 = 424 kg dm
- Conversion factor dry matter to carbon content: 0.5 (Holz Lexikon, 1988 [10]).

5A3 Changes in Biomass Stocks: Net CO_2 Emissions/Removals

The increment of wood in products and buildings is not included in the final balance.

Greenhouse Gas Inventory 1995

5A (Sheet 2) Changes in Forest and Other Woody Biomass Stocks - Annual Harvest

SOURCE AND SINK CATEGORIES	ACTIVITY DATA	CARBON EMISSION ESTIMATES	AGGREGATE EMISSION FACTOR
Sector Specific Data (units)	A Amount of Biomass Removed (kt dm)	B Carbon Emission/Removal Estimates (Gg C)	C Carbon Emission Factors (t C/ t dm) C = B/A
Total Biomass Removed in Comm. Harvest	2275	1137.5	0.5
Traditional Fuelwood Consumed	518	259	0.5
Total Biomass Consumption	2793	1396.5	0.5

Greenhouse Gas Inventory 1995

5A (Sheet 3) Changes in Forest and Other Woody Biomass Stocks - Net CO2 Emissions/Removals

SOURCE AND SINK CATEGORIES	A EMISSIONS/UPTAKE C (Gg)	B EMISSIONS/REMOVALS CO2 (Gg) B = A x (44/12)
Total Annual Growth Increment	2787.5	10221
Total Annual Harvest	1396.5	5121
NET EMISSIONS (+) OR REMOVALS (-)	- 1391	- 5100

6 Waste

Data base for the calculation of emissions is FOEFL report no. 256 "Emissions polluantes dues à l'activité humaine en Suisse de 1900 à 2010" [4]. Emission factors will be found in [3].

Calculation of the emissions of wastewater treatment has been done with the number of connected inhabitants. Practically all emitted gases from wastewater treatment are energetically used (40% in combustion installations and 60% in stationary motors).

Greenhouse Gas Inventory 1995

6 Waste

IPCC	Source/Sink Categories	Product.	CO2	CH4	N2O	NOx	CO	NMVOC	SO2	CO2	CH4	N2O	NOx	CO	NMVOC	SO2
		1'000 t	1'000 Gg	Gg	Gg	Gg	Gg	Gg	Gg	t/t	kg/t	kg/t	kg/t	kg/t	kg/t	kg/t
6	**Waste**		**1.35**	**66.53**	**0.28**	**6.25**	**5.51**	**1.94**	**2.51**							
6A 1	Landfills		0.136	64.800		0.474	1.840	1.020	0.045							
6B 1/2	Wastewater Treatment			1.480	0.067	0.626	0.397	0.007	1.210							
6C	Waste Incineration		1.210	0.250	0.213	5.150	3.270	0.867	1.250							
6D	Other (Shredder)	422					0.002	0.042						0.005	0.0001	

