Switzerland's Fourth National Communication under the UNFCCC

First National Communication under the Kyoto Protocol to the UNFCCC

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Overview

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Foreword

This report is the fourth in a series of publications providing a comprehensive account of Switzerland's efforts to comply with its obligations under the Climate Change Convention. It documents the progress that has been made on many fronts since the previous report appeared in 2001 but also indicates the challenges that lie ahead.

The entry into force of the Kyoto Protocol on 16 February 2005 underlines the importance of the measures that have been implemented to date and those currently being prepared. An interim assessment of projected emission trends conducted in the winter of 2004/2005 showed that additional efforts are required to meet Switzerland's target under the Kyoto Protocol. In the summer of 2005, a number of important decisions were taken by the Federal Council to address the existing need for action.

However, this is no reason to slacken our efforts in the field of climate policy: in recent years, in Switzerland as in other regions all over the world, many natural disasters have shown the devastating effects of extreme climatic events. National and concerted international efforts need to be stepped up in order to protect human society from the potentially tragic impacts of climate change.

The Kyoto Protocol is but a first step on the road to achieving the ultimate objective of the Climate Convention: the stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Switzerland is prepared to cooperate in the further development of an international climate regime which contributes to sustainable development, ensures the participation of all major emitters, is cost-effective, strengthens international cooperation and fosters technology development and diffusion.

Swiss Agency for the Environment,
Forests and Landscape

Bruno M. Oberle
Director

November 2005

1. Executive Summary

1.1. Introduction and review of recent developments

This report is Switzerland's fourth National Communication (NC4) 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 and – for the first time – the Kyoto Protocol.

The third National Communication (NC3) was submitted on 7 November 2001, and an in-depth review was carried out between February and May 2002. In the preparation of NC4, the results of the in-depth review of NC3 were taken into account by, *inter alia*,

- integrating the results of a broad-based stakeholder review of a draft version of the present report, involving NGOs, semi-private and private organizations and associations from business, scientific and environmental circles;
- addressing in more detail the efforts and measures undertaken at the cantonal level in Swiss climate policy; and
- basing the GHG projections on the GHG inventory data, thereby enhancing consistency in the presentation of inventory and projections data.

The most important recent developments relating to Swiss climate policy are as follows:

- As from July 2001, the business community embarked on the process of concluding **voluntary agreements** for GHG emission reductions under the CO_2 Act, under the umbrella of the privately run Energy Agency for the Economy.
- Switzerland ratified the **Kyoto Protocol** in July 2003 and has established a Designated National Authority for the flexible mechanisms. An ordinance concerning the requirements for CDM/JI projects, as well as the quantity of certificates from abroad that can be used for compliance (supplementarity), was adopted by the Federal Council in June 2005.
- The Ordinance relating to Environmentally Hazardous Substances has been revised in order to provide for measures to control **synthetic GHG emissions**. The revised ordinance entered into force on 1 January 2004.
- Under the CO_2 legislation, the Federal Council decided in the spring of 2005 to introduce a **CO_2 tax** of CHF 35 per tonne of CO_2 on process and heating fuels (tax rate subject to approval by Parliament), and to accept the "**climate cent"** on motor fuels as a provisional voluntary measure until 2007. Projections indicate that the emission reduction targets under the Kyoto Protocol and the CO_2 Act will not be reached without these additional measures.
- In more general terms, since 2001:
  - the coordination between **spatial development** and **transport infrastructure** has been enhanced, strategies have been elaborated for the improvement of transport infrastructure in urban/suburban areas, public transport services have been considerably extended, and – facilitated by the heavy vehicle fee – efforts to shift freight transport from road to rail are having visible effects;
  - the **Agriculture reform** introduced in the 1990s has led to a continuing decrease in GHG emissions from farming, and to a change towards considerably more market-oriented and environmentally sound forms of agricultural production in Switzerland;
  - regarding the forestry sector, Switzerland has elaborated a new **National Forest Programme** designed to improve both the economic and the protective functions of the forest.

1.2. National circumstances

Political profile

Switzerland is a confederation with a federal government, a bicameral parliament and a Federal Supreme 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 authorities and the cantons. As Switzerland's political system incorporates strong formal and informal elements of direct democracy, the Swiss people are sovereign and ultimately the supreme political authority.

Switzerland has been a member of several international organizations (e.g. OECD, World Bank Group, all UN specialized agencies) for many years, but only joined the United Nations as a full member in September 2002. Although Switzerland is not a member of the European Union (EU), most new Swiss laws or changes to existing laws have been made compatible with EU legislation.

Population, geography and climate profile

At the end of 2004, the population in Switzerland was 7.418 million, with more than two thirds living in metropolitan areas. Population growth is nowadays mainly due to immigration and increasing life expectancy. A growing proportion of the population is of retirement age, while the share of persons below the age of 20 has been declining since the 1970s.

The country's area is approximately 41,300 km^2, with 31% forests, 37% cropland and permanent pasture, 7% built-up and 25% unproductive land.

Climatic conditions, average temperatures and precipitation patterns vary significantly across Switzerland, depending mainly on altitude and location. The Alps act as a climatic divide. A significant temperature increase of about 1.5°C and a trend towards a wetter climate, particularly in winters North of the Alps, has been observed since the 1970s.

Economic profile

Switzerland's economy is dependent on foreign trade. In 2003, exports amounted to 44% of gross domestic product (GDP). The main export goods and services come from the microtechnology, biotechnology, pharmaceuticals, banking and insurance sectors. In 2003, the value of one tonne of exported goods was two and a quarter times more than that of the same amount of imports. More than 300,000 private-sector enterprises exist, of which 75% are service suppliers.

Nominal GDP for 2003 was CHF 433 billion, an increase of 0.53% over the previous year. Real GDP has been rising slightly over the last decade.

Traditionally a low-unemployment country, Switzerland has experienced a dramatic increase in unemployment since the early 1990s. In 2004, the unemployment rate was 4.4%.

Sector characteristics

- **Energy**: Energy use in Switzerland was 877.3 PJ in 2004, i.e. 0.5% above the previous year and 11.6% above the level of 1990. Over 90% of gross energy consumption was imported from abroad. Oil products made up 58% of final energy consumption, while electricity accounted for 23% and gas 12%. The largest increases in total final energy consumption since the 1980s have been recorded by the transport sector (58%) and the industry sector (24%). In 2003, transport accounted for 33% of energy end use.

  Electricity generation is almost free of fossil fuels (roughly 60% hydropower and 40% nuclear power, plus a small share from thermal power plants or other renewable sources such as solar, wind and biogas). Electricity is traded across Switzerland's borders on a fairly large scale. Amongst the factors affecting this trade are hydrological and climatic conditions. Traditionally a net exporter of electricity, Switzerland's exports have decreased significantly in the last few years.

  Energy productivity has remained constant in recent decades; i.e., the index of energy consumption has increased broadly in line with that of GDP.

- **Transport**: The share of road transport is still growing compared to rail in the passenger and freight sectors, although – by international standards – Swiss railways play a very important role, especially in passenger and transalpine freight transport.

  So-called "fuel tourism" occurs because petrol prices are at present significantly lower than in neighbouring countries. This has a considerable effect on the amount of fuel sold in Switzerland.

  The aviation sector has undergone a dramatic decrease in flights and passenger numbers in the aftermath of the terrorist attacks in New York and due to the cessation of operations of the former national airline Swissair in 2001.

- **Agriculture**: The agriculture sector has undergone major structural changes in the last decades. Today, farmers have become a small minority in service-oriented Switzerland (5% of the labour force). Since the early 1990's, agricultural policy has become more commercially and environmentally oriented. The required standard of ecological performance – a condition to receive non-product-related direct payments to compensate for public-interest and environmental services – is now met by almost all farms, and organic farming had reached a share of about 10% by 2005.

- **Forestry**: About one quarter of woodland is in private hands, while about three quarters is in public ownership (local authorities and public corporations). Growing stock is rather large. The forested area is continuously increasing, particularly in locations where natural regeneration of land previously used in agriculture plays an important role. The Forest Act and associated regulations are intended to safeguard timber production, maintain biodiversity and provide protection against natural hazards.

1.3. Greenhouse gas inventory information

Switzerland provides standardized technical inventories according to UNFCCC and IPCC guidelines on a yearly basis. The latest submission, containing the 2003 inventory, dates from April 2005.

Overview of the Swiss 2003 GHG Inventory

Emissions of carbon dioxide (CO_2)

In 2003, national gross CO_2 emissions amounted to 44.7 million tonnes or 6.05 tonnes per capita. Nearly three quarters of these emissions came from transport (34%) and small-scale combustion (26% residential, 12% commercial/institutional). Industry accounts for 20% of CO_2 emissions (17% energy-related, 4% non-energy-related). Other sources are of minor importance.

At present, the net result of carbon releases (due to harvesting and the cultivation of organic soils) and carbon uptake is an absorption of the order of 1.8 million tonnes of CO_2. This absorption corresponds to 4% of gross CO_2 emissions.

Emissions of methane (CH_4)

CH_4 emissions were 175,000 tonnes in 2003, with more than three quarters from the agricultural sector and 11% from the waste sector.

Emissions of nitrous oxide (N_2O)

N_2O emissions were 10,000 tonnes in 2003, with agriculture being the most important source (about 81% of the total). Transport was the second largest contributor, with 5% of total emissions.

Other GHGs (HFCs, PFCs, SF_6)

To date, emissions of HFCs, PFCs and SF_6 have been of marginal importance in Switzerland (about 1.5% of overall GHG emissions). For 2003, the following figures (in CO_2 equivalents) have been calculated: 529,000 tonnes HFCs, 66,000 tonnes PFCs and 169,000 tonnes SF_6.

Precursor gases

Of the total of 92,000 tonnes of NO_X emissions, 54% came from the transport sector. Other sources were industry (20%), agriculture (13%), small-scale combustion in the residential/commercial/ institutional sectors (10%) and waste (3%).

Of the total of 425,000 tonnes of CO emissions, 65% originated in the transport sector. About 18% was contributed by industry, 9% by agriculture and 8% by small-scale combustion.

In total, NMVOC emissions were 125,000 tonnes. The main sources were solvent use in industry (54%) and the transport sector (22%). Industrial combustion and processes accounted for 16% of NMVOC emissions.

Emissions of sulphur dioxide (SO_2)

Emissions of SO_2 amounted to 19,000 tonnes in 2003. Small-scale combustion was the leading contributor (34%), followed by energy-related (30%) and non-energy-related emissions from industry (19%).

IPCC n°	Source/sink category	CO_2 (million tonnes)	CH_4 (000 tonnes)	N_2O (000 tonnes)	F-gases (million tonnes CO_2 eq.)	NO_x (000 tonnes)	CO (000 tonnes)	NMVOC (000 tonnes)	SO_2 (000 tonnes)
1	All energy	41.72	17.02	0.98	n.o.	84.92	405.18	46.07	13.56
	Fuel combustion	*41.64*	*5.07*	*0.98*	*n.o.*	*84.87*	*405.17*	*39.88*	*13.56*
	Fugitive emissions	*0.08*	*11.95*	*0.00008*	*n.o.*	*0.05*	*0.01*	*6.18*	*0.0004*
2	Industrial processes	1.81	0.45	0.31	0.76	0.32	12.05	7.31	3.46
3	Solvent use	n.o.	n.o.	0.40	n.o.	0.05	0.09	66.82	0.04
4	Agriculture	i.e.	137.99	7.98	n.o.	4.29	5.88	4.22	0.02
6	Waste	1.19	19.36	0.30	n.o.	2.33	1.72	0.26	1.77
	Total gross emissions	**44.72**	**174.81**	**9.97**	**0.76**	**91.89**	**424.93**	**124.68**	**18.85**
5	Land use change and forestry	-1.77	n.o.	n.o.	n.o.	n.o.	n.o.	n.o.	n.o.
	Total net emissions	**42.96**	**174.81**	**9.97**	**0.76**	**91.89**	**424.93**	**124.68**	**18.85**
	International bunkers	*3.67*	*0.23*	*0.12*	*n.o.*	*18.04*	*4.24*	*0.21*	*0.98*

n.o. = not occurring; i.e. = emissions from organic soils included under source category 5 (LUCF)

Table 1-1: Overview of emissions and removals, 2003

Recent emission trends

The 2003 level of CO_2 emissions (44.7 million tonnes) was very close to the 1990 value (44.4 million tonnes). In the intervening period, emissions fluctuated around this level within a margin of ± 4%. The fact that emissions remained fairly stable can be seen as the result of a combination of two factors: policies/measures influencing GHG emissions and weak economic development.

CH_4 emissions declined by 17.5% from 1990 to 2003. This trend primarily reflects changes in the agricultural and waste sector.

N_2O emissions remained relatively stable as a result of two opposing trends: while agricultural emissions declined between 1990 and 2003, emissions from the transport and waste sectors tended

to increase as a result of increased use of first-generation catalytic converters in passenger cars and waste incineration plants.

Emissions of HFCs have risen markedly since the beginning of the 1990s, as these gases are increasingly being used as cooling agents instead of CFCs. Emissions of SF_6 show both upward and downward trends in its main fields of application – as an insulating gas in electrical equipment and windows, respectively. PFCs are of minor importance.

Precursor gas emissions have declined significantly since 1990: NO_x and CO emissions showed an almost constant decline of about 4% per year from 1990 to 2003, mainly due to the increased use of catalytic converters in passenger cars. Emissions of NMVOCs experienced an average yearly reduction of about 6%. This also reflects the increased use of catalytic converters, as well as more stringent measures to limit emissions from the use of solvents.

As a result of lower sulphur content in light and heavy fuel oil, SO_2 emissions declined by nearly 60% from 1990 to 2003.

Overall emissions

In 2003 Switzerland's gross CO_2 equivalent GHG emissions were 52.25 million tonnes. If removals by sinks are considered, this amount is reduced to net emissions of 50.49 million tonnes.

	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Total
(million tonnes CO_2 eq.)	44.72	3.67	3.09	0.53	0.07	0.17	52.25
Percentage of total	85.59%	7.03%	5.92%	1.01%	0.13%	0.32%	100.00%

Table 1-2: CO_2 equivalent emissions by gas, 2003

In comparison with 1990 data, there were no significant changes in the relative contributions of CO_2, CH_4 and N_2O to total CO_2 equivalent emissions. CO_2 contributed the largest share of emissions, accounting for 85.6% of the total in 2003. The contribution by sector and by gas is shown in Figure 1-1. The largest contributions are from the transport sector (30%) and from the residential sector (23%).

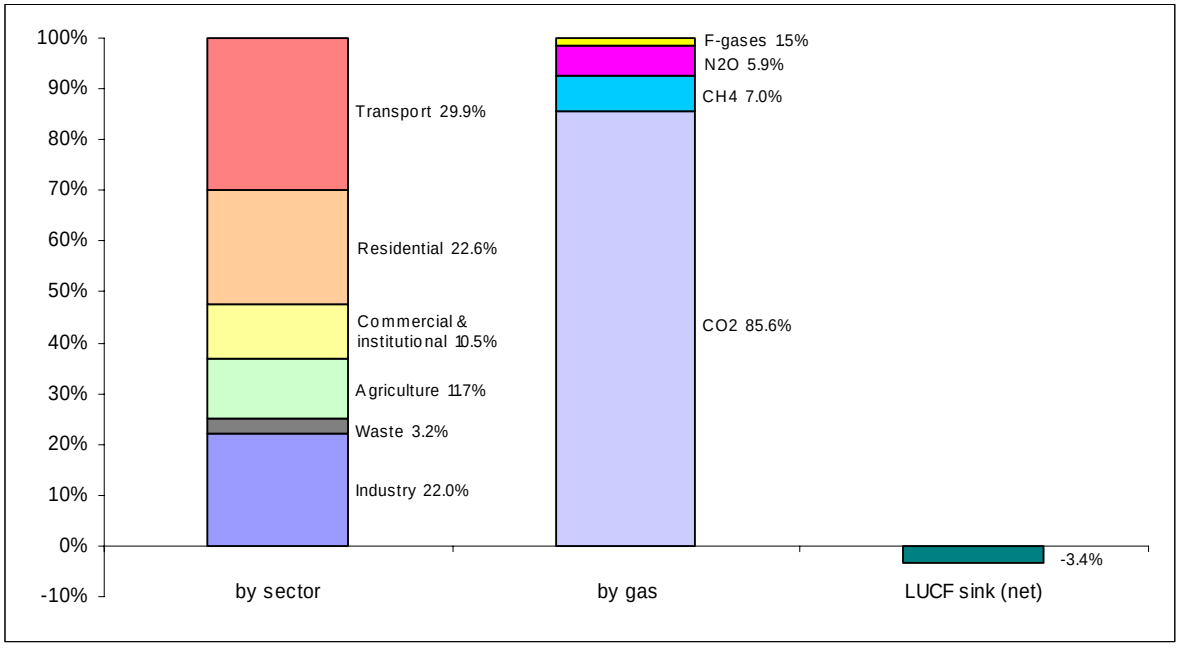


Figure 1-1: Shares of CO_2 equivalent emissions by sector and by gas, 2003 (not including international bunkers)

1.4. Policies and measures

Climate policy in Switzerland is incorporated into other sectoral policies that existed well before climate change became an important issue. All policies are embedded in a general approach of sustainable development.

Federal Act on the Reduction of CO_2 Emissions

The CO_2 Act establishes a broad framework for measures designed to reduce CO_2 emissions and is the core element of Swiss climate policy. It covers energy-related CO_2 emissions and provides the principal legal basis for compliance with Switzerland's Kyoto commitments. The CO_2 Act stipulates an overall reduction target of 10% by 2010 compared to 1990 levels. Apart from this overall reduction target, emissions from heating/process fuels are to be lowered by 15% and emissions from transport fuels by 8%.

In the first stage of implementation of the CO_2 Act, priority was to be given to voluntary action to lower fossil fuel consumption. However, as periodically updated energy projections indicated in 2004 that voluntary and other CO_2-related measures would not be sufficient to meet the reduction target in 2010, the Federal Council is authorized to resort to an incentive tax. The tax rates depend on the shortfalls in meeting the sectoral targets and require the approval of Parliament. Net revenues are to be fully redistributed to the population on a per-capita basis and to businesses as a percentage of wages paid. Exemption from the tax will be granted to energy-intensive and high-emitting industries which have entered into legally binding CO_2 reduction commitments.

The CO_2 Act also allows for the use of flexible mechanisms supplemental to domestic action. An ordinance relating to the requirements for CDM/JI projects, certificates and supplementarity was adopted by the Federal Council in June 2005, and the National Registry is expected to be implemented and operational by mid-2006.

The Swiss Oil Association, supported by other business and transport associations, proposed the "climate cent" as an additional voluntary measure to meet the CO_2 target in the transport sector. Retailers are to levy a surcharge of CHF 0.01–0.02 per litre on transport fuels and pay the revenues into a fund for the financing of mitigation projects within Switzerland and project-based flexible mechanisms abroad. Funds will be managed by the newly established non-governmental "Climate cent" foundation, which is likely to become the major user of the flexible mechanisms.

Having assessed several options, the Federal Council decided on 23 March 2005 to introduce a CO_2 tax, to request Parliament's approval of a tax rate of CHF 35 per tonne of CO_2 on heating/process fuels, and to accept the Swiss Oil Association's proposal for a "climate cent" to be levied on transport fuels, as a provisional voluntary measure until 2007.

Environmental policy

The Federal Act on the Protection of the Environment (revised in 1995 and 2003) focuses on the precautionary and the polluter-pays principle. Moreover, a number of ordinances (e.g. on air pollution control, waste disposal, and hazardous substances) are relevant to climate change and provide a basis for reducing emissions. In addition to the ongoing tightening of emission standards (especially in the transport sector), incentive taxes on NMVOCs and on the sulphur content of light fuel oil are designed to reduce emissions from industry and households.

Energy policy

The Federal Energy Act of 1998 and the associated ordinances provide the legal framework for federal energy policy. This policy calls for extensive cooperation with the private sector, reaffirms the principle of subsidiarity for state intervention and gives priority to voluntary measures. In addition, the division of responsibilities between the federal government and the cantons is regulated, particularly with regard to energy requirements for buildings and the preparation of the cantons' own support programmes.

The federal government can provide funds for cantons that have established programmes promoting energy efficiency and renewable forms of energy. In the context of voluntary agreements, the tasks of coordination, evaluation, monitoring and reporting are delegated to private energy agencies.

The most important energy efficiency measures are implemented under the SwissEnergy programme (2001–2010), which followed the Energy 2000 programme (1991–2000). Between 1991 and 2000, CHF 560 million was spent on various sub-programmes addressing the most important economic sectors. From 2001, less funding was available for the SwissEnergy Programme: the budget was reduced from CHF 75 million in 2001 to CHF 49 million in 2004, and CHF 45 million as of 2005.

SwissEnergy uses three kinds of measures that complement one another: first and foremost, in accordance with the provisions of the Energy Act and CO_2 Act, it supports voluntary measures based on service agreements awarded to non-governmental agencies, and concludes voluntary agreements on energy reduction targets with companies and sectors. Alongside voluntary measures, energy and building legislation calls for more comprehensive promotional and mandatory measures. These include regulations governing the energy consumption of motor vehicles, appliances and buildings.

Key measures that have been implemented under the SwissEnergy programme since 2001 include:

- the conclusion of a service agreement with the Energy Agency for the Economy (EAEc); the privately run EAEc helps companies to identify in-house measures for the reduction of energy consumption and CO_2 emissions,
- the introduction of an energy efficiency label for cars, enhancing transparency for consumers selecting or buying a new car,
- the introduction of an energy efficiency label for household appliances,
- the launching of a new quality assurance system to improve the certification procedure for the MINERGIE label, which is awarded to buildings that use only a third of the total energy consumed by an average existing building,
- services offered to large-scale consumers with the aim of reducing energy consumption in public buildings by at least 10%,
- further promotion of the “Energy City” label (more than 1 in 4 Swiss residents already live in an “Energy City”), a model which cities in Germany and Austria have started to work with as well,
- creation of a network involving several private agencies and competence centres for the promotion of renewable energy and energy efficiency (rational use of energy).

In February 2002, a target agreement was reached with the Association of Swiss Automobile Importers (“auto-schweiz”) to reduce the fuel consumption of new motor cars by 24% between 2000 and 2008. SwissEnergy is supporting this effort with a compulsory energy label for new motor vehicles introduced in 2003, and through a special campaign. As a result, the average fuel consumption of new cars decreased in 2004 by 6.9% compared to the year 2000 and now lies for the second year below 8 litres/100 km. However, the agreed mid-term target of 7.4 litres/100 km was not met, despite the increase in diesel vehicles and technological improvements.

In 2004, SwissEnergy achieved total sustainable savings estimated at around 6% (50 PJ) of Switzerland’s final energy consumption (3% through voluntary measures alone). The efficiency of the programme is being continually increased by concentrating limited financial resources on measures with a high energy-saving potential.

The combined long-term impact (1990–2004) of SwissEnergy and the former Energy 2000 programme on Switzerland’s CO_2 emissions rose in 2004 by around 10% to 2.8 million tonnes (including 1.6 million tonnes through voluntary measures). In the absence of these programmes, CO_2 emissions would now be at least 7% higher.

Important planned measures include a mineral oil tax reduction on biofuels and natural gas, and a bonus/penalty system promoting energy efficiency for new cars.

As Switzerland's existing nuclear plants will be reaching the end of their useful life around 2020, their replacement and the need to meet future power requirements without producing high levels of CO_2 emissions are key energy policy issues. The legal procedure for the planning of a new nuclear plant may take more than fifteen years. As an alternative mid-term solution, plans exist to replace the existing nuclear power plants with combined cycle gas turbine plants. This option would need to be carefully assessed in the light of its implications for the objectives of Swiss climate policy.

Transport policy

Switzerland has developed an integrated approach to transport policy, focusing on better coordination between transport modes. This approach has been strengthened in recent years with the integration of transport policy into spatial development and the general sustainability context.

- In 2004, the modernization of the railway infrastructure led to a 12% increase in passenger transport service levels from one day to the next (more trains, faster connections between Swiss cities). Work is also progressing on the two new transalpine base tunnels (St Gotthard, Lötschberg). The first tunnel (Lötschberg) will open on schedule in 2008; the new St Gotthard link is expected to open by 2015. This will increase capacity and attractiveness for both transalpine freight and passenger transport from Switzerland and Northern Europe to Italy.
- Since 2001, freight transport policy has been based on the successful implementation of the distance-related heavy vehicle fee (HVF), accompanied by an increase of the weight limit to the European average. These measures have provided a strong incentive to increase average truck load factors, to reduce traffic volumes and to shift freight from road to rail, especially for transalpine freight transport. In each of the first two years following the introduction of the HVF, traffic levels were reduced by 5%. With the second stage of the HVF as of 2005, the fee has been increased per kilometre and tonne, and the weight limit has been increased to 40 tonnes. By 2007, according to model calculations, a drop of about 6–8% is expected in CO_2 and NO_x values relative to a business-as-usual scenario.
- In addition, energy-related measures in the transport sector are part of the SwissEnergy programme, e.g. efforts to improve driving behaviour, promotion of car sharing and measures to reduce the specific energy and fuel consumption of new cars.

Several new measures are planned or already adopted with regard to the improvement of the traffic situation in urban areas and agglomerations and the further promotion of combined freight transport.

In 2004, the Federal Council presented a fundamental report on Swiss aviation policy, assessing the current state of Swiss aviation, including an analysis of problems and a discussion of strategies for action. Within the European and the International Civil Aviation Organizations, Switzerland is lobbying for the implementation of internationally coordinated measures to limit and reduce GHG emissions from aviation.

Agricultural policy

Since the beginning of the 1990s, agricultural policy has been fundamentally reformed in a three-stage process. The centrepiece of this reform is a reduction in regulated prices and the introduction of non-product-related direct payments to compensate for public-interest and environmental services. The emphasis has shifted from the security of food supplies to stewardship of the cultural landscape and preservation of natural resources.

To date, the new agricultural policy has facilitated improvements in the environmental sphere (lower atmospheric emissions of ammonia, lower nitrate levels in groundwater, more ecological compensation areas, lower soil phosphorus concentrations, etc.), while leaving economic and social conditions (incomes, competitiveness) relatively stable. Positive effects have also come from increasing compliance with the required standard of ecological performance (criteria now met by almost 100% of farms) – in particular, the requirement for maintenance of an appropriate soil nutrient balance.

The key challenge for the next stage of the agricultural reform is to exploit the existing potential for productivity gains so as to improve competitiveness at all levels of the food industry and thus reduce costs to the economy. At the same time, the reliance on protectionist measures will decrease and the basis for the implementation of future WTO commitments will improve. With further transfers of resources away from market support measures towards direct payments, the Agricultural Policy 2011 will continue consistently to follow the path taken by the reform process since the beginning of the 1990s.

Forestry policy

There is a long tradition of forest protection in Switzerland. Several Acts designed to put a stop to the depletion of forests, to manage the remaining forest areas sustainably, and to promote afforestation have resulted in an increase of nearly 50% in the forested area of Switzerland since the middle of the 19th century. In 2004, the new National Forest Programme was published, outlining the action plan for 2004–2015. Based on this action plan, the new Forest Act is now under revision.

In 2004, on the basis of a parliamentary motion, the Swiss Parliament also decided to elect forest management as an activity under Article 3.4 of the Kyoto Protocol. Ongoing case studies should provide the basis for national rules for assessing and accounting for removals by sinks and emissions by sources in the forest management sector.

Making better use of timber is crucial to current Swiss forestry policy. The goal is to prevent further increases in growing stock and to help to improve and maintain the structure of forest stands in good condition, so that their social and economic functions are ensured. Under the National Forest Programme, public financial support will mainly be restricted to forest areas with protective functions against natural hazards.

Waste policy

Since 2000, the cantons have been responsible for ensuring that non-recycled combustible waste is incinerated rather than disposed of at landfill sites. In addition, since 1 January 2001, waste disposal at landfill sites in Switzerland has been taxed at a rate of CHF 15–20 per tonne, depending on the type of waste. Any exports of waste to landfill sites abroad are taxed at CHF 50 per tonne. By 2004, incineration capacities had reached a level at which the ban on landfilling could be fully enforced.

In recent years, CH_4 emissions from waste have been significantly reduced, and emissions from existing landfills are expected to continue to diminish in the coming years. CO_2 emissions from waste incineration are lower than accumulated long-term CH_4 emissions from waste disposal in landfill sites. In addition, as plants have to be operated in such a way that the heat produced by incineration is reused, 40% of the energy generated at waste incineration plants is now used for district heating and electricity production.

Overview of measures implemented (situation as in June 2005)

Name of policy or measure	Objective and/or activity affected	GHGs affected	Type of instrument	Status	Implementing entity or entities	Impact indicators
1 CO_2 Act	Setting targets and timeframe for reduction of energy-related CO_2 emissions (overall target: minus 10% by 2010 compared to 1990)	CO_2, precursors	Legal Voluntary, with option for economic incentive tax	In force since 1 May 2000; guidelines for voluntary action issued in July 2001, superseded by CO_2 Ordinance adopted in June 2005	SAEFL	Fulfilment of CO_2 requirements according to CO_2 Act (periodic monitoring of overall emissions; progress reports by players engaged in voluntary agreements)
2 Kyoto Protocol flexible mechanisms	The flexible mechanisms are understood to be primarily an instrument for the private sector. The major buyer of certificates in Switzerland is expected to be the "Climate cent" foundation.	CO_2	Economic	The necessary institutions have been established (legal framework, secretariat). For the time being, no budget allocated for investment in CDM/ JI projects.	SAEFL and SFOE with the aid of the Energy Agency for the Economy (EAEc)	Entities with binding commitments are allowed to cover up to 8% of their reduction target with emission certificates. Other actors (e.g. "climate cent") are allowed to cover up to 1.6 million tonnes CO_2 eq./year through the flexible mechanisms. The total admissible contribution from flexible mechanisms corresponds to approx. 50% of the difference between base year and target.
3 Energy Act	Ensure secure energy supply, contribute to rational and efficient energy use	CO_2	Framework legislation - institutional - economic - regulatory	Implemented since 1998	SFOE, cantons	Development of overall energy consumption. Fossil fuel savings through mandatory measures in 2004: 17.6 PJ (1.2 million tonnes CO_2)
4 "SwissEnergy" action plan (successor to "Energy 2000" programme)	10% reduction in fossil fuel consumption from 2000 to 2010	CO_2	Voluntary agreements	Implemented since 2001 (follow-up to "Energy 2000").	SFOE, cantons and partners in the public and private sectors	Direct and indirect effects of the programmes since 1990 measured in terms of energy saved and reduction in CO_2 emissions (2004: 23.7 PJ and 1.6 million tonnes CO_2 respectively)
5 Cantonal and communal energy laws	Bring cantonal/ communal energy legislation in line with the federal Energy Act	CO_2	Framework legislation - institutional - economic - regulatory	Continuously implemented	Swiss cantons and local authorities	Status of cantonal/communal energy legislation
6 Energy efficiency programmes in the buildings sector, MuKEn modules (model cantonal energy provisions)	Introduce/promote SIA standards, MINERGIE label etc.	CO_2	Institutional Regulatory	Implemented since 2001 (follow-up to "Energy 2000")	SFOE, cantons and partners in the public and private sectors	Energy consumption in new and renovated buildings. Quantitative impact of activities largely corresponding to the effects of the Energy Act (see measure 3 above)

Name of policy or measure	Objective and/or activity affected	GHGs affected	Type of instrument	Status	Implement-ing entity or entities	Impact indicators
7 Energy efficiency programmes in the commercial and industrial sector	Voluntary agreements, models for large-scale consumers to fully exploit technological potential	CO_2	Voluntary agreements	Implemented since 2001	SFOE, partners in the public and private sectors	Energy consumption in commercial and industrial sector. 2.7 PJ of final energy saved in the period 2001–2004
8 Energy efficiency programmes in the transport sector	Agreement on targets with Association of Swiss Automobile Importers Energy efficiency label for cars	CO_2	Voluntary agreements	Implemented since 2001 (follow-up to "Energy 2000")	SFOE, partners in the public and private sectors	Energy consumption in transport sector 0.77 PJ of final energy saved in the period 2001–2004
9 Amendment to the Energy Act	Improved feed-in tariffs for renewable energy Guarantee of origin for electricity	CO_2 (at the global level*)	Regulatory	Implemented since 2005	SFOE, cantons and partners in the public and the private sectors	Increased generation of renewable electricity
10 Heavy vehicle fee (HVF)	Transfer of freight traffic from road to rail, reduction in transalpine road traffic	CO_2, precursors	Economic	Implemented since 2001	Customs authorities, Federal Roads Authority	Load factors, change in road/rail vehicle-kilometres Expected reduction in vehicle-kilometres for HGVs in 2005: 13.6–17.2%
11 Modal shift measures in the transport sector	Transfer of freight traffic from road to rail, reduction in transalpine road traffic (supporting the HVF); expansion of railway infrastructure and services	CO_2, precursors	Institutional Subsidies (combined transport)	Implemented since 2000	Federal Office of Transport	Reduction in vehicle-kilometres for HGVs, increase in combined transport, transalpine truck traffic volume Expected reduction in vehicle-kilometres for HGVs in 2005 (including effects of HVF): 18–21.7%
12 Sustainability and protection of forested area	Sustainable forest management, no reduction in forested area	CO_2	Regulatory	Implemented since 1993	SAEFL	Number of trees, and their CO_2 absorption
13 GHG gas mitigation in agriculture	Promotion of ecological practices on farms	CH_4, N_2O	Economic Voluntary	Implemented since 1993	FOAG	Reduction in cattle population, and in the use of mineral fertilizers
14 Amendment of the Ordinance relating to Environmentally Hazardous Substances	Reduction in use and emissions of synthetic GHGs in all main sectors	HFCs, PFCs, SF_6	Regulatory Voluntary	Implemented since 2004	SAEFL, cantons	Expected reduction of emissions growth: 100,000–500,000 tonnes CO_2 eq. in 2010
15 NMVOC tax	Reduction in fugitive fuel emissions	Precursors	Economic	In force since 1999	SAEFL	Expected reduction: 27,000 tonnes of NMVOCs

*****Since power generation is almost carbon-free in Switzerland, renewable energy does not reduce CO_2 emissions directly in this country, but at the global level, e.g. if it is used to replace coal-based power.

Table 1-3: Most important measures implemented

Overview of measures adopted or planned (situation as in June 2005)

Name of policy or measure	Objective and/or activity affected	GHGs affected	Type of instrument	Status	Implementing entity or entities	Impact indicators
1 CO_2 tax	Reduction of CO_2 emissions from heating/process fuels	CO_2, precursors	Economic	Adopted by Federal Council and submitted to Parliament for adoption	SAEFL	Fulfilment of CO_2 reduction target for non-transport fuels
2 "Climate cent"	Mitigation projects within and outside Switzerland	CO_2, precursors	Voluntary	Agreement concluded in 2005	"Climate cent" foundation	Fulfilment of CO_2 reduction target for transport fuels
3 Emissions trading	Scheme for companies engaged in legally binding reduction commitments	CO_2	Economic	Ordinance adopted by Federal Council, due to enter into force after adoption of CO2 tax rate by Parliament	SAEFL	Trading volume monitored in national registry
4 Bonus/penalty system for cars	Reduction in fuel consumption of new cars Improvement of general environmental performance	CO_2, precursors	Economic	Evaluation of models	SFOE, Swiss Customs Swiss Federal Roads Authority	Fuel consumption of new cars: general environmental performance of cars
5 Programmes in the transport sector	Infrastructure expansion in agglomerations; reduction of traffic growth, new attempts to shift from road to public/non-motorized transport	CO_2, precursors	Infrastructure	New financing options for infrastructure financing (road, rail) in consultation	DETEC	Implementation of infrastructure programmes in agglomerations
6 Electricity Market Act	Measures supporting the liberalization of electricity markets: promotion of renewable forms of energy	CO_2 (at the global level*)	Institutional Regulatory	Public consultation concluded; expected entry into force in 2007	SFOE	Share of renewable electricity
7 Revision of mineral oil tax legislation	Promotion of alternative fuels by tax reduction, and tax increase for petrol	CO_2, precursors	Economic	Public consultation concluded; expected entry into force in 2007	Swiss Customs	Share of alternative fuels
8 Decision by Parliament to account for sinks	Forest management to enhance and conserve sinks	CO_2	Not yet defined	Decided in 2004, implementation starting in 2008	SAEFL	Maximum contribution to Kyoto reduction objective: 1.835 million tonnes of CO_2 per year (Decision 11/CP.7, Appendix)
9 Ecological tax reform	Shifting tax burden from labour to energy use	CO_2, other emissions	Economic	Suspended and reconsidered for post-2012 period	Federal Department of Finance	Model calculations

*****Since power generation is almost carbon-free in Switzerland, renewable energy does not reduce CO_2 emissions directly in this country, but at the global level, e.g. if it is used to replace coal-based power.

Table 1-4: Most important measures adopted or planned

1.5. Projections and the total effect of measures

Projections for CO_2, CH_4 and N_2O emissions

The projections for CO_2 emissions are based on scenarios using bottom-up model calculations. These models are applied to yield long-term energy consumption projections from 1990 to 2020. Non-energy-related CO_2 emissions are based on an overview of the information available for all Kyoto Protocol gases for the period 1990–2010, as published in May 2005. The future development of removals by the LUCF sector (including emissions from organic soils) is highly uncertain. Table 1-5 shows overall emission trends for 2005, 2010 and 2020 "with measures implemented".

(million tonnes CO_2 eq.)	CO_2			CH_4			N_2O		
Sector	**2005**	**2010**	**2020**	**2005**	**2010**	**2020**	**2005**	**2010**	**2020**
All energy	40.94	40.40	39.11	0.35	0.34	0.34	0.26	0.22	0.20
Fuel combustion	*40.86*	*40.32*	*39.03*	*0.11*	*0.10*	*0.10*	*0.26*	*0.22*	*0.20*
Fugitive emissions	*0.08*	*0.08*	*0.08*	*0.25*	*0.24*	*0.24*	*0.00*	*0.00*	*0.00*
Industrial processes	1.86	1.86	1.86	0.01	0.01	0.01	0.10	0.10	0.10
Solvent use							0.13	0.13	0.13
Agriculture				2.89	2.86	2.80	2.45	2.35	2.35
Waste	1.19	1.19	1.19	0.35	0.24	0.12	0.09	0.09	0.09
Total emissions	**43.98**	**43.45**	**42.15**	**3.61**	**3.45**	**3.28**	**3.03**	**2.88**	**2.87**
LUCF	(-1.60)	(-1.60)	(-1.60)						
International bunkers	*3.68*	*3.82*	*4.13*						

LUCF = Land use change and forestry; brackets indicate a high degree of uncertainty

Table 1-5: Projections for emissions of CO_2, CH_4 and N_2O in 2005, 2010 and 2020

Synthetic GHG emissions

Table 1-6 presents projections for emissions of synthetic GHGs. The results are based on a model which calculates actual emissions for all relevant UNFCCC categories and covers the period from 1990 to 2010. The trend between 2010 and 2020 is highly uncertain.

(million tonnes CO_2 eq.)	**2005**	**2010**	**2020**
HFCs	0.64	0.73	(0.73)[a]
PFCs	0.10	0.10	(0.10)
SF_6	0.16	0.16	(0.16)
Total	**0.89**	**0.99**	**(0.99)**

[a] Brackets indicate a high degree of uncertainty.

Table 1-6: Projections for emissions of synthetic gases in 2005, 2010 and 2020

Aggregate effects of policies and measures

Table 1-7 and Figure 1-2 show the expected development of GHG emissions for the period 1990–2020, considering the aggregate effect of measures currently implemented. The projected overall reduction between 1990 and 2020 amounts to 6%. Between 1990 and 2010, the overall reduction is 3%.

(million tonnes CO_2 eq.)	**1990**	**2000**	**2005**	**2010**	**2015**	**2020**
CO_2	44.37	43.66	43.98	43.45	42.83	42.15
CH_4	4.45	3.74	3.61	3.45	3.36	3.28
N_2O	3.34	3.19	3.03	2.88	2.87	2.87
HFCs	0.00	0.41	0.64	0.73	(0.73)[a]	(0.73)
PFCs	0.10	0.07	0.10	0.10	(0.10)	(0.10)
SF_6	0.18	0.20	0.16	0.16	(0.16)	(0.16)
Total emissions	**52.45**	**51.26**	**51.51**	**50.77**	**50.04**	**49.29**

[a] Brackets indicate a high degree of uncertainty.

Table 1-7: Aggregate effect on emissions between 1990 and 2020, by GHG

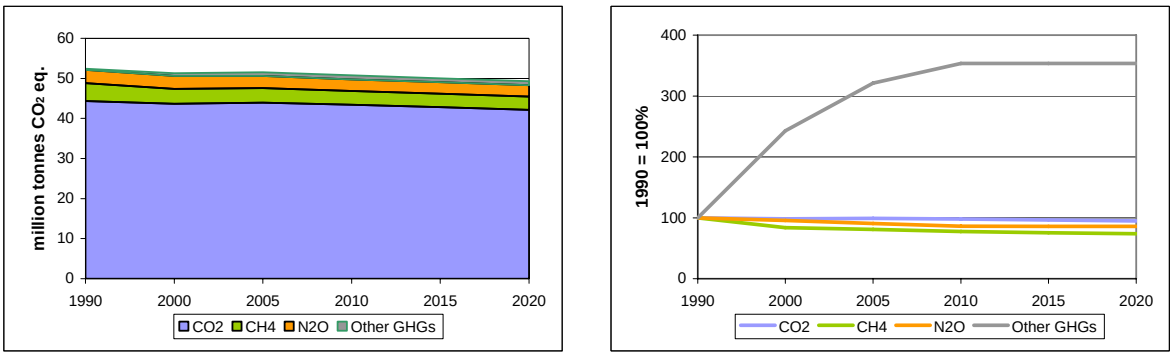


Figure 1-2: Development of CO_2 equivalent emissions from 1990 to 2020, based on energy scenario "with measures implemented" (HFC, PFC and SF_6 emissions are kept constant after 2010).

Under the Kyoto Protocol, Switzerland's target for average annual CO_2 equivalent GHG emissions in the first commitment period (2008–2012) is 48.25 million tonnes – a reduction of 8% below 1990 levels. However, the projections without additional measures show annual emissions of 50.8 million tonnes. The target shortfall is thus 2.5 million tonnes. Under a scenario that includes the effects of adopted and planned measures (i.e. the CO_2 tax on heating and process fuels, the "climate cent", a bonus/penalty system for new cars and preferential treatment of alternative transport fuels), the Kyoto targets are met. The reductions in annual emissions due to additional measures are estimated at 2.9 million tonnes of CO_2 equivalent during the Kyoto commitment period (Table 1-8).

Additional measures	**Estimated annual reduction potential by 2008–2012** (million tonnes CO_2 equivalent)
Incentive CO_2 tax on heating and process fuels	0.7
Climate cent: domestic projects	0.2
Bonus/penalty system + preferential treatment of alternative fuels	0.4
Total effect of additional domestic measures	*1.3*
"Climate cent": international projects (certificates)	1.6
Total	*2.9*

Table 1-8: Estimated reduction potential of additional measures

Precursors and SO_2

The estimates are based on long-term forecasts for air pollutants. As a result of measures to reduce air pollution, all emissions will tend to decline. Between 1990 and 2020, the following changes are expected:

- NO_X emissions: -63%
- NMVOC emissions: -65%
- CO emissions: -66%
- SO_2 emissions: -63%.

1.6. Impacts, vulnerability assessment and adaptation

Impacts

Recent research indicates a warming trend of about 1.4ºC over most parts of Switzerland (1.0ºC in the southernmost part) during the 20th century, based on homogenized data from 12 stations. Since 1970, decadal warming has been about three times higher than the global average. In the course of the 20th century, precipitation increased during the winter in northern and western regions by 20–30%, while it decreased by the same amount during the autumn in the southern part of the country. Over the same period, the frequency of intense daily precipitation events (average return period of 30 days) increased by between 20% and 80% at most of the stations north of the Alps.

Impacts of this warming trend can mainly be seen in the melting of perennial surface and subsurface ice in the Alps, which has continued in recent years, with a clear tendency towards acceleration. Roughly 25% of the glacier volume in the Alps has been lost since the mid-1970s. The extremely hot and dry summer of 2003 eliminated an additional 5–10% of Alpine glacier volume within the space of one year. Many rockfall events from steep rock walls with warm permafrost were also observed in 2003.

The warming trend and changing precipitation patterns are also expected to have significant effects on ecosystems and hydrological cycles. The possibly increased intensity of storms and reduced snowfall and snow cover duration are particularly important for alpine areas, tourism and forestry. Public health is also affected by a warmer climate: the heatwave of the summer of 2003, for instance, led to an increase in mortality of around 7% in Switzerland. Two thirds of all communes have experienced flooding in the last 30 years, with total losses during this period amounting to CHF 8 billion.

Considerable progress has been made in understanding and simulating various forms of extreme climate events, in particular hot and cold spells, windstorms and heavy precipitation. While it is difficult, or may even be impossible, to identify or exclude a statistically valid trend in the frequency of rare extreme events, statistical predictions are now possible for trends in “intensive”

events: for example, heavy precipitation events (which do not usually lead to damage) have become more frequent since the beginning of the last century. Also, the volume of precipitation in winter has increased substantially in almost all parts of Switzerland since the beginning of the last century.

The insurance sector (an important service sector in Switzerland) is affected by increased payments due to extreme weather events. Claims due to natural disasters have risen constantly over the past decades, although quantitative attribution to climate change has not been possible. Higher losses are primarily due to increases in infrastructure and economic assets in vulnerable areas. A potential shift in the intensity and frequency of extreme weather events may also have an impact. Insured and economic weather-related losses increased by factors of 7 and 24, respectively, between the 5-year periods 1970–1974 and 2000–2004.

Vulnerability assessments

Even though there have been numerous studies of the vulnerability of natural and societal systems, vulnerability to climate change has not yet been studied in a systematic and comprehensive manner. The Swiss Advisory Body on Climate Change (OcCC) and the Forum for Climate and Global Change of the Swiss Academy of Sciences (ProClim-) are currently preparing an assessment of the climate vulnerability of various natural and human systems in Switzerland on the basis of a regional climate change scenario for 2050. The sectors investigated are ecological systems, water resources, agriculture, human health, energy, insurance, tourism and infrastructure. These sectors are likely to be the most vulnerable to the effects of climate change. The report will be completed in 2006.

Adaptation

The legal regulations for adaptation measures are still based on a sector-oriented approach, reflecting traditional hazards such as flooding, rockfalls, landslides and avalanches, which are closely linked to life in a mountainous area. In recent years, vigorous efforts have been made to apply the same strategy and similar approaches for dealing with natural hazards. The most important legal provisions relate to flood protection and forest management. With a view to achieving an integrated approach to disaster reduction, a new flood protection strategy has been developed and is currently being implemented by the cantonal authorities.

Responsibility for protection against natural hazards still rests primarily with the cantons. The emphasis is increasingly being placed on preventive measures rather than disaster management. Therefore, hazard and risk assessment, the definition of protection targets, integrated planning of measures (mapping, technical measures and warning systems) and the limitation of residual risk are of central importance.

In 1997, the Swiss government established the National Platform for Natural Hazards (PLANAT) in order to fill gaps in legislation and to ensure that preventive efforts are not duplicated in the area of natural hazards and that synergies are exploited. PLANAT is organized as an extra-parliamentary commission, bringing together representatives of federal government, the cantons, the research community, professional associations, business and the insurance sector. In 2003, PLANAT presented to the Federal Council an overarching, interlinked strategy to improve protection against natural hazards, corresponding to the Federal Council's sustainability policy. The work plan established for implementation of the strategy takes various aspects of climate change-related risks into account.

Several online systems have been launched in recent years offering information and warnings concerning weather hazards, e.g. storms, heavy rain or heat waves. Alerts are distributed by e-mail, fax or text message.

1.7. Financial resources and transfer of technology

Switzerland's international activities and commitments are as follows:

- From 2000 to 2003, Switzerland's **official development aid** for developing and transition countries amounted to about CHF 6.4 billion. Most of this was provided through bilateral assistance projects.
- **Bilateral assistance for developing countries**: In 1992, Switzerland launched a bilateral Global Environmental Programme (GEP), the objective of which is to support the efforts of developing countries in the implementation of multilateral environmental agreements. The GEP has three focal areas: climate change/energy, biodiversity and sustainable management of natural resources. In the focal area of climate change, the priority themes are the elaboration of policies and action plans, human and institutional development, policy dialogue, the promotion of renewable energy and energy efficiency, and cross-cutting issues (climate/forestry/land management, positive interactions between agreements). During the period 2001–2004, 25 projects received a total of CHF 26.3 million in the sectors of energy, transport and industry. In addition to the GEP, other projects which are aimed at sustainable resource management contribute significantly to climate change mitigation and adaptation.
- **Bilateral assistance for Central and Eastern Europe and the CIS:** This is based on three framework credits approved by the federal parliament in 1990, 1992 and 1999, and an extension of the third credit in 2004. Of the total amount of CHF 2.95 billion, CHF 1.9 billion was allocated for financial co-operation. Bilateral financial co-operation is primarily based on two instruments: grants for priority infrastructure projects in the environment and energy sectors that cannot be financed commercially, and credit guarantees to finance the export of Swiss goods and services to manufacturing companies or for infrastructure projects, the profitability of which allows commercial financing.
- **Specific support for both developing and transition countries**: The Swiss AIJ Pilot Programme (SWAPP), launched in April 1997 to allow Switzerland to participate in the pilot phase for AIJ ("activities implemented jointly") and to gain experience with the joint implementation of climate protection projects across national borders, was extended in December 2001 by four years. SWAPP undertakes a broad range of activities, such as government financing of AIJ projects; designing incentives for private sector investments; contributing to methodological progress; capacity-building activities, networking and information; and participation in the CDM Executive Board of the UNFCCC.
- **Multilateral assistance**: Since the establishment of the Global Environment Facility (GEF) – now the financial mechanism of the Convention – Switzerland has consistently contributed to its replenishment. Between 1991 and 2002, Switzerland contributed CHF 203 million to the GEF. For the period 2003–2006, CHF 99 million has been committed to the GEF. From 1997 to 2004, Switzerland supported the National Strategy Study (NSS) programme of the World Bank with USD 4 million, with the aim being to assist non-Annex I countries in defining their negotiation positions and to develop national strategies regarding emerging international market incentive instruments which will facilitate technology transfer to developing and transition countries. Contributions covered 13 national CDM/JI strategies in Latin America, Africa, Asia and Eastern Europe. Switzerland's total multilateral assistance from 2001 to 2004 amounted to approximately CHF 1.25 billion.
- **Activities relating to transfer of technology and adaptation**: Special emphasis is given to supporting the efforts of the partner countries to define their own policies and strategies in order to improve acceptance and foster implementation of international environmental and trade agreements. Another priority is the promotion of the transfer of environmentally sound technologies, e.g. by strengthening environmental information systems and legislation, and through technical assistance, training and the provision of financial facilities and infrastructure project financing. With REPIC (Renewable Energy Promotion in International Co-operation), a new platform bringing together four federal agencies has been established in order to strengthen and coordinate activities for the promotion of renewable energy in international cooperation at a strategic level.

- **Implementation of Kyoto commitments**: At COP 6bis, Switzerland signed a political declaration issued jointly with the EU, Iceland, Norway, New Zealand and Canada, committing itself to payments to the Special Climate Change Fund (SCCF) on the basis of an emissions-based burden-sharing formula. This results in a Swiss share of USD 1.23 million per year. Meanwhile, the payment modality has been approved by the Swiss Parliament.

1.8. Research and systematic observation

The most important topics of Swiss **climate research** are the physical climate systems (e.g. studies on atmospheric processes and dynamics, alpine vulnerability, regional climate, the analysis of time series data, the history of the climate, and monitoring). Other important topics are the analysis of biogeochemical processes, the impacts of climate change, and the human dimensions of global change.

In 2004, about 300 research projects were in progress on climate and global change and on related human aspects, with a large proportion devoted to the paleoclimate. Swiss research is mainly funded by the National Science Foundation (programme research and individual projects), the EU and COST (projects in the framework of the European Cooperation in the field of Scientific and Technical research).

In 2004, National Science Foundation funding for projects on climate and global change amounted to some CHF 16.2 million. The funding provided for EU projects in the same fields was about CHF 10 million, and for COST projects about CHF 1.7 million.

Two National Centres of Competence in Research (NCCR) are concerned with climate change issues:

- The NCCR Climate (www.nccr-climate.unibe.ch) was created in April 2001 with an intended duration of 12 years. Its goals are to acquire a better understanding of climate system processes, variability and predictability and the complex inter-relationships between climate, economic and societal driving factors; to adapt and refine scientific tools and knowledge acquired for Switzerland, considering specific characteristics in physical, chemical, biological, geographical, economic and societal factors; and to transfer and apply knowledge to assess the future cost and risks of expected climate change, and to provide a basis for adaptation strategies.
- The NCCR North-South (www.nccr-north-south.unibe.ch) focuses on **international research cooperation** and promotes high-quality research with the aim of contributing to an improved understanding of the status of different syndromes of global change, of the pressures that these syndromes and their causes exert on different resources (human, natural, economic), and of the responses of different social groups and society as a whole.

Switzerland makes major contributions to international research programmes, such as the World Climate Research Programme (WCRP), the International Geosphere-Biosphere Programme (IGBP), the PAGES and Global Change and Terrestrial Ecosystems (GCTE) projects, the DIVERSITAS programme, and the International Human Dimensions Programme (IHDP) on Global Environmental Change. Of the projects funded by the National Science Foundation, about 80 were from the field of IGBP, about 40 from that of WCRP, about 25 from IHDP and about 10 from DIVERSITAS.

Coordinating and overseeing publicly funded **energy research** are responsibilities of the Swiss Federal Office of Energy (SFOE), which is advised by the Federal Commission for Energy Research (CORE) on research and putting research results into practice. Details of the energy research supervised by the authorities are presented in the Swiss Federal Energy Research Master Plan, which is updated every four years. The main task of the "Energy policy fundamentals research programme" at the SFOE (www.ewg-bfe.ch) is to develop the basis for new energy policy instruments.

Under the leadership of the Federal Office of Meteorology and Climatology (MeteoSwiss), many government agencies in Switzerland engage in the **systematic observation** of elements of the

climate system. Switzerland has a comprehensive observational coverage of its territory, contributes to shared international programmes and has a long instrumental temperature record, as well as the longest glacier monitoring records.

Switzerland is actively involved in meteorological land surface and atmospheric observation systems. A new measurement and planning concept for all MeteoSwiss-run stations was published in 2002, with a vision for 2010 according to user requirements. Switzerland is also engaged in various international programmes, including Global Atmosphere Watch (the upgrading of the regional station at Jungfraujoch adds a twenty-third station to the planned minimum of 30 global GAW stations worldwide). Following the ratification of the Kyoto Protocol, the Swiss government made available new funds for the transition of the Alpine Surface Radiation Budget (ASRB) research project into a fully operational MeteoSwiss network. Terrestrial and ecological observations are shared among several specialized federal agencies in the fields of hydrology, avalanche forecasting, and glacier/permafrost monitoring.

In 2005, the national focal point for the Global Climate Observing System (GCOS) was upgraded to a Swiss GCOS Office, designed to enhance the coordination of the various climatological observation activities of federal agencies, universities and research institutes. Switzerland has also provided financial support for the implementation of the Global Earth Observation System of Systems (GEOSS) secretariat at the WMO in Geneva.

1.9. Education, training and public awareness

Activities in education, training and public awareness are carried out by the federal, cantonal and local authorities as well as by the private sector.

Selected government and government-sponsored activities

- Information platforms have been developed by the Swiss Agency for the Environment, Forests and Landscape (SAEFL), the Federal Office of Meteorology and Climate (MeteoSwiss) and the Federal Office for Water and Geology (FOWG, hosting the National Platform for Natural Hazards PLANAT). The official SAEFL climate website (www.environment-switzerland.ch/climate) is continuously expanding its services and has become an important source of information for a broad audience.
- Another important source of information and training is the SwissEnergy programme. Through the network of players active in the fields of renewable energy and energy efficiency the programme offers various training and further education activities.
- In the early summer of 2005, based on an in-depth analysis of the detrimental health effects of the 2003 heat wave, the Swiss Federal Office of Public Health (SFOPH) and SAEFL launched an information campaign to raise awareness about the dangerous effects heat can have. Material containing recommendations for those with a personal or professional responsibility for caring for people most at risk was widely distributed through the appropriate channels and made available online (www.canicule.ch; www.hitzewelle.ch).

Further important activities with governmental support include the Swiss Advisory Body on Climate Change (OcCC) and the Swiss Academy of Sciences' Forum for Climate and Global Change (Pro Clim-). The OcCC (www.occc.ch) operates independently from the federal administration and thus guarantees a non-governmental view. It issues assessment reports and position papers on particular climate change topics. ProClim- runs a web-based information system (www.proclim.ch) and an internet platform on information sources relating to climate change (www.climate-change.ch).

Selected private-sector activities

- The Alliance for a responsible climate policy is formed by 48 Swiss environmental, religious, consumer, union and development aid organizations from civil society. The members and supporters of the Alliance account for 25% of the Swiss population. The Alliance provides information for the media and policymakers.