7A Summary Report 1995

IPCC	Source/Sink Categories	CO2 Emiss. 1'000 Gg	CH4 Gg	N2O Gg	NOx Gg	CO Gg	NMVOC Gg	SO2 Gg
Total	**Emissions and Removals**	**39.1**	**235**	**11.8**	**134**	**510**	**201**	**34**
	(Without Int. Bunkers)							
1	**All Energy**	**40.2**	**20.6**	**2.0**	**127**	**488**	**74**	**28**
1A	Fuel Combustion	40.1	7.8	2.0	126.8	488.3	65.6	27.6
	1 Energy/Transformation	1.15	0.08	0.01	1.76	0.34	0.05	2.33
	2 Industry	5.17	0.31	0.02	11.92	12.05	0.42	7.88
	3 Transport	14.58	3.52	1.78	82.36	318.33	50.33	2.11
	4 Small Combustion	18.29	0.94	0.15	19.36	48.83	6.69	14.61
	5 Other	0.94	0.39	0.03	8.87	51.80	7.27	0.24
	6 Biomass		2.60	0.04	2.50	56.93	0.87	0.44
1B	Fugitive Emissions	0.07	12.78		0.15	0.03	8.19	
	2 Oil/Natural Gas	0.07	12.78		0.15	0.03	8.19	
2	**Industrial Processes**	**2.6**	**0.40**	**0.31**	**0.33**	**10.6**	**7.6**	**3.6**
3	**Solvent Use**			**0.38**	**0.04**	**0.09**	**117**	**0.04**
4	**Agriculture**		**148**	**8.8**	**0.0**	**5.9**	**0.3**	**0.02**
4A	Enteric Fermentation		127.60					
4B	Manure Management		19.95					
4D	Agricultural Soils *			8.8				
4F	Burning of Residues		0.20		0.03	5.88	0.25	0.02
5	**Land Use Change/Forestry**	**-5.1**						
5A	Change Biomass Stock	-5.10						
6	**Waste**	**1.3**	**66.5**	**0.28**	**6.3**	**5.5**	**1.9**	**2.5**
6A	Waste Disposal	0.14	64.80	0.00	0.47	1.84	1.02	0.05
6B	Wastewater Treatment	0.00	1.48	0.07	0.63	0.40	0.01	1.21
6C	Waste Incineration	1.21	0.25	0.21	5.15	3.27	0.87	1.25
6D	Other Waste					0.00	0.04	
	International Bunkers	**2.4**						

*) Values not yet available (exception: N2O)

7B Short Summary Report 1995

IPCC	Source/Sink Categories	CO2 Emiss. 1'000 Gg	CH4 Gg	N2O Gg	NOx Gg	CO Gg	NMVOC Gg	SO2 Gg
Total	**Emissions and Removals**	**39.1**	**235**	**11.8**	**134**	**510**	**201**	**34**
	(Without Int. Bunkers)							
1	**All Energy**	40.2	21	2.0	127	488	74	28
1A	Fuel Combustion	40.1	7.8	2.02	126.8	488.3	65.6	27.6
1B	Fugitive Emissions	0.07	12.8		0.15	0.03	8.2	
2	Industrial Processes	2.6	0.40	0.31	0.33	10.6	7.6	3.6
3	Solvent Use			0.38	0.04	0.09	117	0.04
4	Agriculture *		148	8.8	0.0	5.9	0.3	0.02
5	Land Use Change/Forestry	-5.1						
6	Waste	1.3	66.5	0.28	6.3	5.5	1.9	2.5
	International Bunkers	2.4						