- In addition, Swiss environmental NGOs raise awareness through campaigns and projects, produce teaching materials and organize special events for young people. The most active organizations are WWF and Greenpeace.

2. National circumstances

2.1. Political profile

Administrative structures

Switzerland is a confederation, with a federal government, a bicameral parliament and a Federal Supreme 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 authorities and the cantons.

The federal government consists of the seven members of the Federal Council, together with the Federal Chancellor, and is elected by the United Federal Assembly for a four-year term. The federal administration comprises the Federal Chancellery and seven Federal Departments (for details, see http://www.admin.ch/ch/e/bk/buku/buku2005/19.pdf).

The Swiss parliament has two chambers which, when in joint session, are known as the United Federal Assembly. This is the country's legislative authority. The National Council, through its 200 members, represents the population of the country as a whole – the individual cantons are represented in proportion to the number of their inhabitants. The Council of States represents the 26 cantons – 20 cantons are represented by two members while the six former half-cantons each send one representative to the 46-strong chamber.

Subsidiarity plays an important role in Switzerland. This is reflected in constitutional law, which states that unless legislative power is explicitly assigned to the federal level, the cantons are sovereign, i.e. entitled to legislate in an area of policy. This fundamental principle helps to protect 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 financial equalization amongst cantons, substantial differences remain in the level of taxation of both households and companies.

Cooperation is an important principle, both vertically and horizontally. In matters where the federal authorities are responsible for legislation, the role of the cantons is to implement (enforce) such legislation. Very often, the cantons have substantial latitude to take local or regional conditions into account. At a lower level, similar autonomy is granted to the municipalities by the cantons.

At the same time, cantons cooperate horizontally and have, in a number of policy areas, concluded agreements that facilitate harmonized, effective implementation.

The legislative system comprises several hierarchical levels. All legislation must ultimately be based on the (written) Constitution. Laws of different kinds (federal acts and federal decrees) implement constitutional matters. Regulation at both of these levels is subject to the approval of the electorate, which is not the case for ordinances, through which the government alone implements the contents of laws.

Federal revenue and expenditure

Figures 2-1 and 2-2 show the present structure of federal revenue and expenditure. Federal revenue contributed about 36% to total revenue at all three administrative levels in 2004 (confederation, cantons, communes).

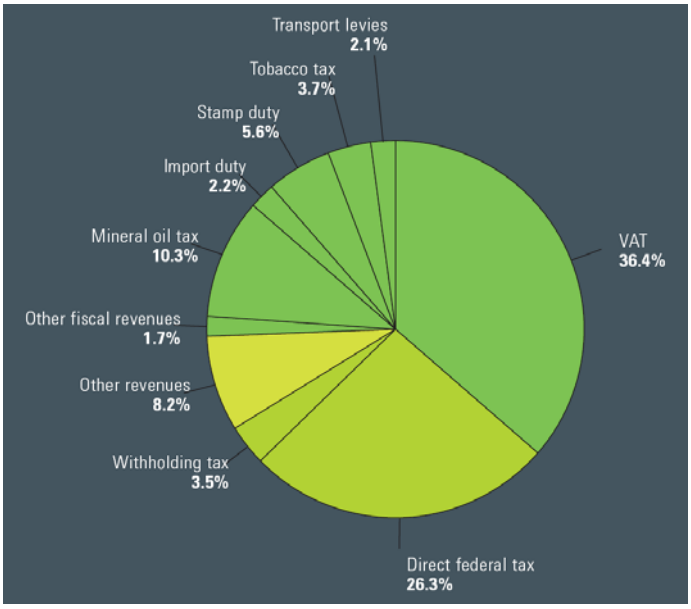


Figure 2-1: Breakdown of federal revenue in 2003 (FCh 2005)

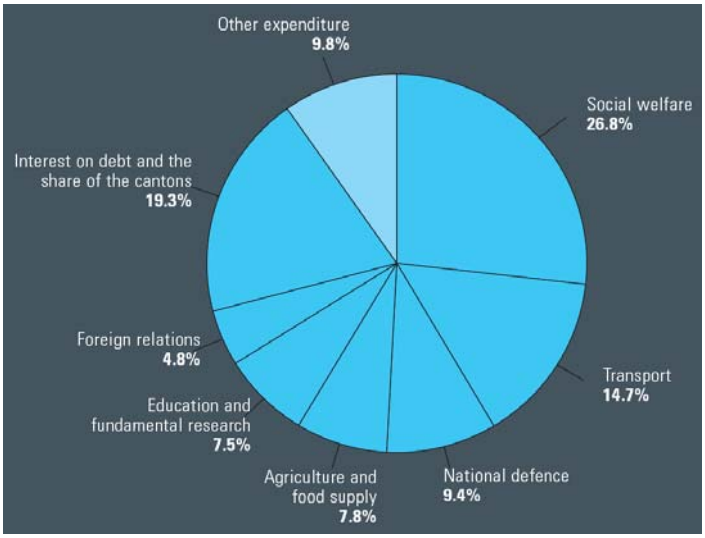


Figure 2-2: Breakdown of federal expenditure in 2003 (FCh 2005)

Democratic instruments

According to the Federal Constitution, the Swiss people are sovereign and ultimately the supreme political authority. This includes all Swiss adults who are eligible to vote – some 4.8 million citizens, i.e. around 60% of the resident population. Those under the age of 18 and foreign nationals have no political rights at federal level.

Switzerland is a representative democracy, with strong formal and informal elements of direct democracy. By means of a popular initiative, citizens can seek an amendment to the Constitution (or, at the cantonal level, also an amendment to a law). Popular initiatives may comprise a general proposal or contain detailed regulations. In most cases, a proposal must be accepted by a majority

of the electorate and of the cantons if it is to become part of the Constitution. This requirement for a "double" majority (population and cantons) mainly serves to protect the interests of less populous rural cantons.

The second formal instrument of direct democracy is the referendum. This allows citizens to veto decisions made by parliament. The referendum may be mandatory or optional. It is possible to have a referendum concerning regulations at the level of the Constitution, formal laws, international treaties and generally binding federal decrees that are put into effect as a matter of urgency. Both popular initiatives and referendums also exist at the cantonal level.

The petition is an informal instrument of public participation and is non-binding.

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

International relations

Switzerland is a member of several international organizations (e.g. the OECD, the World Bank Group and all UN specialized agencies). In March 2002, the Swiss population also voted for UN membership, and since 10 September 2002 Switzerland has been a full member of the United Nations.

Although membership of the European Union (EU) remains a strategic aim of the Swiss Federal Council, Switzerland is not a member of the EU. A majority of Swiss voters rejected membership of the European Economic Area (EEA – the economic core of the EU treaty) in 1992. A similar vote in 2001 had the same outcome.

Nonetheless, most new Swiss laws or changes to existing Swiss laws have been made compatible with EU legislation. The aim is to facilitate possible subsequent membership of the EU. As a result of Switzerland's strong economic ties with many EU countries (notably Germany), a "virtual" dependency exists, despite the formal political absence of Switzerland from the EU.

Since rejecting EEA membership in 1992, Switzerland has been engaged in bilateral negotiations with the EU on major policy areas. These negotiations were very important in shaping Swiss policy on freight transport (see Section 4.2.4). In 1999, the Bilateral Agreements I were concluded between Switzerland and the European Union. These cover the free movement of persons, civil aviation, overland transport, agriculture, elimination of technical barriers to trade, public procurement markets and research.

Negotiations on the Bilateral Agreements II started in 2001, mainly because of the EU's plans to integrate Switzerland into its system for cross-border taxation of savings and to increase cooperation on combating fraud in the area of indirect taxes. At Switzerland's request, the negotiations were extended to cover additional areas of importance, namely, cooperation in the fields of police and justice, asylum and migration ("Schengen/Dublin") and the remaining dossiers ("leftovers") from negotiations on the Bilateral Agreements I (processed agricultural products, statistics, media, pensions, education, and environment). Concerning the environment dossier, by 2006 Switzerland is to become a member of the European Environment Agency, which is considered an important instrument for international cooperation on protection of the environment. Subject to the outcome of a referendums on the free movement of people from the 10 EU accession states, ratification of the Bilateral Agreements II is expected by the end of 2005.

2.2. Perceptions of political problems

Due to structural and cyclical changes in national and international labour markets, unemployment began to rise at the beginning of the 1990s and became a major public concern during that decade. Figure 2-3 shows levels of concern about unemployment issues from the late 1980s until today. Unemployment trends are shown in Section 2.5.

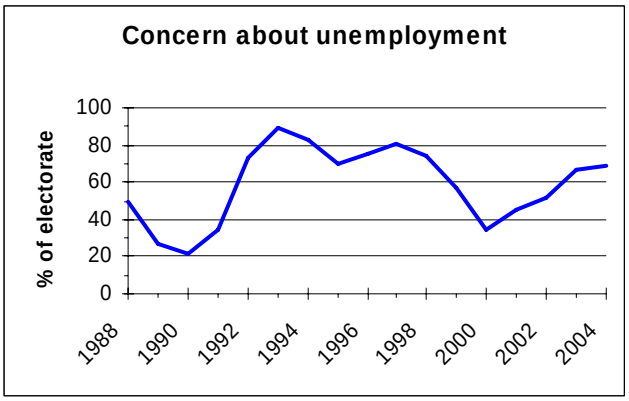


Figure 2-3: Proportion of the electorate concerned about unemployment between 1988 and 2004 (GfS 2004)

On the other hand, concern about environmental issues has been constantly decreasing among the Swiss population since the late 1980s (Figure 2-4). In 1988, in the aftermath of the nuclear catastrophe in Chernobyl, more than 70% of adults were concerned about environmental protection issues. This rate has since decreased to a mere 11%. A substantial drop was observed in 1995, when environmental problems were superseded by economic and social policy issues as a major concern – especially unemployment (see above) and rising healthcare costs. However, a variety of opinion polls show that great importance is attached to climate change when respondents are asked to rank specific environmental issues deserving increased political attention.

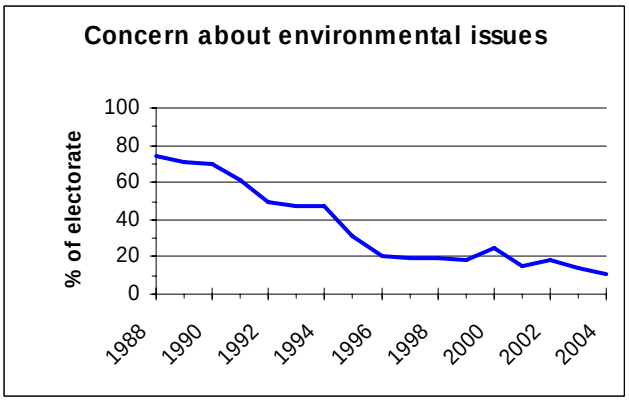


Figure 2-4: Proportion of the electorate concerned about environmental issues between 1988 and 2004 (GfS 2003 and 2004)

2.3. Population

At the end of 2004, the population of Switzerland was 7.418 million. Figure 2-5 shows the increase in population from 1960 to the end of 2004. In 2004, the population density was 179.6 persons per km^2, with more than two thirds of the Swiss population living in cities or metropolitan areas.

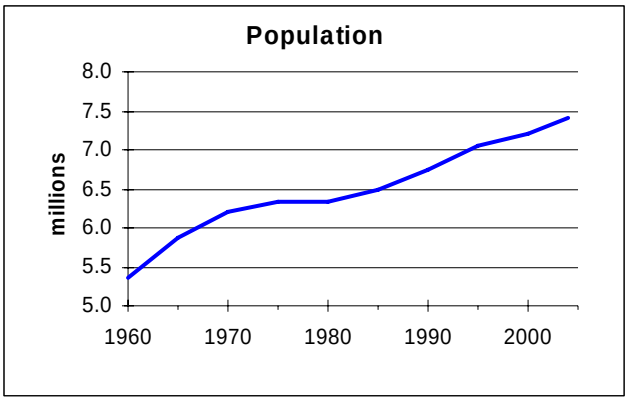


Figure 2-5: Population between 1960 and 2004 (SFSO 2004a, 2004d, and 2005b)

Population growth is mainly the effect of immigration and increasing life expectancy (see also "Age structure", below). 27% of children born in Switzerland in 2003 were foreign nationals.

Household size and housing: The number of households is increasing (+10% between 1990 and 2000) while the number of persons per household is decreasing. In 2000, the average person required 44 m^2 of living space, which is about 14% more than in 1990.

Commuting and mobility: By 2000, roughly 6 out of 10 people worked in a location other than their place of residence. In parallel with the growing separation of workplace and place of residence, transport volumes, and in particular private car use, have increased sharply.

Age structure: Figure 2-6 shows the demographic structure of Switzerland by age, sex and nationality. Foreign nationals account for about 20% of the population. A growing proportion of the population is of retirement age, while the share of persons below the age of 20 has been declining since the 1970s.

Figure 2-6: Age structure of the population of Switzerland in 2003 (FCh 2005)

Languages: Figure 2-7 illustrates the multilingual character of Switzerland. It shows the distribution and share of the various languages spoken and officially used in this country.

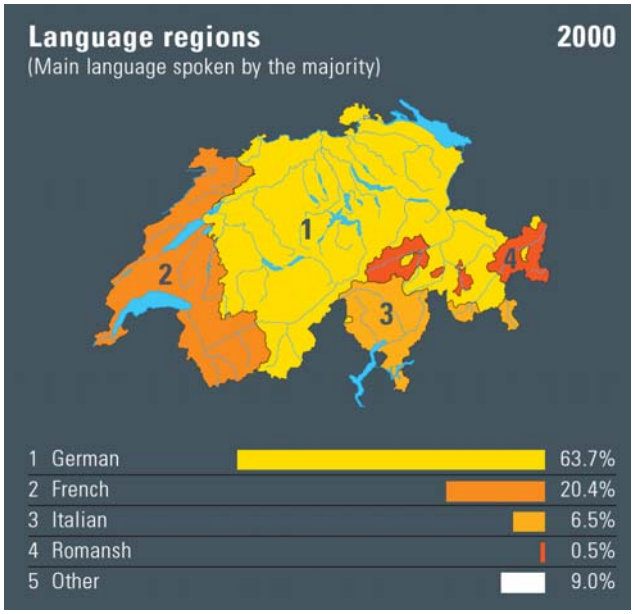


Figure 2-7: Language regions of Switzerland (FCh 2005)

2.4. Geography

Switzerland is located between 45°49' and 47°48' north and from 5°57' to 10°30' east. It covers an area of 41,300 km^2, comprising 31% forest and woodland, 37% cropland and pastureland, 7% built-up and 25% unproductive land (situation in the mid-1990s).

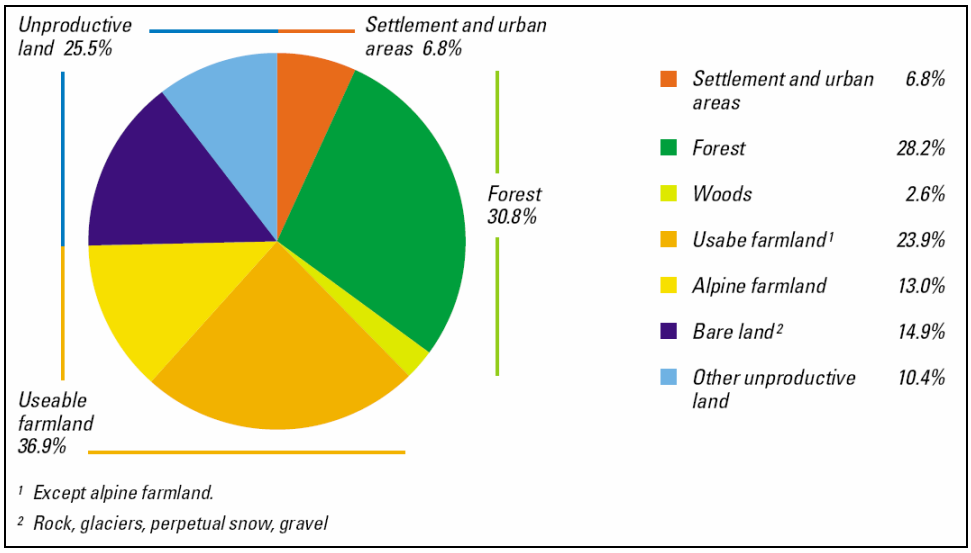


Figure 2-8: Types of land use (SFSO 2005d)

The size of the built-up area more than doubled between 1950 and 1990 and has continued to expand ever since, mainly at the expense of agricultural land. Built-up land accounts for half the settled area, and transport infrastructure for one third (the rest consists of industrial sites, parks and

recreational areas, landfills, etc.). Woods/forests have also expanded, mainly in fringe areas (brushwood encroaching on isolated alpine pastures).

The location in the heart of Europe and in the centre of the European Union leads to substantial imports and exports of goods and services, and to flows of transit traffic through Switzerland. The main, 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 designed to facilitate and speed up transalpine traffic are currently under construction and are expected to open in 2007 (Lötschberg base tunnel) and in 2015 (Gotthard base tunnel), respectively.

2.5. Climate trends

Climatic conditions, average temperature and precipitation patterns vary significantly across Switzerland, depending mainly on altitude and location. The Alps – running from east to west – act as a climatic divide. Particularly since the 1970s, measurements have indicated a marked shift towards a warmer and – particularly in winter – wetter climate.

Temperature

While average temperatures in the Northern Hemisphere increased by 0.6°C during the last century, an average increase of about 1.4°C was observed in the part of Switzerland north of the Alps. Figure 2-9 depicts the annual temperature anomalies since 1864 with respect to the 1961-1990 reference period.

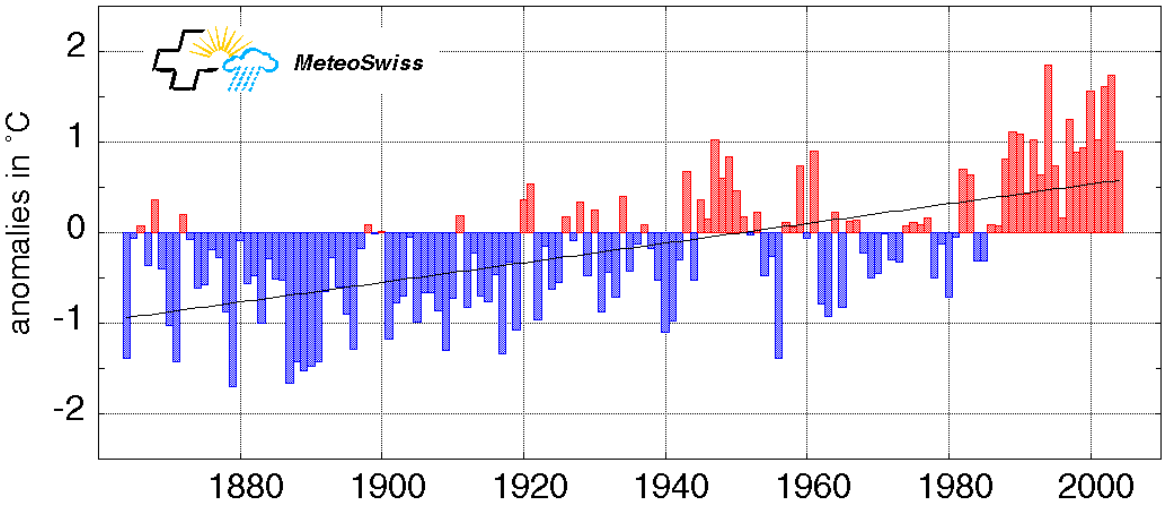


Figure 2-9: Annual temperature anomalies for the period 1864-2004 with respect to the 1961-1990 mean. (MeteoSwiss 2004)

The temperature increase is nearly twice as high in winter than in summer. Winter and summer have shown marked differences in long-term temperature development since 1864. Table 2-1 shows the temperature trends between 1864 and 2001 for the two seasons (winter and summer half-years) and for the whole calendar year.

Temperature increases			
Region	*Winter (October – March)*	*Summer (April – September)*	*Calendar year*
Lowlands north of the Alps	1.4–1.5	0.4–0.7	1.0–1.2
Northern slope of the Alps	1.4	0.6–0.7	1.0–1.1
Central Alps	0.9–1.6	0.4–0.9	0.6–1.3
Lowlands south of the Alps	1.0	n.s.	0.6
Jura	1.4	0.8	1.1

Table 2-1: Temperature increases between 1864 and 2001 in degrees Celsius per century for winter, summer and the calendar year. Trends not significant at the 1% level are indicated by n.s. *= not significant. (MeteoSwiss 2004)*

From the 1970s, and in some places from the 1980s, winters started to become warmer. In the 1980s, summers underwent a rapid change towards higher temperatures, although fluctuations had been observed repeatedly before. The summers of the 1990s in general and the summer of 2003 in particular were exceptionally hot.

Since the end of the 1970s the summer and winter months experienced a strong warming, precipitation volumes increased during the winter and a statistically significant higher frequency of heavy precipitation events was recorded during the winter and the late summer season (Schmidli and Frei, 2005). There is no doubt that during the last 20 years of the 20th century the Swiss climate underwent the most substantial changes since the establishment of the national climate measurement and observation network in 1864 (MeteoSwiss 2004).

Precipitation

Despite the small size of the country, precipitation in Switzerland varies from region to region. Typically, there are quasi-periodic fluctuations in total precipitation, which do not necessarily lead to an overall change in the long run. This effect is mainly observed in the summer, but also in the winter; for example, no change in total precipitation is detectable for the Northern slope of the Alps or the Lowlands South of the Alps. During the winter season there is an appreciable, statistically significant precipitation increase in several but not all parts of the country. Table 2-2 shows the precipitation trends between 1864 and 2001 for the two seasons (winter and summer half-years) and for the whole calendar year.

Precipitation increases			
Region	*Winter (October – March)*	*Summer (April – September)*	*Calendar year*
Lowlands north of the Alps	63–87	55	87–111
Northern slope of the Alps	n.s.	n.s.	n.s.
Central Alps	38	n.s.	n.s.
Lowlands south of the Alps	n.s.	n.s.	n.s.
Jura	107	n.s.	100

Table 2-2: Precipitation increases between 1864 and 2001 in millimetres per century for winter, summer and the calendar year. Trends not significant at the 1% level are indicated by n.s. *= not significant. (MeteoSwiss 2004)*

Heating degree days

Figure 2-10 shows the index of heating degree days from 1970 to 2004. Since there is a considerable yearly variation in weather conditions, heating degree days are an important basis for interpreting the year-to-year changes in energy consumption and CO_2 emissions.

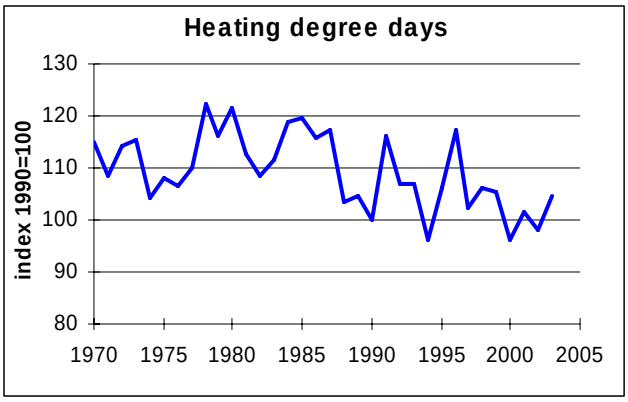


Figure 2-10: Index of heating degree days, 1990=100 (SFOE 2004)

Extreme events

Flooding was the main type of extreme event occurring in the last 30 years (60–95% of all loss events). All three types of extreme event show a slightly increasing trend (Figure 2-11), which is however of limited significance due to large fluctuations in the observed time series (Schmid et al. 2004).

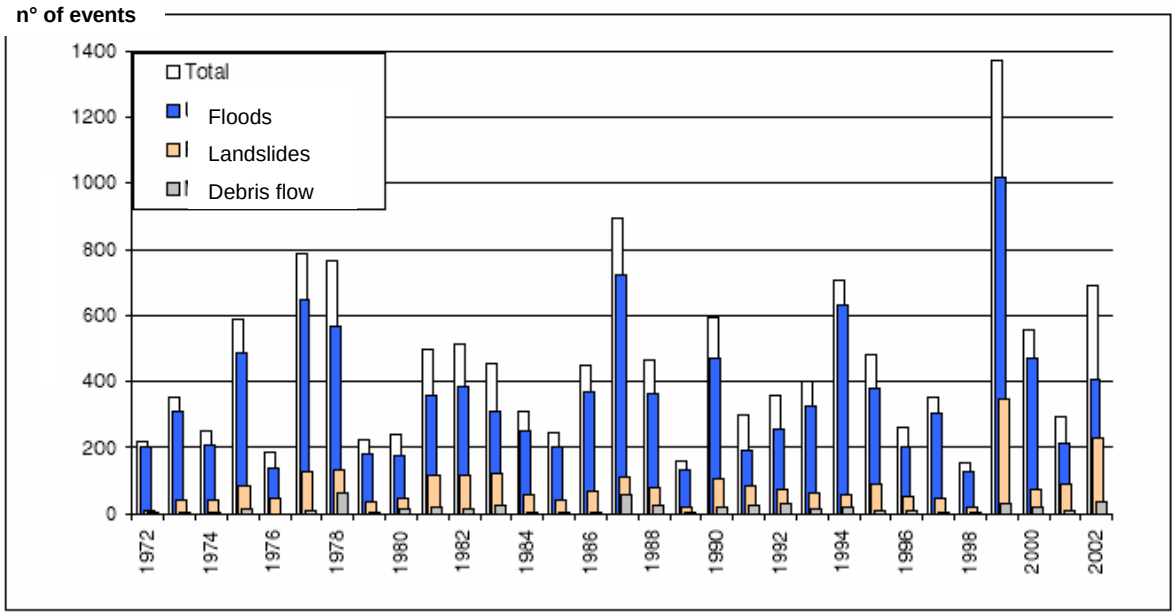


Figure 2-11: Loss events by type (floods, landslides and debris flows) 1972–2002 (Schmid et al. 2004)

Analysis of losses incurred due to extreme events over the past three decades shows only a slight increase, which is not proportional to the growth in population, settlement area and density of assets. This can be partly attributed to the effects of measures implemented in the late 1980s (such as structural flood protection measures, see Section 6.3.2.).

2.6. Economy

Main characteristics

Switzerland has virtually no mineral resources and a restricted surface area. The country's economy is dependent for its wealth on foreign trade, which represents a very high proportion of GDP. The main export sectors are microtechnology, high technology, biotechnology, the pharmaceuticals industry and banking and insurance. The major trading partners are the industrialized countries which accounted for 79.2% of Swiss exports and 90.7% of its imports in 2004. Within this grouping, the EU plays a particularly important role (62.6% of exports and 83.4% of imports).

Switzerland imports bulky raw materials and exports high-quality goods. In 2003, the value of one tonne of exported goods was two and a quarter times more than that of the same amount of imports. The relatively small size of its domestic market – a total population of just over 7,400,000 – is another factor which has encouraged Swiss manufacturers to look abroad: they need foreign markets in order to make investment in research and development worthwhile.

The number of enterprises is constantly rising, especially in the services sector. In 2001, more than 300,000 private-sector enterprises existed, 12% more than in 1991. 75% of all enterprises are service suppliers. Most of the enterprises are small or medium-sized, with less than 250 employees. In 1998, the average number of employees per company in the secondary sector was 12.6.

Workforce by sector

Since the 1960s, the proportion of the total workforce employed the industrial and commercial sector has fallen from half to less than a quarter. By 2004, the proportion employed in the primary sector had dropped from 15% to below 4%. At the same time, almost 73% of employees made their living in the services and administration sector (SFSO 2005c).