*) Agricultural soils incomplete

8A Overview Table 1995

IPCC	Source/Sink Categories	CO2 Estimate	CO2 Quality	CH4 Estimate	CH4 Quality	N2O Estimate	N2O Quality	NOx Estimate	NOx Quality	CO Estimate	CO Quality	NMVOC Estimate	NMVOC Quality	SO2 Estimate	SO2 Quality	HFCs Estimate	HFCs Quality	PFCs Estimate	PFCs Quality	SF6 Estimate	SF6 Quality	Doc.	Disaggr.	Footn.
	Total National Emissions																							
	and Removals		**H**		**M**		**L**		**M**		**M**		**M**		**M**		**L**		**L**		**L**			
1	**All Energy**	**ALL**	**H**	**ALL**	**M**	**ALL**	**M**	**ALL**	**M**	**ALL**	**M**	**ALL**	**M**	**ALL**	**M**							**H**	**2**	
1A	Fuel Combustion	ALL	H	ALL	M	ALL	M	ALL	M	ALL	M	ALL	M	ALL	M							M		
1A1	Energy/Transformation	ALL	H	ALL	M	ALL	M	ALL	M	ALL	M	ALL	M	ALL	M							H		
1A2	Industry	ALL	H	ALL	M	ALL	M	ALL	M	ALL	M	ALL	M	ALL	M			ALL	L			H		
1A3	Transport	ALL	H	ALL	M	ALL	M	ALL	M	ALL	M	ALL	M	ALL	M							H		
1A4	Small Combustion	ALL	H	ALL	M	ALL	M	ALL	M	ALL	M	ALL	M	ALL	M							H		
1A5	Other	ALL	H	ALL	M	ALL	M	ALL	M	ALL	M	ALL	M	ALL	M							H		
1A6	Biomass for Energy	ALL	H	ALL	M	ALL	M	ALL	M	ALL	M	ALL	M	ALL	M							M		
1B	Fugitive Emissions	ALL	H	ALL	M	ALL	M	ALL	M	ALL	M	ALL	M	NO								M	3	
1B1	Solid Fuels	NO		NO		NO		NO		NO		NO		NO										
1B2	Oil and Natural Gas	ALL	H	ALL	M	ALL	M	ALL	M	ALL	M	ALL	M	ALL	M							M	3	
2	**Industrial Processes**	**ALL**	**H**	**ALL**	**M**	**ALL**	**M**	**ALL**	**M**	**ALL**	**M**	**ALL**	**M**	**ALL**	**M**							**M**	**2; 3**	
3	**Solvent Use**	**NO**		**NO**		**ALL**	**M**	**ALL**	**M**	**ALL**	**M**	**ALL**	**M**	**NO**		**ALL**	**L**			**ALL**	**L**	**M**	**3**	
4	**Agriculture**	**NE**		**PART**	**M**	**PART**	**L**	**PART**	**M**	**PART**	**M**	**PART**	**M**	**PART**	**M**							**M**		
4A	Enteric Fermentation	NE		ALL	M	ALL	L	NO		NO		NO		NO									3	
4B	Animal Wastes	NE		ALL	M	ALL	L	NO		NO		NO		NO									3	
4D	Agricultural Soils	NE		NE		NE		NE		NE		NE		NE								L	2	
4F	Burning of Residues	NE		ALL	M	NO		ALL	M	ALL	M	ALL	M	ALL	M							L	2	
4G	Other	NE		NO		NO		NO		NO		NO		NO										
5	**Land Use Change &**																							
	Forestry	**PART**	**H**	**NE**		**NE**		**NE**		**NE**		**NE**		**NO**								**M**	**1**	
5A	Changes in Biomass	PART	H	NE		NE		NE		NE		NE		NO										
5B	Conversion	IE		NE		NE		NE		NE		NE		NO										
5C	Abandonment	IE		NE		NE		NE		NE		NE		NO										
6	**Waste**	**ALL**	**H**	**ALL**	**M**	**ALL**	**M**	**ALL**	**M**	**ALL**	**M**	**ALL**	**M**	**ALL**	**M**							**H**	**2**	
6A	Solid Waste Disposal	ALL	H	ALL	M	ALL	M	ALL	M	ALL	M	ALL	M	ALL	M							H		
6B	Wastewater Treatment	ALL	H	ALL	M	ALL	M	ALL	M	ALL	M	ALL	M	ALL	M							H		
6C	Waste Incineration	ALL	H	ALL	M	ALL	M	ALL	M	ALL	M	ALL	M	ALL	M							H		
6D	Other	NO		NO		NO		NO		PART	M	PART	M	NO								M		
	International Bunker	ALL	M	NE		NE		NE		NE		NE										M	1	a

Footnote a: due to statistical problems part of bunker fuel emissions are included in domestic civil aviation (1A3 a).

NOTATION KEY FOR OVERVIEW TABLE							
Estimates		**Quality**		**Documentation**		**Disaggregation***	
code	*Meaning*	*code*	*Meaning*	*code*	*Meaning*	*code*	*Meaning*
PART	Partly estimated	H	High Confidence in Estimation	H	High (all background information included)	1	Total emissions estimated
ALL	Full estimate of all possible sources	M	Medium Confidence in Estimation	M	Medium (some background information included)	2	Sectoral split
NE	Not estimated	L	Low Confidence in Estimation	L	Low (only emission estimates inlcuded)	3	Subsectoral split
IE	Estimated but included elsewhere						
NO	Not occurring						
NA	Not applicable						
* See following table for a complete explanantion of each code							