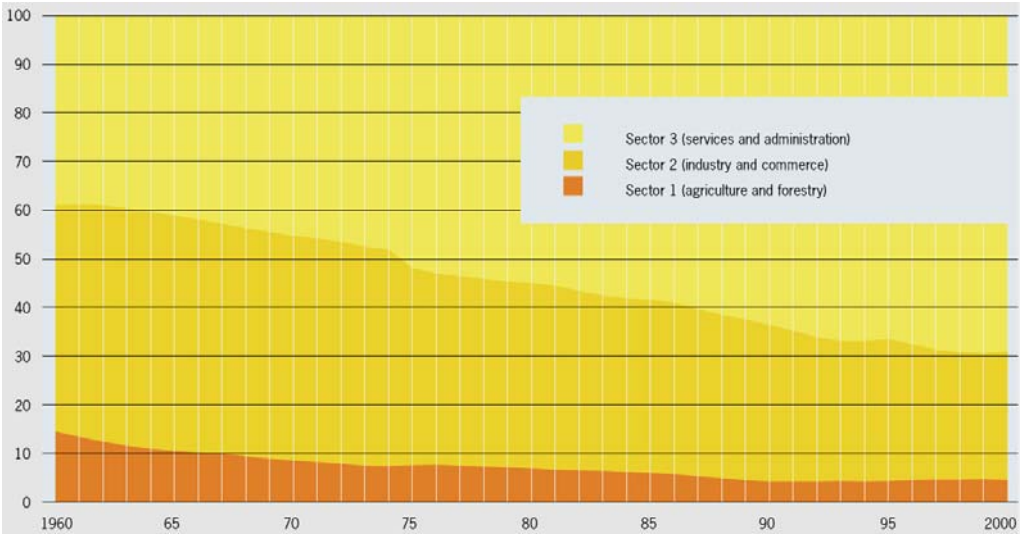


Figure 2-12: Workforce by sector (in %) from 1960 to 2000 (SFSO 2002)

Gross domestic product

Switzerland's nominal GDP experienced only modest growth in the 1990s. It reached CHF 433 billion in 2003, an increase of 0.53% over the previous year. Real GDP remained flat in the early 1990s, but has been increasing since 1995. Nevertheless, in 2003 it decreased by 0.35% compared to the previous year. Figure 2-13 shows nominal and real GDP trends in absolute terms for the period from 1990 to 2003, and Figure 2-14 shows how nominal and real GDP developed in relative terms over the same period.

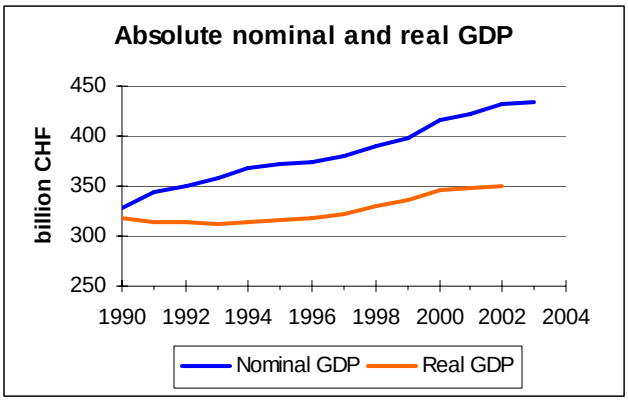


Figure 2-13: Absolute nominal and real GDP in current and 1990 prices, respectively, for the period from 1990 to 2002 (real GDP) and 1990 to 2003 (nominal GDP) (SFSO 2004b, 2005c and SAEFL 2004)

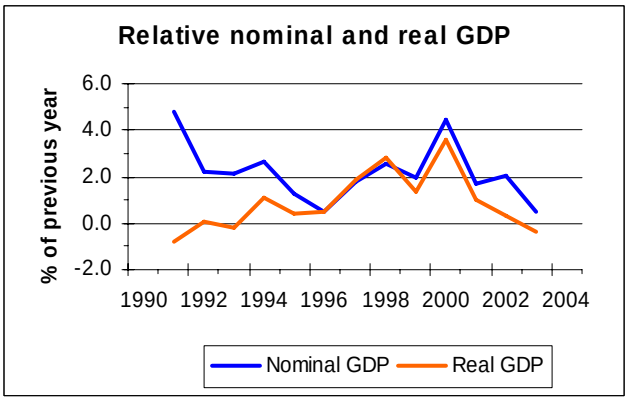


Figure 2-14: Year-on-year percentage changes in nominal and real GDP in current and previous-year prices, respectively, for the period from 1990 to 2003 (SFSO 2004a and 2004b)

From 1990 to 2004, real GDP per capita (i.e. real GDP per full-time job) increased steadily, interrupted by a slight decrease in 2001 (Figure 2-15).

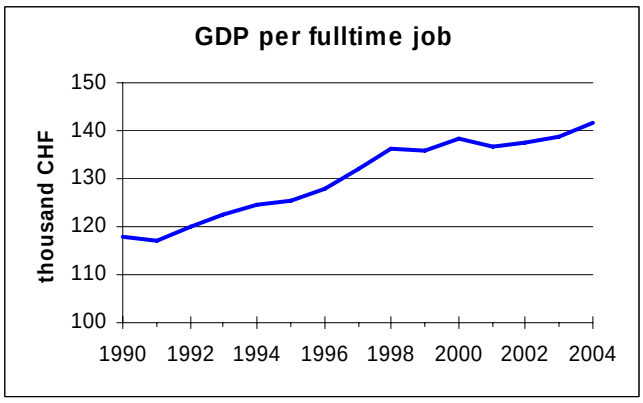


Figure 2-15: Real GDP per capita (per full-time job) from 1990 to 2004 (SFSO 2004b and 2004c)

Unemployment

Traditionally a low-unemployment country, Switzerland experienced a dramatic increase in unemployment from the beginning of the 1990s, basically as a consequence of the overall economic slowdown. Apart from foreign nationals of either sex, the category most affected by this development was Swiss women. As Figure 2-16 shows, the total rate of unemployment has peaked twice since 1991 – at 4.2% in 1997 and at 4.4% in 2004.

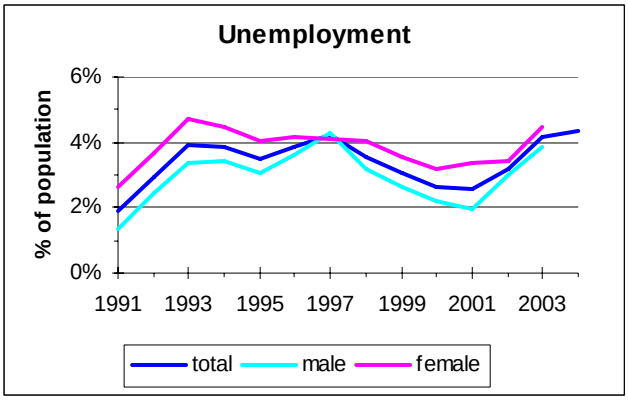


Figure 2-16: Rate of unemployment as a percentage of the population between 1991 and 2004; disaggregated figures not yet available for 2004 (SFSO 2004a)

Public debt

In parallel with rising unemployment, aggregate government spending of all three administrative levels has exceeded revenues since 1990, which has led to increasing debt. Following a record surplus in 2000, revenues have rapidly decreased again since 2001. Figure 2-17 shows the national budget from 1950 to 2003, revealing the excessive levels of public debt that prevailed in the 1990s.

In 2003, the Swiss government and parliament decided to embark on a rigorous retrenchment programme and are currently implementing a variety of cost-saving measures designed to close the gap between expenditures and revenues rapidly.

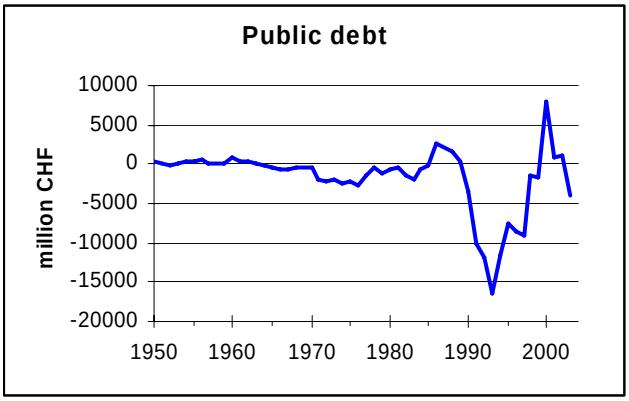


Figure 2-17: Public debt of all administrative levels between 1950 and 2003 (SFSO 2004a)

2.7. Energy

Switzerland does not have any fossil fuel resources of its own. In 2004, over 90% of gross energy consumption was imported. 57.0% of total final energy consumption was oil, 23.1% electricity and 12.1% natural gas. The remaining 7.8% comprised wood, waste, district heating, coal and several renewable forms of energy. 14.0% of gross energy consumption was from renewable sources, most of it hydroelectricity.

Energy supply and final energy consumption

In 2004, total energy supply was 1,174,610 TJ, representing 100.2% of gross consumption. Total final energy consumption was 877,290 TJ, i.e. 0.5% above the previous year and 11.6% above the level of 1990. Energy flows for Switzerland in 2003, expressed in terajoules, are shown schematically in Figure 2-18.

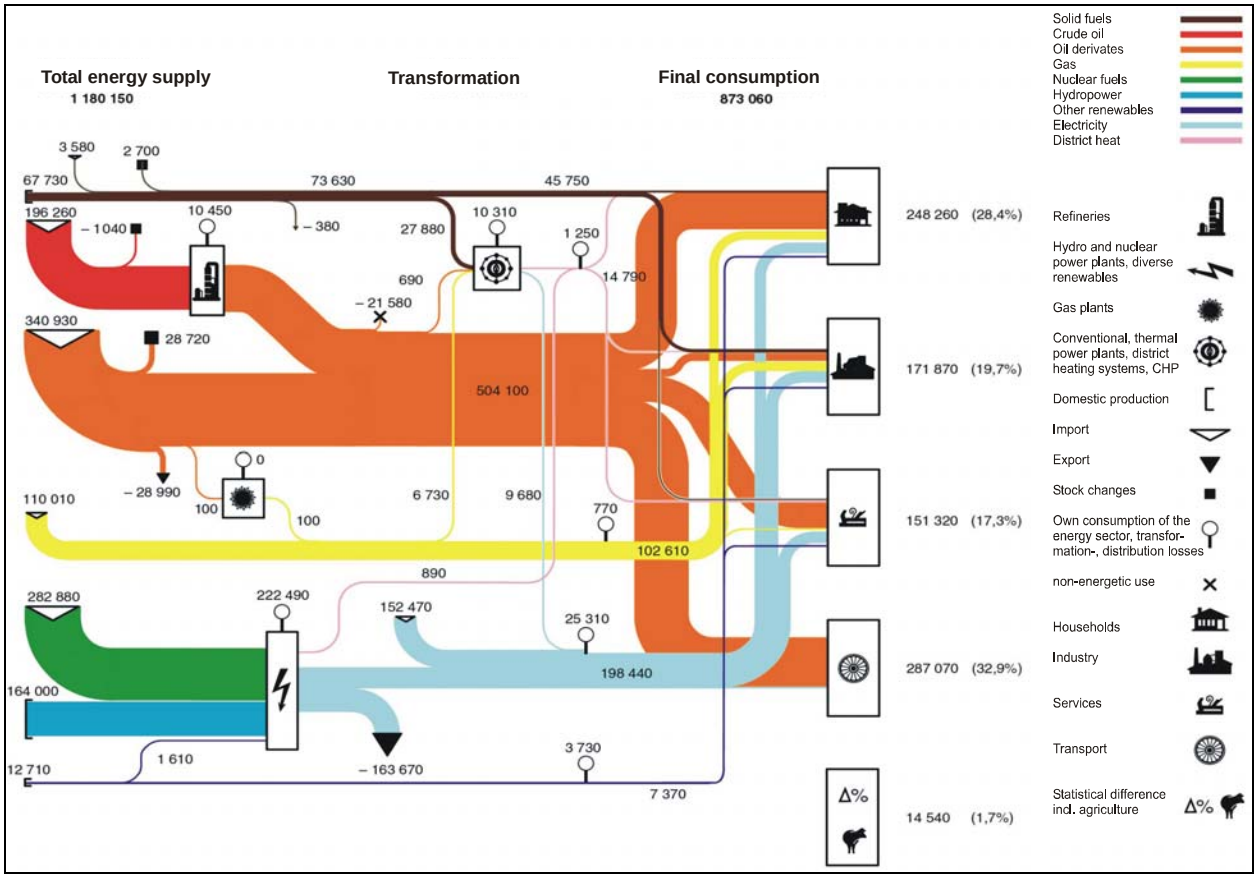


Figure 2-18: Energy flow diagram for Switzerland in TJ for 2003 (SFOE 2004)

Figure 2-19 illustrates the relation of energy supply to energy consumption, both by consumption by energy source and by type of consumer.

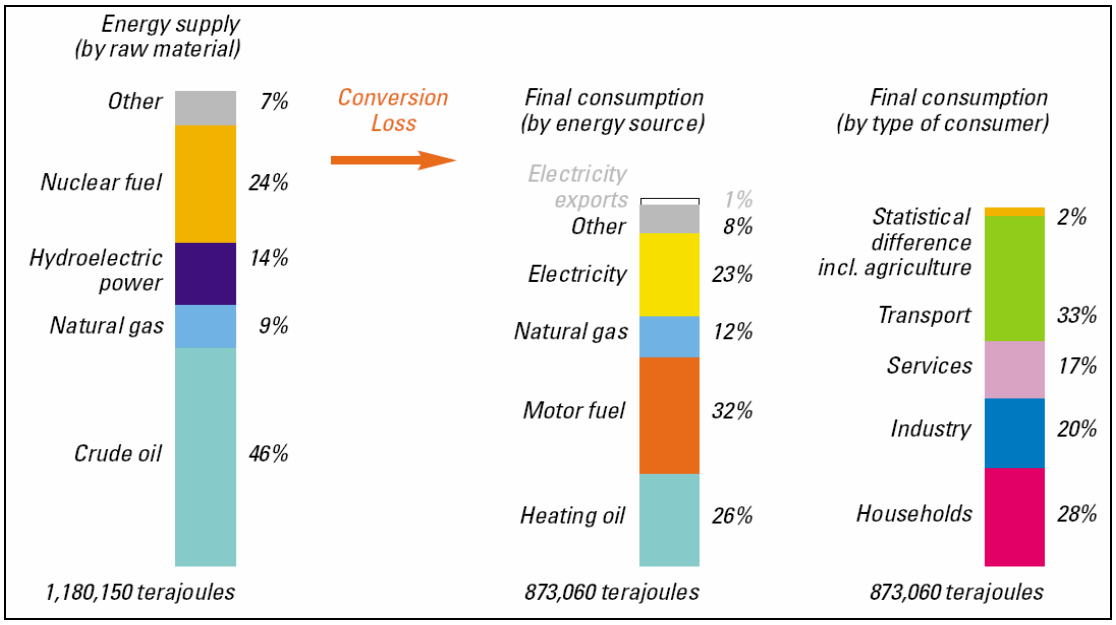


Figure 2-19: Total energy supply and final energy consumption in TJ for 2003 (SFSO 2005d)

In 2003, 55.8% of electricity generation was from hydropower plants, 39.7% from the five domestic nuclear power plants and the remaining 4.4% from thermal power plants or other renewable sources, i.e. solar, wind and biogas. The contribution of the renewables solar and wind to electricity generation is still small (about 1%). However, supported by the "Energy 2000" programme and since 2001 by "SwissEnergy", it increased markedly between 1991 and 2003 – solar energy from 2.0 to 16.6 GWh and wind power from 0.1 to 5.2 GWh.

Between 1980 and 2003, total final energy consumption increased by 25.5%. The largest increase occurred in the transport sector (57.7%), whereas energy consumption in industry increased by 24%. Energy use in the services sector has been decreasing since 1998 but is rising again slightly. The household sector had an increase of 10.9%. In 2003, transport accounted for 33.4% of energy end use, whereas in 1950 its share was only 15%.

Figure 2-20 shows the development of final energy consumption by energy source since 1910.

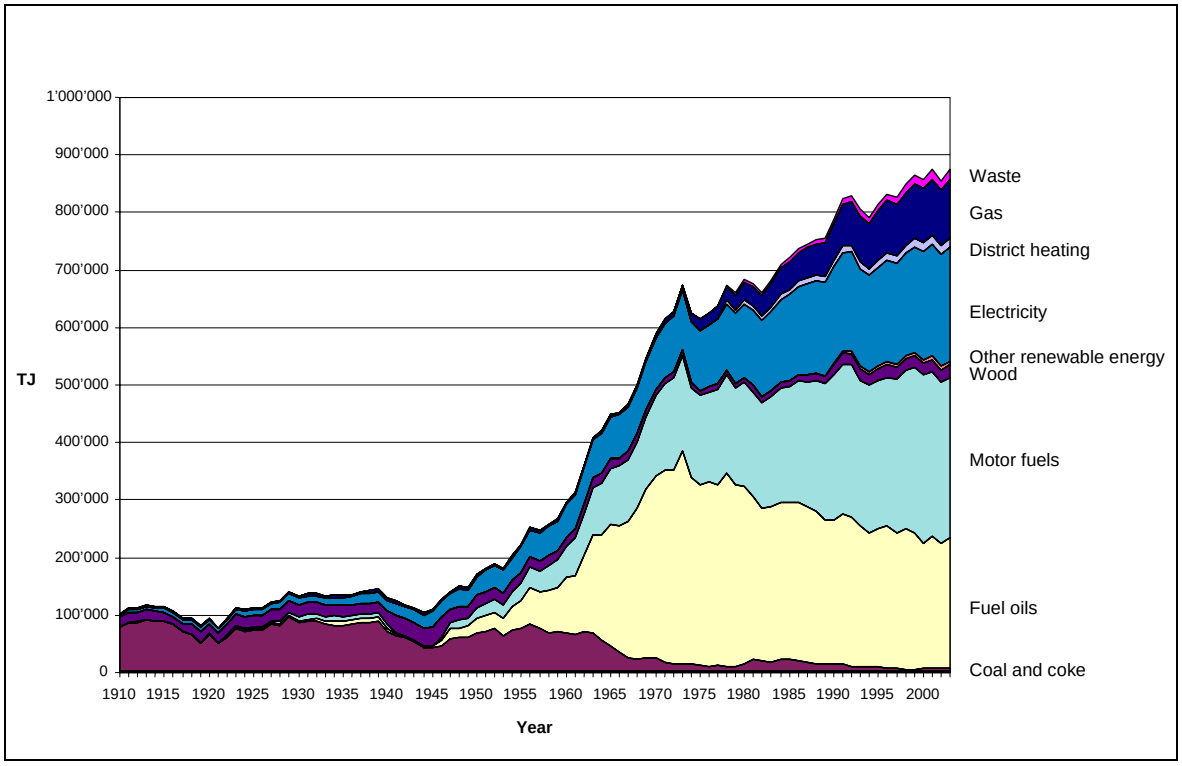


Figure 2-20: Final energy consumption between 1910 and 2003 (SFOE 2004)

Energy end use by the transport, industry and services, and household sectors relative to 1990 is shown in Figure 2-21.

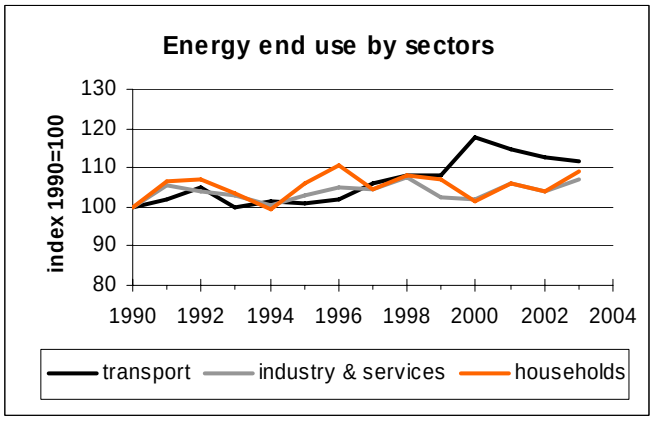


Figure 2-21: Indices of energy end use by the transport, industry and services, and household sectors between 1990 and 2003; 1990=100 (SFOE 2004)

Energy productivity has remained constant in recent decades; in other words, the index of energy consumption has increased broadly in line with that of GDP (Figure 2-22). The ratio of CO_2 emissions to real GDP is shown in Section 2.12.

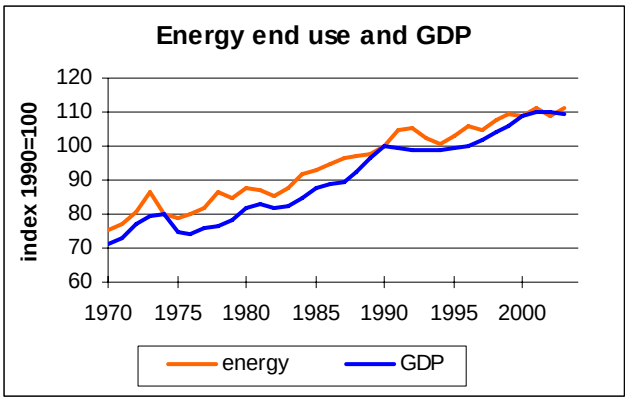


Figure 2-22: Indices of energy end use and GDP between 1970 and 2003; 1990=100 (SFOE 2004)

Energy prices

Between 1970 and the mid-1990s, the real prices of energy sources decreased in general, reaching a historic low. However, from the end of the 1990s, real energy prices rose again slightly and/or stabilized (Figure 2-23).

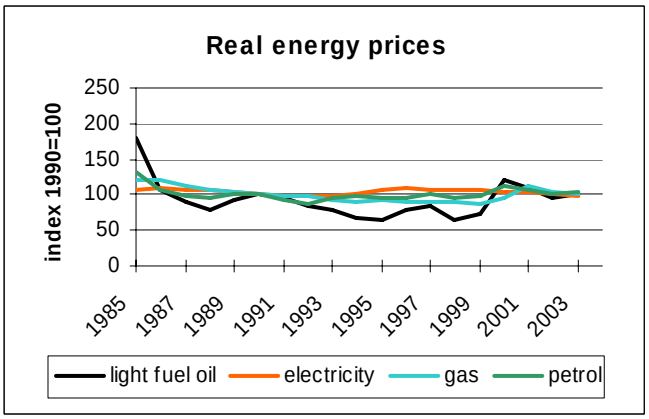


Figure 2-23: Indices of real energy prices of major energy sources at retail and household level between 1985 and 2003; 1990=100 (SFOE 2004)

Energy prices are composed of a basic price, energy taxes and value-added tax (VAT). In comparison with other European OECD countries, Switzerland has average electricity prices for households, but high electricity prices for industry. Gas prices are also high. With or without energy taxes, petrol prices in Switzerland are relatively low, unlike diesel prices, which are relatively high. Furthermore, among most European OECD countries, Switzerland has the lowest prices for light fuel oil (SFOE 2001b).

Electricity trade

Electricity is traded across Switzerland's borders on a fairly large scale. Amongst the factors affecting the volume traded are hydrological and climatic conditions. Traditionally, Switzerland has been a net exporter of electricity; however, exports have decreased significantly in the last few years. Exchanges take place with several Western and Central European countries. Figure 2-24 shows Switzerland's total physical electricity exchanges and its individual exchanges with neighbouring countries for 2004. In 2004, total Swiss electricity exports exceeded imports by only 703 GWh.

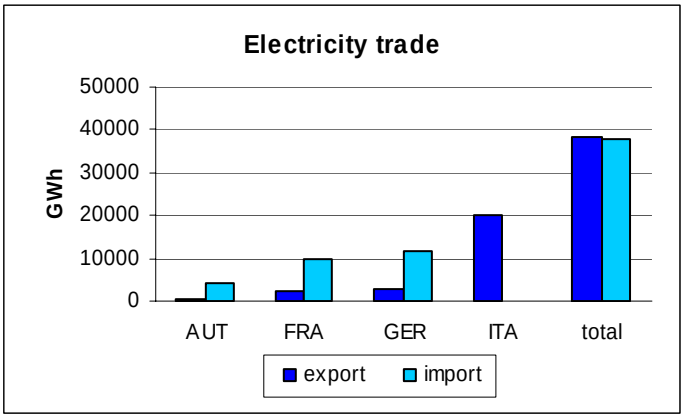


Figure 2-24: Total physical electricity exchanges and individual exchanges with neighbouring countries in 2004 (SFOE 2005a and www.ucte.org)

2.8. Transport

For decades, traffic volumes have been growing continuously, in line with global trends. Recent decades have seen road transport gaining a growing share compared to rail in the passenger and freight sectors.

Unlike the road network which has been expanded by more than 40% since the 1980s, Switzerland's rail infrastructure has not changed significantly over the past 50 years. Nevertheless, by international standards, Swiss railways play an important role in the transport market, especially in passenger and transalpine freight transport.

Passenger transport

Passenger transport in Switzerland is still growing. Between 1980 and 2000, total passenger-kilometres travelled increased by nearly 30% in private transport (road traffic) and by almost 50% in public transport (road and rail traffic). Figure 2-25 shows the demand for passenger transport by road and rail between 1960 and 2000. In comparison, passenger transport by air is negligible.

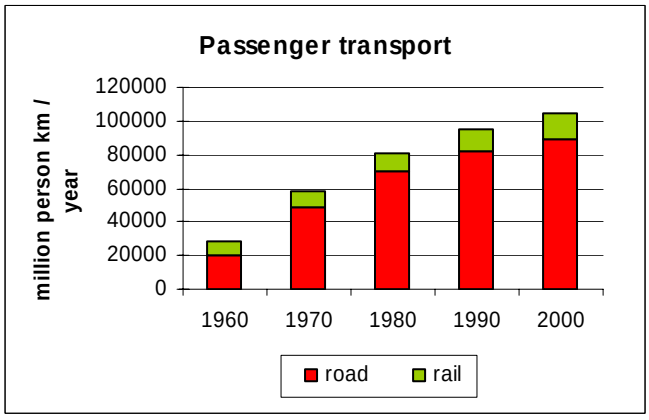


Figure 2-25: Passenger transport by road and rail between 1960 and 2000 (SFSO 2000b, 2004a and 2005a)

Car ownership (including minibuses) increased from 510,000 vehicles in 1950 to 3.76 million vehicles in 2002. Today, three out of four households in Switzerland own at least one car.

Freight transport

As in most European countries, rail has been losing market share to road in the freight transport sector since the 1960s. Figure 2-26 shows the market shares of freight transport by road and rail between 1960 and 2000. As for passenger transport, freight transport by air is negligible in comparison with road and rail transport.

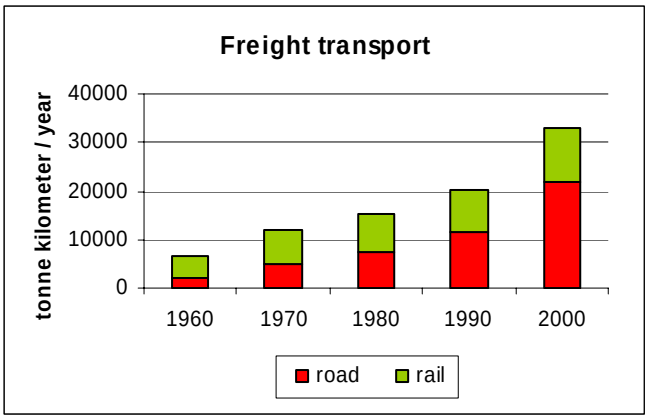


Figure 2-26: Freight transport by road and rail between 1960 and 2000 (SFSO 2000b, 2004a, and 2005a)

Rail has suffered a similar setback in transalpine freight transport, although Swiss rail transport has traditionally had and still has a particularly strong position compared to that in neighbouring alpine countries. This is mostly due to the restrictions imposed on road freight transport in Switzerland.

Figure 2-27 shows transalpine freight transport by road from 1983 to 2003 for Switzerland (CH), Austria (AUT) and France (FRA). Figure 2-28 shows transalpine freight transport by rail for the same countries and period.