Glossary of units and abbreviations used in tables

C	carbon
Gg	gigagram (equivalent of 1'000 tonnes)
ha	hectares
HDT	Heavy Duty Truck
HFO	Residual Fuel Oil
kha	kilohectares
kg/t	kilogram per tonne
kg/TJ	kilogram per Tera Joule
kt dm	kilotonnes dry matter
LDT	Light Duty Truck
LFO	Gas Oil
p	pieces
PC	Passenger Car
t	tonne(s)
t dm	tonnes dry matter
t/t	tonne per tonne
t/TJ	tonne per terajoule
TJ	terajoule

Bibliography

[1] Federal Office of Energy: Swiss Energy Statistics, Berne (annual).

[2] Swiss Petroleum Association/Union Pétrolière: Rapport Annuel, Zurich (annual).

[3] Federal Office of Environment, Forests and Landscape: Handbook "Coefficients d'émission des sources stationnaires"; Berne, 1995.

[4] Federal Office of Environment, Forests and Landscape: Report No. 256 des cahiers de l'environnement: "Emissions polluantes dues à l'activité humaine en Suisse de 1900 à 2010"; Berne, 1995.

[5] Federal Office of Environment, Forests and Landscape: Report No. 255 des cahiers de l'environnement: "Emissions polluantes du trafic routier de 1950 à 2010"; Berne, 1995.

[5a] Federal Office of Environment, Forests and Landscape: Handbook on Diskettes "Manuel informatisé des coefficients d'émission du trafic routier de 1980 à 2010" (Version 1.1); Berne, 1995.

[6] Federal Office of Environment, Forests and Landscape: Report "Schadstoffemissionen und Treibstoffverbrauch des Off-Road Sektors"; Berne, 1996 (french version available only as a summary).

[7] Institut fédéral de recherches forestières: Inventaire forestier national suisse, rapport no 305; Birmensdorf, 1988.

[8] Keller, W.: Einfacher ertragskundlicher Bonitätsschlüssel für Waldbestände in der Schweiz. Eidg. Anst. forstl. Versuchswes., Mitt. 54,1, Birmensdorf, 1978.

[9] Burschel, P., E. Kürsten und B.C. Larson: Die Rolle von Wald und Forstwirtschaft im Kohlenstoffhaushalt. Forstliche Forschungsberichte München, Nr. 126, Munich, 1993.

[10] Holz Lexikon, Stuttgart, 1988.

Reference for inventory reporting formats:

IPCC Guidelines for National Greenhouse Gas Inventories, Vol.1-3, 1995

Updated/revised 1990-1994 data

Some major changes in the data calculation and reporting approach have occured in the field of agricultural emissions in the 1995 GHG inventory. In order to maintain consistent time series, in the following tables data from 1990 on are given on a uniform basis.

Develop-ment

Greenhouse Gas-Inventories 1990-1995
CO2 (1'000 Gg)

IPCC	Source/Sink Categories	1990	1991	1992	1993	1994	1995
1	**Energy**	40.39	42.29	41.35	40.08	39.27	40.20
1A	Fuel Combustion	40.33	42.22	41.28	40.01	39.20	40.13
1A1	Energy/Transformation	0.96	1.30	1.42	1.05	1.01	1.15
1A2	Industry	5.41	5.52	5.14	4.96	5.01	5.17
1A3	Transport	14.67	15.24	14.64	14.62	14.87	14.58
1A4	Small Combustion	18.32	19.19	19.12	18.43	17.37	18.29
1A5	Other	0.97	0.97	0.96	0.95	0.94	0.94
1B	Fugitive Emissions Fuels	0.06	0.07	0.07	0.07	0.07	0.07
2	**Industrial Processes**	3.36	3.03	2.74	2.55	2.73	2.62
3	**Solvent Use**	n.o	n.o	n.o	n.o	n.o	n.o
4	**Agriculture**	n.e	n.e	n.e	n.e	n.e	n.e
5	**Land Use/Forestry**	-4.36	-4.38	-4.43	-5.16	-5.15	-5.10
6	**Waste**	1.32	1.33	1.34	1.34	1.34	1.35
	Total	**40.7**	**42.3**	**41.0**	**38.8**	**38.2**	**39.1**

Development **Greenhouse Gas-Inventories 1990-1995**
CH4 (Gg)

IPCC	Source/Sink Categories	1990	1991	1992	1993	1994	1995
1	**Energy**	23.56	23.28	22.67	22.04	21.33	20.61
1A	Fuel Combustion	8.92	8.82	8.51	8.27	8.06	7.83
1A1	Energy/Transformation	0.05	0.07	0.08	0.07	0.07	0.08
1A2	Industry	0.32	0.34	0.33	0.34	0.34	0.36
1A3	Transport	4.47	4.28	4.08	3.88	3.76	3.52
1A4	Small Combustion	3.71	3.75	3.64	3.60	3.50	3.48
1A5	Other	0.37	0.38	0.38	0.38	0.39	0.39
1B	Fugitive Emissions Fuels	14.64	14.46	14.16	13.77	13.27	12.78
2	**Industrial Processes**	0.43	0.43	0.42	0.41	0.41	0.40
3	**Solvent Use**	n.o	n.o	n.o	n.o	n.o	n.o
4	**Agriculture ***	150.90	152.50	151.30	150.30	147.40	147.60
5	**Land Use/Forestry ****	n.e	n.e	n.e	n.e	n.e	n.e
6	**Waste**	68.61	68.22	67.82	67.32	66.93	66.53
	Total	**244**	**244**	**242**	**240**	**236**	**235**

*) 3 years average; without agricultural soils (values not yet available)
**) values not yet available

Develop-ment **Greenhouse Gas-Inventories 1990-1995**
N2O (Gg)

IPCC	Source/Sink Categories	1990	1991	1992	1993	1994	1995
1	**Energy**	1.39	1.52	1.64	1.77	1.88	2.03
1A	Fuel Combustion	1.39	1.52	1.64	1.77	1.88	2.03
1A1	Energy/Transformation	0.01	0.01	0.01	0.00	0.00	0.01
1A2	Industry	0.03	0.03	0.03	0.03	0.03	0.03
1A3	Transport	1.13	1.26	1.38	1.52	1.64	1.78
1A4	Small Combustion	0.19	0.19	0.19	0.19	0.18	0.18
1A5	Other	0.03	0.03	0.03	0.03	0.03	0.03
1B	Fugitive Emissions Fuels	0.00	0.00	0.00	0.00	0.00	0.00
2	**Industrial Processes**	0.32	0.32	0.32	0.31	0.31	0.31
3	**Solvent Use**	0.35	0.35	0.36	0.37	0.38	0.38
4	**Agriculture ***	9.20	9.21	9.15	9.06	8.92	8.82
5	**Land Use/Forestry ***	n.e	n.e	n.e	n.e	n.e	n.e
6	**Waste**	0.22	0.23	0.24	0.25	0.27	0.28
	Total	**11.5**	**11.6**	**11.7**	**11.8**	**11.8**	**11.8**

*) Values not yet available or not yet complete

Develop-ment **Greenhouse Gas-Inventories 1990-1995**
NOx (Gg)

IPCC	Source/Sink Categories	1990	1991	1992	1993	1994	1995
1	**Energy**	155.81	150.55	143.48	135.89	130.57	126.92
1A	Fuel Combustion	155.75	150.40	143.33	135.74	130.42	126.77
1A1	Energy/Transformation	1.50	2.26	2.55	1.88	1.39	1.76
1A2	Industry	15.77	14.48	12.56	11.63	11.66	12.30
1A3	Transport	106.82	101.70	96.60	91.49	87.68	82.36
1A4	Small Combustion	22.85	23.14	22.78	21.89	20.83	21.48
1A5	Other	8.81	8.82	8.84	8.85	8.86	8.87
1B	Fugitive Emissions Fuels	0.06	0.15	0.15	0.15	0.15	0.15
2	**Industrial Processes**	0.46	0.44	0.41	0.38	0.35	0.33
3	**Solvent Use**	0.04	0.04	0.04	0.04	0.04	0.04
4	**Agriculture ***	n.e	n.e	n.e	n.e	n.e	n.e
5	**Land Use/Forestry ***	n.e	n.e	n.e	n.e	n.e	n.e
6	**Waste**	6.75	6.66	6.55	6.41	6.33	6.25
	Total	**163**	**158**	**150**	**143**	**137**	**134**