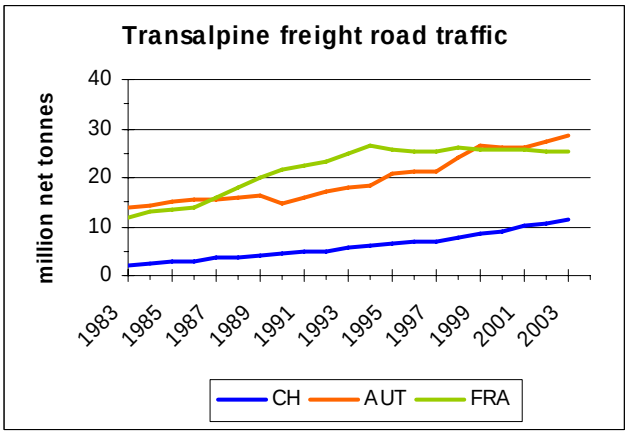


Figure 2-27: Transalpine freight transport by road for Switzerland, Austria and France between 1983 and 2003 (SFSO 2000b, 2004a, and 2005a)

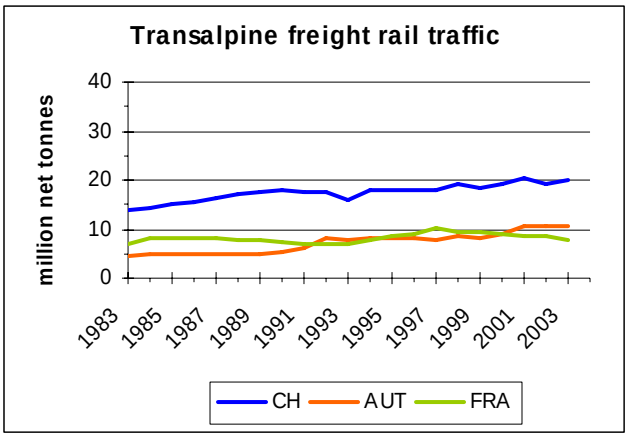
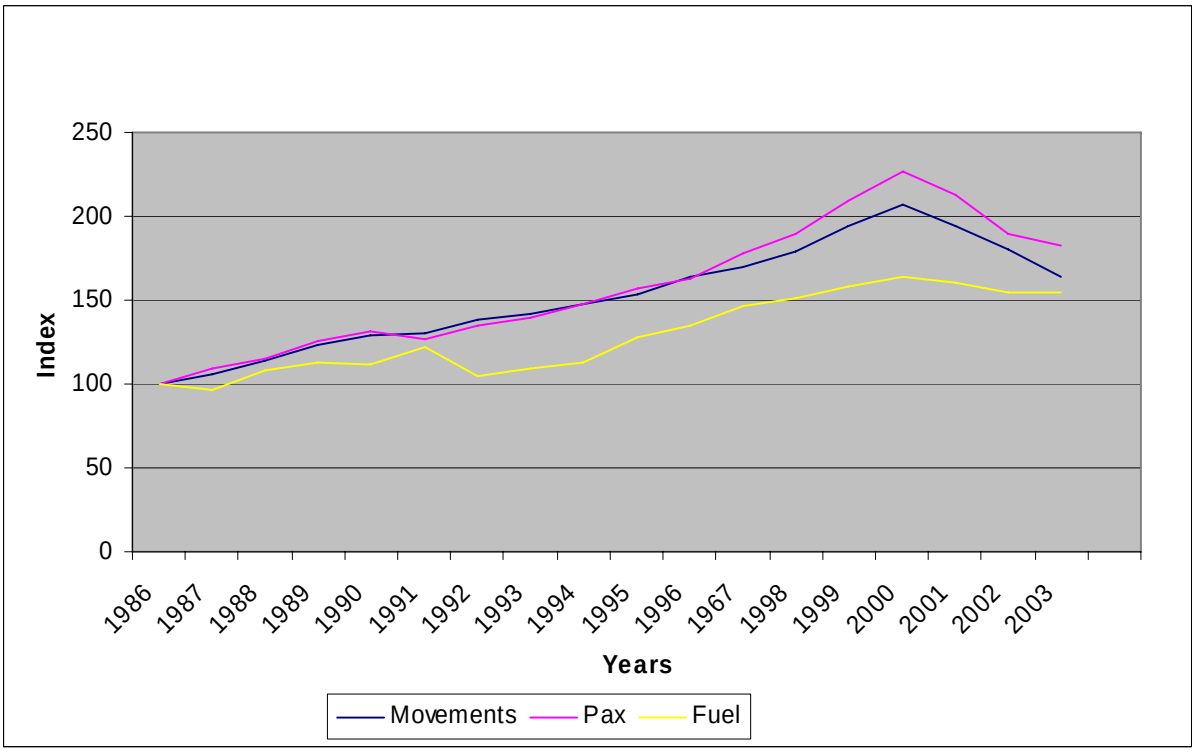


Figure 2-28: Transalpine freight transport by rail for Switzerland, Austria and France between 1983 and 2003 (SFSO 2000b, 2004a, and 2005a)

Aviation

The aviation sector has experienced constant growth since its inception. Only the combination of terrorist attacks in New York in 2001 ("9/11") and a worldwide economic crisis led to a dramatic decrease in flights and passenger numbers. In Switzerland, this development was accentuated by the difficulties that led to the cessation of operations of the former national airline Swissair. Figure 2-29 shows how aircraft movements, passenger numbers and domestic aviation fuel consumption have developed in Switzerland since the 1980s.



'Pax' = Passengers
'Fuel' = Development of civil aircraft fuel consumption within Swiss boundaries; data are not corrected for changes in calculation methodology and inclusion of more fuel types after 1986.

Figure 2-29: Development of aircraft movements, passenger numbers and fuel consumption in Switzerland in scheduled and charter flight operations from 1986 to 2003; 1986=100. (Swiss FOCA)

On the other hand, military aircraft movements are steadily decreasing (Figure 2-30).

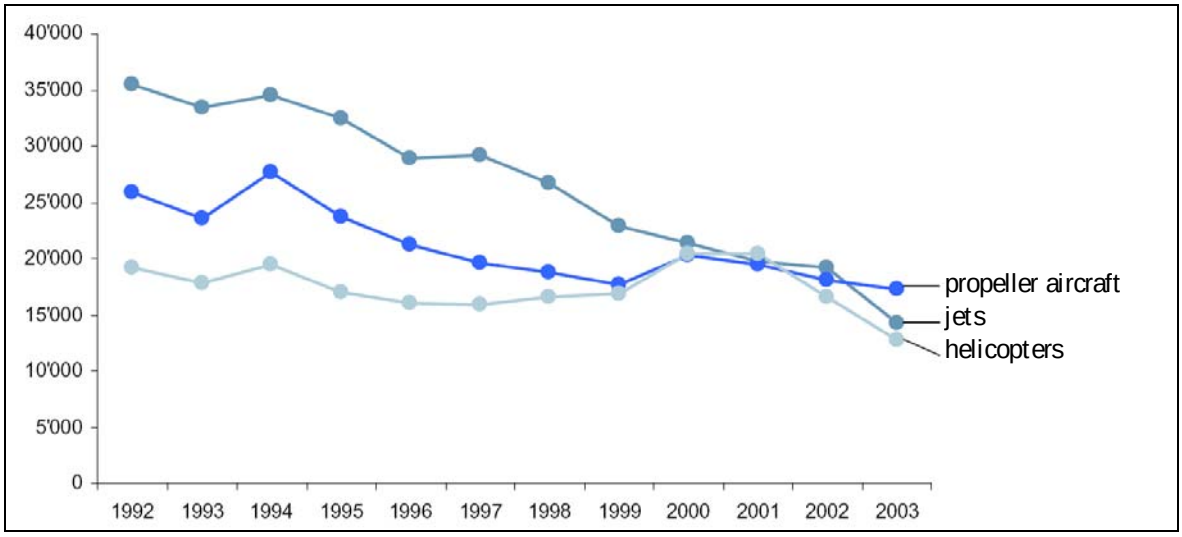


Figure 2-30: Number of movements of various types of military aircraft from 1992 to 2003. (Source: Dübendorf airbase)

2.9. Waste

In 2003, 2.58 million tonnes of municipal solid waste was generated, i.e. 351 kg per capita. Recycling is highly developed in Switzerland. The amount of solid waste collected for recycling increased by 32% from 1992 to 2002 and now makes up some 46% of the total amount of municipal solid waste (Figure 2-31).

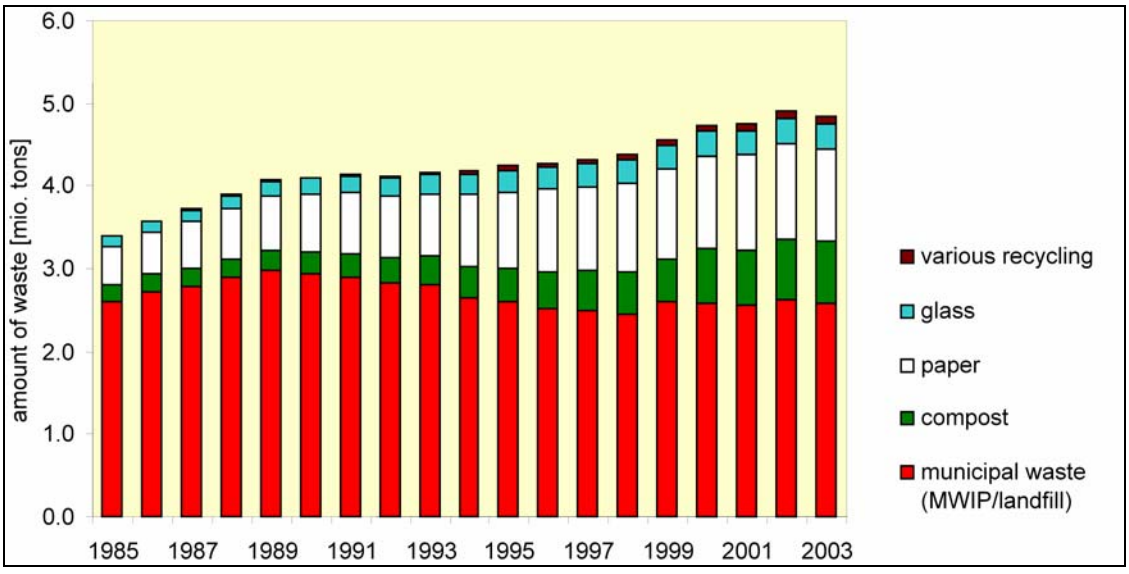


Figure 2-31: Development of recycling since 1985

With regard to the synthetic fraction (relevant to CO_2), separate collection of PET has increased significantly in recent years. In 2003, 33,000 tonnes or 71% of the total amount of PET consumed was collected and recycled.

2.10. Agriculture

According to the agricultural census of 2002, the area used by farmers amounted to 1,069,800 ha, or 25.3% of the area of Switzerland (not including alpine areas used as summer pastures only, which cover another 14% of the area of Switzerland). In 1900, 31% of the labour force in Switzerland worked on a farm. Today the corresponding proportion is less than 5%. Farmers have become a small minority in a service-oriented country. This minority manages, shapes and tends almost 40% of the country's area.

The climate and topography of Switzerland are favourable for cattle farming; the proportion of permanent grassland is high. In 2002, natural grassland and pasture land accounted for 61%; sown meadows for 11%; arable land for 26%; and fruit, wine and vegetables for 2% of the area used by farmers.

In 2002, livestock included nearly 1.6 million head of cattle, i.e. 14% fewer than in 1990. This decrease is due in part to a reduction in demand for animal products (as a reaction to the problem of BSE), but also to improvements in breeding (higher milk yield per cow) and the imposition of milk quotas. The number of pigs fell by some 18% between 1990 and 2002, to 1.55 million. The number of horses, sheep and goats is small relative to the total livestock population.

Dairy products and meat are the most significant outputs of Swiss agriculture. The main crop products in 2000 were grape must, cereals, vegetables and fruit. Labour-intensive fruit and vegetable cultivation has increased in significance in recent years.

Since the 1950s, Swiss agriculture has undergone profound structural changes, with the number of farms falling on average by 1–2% annually. By 2002, the number of farms had dropped to some 67,000 units, with the average farm size reaching about 16 ha. The number of smallholdings (less than 3 ha) decreased by almost 61% between 1990 and 2002, while the number of relatively large farms (over 20 ha) increased by 35%.

Since the early 1990s, and increasingly since the adoption of the new agricultural article of the Federal Constitution in 1996, agricultural policy has become more commercially and environmentally oriented, with environmentally friendly farming methods playing a greater role. As a consequence, the required standard of ecological performance is now met by almost all farms and the number of organic farms has doubled since 1996, reaching a share of about 10%.

2.11. Forestry

Switzerland's total forested area (including scrub and stands of green alder or Swiss mountain pine) was 1,234,000 ha in 1993/95, as estimated by the second National Forest Inventory. The distribution of forests across Switzerland is highly variable. The Central Lowlands and the Alps have the least forest cover, with 24% and 25% respectively, while the Southern Alps and the Jura are the most densely forested, with 48% and 41%. The foothills of the Alps lie between the two extremes at 33%. Overall, 30% of Switzerland is covered with forest.

Since the first National Forest Inventory in 1983/85, the forested area has risen by 48,000 ha or around 4%. The differences between the regions are striking: the greatest increase (around 7.6%) was recorded in the Alps as a consequence of natural regeneration of land previously used in agriculture, while the area of forest on the Central Lowlands has remained unchanged.

Spruce is the predominant species in Switzerland (48%), followed by beech (17%) and fir (15%). Together, these species account for around four fifths of growing stock. Spruce predominates at all altitudes, accounting for 33% in lowland areas and 64% at high altitudes.

Just over a quarter of Swiss woodland is in private hands, while 73% is in public ownership. The majority of publicly owned woodland, some 68%, belongs to local authorities and public corporations. The cantons and federal government together own only 5%. The average size of each public holding of woodland is 254 ha, while the corresponding figure for privately owned holdings is only 1.34 ha.

With an average of 367 m^3/ha, growing stock in Swiss forests is relatively large. Figures for average annual growth range between 5 m^3/ha on the southern side of the Alps and nearly 15 m^3/ha in the "Mid-Central Plateau" economic region. Overall woodland growth throughout Switzerland amounts to about 9 million m^3 annually, of which at least 4 million m^3 was harvested each year between 1991 and 2003. Extraordinary events may bring about a transient increase in the volume harvested: on 26 December 1999, 12.8 million m^3 of timber was blown down by Hurricane Lothar. The majority of this timber was collected and recorded as windthrow for the years 2000 and 2002 (see also Figure 3-8). In 2003, drought and bark beetle also led to an increase in harvested volumes.

Swiss domestic timber consumption varied between 6.0 and 7.2 million m^3 in the period 1991–2001. One striking trend is the rising proportion of timber exported. This rise is primarily accounted for by beech, which is mainly processed in Italy. Imports rose less rapidly than timber consumption, thus resulting in a positive impact on domestic timber utilization. Value added in forestry was some CHF 413 million in 1995, or 0.12% of gross domestic product. In 1995, some 9,000 people were working in the forestry sector. These jobs are mainly located in peripheral regions of Switzerland.

The Forest Act and the associated regulations are intended to safeguard timber production, maintain biodiversity and provide protection against natural hazards. Timber harvesting has to be carried out using methods that are not harmful to the soil or tree stands. Tree species native to Switzerland are to be selected, while forest regeneration is to be permanent and provide small-scale units graduated in terms of age and species.

2.12. Emission trends since 1900

In most sectors, the quality of data on GHG emissions is only satisfactory from about 1950 onwards, 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.

CO_2 emissions

Gross anthropogenic CO_2 emissions have increased markedly since 1950. This has mainly been due to a large increase in fossil fuel consumption. Since 1980, emissions have remained fairly stable. Figure 2-32 shows historical CO_2 emissions from 1900 to 2000.

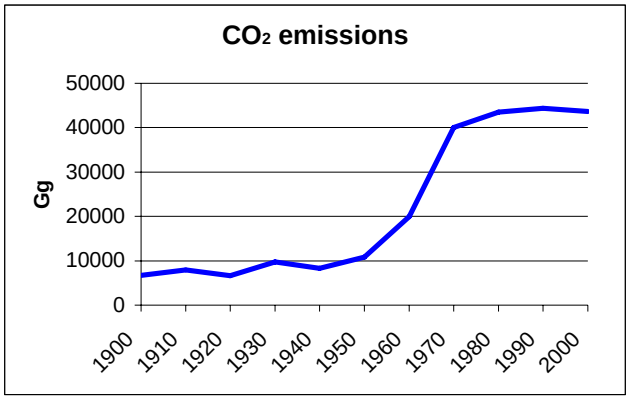


Figure 2-32: CO_2 emissions between 1900 and 2000 (SAEFL 2005)

As Figure 2-33 shows, CO_2 emissions per capita peaked in 1980 but subsequently decreased and have been stable since 2000.

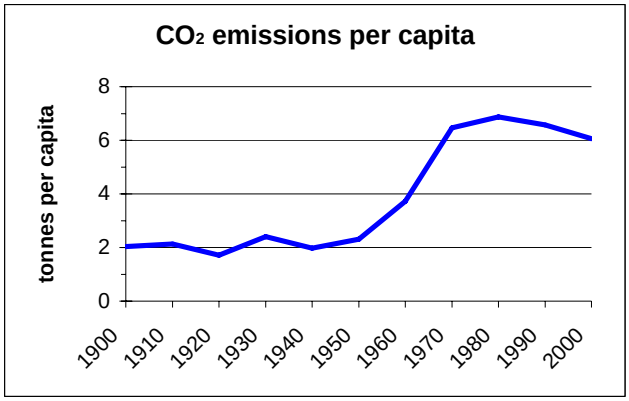


Figure 2-33: CO_2 emissions per capita between 1900 and 2000 (SAEFL 2005; SFSO 1981; SFSO 2004d).

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 emission-intensive.
- Electricity generation in Switzerland (hydro and nuclear power) causes relatively low CO_2 emissions. As a result, per capita emissions are lower than in other countries.
- Since the emissions inventory relates to Swiss territory, energy embodied in products consumed in Switzerland but produced abroad is not taken into account. Accordingly, CO_2 emissions from, e.g., electricity imports are not included. The CO_2 emissions corresponding to imported energy embodied in the energy and foodstuffs sectors amount to about one third of total domestic CO_2 emissions (SAEFL 2000b).
- Emissions of CO_2 from road transport are based on fuel sold in Switzerland. This includes the so-called fuel tourism which takes place because prices of the predominant motor fuel in Switzerland, petrol, are at present significantly lower than in neighbouring countries.

Gross CO_2 emissions per unit of real GDP increased until around 1970, but have decreased since then, as indicated by Figure 2-34.

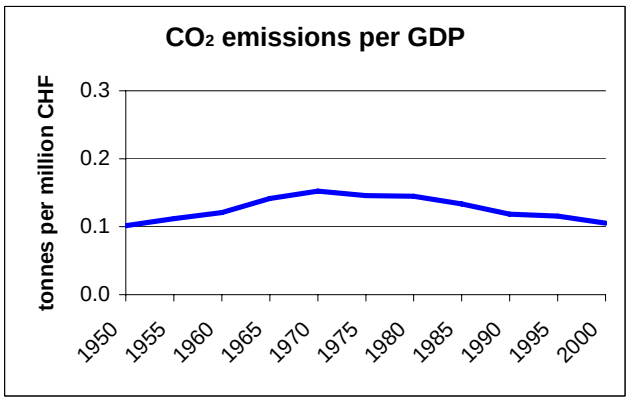


Figure 2-34: CO_2 emissions per unit of real GDP in 2000 prices between 1950 and 2000 (SAEFL 2005; SFSO National accounts)

CH_4 emissions

Total methane emissions increased steadily from 1950, peaked around 1980 and have since decreased. In 1990, the largest source of emissions was the agricultural sector (62%, mainly cattle), followed by the waste sector (28%, mainly landfills). Emissions from all sources have decreased in recent years (decreasing number of livestock and improved feed quality; technical improvements; ban on landfilling). Figure 2-35 shows historical CH_4 emissions from 1900 until 2000.

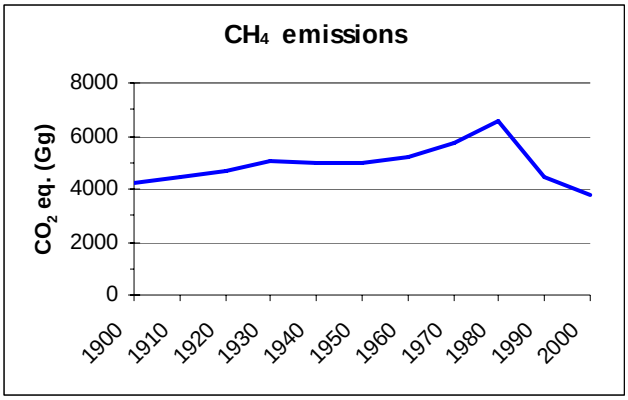


Figure 2-35: CH_4 emissions between 1900 and 2000 (SAEFL 2005)

N_2O emissions

Emissions of nitrous oxide were already substantial in 1910 (almost 2 million tonnes of CO_2 equivalent) and increased steadily until the 1980s. Since then, N_2O emissions have decreased slightly. Figure 2-36 shows historical N_2O emissions from 1900 until 2000.

The main source is agriculture (85% in 1990, decreasing to 80% in 2003). The contribution of the transport sector increased rapidly following the introduction of first-generation catalytic converters in the late 1980s (7% in 1990, rising to 10% in 2003).

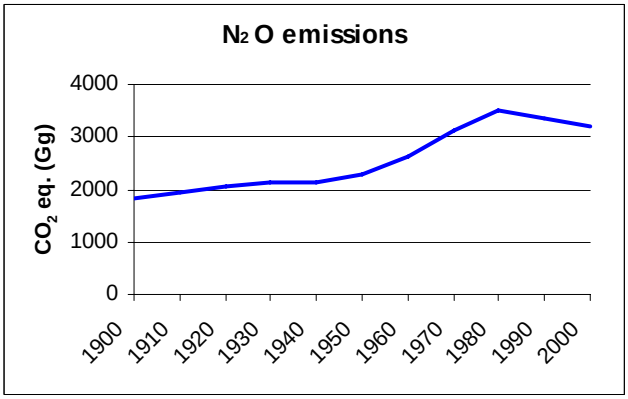


Figure 2-36: N_2O emissions between 1900 and 2000 (SAEFL 2005)

Precursor gases (NO_X, NMVOCs, CO)

Emissions of NO_X increased gradually between 1900 and 1950. After 1950, they rose more rapidly, reaching a peak around 1980, when they were six times as high as in 1950. The rapid increase was due to road transport. The decrease since 1985 has been due to the market penetration of the catalytic converter for passenger cars, which has been mandatory for new cars since 1987. This device reduces specific NO_X emissions (emissions per kilometre driven) by 80–90% and lowering overall NO_X emissions to the level of 1965.

Emissions of NMVOCs increased by a factor of 3.5 between 1900 and 1950. Between 1950 and 1980, they increased almost fivefold, mainly as a result of the increased use of solvents in industry, in the small-scale service sector and in private households, but also because of the rapid growth in transport. Over the past two decades, emissions returned to levels below the 1960 level.

Emissions of CO increased by a factor of 2.8 between 1950 and 1975. Since the 1950s, transport has superseded coal and wood-fired heating as the main source. Meanwhile, CO emissions have returned to levels slightly below 1950.

Figure 2-37 shows historical emissions of the three precursor gases between 1900 and 2000.

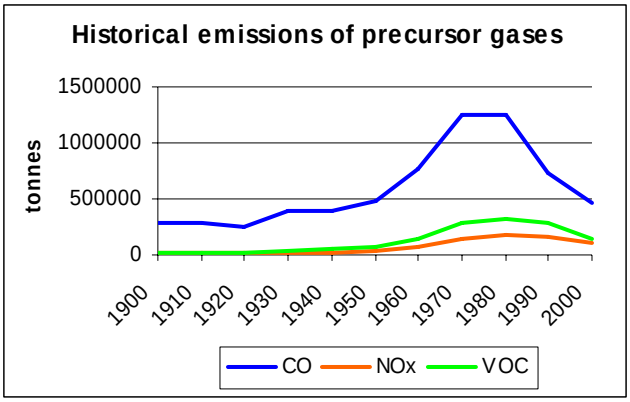


Figure 2-37: Emissions of the precursor gases CO, NO_x and NMVOCs between 1900 and 2000 (SAEFL 2005)

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Relevant websites

Confoederatio Helvetica – Website of the federal authorities of the Swiss Confederation: http://www.admin.ch/ch/index.en.html

SFSO – Swiss Federal Statistical Office: http://www.bfs.admin.ch

SFOE – Swiss Federal Office of Energy: http://www.swiss-energy.ch

UCTE – Union for the Co-ordination of Transmission of Electricity: http://www.ucte.org

3. GHG inventory information

Standardized, technical inventory information, as required by the Guidelines for the Preparation of National Communications and the revised IPCC Guidelines for National Greenhouse Gas Inventories, is provided in Annex 1 of this report. In this chapter, inventory data will be presented and commented on more comprehensively, illustrating main sources and sinks (see Section 3.1), trends in emissions since 1990 (see Section 3.2), and the contributions of the various GHGs to total Swiss emissions (see Section 3.3).

When comparing emissions data in this report with figures presented in Switzerland's Third National Communication (2001), the following changes should be borne in mind:

- The figures for 1990 and 2000 are the real figures from the 2003 Inventory, rather than modelled values (no adjustment for climatic conditions).
- Energy production from waste was transferred from sector 6 "Waste" to sectors 1.A.1 "Energy Transformation" (waste incineration appliances) and 1.A.2. "Industry" (waste use in cement production).
- CO_2 emissions from the cultivation of organic soils and from liming of agricultural soils are now included.
- The traffic model was recalculated with new activity data and new emission factors (coordination of the estimation of emission factors with Germany and Austria).
- Emissions in the "Offroad" sector were recalculated.
- The 3-year averages in the agricultural sector were replaced by yearly figures.
- A new waste disposal model was implemented according to IPCC Good Practice Guidance.

For details on data improvements in the GHG inventory, see SAEFL 2005.

3.1. Overview of sources and sinks (Swiss Greenhouse Gas Inventory 2003)

3.1.1. CO_2

In 2003, national gross CO_2 emissions amounted to 44,700 Gg or 6.05 tonnes per capita. Three quarters of these emissions came from transport (34%) and small-scale combustion (26% residential, 12% commercial/institutional). Industry accounts for 20% of CO_2 emissions (17% energy-related, 4% non-energy-related). Other sources are of minor importance.

The allocation of emissions from aircraft to domestic and international flights has been revised since the last report. For 2003, bunker fuel emissions from international aviation are estimated at 3,700 Gg. In line with UNFCCC reporting instructions, these are not included in the national emission figures.

At present, the net result of carbon releases (due to harvesting and the cultivation of organic soils) and carbon uptake is an absorption of the order of 1,800 Gg CO_2. This absorption corresponds to 4% of gross CO_2 emissions.

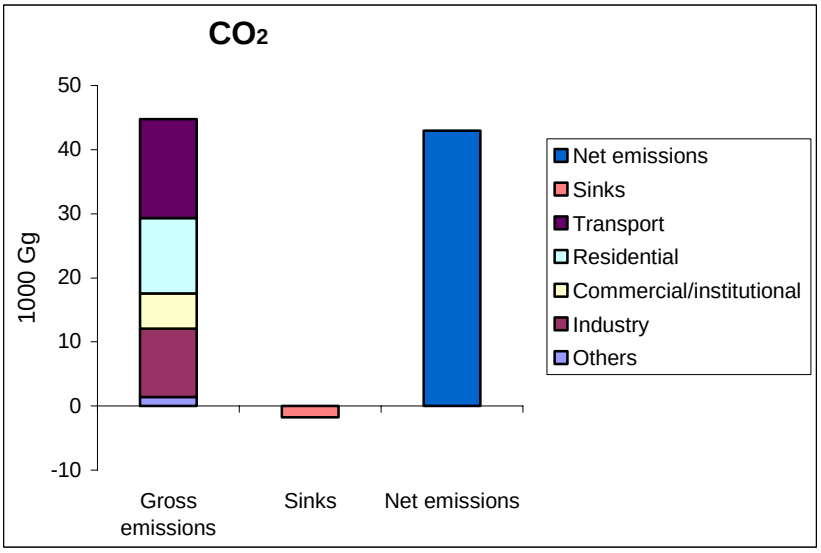


Figure 3-1: CO_2 emissions and removals by sector (not including international bunkers), 2003

3.1.2. CH_4

CH_4 emissions were 175 Gg in 2003. Over three quarters of this total came from the agricultural sector, with enteric fermentation in ruminants accounting for about 86% of agricultural emissions. The second most important source of CH_4 emissions was the waste sector (11% of the total). Taken together, these two sectors account for 90% of Swiss CH_4 emissions.

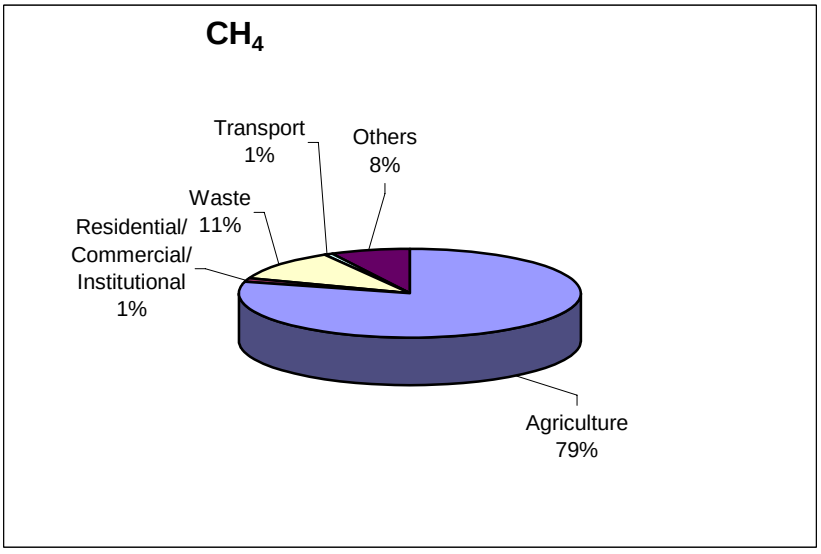


Figure 3-2: CH_4 emissions by sector, 2003

3.1.3. N_2O

N_2O emissions were 10 Gg in 2003, with agriculture being the most important source (about 81% of the total).

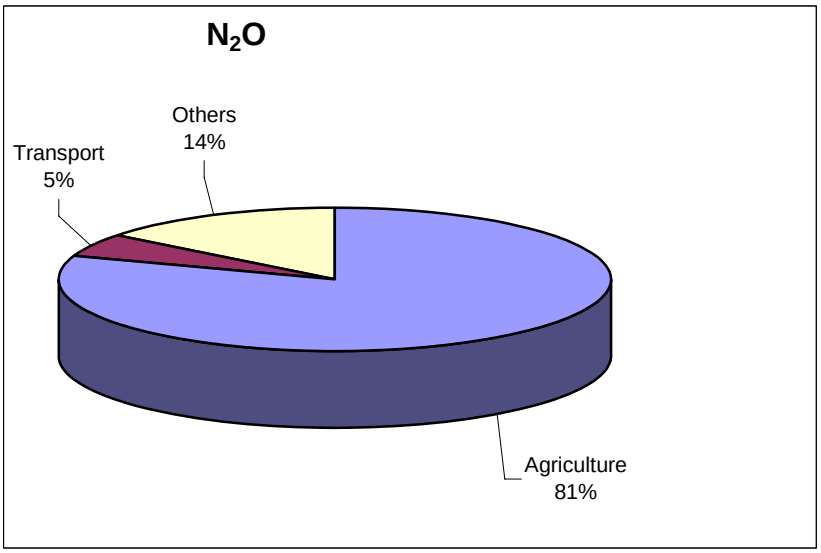


Figure 3-3: N_2O emissions by sector, 2003

3.1.4. Other greenhouse gases (HFCs, PFCs, SF_6)

To date, emissions of HFCs, PFCs and SF_6 have been of marginal importance in Switzerland (about 1.5% of overall gross GHG emissions). For 2003, the following figures (in CO_2 equivalents) have been calculated: 529 Gg HFCs, 66 Gg PFCs and 169 Gg SF_6.

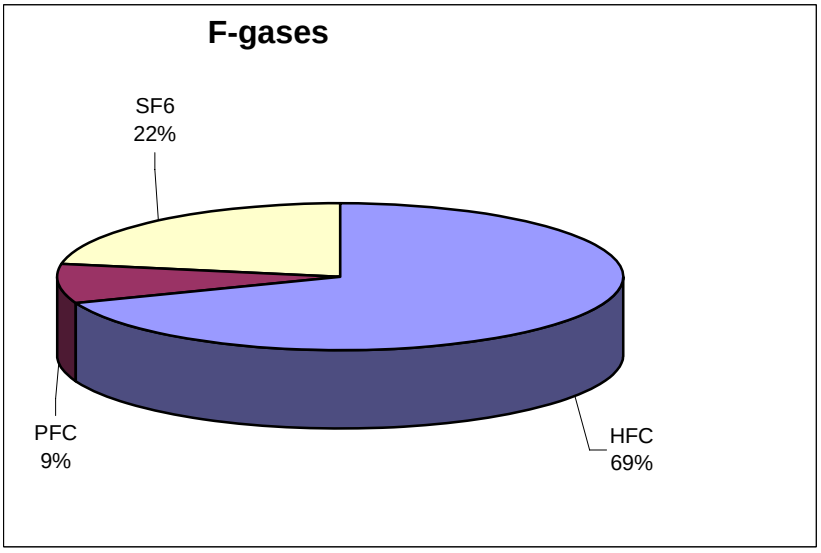


Figure 3-4: Emissions of fluorinated gases, 2003

3.1.5. Precursor gases

NO_X

Of the total of 92 Gg NO_X emissions, 54% came from the transport sector. Other sources were small-scale combustion in the residential/commercial/institutional sectors (10%), agriculture (13%), industry (20%) and waste (3%).

CO

Of the total of 425 Gg CO emissions, 65% originated in the transport sector. About 8% was contributed by small-scale combustion, 18% by industry and 9% by agriculture.

NMVOCs

In total, NMVOC emissions were 125 Gg. The main sources were solvent use in industry (54%) and the transport sector (22%). Industrial combustion and processes accounted for 16% of NMVOC emissions.

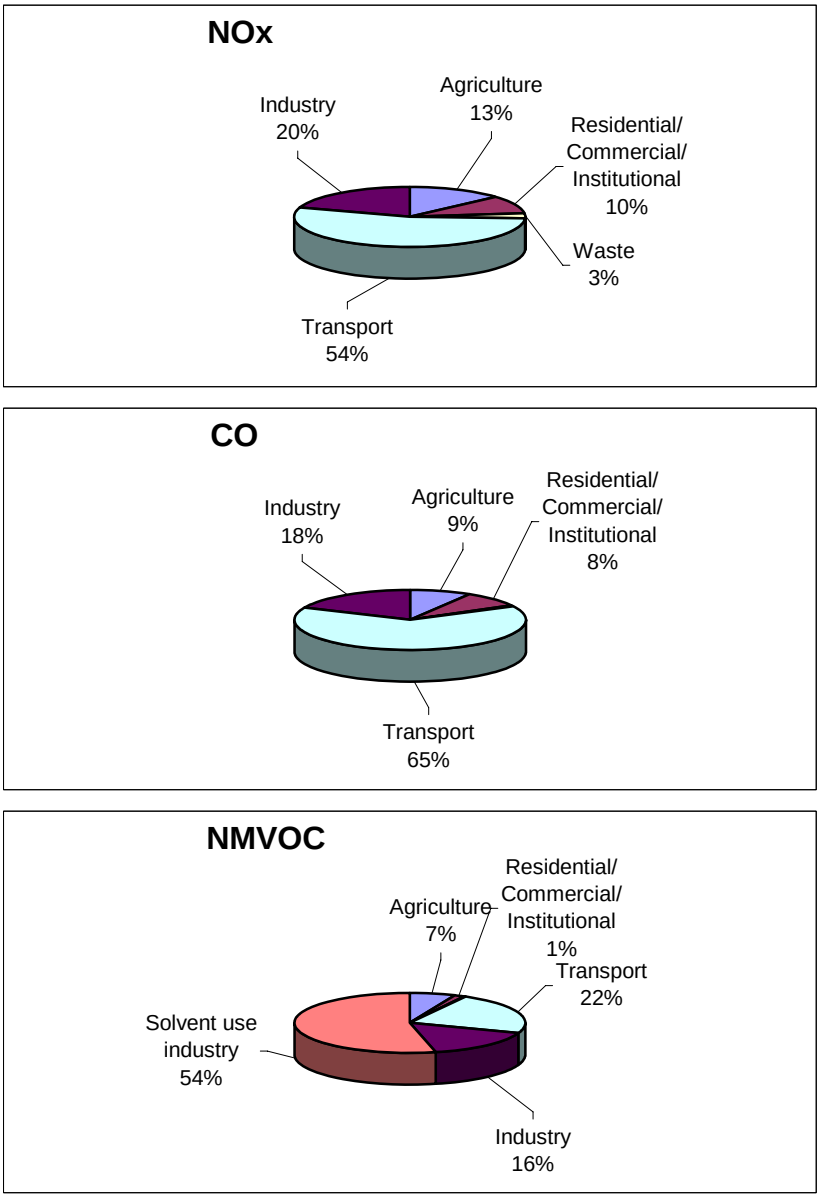


Figure 3-5: Emissions of precursor gases by sector, 2003

3.1.6. SO_2

Unlike the above gases, SO_2 is not a greenhouse gas. Indeed, SO_2 emissions counteract the process of global warming and may mask warming effects at the local to regional scale. Emissions of SO_2 amounted to 18.9 Gg in 2003. Small-scale combustion was the leading contributor (34%), followed by energy-related (30%) and non-energy-related emissions from industry (19%).

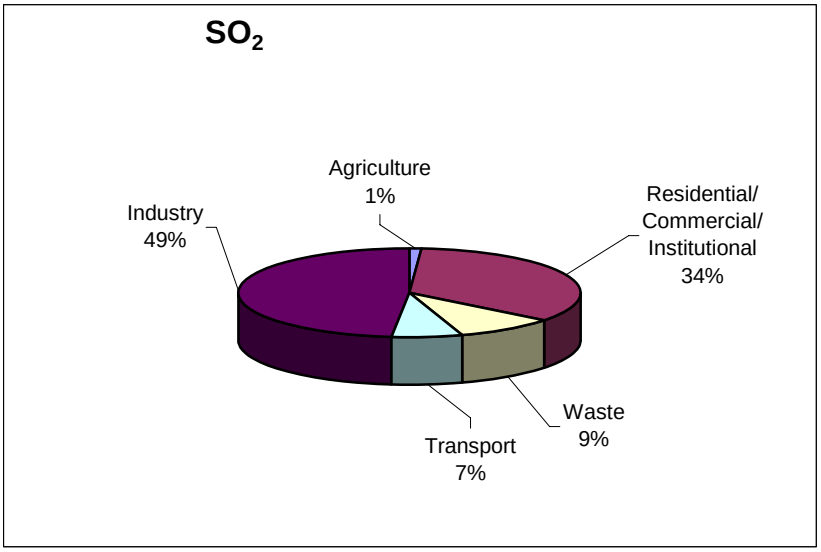


Figure 3-6: SO_2 emissions by sector, 2003

3.1.7. Summary 2003

IPCC n°	Source/sink category	CO_2 000 Gg	CH_4 Gg	N_2O Gg	F-gases 000 Gg CO2 eq.	NO_x Gg	CO Gg	NMVOC Gg	SO_2 Gg
1	All energy	41.72	17.02	0.98	n.o.	84.92	405.18	46.07	13.56
	Fuel combustion	*41.64*	*5.07*	*0.98*	*n.o.*	*84.87*	*405.17*	*39.88*	*13.56*
	Fugitive emissions	*0.08*	*11.95*	*0.00008*	*n.o.*	*0.05*	*0.01*	*6.18*	*0.0004*
2	Industrial processes	1.81	0.45	0.31	0.76	0.32	12.05	7.31	3.46
3	Solvent use	n.o.	n.o.	0.40	n.o.	0.05	0.09	66.82	0.04
4	Agriculture	i.e.	137.99	7.98	n.o.	4.29	5.88	4.22	0.02
6	Waste	1.19	19.36	0.30	n.o.	2.33	1.72	0.26	1.77
	Total gross emissions	**44.72**	**174.81**	**9.97**	**0.76**	**91.89**	**424.93**	**124.68**	**18.85**
5	Land use change and forestry	-1.77	n.o.	n.o.	n.o.	n.o.	n.o.	n.o.	n.o.
	Total net emissions	**42.96**	**174.81**	**9.97**	**0.76**	**91.89**	**424.93**	**124.68**	**18.85**
	International bunkers	*3.67*	*0.23*	*0.12*	*n.o.*	*18.04*	*4.24*	*0.21*	*0.98*

n.o.: not occurring; i.e.: emissions from organic soils included under source category 5 (LUCF)

Table 3-1: Overview of emissions and removals, 2003

3.2. Recent trends in emissions

3.2.1. Overview

Table 3-2 and Figure 3-7 show emission trends for all major source categories. As the largest share of emissions originated from the energy sector, Table 3-2 also shows the contributions of the energy sub-sectors.

Source and Sink Categories	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
	CO_2 equivalent (Gg)													
1 Energy	**40'968**	**43'074**	**43'176**	**40'893**	**40'025**	**40'922**	**41'680**	**41'088**	**42'290**	**42'370**	**41'243**	**42'045**	**41'252**	**42'384**
1A1 Energy Industries	1'425	1'776	1'872	1'562	1'581	1'641	1'821	1'773	2'004	1'799	1'634	1'743	1'762	1'753
1A2 Manufacturing Industries and Construction	6'191	6'109	5'891	5'708	5'786	5'882	5'668	5'624	5'867	5'903	5'897	6'034	5'937	5'936
1A3 Transport	14'382	14'901	15'213	14'153	14'350	14'036	14'064	14'686	14'909	15'523	15'811	15'505	15'406	15'604
1A4 Other Sectors	17'865	19'197	19'121	18'397	17'240	18'308	19'042	17'964	18'478	18'120	16'892	17'748	17'134	18'089
1A5 Other (Offroad)	723	719	715	711	707	703	696	687	679	671	663	666	668	670
1B Fugitive Emissions from Oil and Natural Gas	382	372	364	361	360	351	359	353	353	353	346	348	345	331
2 Industrial Processes	**3'228**	**2'872**	**2'708**	**2'375**	**2'517**	**2'476**	**2'324**	**2'267**	**2'339**	**2'378**	**2'647**	**2'730**	**2'657**	**2'686**
3 Solvent and Other Product Use	**108**	**110**	**112**	**114**	**117**	**119**	**119**	**120**	**120**	**121**	**121**	**121**	**123**	**124**
4 Agriculture	**6'082**	**6'090**	**5'972**	**5'956**	**5'801**	**5'753**	**5'742**	**5'585**	**5'549**	**5'536**	**5'498**	**5'520**	**5'464**	**5'372**
6 Waste	**2'061**	**1'950**	**1'910**	**1'808**	**1'709**	**1'663**	**1'634**	**1'622**	**1'665**	**1'682**	**1'748**	**1'678**	**1'691**	**1'686**
Total (without CO_2 from LUCF)	**52'446**	**54'096**	**53'877**	**51'147**	**50'167**	**50'933**	**51'498**	**50'682**	**51'964**	**52'086**	**51'257**	**52'094**	**51'187**	**52'252**
5 Land-Use Change and Forestry	-1'273	-1'339	-1'424	-2'388	-2'392	-2'355	-2'507	-2'674	-2'602	-2'256	149	450	305	-1'766
Total (with net CO_2 emissions/removals)	51'173	52'757	52'454	48'759	47'776	48'578	48'991	48'008	49'361	49'830	51'406	52'545	51'492	50'485

Table 3-2: Summary of Switzerland's CO_2 equivalent GHG emissions by sector, 1990–2003

The relative contributions of the various source categories are shown for selected years in Table 3-3. During the period under consideration, the share of the energy sector increased slightly (from 78% to 81%), while the other sectors' shares decreased (industrial processes from 6% to 5%; agriculture from 12% to 10%, and waste from 4% to 3%).

Source and sink categories	1990	1995	2000	2003
1 Energy	78.1%	80.3%	80.5%	81.1%
1A1 Energy Industries	*2.7%*	*3.2%*	*3.2%*	*3.4%*
1A2 Manufacturing Industries and Construction	*11.8%*	*11.5%*	*11.5%*	*11.4%*
1A3 Transport	*27.4%*	*27.6%*	*30.8%*	*29.9%*
1A4 Other Sectors	*34.1%*	*35.9%*	*33.0%*	*34.6%*
1A5 Other (Offroad)	*1.4%*	*1.4%*	*1.3%*	*1.3%*
1B Fugitive emissions from oil and natural gas	*0.7%*	*0.7%*	*0.7%*	*0.6%*
2 Industrial Processes	6.2%	4.9%	5.2%	5.1%
3 Solvent and Other Product Use	0.2%	0.2%	0.2%	0.2%
4 Agriculture (without CO_2 from energy use)	11.6%	11.3%	10.7%	10.3%
6 Waste	3.9%	3.3%	3.4%	3.2%
Total (without CO_2 from LUCF)	**100%**	**100%**	**100%**	**100%**

Table 3-3: Relative contributions of source categories to total gross CO_2 equivalent GHG emissions for selected years

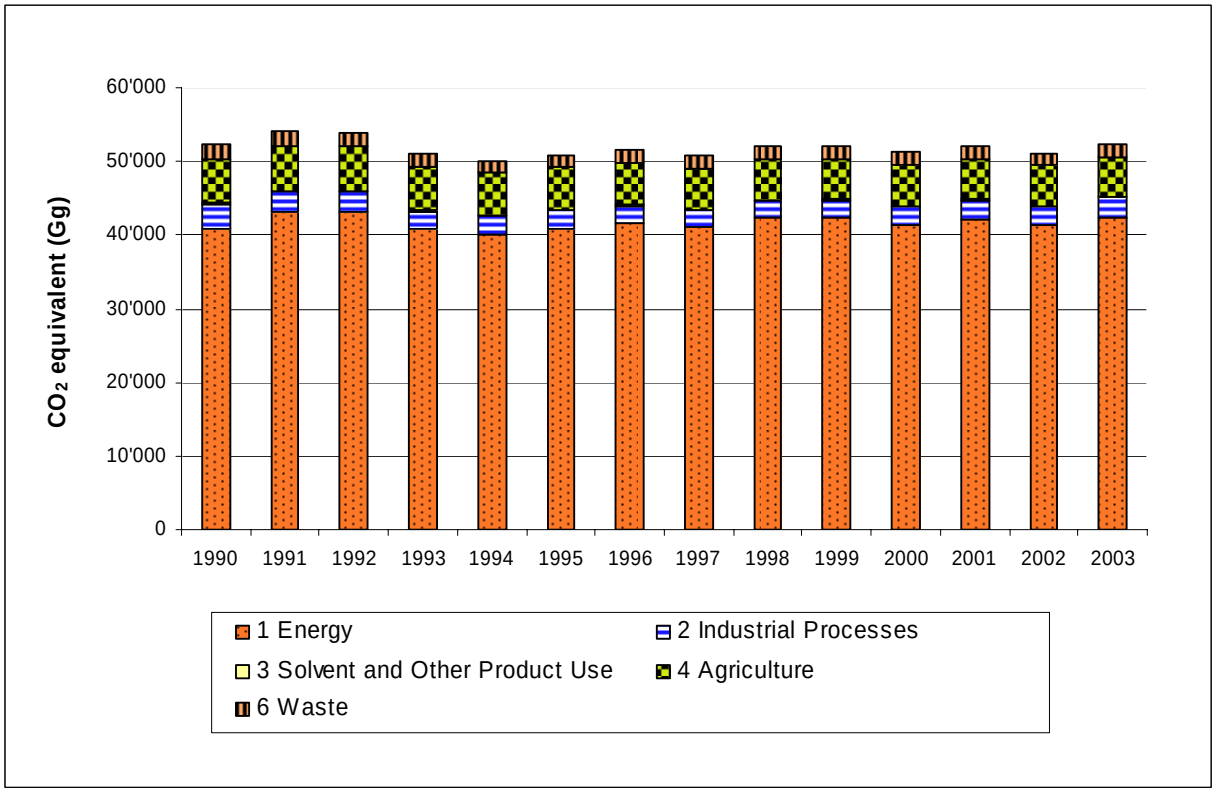


Figure 3-7: CO_2 equivalent GHG emissions by sector (without CO_2 from LUCF), 1990–2003

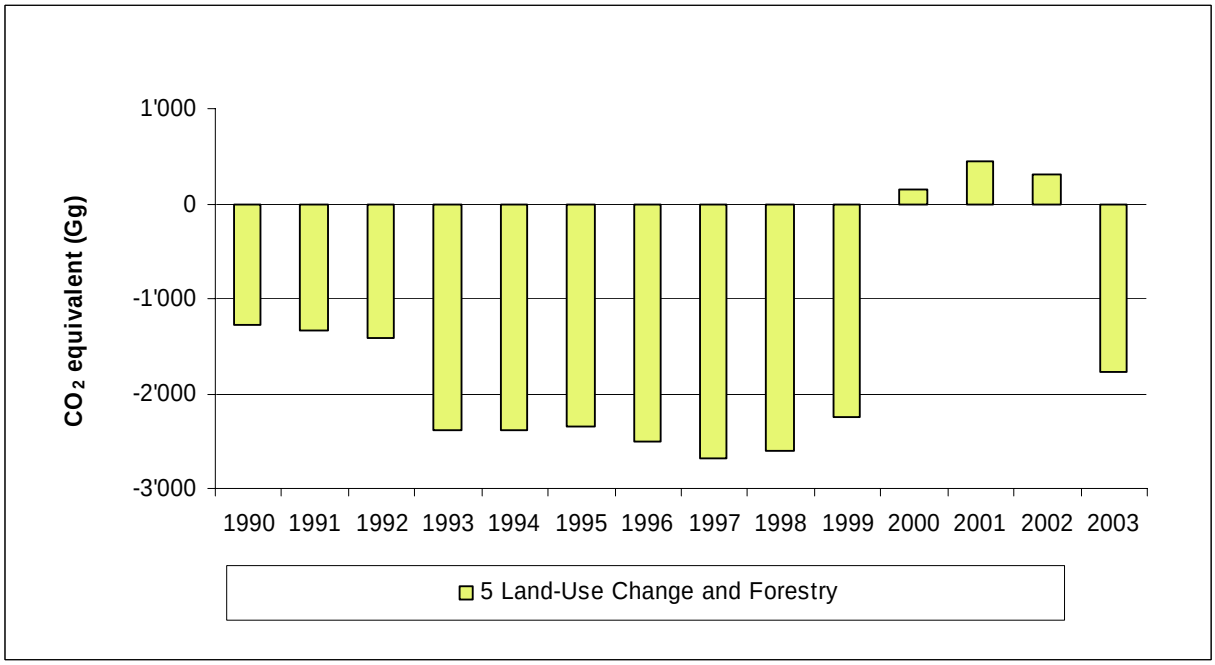


Figure 3-8: GHG removals in the LUCF sector, 1990–2003

Figure 3-8 shows Switzerland's net GHG removals (negative emissions) by sinks in the LUCF sector (at present covering CO_2 removals by forest woody biomass and emissions from organic soils only). In 1990 and 1999, two storms led to significant loss of biomass (the amount destroyed in 1999 was nearly three times higher than average annual net growth of Swiss forests). Disregarding the influence of these extreme events, GHG removals show only slight variations.

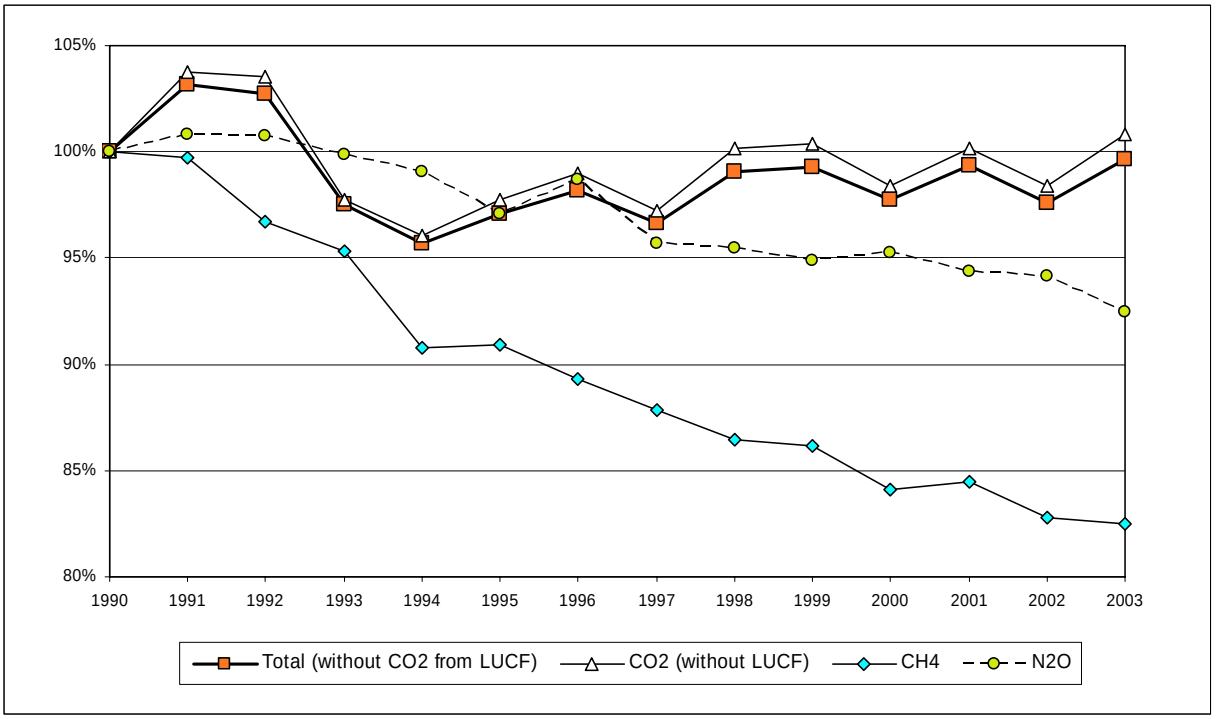


Figure 3-9: GHG emissions relative to the base year 1990 by gas, 1990–2003. The increase in synthetic gases is not shown (274% in 2003, compared to 1990).

Figure 3-9 shows emission trends for the most important greenhouse gases between 1990 and 2003. An interpretation is given in Sections 3.2.2 – 3.2.4.

3.2.2. CO_2

In 1990, gross CO_2 emissions were 44,370 Gg. Subsequently, emissions fluctuated 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 gap between Switzerland and neighbouring countries for petrol and diesel ('fuel tourism').

The 2003 level of 44,720 Gg was very close to the 1990 value. The fact that emissions remained stable can be seen as the result of a combination of two factors: policies/measures influencing GHG emissions (see Chapter 4) and weak economic development in the 1990s (see Section 2.6).

3.2.3. CH_4

CH_4 emissions declined from 212 Gg in 1990 to 175 Gg in 2003, an overall decrease of 17.5%. This trend primarily reflects changes in the agricultural (-10%) and waste sector (-45%), as CH_4 emissions are closely linked to the number of cattle and the amount of landfilled waste. Emissions also declined in the energy sector.

3.2.4. N_2O

N_2O emissions decreased slightly, from 10.8 Gg in 1990 to 10.0 Gg in 2003. This relative stability is the result of two opposing trends: while agricultural emissions declined by 13% between 1990 and 2003, N_2O emissions from the transport and waste sectors tended to increase as a result of increased use of first-generation catalytic converters in passenger cars and waste incineration plants.

3.2.5. Other greenhouse gases

Emissions of HFCs have increased markedly since the beginning of the 1990s, as these gases are increasingly being used as cooling agents. Emissions of SF_6 show both upward and downward trends in its main fields of application – as an insulating gas in electrical equipment and windows, respectively. Due to the patterns of production and consumption in Switzerland, PFCs are of minor importance.

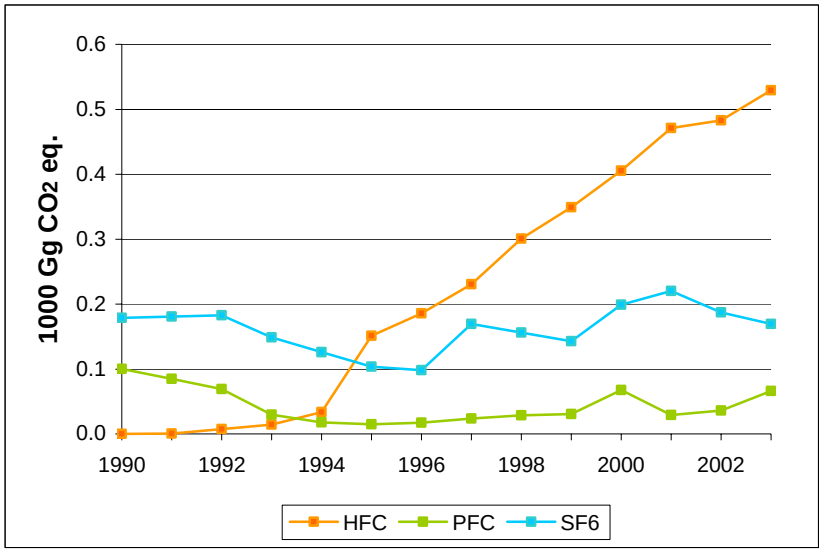


Figure 3-10: Total emissions of HFCs, PFCs and SF_6 between 1990 and 2003

3.2.6. Precursor gases

NO_X

NO_x emissions showed an almost constant decline of about 4% per year from 1990 to 2003. This decline was mainly due to the increased use of catalytic converters in passenger cars.

To a lesser degree, the increasing use of low-NO_x technologies in combustion installations in the 1990s was also responsible for this overall decline.

CO

Decreasing by about 4% per year, CO emissions, too, showed a very marked decline between 1990 and 2003. Again, the main reason for this change was the increased use of catalytic converters in passenger cars.

NMVOCs

Emissions of NMVOCs showed a similar trend, but with an average yearly reduction of about 6%. This reflects the increased use of catalytic converters in passenger cars, as well as more stringent measures to limit emissions from the use of solvents.