*) Values not yet available

Develop-ment **Greenhouse Gas-Inventories 1990-1995**
CO (Gg)

IPCC	Source/Sink Categories	1990	1991	1992	1993	1994	1995
1	**Energy**	677.97	637.54	595.29	554.01	526.01	488.28
1A	Fuel Combustion	677.94	637.51	595.26	553.98	525.98	436.48
1A1	Energy/Transformation	0.29	0.44	0.45	0.44	0.33	0.34
1A2	Industry	16.11	15.57	14.80	14.38	14.19	13.81
1A3	Transport	508.65	467.34	425.91	384.59	356.58	318.33
1A4	Small Combustion	103.69	104.46	103.90	103.87	103.58	104.00
1A5	Other	49.20	49.70	50.20	50.70	51.30	51.80
1B	Fugitive Emissions Fuels	0.03	0.03	0.03	0.03	0.03	0.03
2	**Industrial Processes**	14.35	13.34	12.39	11.55	11.24	10.63
3	**Solvent Use**	0.08	0.08	0.08	0.08	0.09	0.09
4	**Agriculture**	5.88	5.88	5.88	5.88	5.88	5.88
5	**Land Use/Forestry ***	n.e	n.e	n.e	n.e	n.e	n.e
6	**Waste**	8.23	7.69	7.14	6.58	6.04	5.51
	Total	**707**	**665**	**621**	**578**	**549**	**510**

*) Values not yet available

Develop-ment **Greenhouse Gas-Inventories 1990-1995**
NMVOC (Gg)

IPCC	Source/Sink Categories	1990	1991	1992	1993	1994	1995
1	**Energy**	123.26	113.58	101.93	91.55	83.76	73.81
1A	Fuel Combustion	104.99	96.89	88.75	80.44	74.11	65.62
1A1	Energy/Transformation	0.04	0.06	0.07	0.06	0.04	0.05
1A2	Industry	0.44	0.45	0.43	0.42	0.42	0.43
1A3	Transport	90.00	81.73	73.56	65.28	59.00	50.33
1A4	Small Combustion	7.56	7.64	7.61	7.54	7.44	7.54
1A5	Other	6.95	7.01	7.08	7.14	7.21	7.27
1B	Fugitive Emissions Fuels	18.27	16.69	13.18	11.11	9.65	8.19
2	**Industrial Processes**	8.21	7.98	7.72	7.64	7.64	7.62
3	**Solvent Use**	147.00	139.40	133.50	127.40	122.10	116.98
4	**Agriculture ***	n.e	n.e	n.e	n.e	n.e	n.e
5	**Land Use/Forestry ***	n.e	n.e	n.e	n.e	n.e	n.e
6	**Waste**	2.71	2.55	2.41	2.24	2.08	1.94
	Total	**281**	**264**	**246**	**229**	**216**	**200**

*) Values not yet available

Develop-ment **Greenhouse Gas-Inventories 1990-1995**
SO2 (Gg)

IPCC	Source/Sink Categories	1990	1991	1992	1993	1994	1995
1	**Energy**	30.85					27.62
1A	Fuel Combustion						27.62
1A1	Energy/Transformation						2.33
1A2	Industry						7.90
1A3	Transport						2.11
1A4	Small Combustion						15.04
1A5	Other						0.24
1B	Fugitive Emissions Fuels						0.00
2	**Industrial Processes**	7.70					3.61
3	**Solvent Use**						0.04
4	**Agriculture**						0.02
5	**Land Use/Forestry**						0.00
6	**Waste**	3.41					2.54
	Total	**42**					**34**