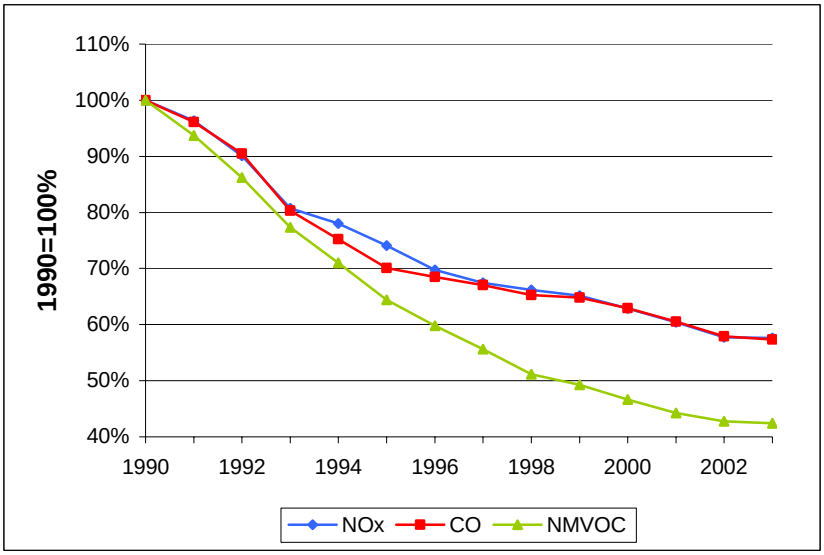


Figure 3-11: Emission trends for precursor gases between 1990 and 2003 (1990=100)

3.2.7. SO_2

SO_2 emissions declined by nearly 60% from 1990 to 2003. This reduction occurred as a result of lower sulphur content in light and heavy fuel oil.

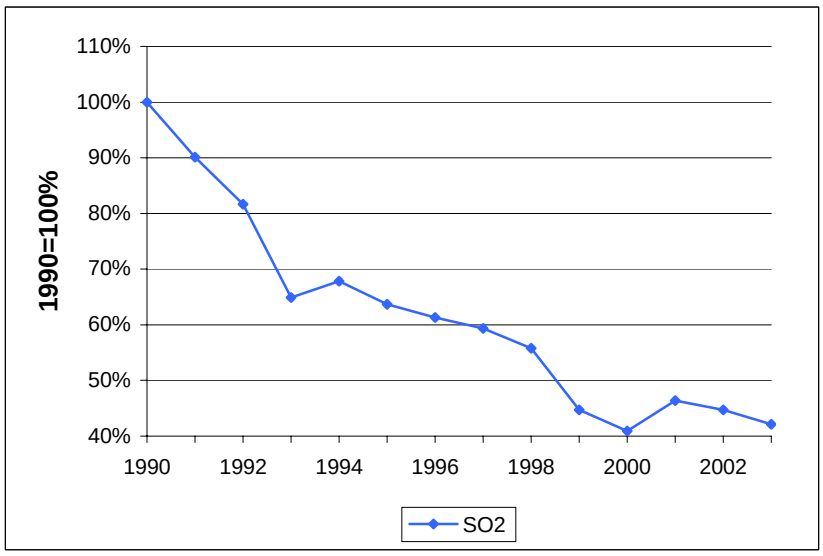


Figure 3-12: Emission trend for SO_2 between 1990 and 2003 (1990=100)

3.3. Overall emissions

3.3.1. CO_2 equivalent emissions by gas

In 2003, based on 1995 GWP values for a 100-year time horizon, Switzerland's gross CO_2 equivalent GHG emissions were 52,250 Gg. If removals by sinks are considered, this amount is reduced to net emissions of 50,490 Gg.

In comparison with 1990 data, there were no significant changes in the relative contributions of CO_2, CH_4 and N_2O to total CO_2 equivalent emissions. CO_2 contributed the largest share of emissions, accounting for 85.6% of the total in 2003.

	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Total
(000 Gg CO_2 eq.)	44.72	3.67	3.09	0.53	0.07	0.17	52.25
Percentage of total	85.59%	7.03%	5.92%	1.01%	0.13%	0.32%	100.00%

Table 3-4: CO_2 equivalent emissions by gas, 2003

3.3.2. CO_2 equivalent emissions by sector

The following sectors were of major importance for their contributions to overall emissions: transport (30%, including 0.5% domestic civil aviation), residential (23%), industry (22%, including 5% non-energy-related emissions), agriculture (12%, including 1.5% CO_2 from agricultural machinery and drying of grass), commercial/institutional (11%) and waste (3%).

Of the total CO_2 equivalent emissions, 81% were energy-related. In 2003, forests once again served as sinks, since the difference between carbon uptake and carbon release was positive (net absorption of 1,800 Gg CO_2 equivalent).

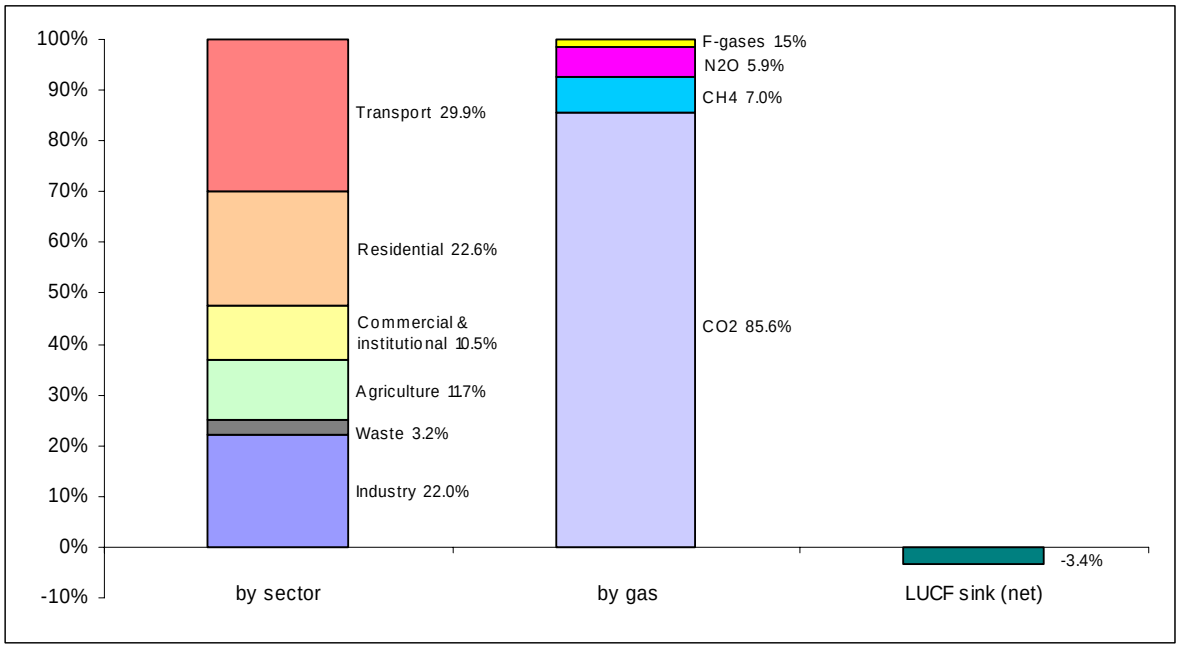


Figure 3-13: Shares of CO_2 equivalent emissions by sector and by gas, 2003 (not including international bunkers)

3.3.3. Recent trend in overall emissions

Between 1990 and 2003, total gross emissions (not including CO_2 in the LUCF sector) remained constant, with fluctuations within a margin of less than ±5%. In 2003, total emissions were at about the same level as in the base year 1990.

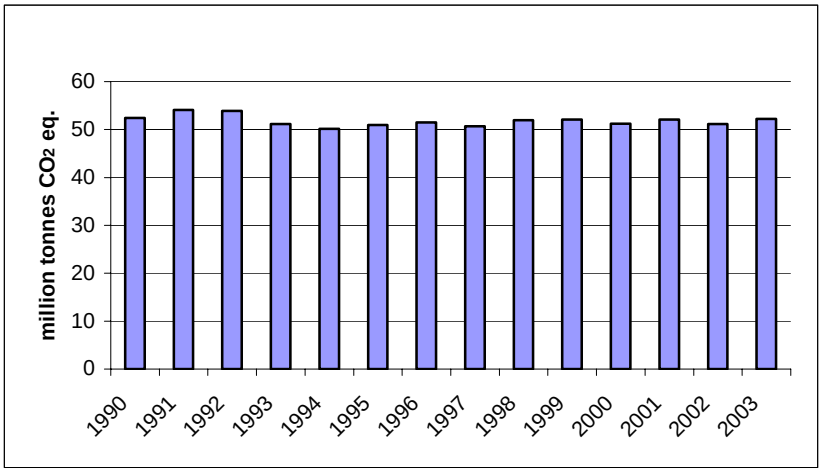


Figure 3-14: Total gross CO_2 equivalent emissions, 1990–2003

3.4. Status of the national inventory system

The Swiss National Inventory System (NIS) is developed and managed under the auspices of the Department of Environment, Transport, Energy and Communications (DETEC). It is hosted by a DETEC agency, the Swiss Agency for the Environment, Forests and Landscape (SAEFL), which is the national entity with overall responsibility for the GHG inventory.

Information relating to the Swiss GHG Inventory is made publicly accessible through a website (www.climatereporting.ch), where detailed contact information is also available.

3.4.1. Institutional setting

As part of a comprehensive project, the SAEFL directorate mandated the agency's Economics, Research and Monitoring Division in early 2004 to design and establish the NIS in order to ensure full compliance with the reporting requirements of the UNFCCC and the Kyoto Protocol by the end of 2006. Having regard to the provisions of Art. 5.1 of the Kyoto Protocol, the project encompasses the following elements:

- Agreements with partner agencies, relating to
  - roles and responsibilities,
  - participation in the inventory development process,
  - data documentation and storage,
  - data use, communication and publication.
- Inventory Development Plan
- QA/QC system

- Official consideration and approval of data
- Upgrading and updating of central GHG emissions database

A SAEFL Inventory Group has been formed to implement and run the NIS. The group consists of the project team at the agency, including a GHG inventory project leader, a National System coordinator, a CRF compilation specialist and database specialists. It is supported by mandated external experts contributing to the preparation of the yearly inventory submission, in particular the National Inventory Report.

The Inventory Group collaborates with several divisions within the agency as well as with several other government agencies that supply relevant data. In addition, certain data are acquired through consultants or industry associations.

Figure 3-15 gives a schematic overview of the institutional setting for the process of inventory preparation within the NIS.

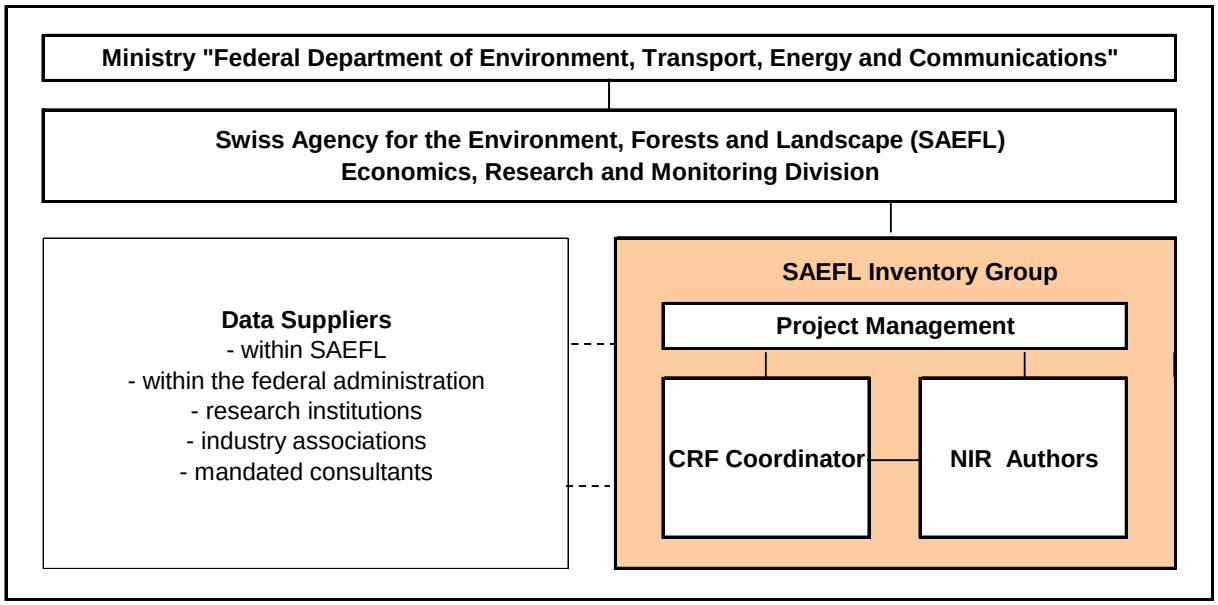


Figure 3-15: Institutional setting for the process of inventory preparation

3.4.2. Roles and responsibilities

The roles and responsibilities of the various actors in inventory-related activities are defined as follows:

SAEFL – Economics, Research and Monitoring Division

- Inventory planning: Definition of roles and responsibilities and conclusion of agreements with contributors to the inventory; establishment of processes for the official consideration, approval and submission of inventory information.
- Inventory preparation: Supervision of compliance with the relevant decisions, guidelines and other guidance; supervision of the implementation of inventory development and QA/QC plans; approval of recalculations; arrangement of independent evaluations of the inventory planning and preparation process and its outcome.
- Inventory management: Supervision of review procedures, in particular of the consideration of issues raised by the inventory review process.

SAEFL Inventory Group

- Inventory planning: Definition and allocation of specific responsibilities in the inventory development process; elaboration of an inventory development and a QA/QC plan; definition of schedules, deadlines and quality objectives.
- Inventory preparation: Supervision of compilation, revision and editing of CRF tables and the NIR; implementation and updating of inventory development and QA/QC plans, periodic internal evaluations of the inventory preparation process.
- Inventory management: Archiving of information on inventory planning and preparation; providing review teams with access to information.

Data suppliers

- Selection of appropriate methods for calculation of emissions.
- Collection of activity data, determination of appropriate emission factors and calculation of emissions.
- Carrying out recalculations.
- Applying QC procedures.
- Implementing relevant tasks specified in the inventory development plan.

The most important data suppliers (as of spring 2005) are listed in Table 3-5.

	Institution	Subject	Data supplied for source category...											References in NIR 2005
			1A1	1A2	1A3	1A4	1A5	1B	R.A.	2	3	4	5	6	
	Data suppliers (annual updates)														
1	SAEFL, Air Pollution Control	EMIS 95 database	x	x		x	x	x		x	x	x		x	SAEFL 1995b
2	SAEFL, Air Pollution Control	Off-road database			x		x								SAEFL 1996a, 2000b
3	SAEFL, Waste Management	Waste Statistics	x	x										x	SAEFL 2003a
4	SAEFL, Hazardous Substances	Import Statistics F-gases								x					SAEFL 2004e
5	SAEFL, Forest Agency	Forest Statistics											x		SFSO 2003
6	SFOE	Global Energy Statistics	x	x	x	x		x	x						SFOE 2003
7	FOCA/BAZL	Air traffic			x										FOCA 2004
8	BABLW	Military Aviation			x										BABLW 2003
9	SFSO	Agric. + Land use data										x	x	x	SFSO 2003, 2004, 2004a
10	FAL	Agric. + Land use change										x	x		SBV 2004; SFSO 2003, 2004
11	WSL	National Forest Inventory											x		SFSO 2004a
12	Cepe/Basics	Energy Consumption		x		x									Cepe 2004, Basics 2004
13	Ind. suppliers: SGCI, Swissmem, VSAI etc.	Synthetic gases								x					Carbotech 2005
14	Swiss Petroleum Ass. (Erdölvereinigung)	Oil Statistics							x						EV 2004
15	Cemsuisse	Cement, clinker prod.		x						x					cemsuisse 2004
	Data suppliers (episodic updates)														
16	SVGW	Gas distribution losses						x							GWA 2004
17	EMPA	Various emission factors	x	x	x	x									NIR 2005, Annex 2.1
18	INFRAS	On-road Emission Model			x										SAEFL 2004a
19	Electrowatt	Off-road activity data			x	x	x								SAEFL 1996a, 2000b
20	TTM Meier	Off-road emission factors			x	x	x								SAEFL 1996a, 2000b
21	INFRAS	Off-road emission model			x	x	x								SAEFL 1996a, 2000b
22	Sigmaplan (based on SFSO area statistics)	Land use change											x		SAEFL 2005c

Table 3-5: Internal (nos 1–5) and external (nos 6–22) data suppliers

CRF coordinator

- Compilation of emissions data; generation of Internal GHG Files.
- Transferring inventory data to CRF tables.
- Carrying out recalculations.
- Ensuring completeness and consistency of inventories.
- Implementation of tasks specified in the inventory development plan concerning CRF tables.
- Documentation of inventory information; archiving of the inventory.

NIR authors

- Carrying out key source analyses.
- Carrying out uncertainty analyses.
- Documentation of the inventory, including QA/QC activities.
- Implementation of tasks specified in the inventory development plan concerning the NIR.
- Editing of the NIR, including checking of consistency between CRF tables and the NIR.

The roles and responsibilities are defined through:

- memoranda of understanding within SAEFL,
- agreements with the other government agencies involved,
- agreements with research institutions and industry associations,
- contracts with consultants.

Conclusion of memoranda of understanding, agreements and contracts is under way and is planned to be completed by early 2006.

3.4.3. Development of emission estimates

SAEFL maintains internal GHG inventory files which contain all the basic data needed to set up the UNFCCC Greenhouse Gas Inventory in the CRF. The underlying data used to compile the internal inventory files are collected by the various data suppliers. Figure 3-16 illustrates in a simplified manner the data collection and processing steps leading to the CRF tables required for reporting under the UNFCCC.

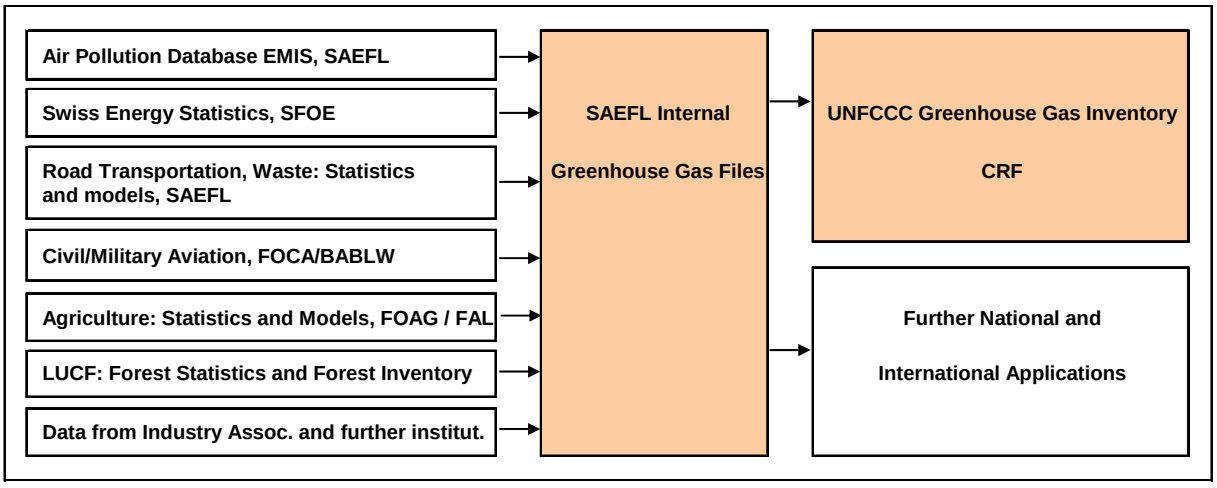


Figure 3-16: Data collection for SAEFL Internal GHG Files and CRF tables

Since the individual data suppliers bear the main responsibility for the quality of the data provided, they are also responsible for the collection of activity data and for the selection of emission factors and methods. However, the relevant guidelines, including IPCC Good Practice Guidance, are to be taken into account. Supervision of data suppliers by the SAEFL inventory group, together with QA/QC and review procedures, provides additional safeguards to maintain or improve the consistency, completeness and accuracy of inventory data.

3.4.4. Key source identification

The key source analysis is performed according to the IPCC Good Practice Guidance (IPCC 2000, chapter 7): a Tier 1 level and trend assessment is applied with the proposed threshold of 95%. For 2003, 34 sources were identified as key sources.

Of the 34 key sources, 19 are in the Energy sector, contributing 80% to total CO_2 equivalent emissions in 2003. The other key sources are from the sectors Industrial Processes (4.5%), Agriculture (9.9%), and Waste (3.0%). There are two major key sources:

- CO_2 emissions from petrol consumption in the transport sector (source category 1A3b Energy, Fuel Combustion, Road Transportation, Gasoline): 22.0% of total emissions;
- CO_2 emissions from light fuel oil consumption in the residential sector (source category 1A4b Energy, Fuel Combustion, Other Sectors, Residential sector, liquid fuels): 18.2% of total emissions.

The ten most important key sources contribute almost 80% to total greenhouse gas emissions. Table 3-6 shows the contributions of the individual key sources (IPCC source category definitions).

No.	Code	Sector Fuel	Gas	1990	2003	Contribution			Key Source by	
				Gg CO_2 eq		level	level cum.	trend	level	trend
9	1A3b	A. Fuel Combustion Gasoline	CO_2	11'269	11'503	22.01%	22.01%	2.79%	yes	yes
16	1A4b	A. Fuel Combustion Liquid Fuels	CO_2	10'234	9'522	18.22%	40.24%	6.82%	yes	yes
14	1A4a	A. Fuel Combustion Liquid Fuels	CO_2	4'448	4'079	7.81%	48.04%	3.57%	yes	yes
8	1A3b	A. Fuel Combustion Diesel	CO_2	2'493	3'535	6.77%	54.81%	10.62%	yes	yes
5	1A2	A. Fuel Combustion Liquid Fuels	CO_2	3'383	3'039	5.82%	60.62%	3.35%	yes	yes
27	4A	A. Enteric Fermentation	CH_4	2'767	2'492	4.77%	65.39%	2.67%	yes	yes
15	1A4b	A. Fuel Combustion Gaseous Fuels	CO_2	1'409	2'218	4.25%	69.64%	8.23%	yes	yes
4	1A2	A. Fuel Combustion Gaseous Fuels	CO_2	1'131	2'013	3.85%	73.49%	8.95%	yes	yes
20	2A1	A. Mineral Products; Cement Production-CO2	CO_2	2'524	1'618	3.10%	76.59%	9.07%	yes	yes
13	1A4a	A. Fuel Combustion Gaseous Fuels	CO_2	932	1'396	2.67%	79.26%	4.73%	yes	yes
30	4D1	D. Agricultural Soils; Direct Soil Emissions	N_2O	1'390	1'208	2.31%	81.57%	1.79%	yes	yes
34	6C	C. Waste Incineration	CO_2	1'109	1'186	2.27%	83.84%	0.82%	yes	yes
17	1A4c	A. Fuel Combustion Liquid Fuels	CO_2	656	735	1.41%	85.25%	0.83%	yes	yes
2	1A1	A. Fuel Combustion Liquid Fuels	CO_2	691	706	1.35%	86.60%	0.17%	yes	
31	4D3	D. Agricultural Soils; Indirect Emissions	N_2O	819	683	1.31%	87.90%	1.35%	yes	yes
18	1A5	A. Fuel Combustion Liquid Fuels	CO_2	709	655	1.25%	89.16%	0.52%	yes	yes
3	1A1	A. Fuel Combustion Other Fuels	CO_2	430	634	1.21%	90.37%	2.08%	yes	yes
7	1A2	A. Fuel Combustion Solid Fuels	CO_2	1'474	565	1.08%	91.45%	9.13%	yes	yes
26	2F1	F. Consumption of Halocarbons and SF6; Refr	HFC	0.02	471	0.90%	92.35%	4.76%	yes	yes
28	4B	B. Manure Management	CH_4	452	400	0.77%	93.12%	0.51%	yes	
29	4B	B. Manure Management	N_2O	448	397	0.76%	93.88%	0.50%	yes	
32	6A	A. Solid Waste Disposal on Land	CH_4	707	372	0.71%	94.59%	3.37%	yes	yes
1	1A1	A. Fuel Combustion Gaseous Fuels	CO_2	235	370	0.71%	95.30%	1.38%	yes	yes
6	1A2	A. Fuel Combustion Other Fuels	CO_2	145	271	0.52%	95.82%	1.27%		yes
19	1B2	B. Fugitive Emissions from Fuels	CH_4	307	251	0.48%	96.30%	0.56%		yes
11	1A3b	A. Fuel Combustion Gasoline	N_2O	87	143	0.27%	96.93%	0.56%		yes
12	1A3e	A. Fuel Combustion Liquid Fuels	CO_2	200	135	0.26%	97.45%	0.66%		yes
22	2C3	C. Metal Production; Aluminium Production-C0	CO_2	139	70	0.13%	98.66%	0.69%		yes
23	2F_o	F. Consumption of Halocarbons and SF6 witho	HFC	--	58	0.11%	98.91%	0.59%		yes
24	2F_o	F. Consumption of Halocarbons and SF6 witho	SF6	114	57	0.11%	99.01%	0.58%		yes
25	2F	F. Consumption of Halocarbons and SF6	PFC	0.04	54	0.10%	99.12%	0.55%		yes
10	1A3b	A. Fuel Combustion Gasoline	CH_4	91	27	0.05%	99.43%	0.64%		yes
21	2C3	C. Metal Production; Aluminium Production-PF	PFC	100	12	0.02%	99.78%	0.89%		yes
33	6A	A. Solid Waste Disposal on Land	CO_2	155	1.5	0.00%	99.97%	1.54%		yes

Table 3-6: Switzerland's key sources: contributions in level and trend analysis, and cumulative contributions ("level cum.")

3.4.5. Recalculation of data

Where deemed necessary to improve the quality of the inventory, recalculations are carried out and documented by the CRF coordinator or the individual data suppliers in consultation with the inventory project leader. Recalculations will be addressed in the context of the official consideration and approval of the inventory once the relevant process has been determined by a government decision. This decision is expected to be taken in the summer of 2006.

3.4.6. QA/QC activities

A draft QA/QC plan was established in early 2005. It builds on the activities and procedures summarized in Table 8.1 of the Good Practice Guidance (IPCC 2000). Many of these are being applied but have not been documented in a systematic manner so far. An initial assessment of on-going QA/QC activities was carried out in the context of preparations for the first NIR submitted in 2004. At the same time, the correspondence of methods used for estimating emissions with the recommendations of the IPCC Good Practice Guidance was evaluated. Further input to the definition of the QA/QC plan was provided by the findings of the first in-depth expert review of the Swiss GHG inventory, which was carried out in September 2004. As a result, a number of checklists have been developed for use in the various stages of inventory preparation.

In 2005, the QA/QC plan will be finalized, supplemented with an implementation schedule and put into force for use in the preparation of the 2006 inventory submission. Along with the implementation of the QA/QC plan, systematic documentation of all QA/QC-related activities will be introduced. As regards quality assurance, systematic independent assessment of the procedures and outputs of the inventory planning, preparation and management process will be initiated by means of a domestic review of the inventory starting in late 2005.

A total quality management system was introduced at SAEFL in 2004. The procedures involved represent an additional element of independent review and quality assurance. The processes preceding the submission and publication of inventory data are defined in the agency's QM system. In early 2005, the first audit of the implementation of internal QA procedures for GHG inventory-related activities was carried out. The findings are to be fed back into the inventory development process.

3.4.7. Procedures for official consideration and approval of the inventory

Formal procedures for official consideration and approval of the inventory will be defined in the summer of 2006 by a government decision concerning the implementation of the Kyoto Protocol in Switzerland.

References

SAEFL, 2005, Swiss Greenhouse Gas Inventory 2003.

IPCC, 1996, Revised IPCC Guidelines for National Greenhouse Gas Inventories, Vols 1-3.

IPCC, 2000, Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories

4. Policies and measures

4.1. The role of climate policy in Swiss sectoral policies

Climate policy in Switzerland is incorporated into other sectoral policies that existed well before climate change became an important issue. All policies are embedded in a general approach of sustainable development. Switzerland has therefore elaborated an action plan on sustainable development, providing guidelines for all policy sectors. A cornerstone of this general sustainability strategy is the cross-sectoral approach to the issue of climate change (see cross-sectoral policies, Section 4.3.1). The CO_2 Act (see Section 4.2.2) establishes a broad framework for measures designed to reduce CO_2 emissions. The following areas of policy relate to the issue of climate change and are discussed in detail in this chapter and in Chapter 7.

Area of policy	Aims and highlights
Sustainability	Sustainable development is embedded in the Swiss constitution and provides a baseline for all sector policies: Consistency of different sectoral policies according to general criteria considering environmental, economic and social concerns. “Sustainable Development Strategy 2002” with an action plan including measures for “refinement of energy and climate protection policy” and “sustainability assessment”.
Environment	Emission reduction targets and timeframe stipulated in the CO_2 Act adopted in 1999. Policies on air pollution and on waste based on the Federal Act on the Protection of the Environment, with a number of important ordinances, e.g. the Ordinance on Air Pollution Control, Technical Ordinance on Waste Disposal, Ordinance relating to Environmentally Hazardous Substances.
Energy	Most CO_2 emissions are energy related. The CO_2 Act is fully compatible with energy policy approaches such as the Energy Act and the related energy efficiency programmes (‘SwissEnergy’ action plan).
Transport	Serious consideration of environmental aspects (especially in the case of road transport). Modernization of the railway infrastructure. Agglomeration policy focusing on improvement of the transport infrastructure in order to prevent uncontrolled urban sprawl and traffic growth. Priority for non-motorized traffic and public transport as backbones of mobility in urban areas. Policy favouring rail for transalpine freight and passenger transport, and the internalization of external costs.
Agriculture	Incentives for environmentally friendly production methods (agricultural reform).
Forestry	Sustainable logging; ban on clearance and clear-cutting, preservation of forested area.
Foreign economic issues and international affairs	Implementation of cooperation and development commitments under the UNFCCC. Fund for global environmental projects as a cornerstone of bilateral activities.
Finance	Green tax and budget reforms.

Table 4-1: Overview of policy areas relevant to climate change

For general information on policy-making in Switzerland, see Section 2.1.

4.2. General policy context

4.2.1. Most important developments since 2001

- Switzerland ratified the **Kyoto Protocol** in July 2003. Ratification was approved overwhelmingly by both chambers of Parliament.
- The national secretariat for the **flexible mechanisms** (Designated National Authority) has been established in 2004. Activities relating to the implementation of the flexible mechanisms, as well as the examination and approval of project proposals, are coordinated by an interdepartmental working group. Use of the flexible mechanisms is governed by rules defined at the international level (UNFCCC, CDM Executive Board). For the time being, the Swiss government does not propose to allocate a budget for the acquisition of certificates from CDM/JI projects. The major user of the flexible mechanisms is likely to be the private "Climate cent" foundation (see below). An ordinance concerning the requirements for CDM/JI projects, as well as the amount of certificates from abroad which can be used for compliance (supplementarity), was adopted by the Federal Council in June 2005. The National Registry is expected to be implemented and operational by mid-2006, or in conjunction with the independent transaction log (ITL).
- The following table gives an overview of important milestones in **Swiss energy policy** since 2001.

January 2001	Federal Councillor Leuenberger officially launches the 'SwissEnergy' programme as a successor to the 'Energy 2000' programme.
July 2001	Signature of service agreements with the Energy Agency for the Economy and the Agency for Renewable Energies and Energy Efficiency. Publication of 'Guidelines on voluntary measures aimed at reducing energy consumption and CO_2 emissions'.
September 2002	Rejection by the electorate in a referendum of the Electricity Market Act, aimed at opening the market in two steps.
May 2003	Rejection by the electorate of two popular initiatives opposing the use of nuclear power.

Table 4-2: Milestones in Swiss energy policy since 2001

- Annual expenditure on the **SwissEnergy programme** (see Section 4.2.3.2) decreased from CHF 75 million in 2001 to CHF 63 million in 2003 (-15%). Under its 2003 retrenchment programme, the Federal Council proposed to cancel the budget altogether as of 2005. However, this aroused strong opposition, especially among the cantons. As a result, Parliament reduced the regular budget from CHF 55 million to 49 million in 2004, and to CHF 45 million as of 2005 (-40% from 2001 to 2005).
- Following the publication of guidelines for **voluntary measures** in July 2001, the business community embarked on the process of concluding voluntary agreements under the umbrella of the privately run Energy Agency for the Economy (see Section 4.2.3.2). Despite these efforts, the need for an incentive tax in both the transport and the household/industry sector remained apparent. As a counterproject to the impending CO_2 tax, the Swiss Oil Association proposed to levy a "**climate cent**" on motor fuels to fund mitigation projects within and outside Switzerland. In March 2005, following a consultation exercise, the Federal Council decided to introduce a **CO_2 tax on process and heating fuels** and to accept the climate levy on motor fuels as a provisional measure until 2007 (see Sections 4.2.2 and 4.4.1).
- In 2002, the Federal Council adopted its **Sustainable Development Strategy 2002**, comprising an action plan with ten action areas and 22 measures. In action area 6 (Environment and natural resources), measure 9 (Refinement of energy and climate protection policy) calls for effective implementation of the national CO_2 Act in accordance with the Kyoto Protocol, and – for the period after 2010 – the development of new objectives according to the "2000-watt society" scenario (see Section 4.2.3.3). Sustainability assessment

(measure 22) is designed to promote the mainstreaming of sustainable development in all relevant policy fields (see Section 4.3.1).

- **Transport policy:** Since the last national communication, Switzerland has enhanced the coordination between spatial development and transport infrastructure and elaborated strategies for the improvement of infrastructure (all transport modes) in urban/suburban areas (agglomerations). At the same time, the range of Swiss public transport services has been extended (RAIL 2000 project). The modal shift of freight transport from road to rail, facilitated by the heavy vehicle fee, has been successfully initiated. In 2005, the HVF-rate has been increased up to 2.5 Swiss cents (average) with an increase of the weight limit up to 40 tonnes in parallel (see Section 4.3.4). Furthermore, aviation policy has been overhauled following the grounding of the national carrier Swissair in 2001 (see Section 4.2.4.2).
- An effort has been made to regulate **synthetic GHG emissions** under the generic name of "substances stable in the air". The revised Ordinance Relating to Environmentally Hazardous Substances entered into force on 1 January 2004. The regulation is based on three main lines of action: 1) to limit the use of substances stable in the air to those applications where there is no preferable alternative; 2) when such substances are used, to reduce emissions as far as possible; and 3) to adopt voluntary binding agreements developed by the industry (SF_6 in the high-voltage equipment sector) (see Section 4.3.5).
- As a result of the **Agriculture reform** introduced in the 1990s, recent years have seen significant improvements in the area of agricultural GHG emissions. Various indicators show that Swiss agricultural production is now considerably more market-oriented and environmentally sound. Restructuring in the direction of larger-scale farms or farms deploying resources in partnership with other enterprises is likely to continue at the same rate. The key challenge for the agricultural sector at the current stage of the reform process is to ensure that the tasks stipulated by the constitution can still be fulfilled despite decreasing protection of the domestic market (WTO, free trade agreement with the EU) and scarce federal funds (see Section 4.2.5).
- Switzerland has elaborated a **National Forest Programme** designed to improve, in a sustainable manner, the economic, ecological and the protective functions of the forest (see Section 4.2.6).

4.2.2. Environmental and climate policy

The principles and instruments of Swiss environmental policy are formulated in the Federal Act on the Protection of the Environment, adopted in 1985 and revised in 1995 and 2003. This modern legislative framework has been supplemented by the Act on the Reduction of CO_2 Emissions, which was adopted in 1999. These two laws provide the basis for the Swiss national policy on climate change.

Both pieces of legislation have a direct bearing on compliance with commitments under the Kyoto Protocol. The CO_2 Act covers about 75% of Switzerland's GHG emissions. The Environmental Protection Act provides for measures to mitigate emissions from waste disposal (CH_4), synthetic gases (HFC, PFC, SF_6) and GHG precursors. Fiscal incentives are recognized as an essential instrument for promoting the efficient use of resources. In the long run, energy and climate policy are guided by the vision of the "2000-watt society", which corresponds to per capita emissions of one tonne of CO_2 per year (see Section 4.2.3.3).

At present, an informal group of representatives of several ministries under the chairmanship of the Swiss Agency for Environment, Forests and Landscape (SAEFL) is ensuring that international developments are followed up at the national level.

The Federal Act on the Protection of the Environment

A number of regulations (ordinances) addressing climate change are associated with the Federal Act on the Protection of the Environment. The most important of these are the following:

- The **Ordinance on Air Pollution Control** (1985, revisions 1992, 1997, 1999 and 2003) contains precautionary emission limits and air quality standards designed to protect public health. Precautionary emission limits have to be tightened if air quality standards are not met either locally or regionally. Specific new measures have been introduced to reduce VOC emissions from solvents and to promote low-sulphur fuel through an incentive tax. An emission-related heavy vehicle fee has also been implemented (see Section 4.3.4). Policies implemented earlier have been brought into line with the EU approach of tightening air pollution limits and exhaust emission limits for all motor vehicles.
- The **National Clean Air Strategy** (1986, reviewed in 1996 and 1999) defines national targets and measures to reduce emissions of SO_2 and GHG precursors such as NO_X and NMVOCs. By 2000, compared with maximum levels between 1980 and 1985, NO_X emissions had been reduced by 45% and NMVOC emissions by 54%. However, further reductions are necessary so as to avoid excessive levels of ozone, particulate matter and nitrogen deposition in particular. The National Clean Air Strategy is **currently being reviewed** to evaluate achievements to date and identify gaps that need to be closed if protection objectives are to be met by 2020. The review report also assesses new technological developments with a view to possible revision of Swiss legislation, taking 'Best Available Techniques' into account, and further exploration of measures to abate air pollution. Consideration is to be given to the question of how air pollution control and climate protection are interrelated (e.g. in connection with the requirements for promotion of diesel-powered vehicles).
- The **Technical Ordinance on Waste Disposal** (1991, revisions 1993, 1996, 1998, 2000) defines the national framework for waste management and introduces a consistent control and monitoring system.
- The **Ordinance Relating to Environmentally Hazardous Substances** (1986, climate-related revisions 1995, 2003) provides for measures to control emissions of persistent substances with a high global warming potential (HFCs, PFCs, SF_6) in almost all sectors. Since the beginning of the 1990s, the Federal Council has been recommending the greatest restraint in the use of these gases, in keeping with its integrated product policy. However, their use is increasing and in 2003 they represented around 1.5% of anthropogenic GHG emissions in Switzerland. Recent projections indicate a further 50% increase in synthetic GHG emissions by 2010. New provisions have been drawn up in consultation with the cantons and the industrial and commercial sectors concerned. They define a clear framework, allowing sectors to take strategic choices promptly in order to limit atmospheric emissions of synthetic GHGs.

The CO_2 Act

Adopted by Parliament in October 1999 and in force since May 2000, the CO_2 Act covering energy-related CO_2 emissions provides the principal legal basis for compliance with Switzerland's Kyoto commitments. To limit the use of fossil fuels accounting for about 75% of Switzerland's GHG emissions, the CO_2 Act stipulates reduction targets for 2010 compared to 1990 levels. Apart from an overall reduction target of 10%, emissions from heating/process fuels are to be lowered by 15% and emissions from transport fuels by 8%. In lowering fossil fuel consumption, priority is to be given to voluntary action. However, if voluntary and other CO_2-related measures do not suffice, the Federal Council is authorized to resort to an incentive tax. The tax rates depend on the shortfalls in meeting the sectoral targets and require the approval of Parliament. Net revenues are to be fully redistributed to the population on a per-capita basis and to businesses as a percentage of wages paid. The need for a CO_2 tax is determined by means of energy projection models (see Section 5.1.1). In assessing how far CO_2 reduction targets have been met, all relevant measures in other policy sectors are to be taken into account. The CO_2 Act allows for the use of flexible mechanisms supplemental to domestic action. The implementation of this provision is regulated in an ordinance. The way in which flexible mechanisms may be used with a view to meeting the Kyoto target is summarized in Section 5.5.2.

With the need for an incentive tax confirmed by periodically updated energy projections, the Swiss Oil Association, supported by economiesuisse, auto-schweiz and the TCS, proposed the "climate cent" as an additional voluntary measure to facilitate compliance with the CO_2 reduction targets. Importers are to levy a surcharge on transport fuels and pay the revenues into a fund for the financing of mitigation projects within Switzerland and project-based flexible mechanisms. Funds will be managed by a newly established non-governmental foundation.

In June 2004, the Federal Council decided to submit for consultation four options for compliance with the CO_2 reduction targets: 1) a CO_2 tax; 2) a CO_2 tax with revenues partly earmarked for use in the area of flexible mechanisms; 3) a CO_2 tax on process/heating fuels only, combined with a voluntary "climate cent" levied on transport fuels and 4) a "climate cent" only. A report comparing the mitigation, economic and financial impacts of these four options was open for stakeholder comments from October 2004 to January 2005. Based on the results of this consultation, the Federal Council decided in the spring of 2005 to adopt the third option (see Section 4.4.1).

Promotion of climate-friendly environmental technology

Switzerland has a long tradition of developing advanced environmental technologies. The promotion of innovations in environmental technology is considered by the government to be of strategic importance as part of Switzerland's contribution to addressing global environmental challenges. In 1997, a new paragraph (Article 49.3) was added to the Environmental Protection Act, providing for financial support for the development of environmentally beneficial technologies. The federal programme subsequently established is run by SAEFL. By the end of 2004, the programme had supported 120 projects, with grants amounting to about CHF 20 million.

As the importance attached to energy efficiency and the production and use of renewable energy has constantly increased, the promotion of environmental technology also creates positive effects for climate policy. This is the case, for example, when "green" electricity is generated by waste incineration plants, or when biogas produced by sewage treatment plants is processed for injection into the normal gas distribution system. Such projects are supported by SAEFL in conjunction with the SFOE. Similarly, new potentials are developed when industrial production systems are optimized (this is known as "cleaner production"); for example, an energy-intensive system to eliminate VOCs from the air may be turned into an energy source through the use of new catalytic processes. A national initiative to promote cleaner production – including energy and eco-efficiency – is currently being launched by a consortium of partners comprising federal and regional authorities, scientific institutions, private firms and industry associations.

4.2.3. Energy policy

4.2.3.1. Legal framework

Article 89 of the Federal Constitution obliges the government to provide an adequate and secure energy mix that is economically as well as environmentally sound. Energy efficiency is to be enhanced, taking account of regional equity and economic viability.

The **Federal Energy Act of 1998** and the associated ordinances provide the legal framework for federal energy policy. This policy calls for extensive cooperation with the private sector, reaffirms the principle of subsidiarity for state intervention and gives priority to voluntary measures. In addition, the division of responsibilities between the federal government and the cantons is regulated. The Confederation can provide funds for cantons that have established programmes promoting energy efficiency and renewable forms of energy. In the context of voluntary agreements, the tasks of coordination, evaluation, monitoring and reporting are delegated to private energy agencies. This is compatible with the spirit of the CO_2 Act (see Section 4.2.2), which gives priority to voluntary action over a command-and-control approach. To some extent, voluntary agreements covered by the Energy Act coincide with private-sector initiatives to avoid the need for a CO_2 tax, on the one hand, and to gain exemption if such a tax is introduced, on the other.

Under the Energy Act, responsibility for the implementation of measures lies with the cantons, particularly with regard to energy requirements for buildings and the preparation of the cantons'

own support programmes (e.g. procedures for the payment of subsidies). On 24 August 2000, the Conference of Cantonal Energy Directors (EnDC) agreed on a package of standard energy regulations to promote harmonization in energy legislation. Most cantons have revised their energy laws in recent years, and virtually all have already developed, or are in the process of preparing, their own support programmes. In 2001, the EnDC approved an Energy Master Plan, guiding implementation of the SwissEnergy programme (see below) at the cantonal level; this cantonal Master Plan is to be updated for the second half (2006–2010) of the SwissEnergy programme.

Swiss energy policy under IEA review

In late 2002 Switzerland was visited by an International Energy Agency (IEA) review team. The following paragraphs are excerpts from the related IEA press release (IEA/PRESS(03)19, Berne, 9th September 2003).

- **Climate Change Mitigation**

Of the IEA's 3 Es (energy security, economy and environment), environmental issues have a high priority in Swiss energy policy. Switzerland intends to use energy policy measures as a means of achieving its Kyoto target of an 8% reduction in greenhouse gas (GHG) emissions below 1990 levels by 2008 to 2012. SwissEnergy aims to reduce carbon dioxide (CO_2) emissions by 10% below 1990 levels, through a 15% reduction in the consumption of combustibles and an 8% reduction for motor fuels. Measures proposed to achieve these targets include the development of voluntary commitments (VC's) and voluntary agreements (VA's) with industry. Other measures of SwissEnergy include promotional activities and information dissemination programmes for industry, as well as regulations and standards for buildings, vehicles and electrical appliances. A CO_2 "incentive" tax will be imposed if these fail to achieve adequate reductions.

SwissEnergy has been conscientiously monitored for energy consumption, public expenditure, private investments, employment impacts and the cost-effectiveness of the measures. But statistics show that despite considerable efforts, these policies and measures may not suffice to achieve the Kyoto target or the more stringent national target for CO_2 reductions. Swiss energy-related CO_2 emissions increased by 5.6% during the period 1990–2001. These may fall if and when the CO_2 "incentive" tax is imposed, but work needs to start promptly if the tax is to be introduced in the near-term. The Report recommends that the government should further develop emissions trading and other flexible mechanisms, even if these are only supplementary alternatives to domestic reductions. Or, a portion of the tax revenues could be devoted to purchasing GHG emissions permits on the international market.

- **Energy Prices**

Energy pricing and taxation should be reviewed. Swiss heating oil prices are among the lowest in OECD Member countries, partly due to the unduly low share of the tax component. This encourages neither energy saving nor the use of alternative energies with lower CO_2 emissions. Gasoline prices in Switzerland are lower than in neighbouring countries, leading to some "fuel tourism".

Natural gas prices however, are among the highest in IEA Member countries owing to the topography, market size, low connection density and the fragmented market structure. These factors discourage market penetration of natural gas.

Electricity prices in Switzerland, particularly for small- and medium-sized enterprises, are higher than the European average. This is partly due to the taxes and charges set by the cantons and municipalities. Concerns exist about the efficiency of the operation of many publicly-owned small utilities and their considerable profits. The current price-setting mechanisms lack transparency and enable crosssubsidies from one consumer group to another. Some electricity is supplied free of charge or at low cost to local authorities, thereby jeopardising energy efficiency.

4.2.3.2. The SwissEnergy programme

The key instrument in Swiss energy policy is the **SwissEnergy programme** (2001-2010), which follows the 'Energy 2000' programme (1991-2000). SwissEnergy was adopted by the Federal

Council and launched in January 2001 in collaboration with the cantons, the municipalities, industry and the environmental organizations. The programme has quantitative objectives and comprehensive strategies for energy efficiency and utilization of renewable energy in industry, buildings and transport, and is based on a broad partnership. The task of SwissEnergy is to support the fulfilment of the national energy and climate policy objectives, and to pave the way for a sustainable energy supply based on innovation and new technologies.

Mandate and objectives: Implementation of Switzerland's energy and climate policy

SwissEnergy is pursuing a clearly defined objective in line with national commitments under the Kyoto Protocol and in accordance with the provisions of the CO_2 Act: to reduce CO_2 emissions by 10% by 2010 compared to the 1990 level. Table 4-3 provides an overview of SwissEnergy targets and achievements by 2004.

	2010 targets	2004 status	Estimated 2004 status without Energy 2000 and SwissEnergy[4]
Efficient energy use			
Consumption of fossil energy[1/2]	-10%	+3.3%	+10.7%
Electricity consumption	≤+5%	+7.3%	+11.7%
CO_2 emissions[1/3]	-10%	+0.7%[7]	+7.6 to +9.0%[6]
from combustibles[3]	-15%	-4.3%[7]	+4.9 to +7.2%[6]
from motor fuels[1/3]	-8%	+8.9%	+11.9%
Renewable energies			
Hydropower production[2/5]	stable	+1.2%	not available
Other forms of renewable energy[2]			
Electricity[2]	+0.5TWh (+1%-point)	+0.15TWh	+0.10TWh[8]
Heating[2]	+0.3TWh (+3%-points)	+1.15TWh	+0.29TWh[8]

1 excluding international flights
2 versus 2000
3 versus 1990
4 estimate based on impact analysis and ex-post analysis
5 estimated average
6 depending on electricity mix (Switzerland or EU)
7 adjusted for heating degree days
8 estimated 2004 status without SwissEnergy

Table 4-3: SwissEnergy targets for 2010: status as of 2004, plus estimated 2004 status without the influence of the Energy 2000 and SwissEnergy programmes (SFOE 2005b).

In 2004, the SwissEnergy budget amounted to CHF 49.1 million. These funds were increased to CHF 113 million through contributions from the cantons and third parties. They are estimated to have generated investments amounting to nearly CHF 1 billion.

Measures: Focus on voluntary action and partnership

SwissEnergy uses three kinds of measures that complement one another: first and foremost, in accordance with the provisions of the Energy Act and CO_2 Act, it supports voluntary measures based on service agreements awarded to non-governmental agencies, and concludes voluntary agreements with companies and sectors, in which energy reduction targets are set. SwissEnergy actively promotes the implementation of voluntary measures by providing information and advice as well as training and further education. Alongside voluntary measures, the provisions of energy and building legislation call for more comprehensive promotional and mandatory measures. These include regulations governing the energy consumption of motor vehicles, appliances and buildings.

Organization: The four sectors

SwissEnergy is a federal government programme that involves the cantons and local authorities, industrial, consumer and environmental associations, and public and private-sector agencies. The structure of the programme – including the four main sectors of implementation and the various programme partners and projects – is illustrated in Figure 4-1.

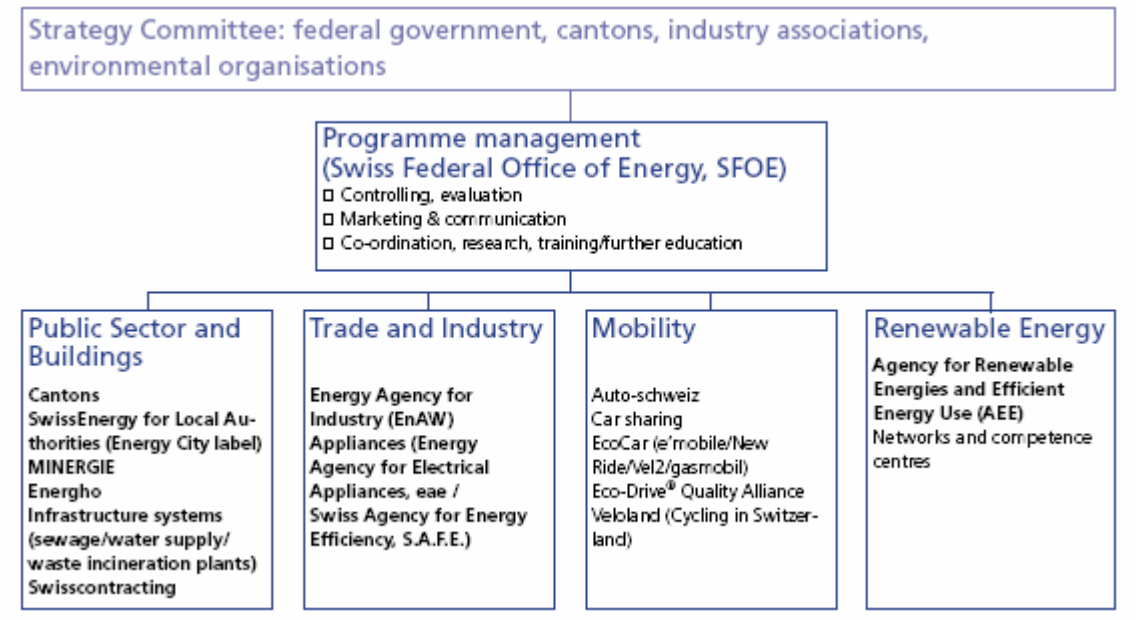


Figure 4-1: SwissEnergy organization chart

Public sector and buildings

As buildings account for approximately 45% of Switzerland's overall energy consumption, they offer a considerable potential for reducing CO_2 emissions. The cantons are SwissEnergy's most important partners: they are responsible for the buildings sector and thus have to implement the programme's objectives through building regulations, promotion programmes and voluntary measures. SwissEnergy supports the "Energy City" label, the "MINERGIE" building standard and optimization of heating and cooling systems in public buildings ("energho" Association) (see Section 4.3.3.2). Energy optimization measures also apply to sewage plants, water supply systems and waste incineration plants. For these purposes SwissEnergy supports energy contracting ("Swisscontracting" Association) as a valuable tool.

Trade and industry

The Energy Agency for the Economy (EAEc, also known as Energy Agency for Industry), closely cooperating with SwissEnergy on the basis of a service agreement, helps companies to elaborate and implement agreements: with a bottom-up approach, company-specific reduction targets are developed for energy consumption and CO_2 emissions. Companies taking on ambitious caps can be exempted from the planned CO_2 tax.

The Swiss Agency for Energy Efficiency (S.A.F.E.) and the Energy Agency for Electrical Appliances (eae) both aim to stabilize electricity consumption in the area of appliances. The energy label for household appliances and lamps, mandatory since 2002, provides an important basis for their activities.

Mobility

In the transport sector, the federal government is seeking to achieve energy and climate policy goals through an optimum combination of voluntary measures, economic instruments, regulations

and support for technology and innovation. In this context, the focus is on increasing energy efficiency and renewable fuels (biogas, bioethanol).

In February 2002, DETEC and "auto-schweiz" (the Association of Swiss Automobile Importers) concluded an agreement to reduce the specific fuel consumption of new motor cars by 24% between 2000 and 2008 (see also Section 4.3.4). This effort is backed by an energy label for new motor vehicles, mandatory since 2003, and by a special campaign. Another important product already launched by the predecessor to SwissEnergy (Energy 2000) is a special course programme for economical and ecological driving behaviour (Eco-Drive®). The most important measures introduced by SwissEnergy in the areas of human-powered and combined mobility are car-sharing, promotion of walking and cycling, consulting services at local level on energy-efficient mobility, consulting on mobility management in companies, and participation in the European "In town, without my car!" campaign.

Renewable energies

A network of various players, coordinated by the Agency for Renewable Energies and Efficient Energy Use (AEE), encourages the changeover to renewable energies (green power, heat pumps, wood, biomass, solar energy, sewage gas, geothermal energy and wind power). One of the explicit objectives of SwissEnergy is to maintain the present level of electricity production from hydropower. This represents a challenge since hydropower remains relatively expensive, compared to combined-cycle gas turbines, for instance.

4.2.3.3. The "2000-watt society" – a vision for Switzerland

The realization of a "2000-watt society" is an ambitious vision for Switzerland's future energy landscape, deriving from the Federal Council's Sustainable Development Strategy. Energy consumption in Switzerland currently corresponds to a continuous output of 6,000 watts per person. According to the Federal Commission for Energy Research (CORE), it would be technically feasible for primary consumption of fossil-based energy to be reduced to a level corresponding to less than 2,000 watts by 2050. Fully realizing the "2000-watt society", however, would take considerably longer, as this would require a reduction of total primary energy consumption to 2,000 watts and a decrease in annual CO_2 emissions to 1 tonne per capita. For the latter goal to be achieved, only 500 of the 2,000 watts could be based on fossil fuels. With the aid of technology roadmaps, CORE is seeking to plot a course towards this goal and to identify research needs in vital areas of technology (SFOE 2004).

How much is 2,000 watts?

Energy is measured in joules or kilowatt-hours. The amount of energy consumed per unit time is known as power and is expressed in watts. Kilowatt-hours (kWh) per day or per year are also used as units of power.

2,000 watts is equivalent to:

• 48 kilowatt-hours per day, or

• 17,500 kilowatt-hours per year,

• or the consumption of around 1,700 litres of heating oil or petrol per year.

According to initial assessments, setting out to achieve the "2000-watt society" involves the following key targets for Switzerland for 2050:

- No fossil fuels to be used for heating buildings
- Energy consumption in the buildings sector to be halved
- Use of biomass resources to be tripled
- Competitive building-integrated solar power systems to be widely introduced, together with new storage technologies
- Average fuel consumption in the car fleet to be reduced to 3 litres per 100 km

- Major changes to be achieved in transport patterns (improved understanding of acceptance problems and barriers to the spread of technology).

However, constant SFOE funding of about CHF 20 million per year for energy research stands in contrast to cuts in SFOE funding for pilot and demonstration projects and the dwindling resources of the privately sponsored energy sector research fund – reduced from CHF 20 million in 1993 to CHF 2 million in 2004. These developments entail a significant reduction in scope for the introduction of new technologies.

4.2.4. Transport policy

4.2.4.1. Development of an integrated approach

Switzerland has developed an integrated strategy to transport policy, focusing on better coordination between transport modes, and paying greater attention to environmental problems. This strategy has been strengthened in recent years with a broader integration of transport policy into spatial development and the general sustainability context.

The following aspects are most important:

- Modernization of the railway infrastructure, including the four major projects: RAIL 2000 (the first phase had been completed by the end of 2004, the second phase is pending); the NRLA (New Rail Link through the Alps) network with two new base tunnels (Gotthard 57 km and Lötschberg 34 km long), supported by the Federal Decree on the Construction of Two New Transalpine Railway Lines of 4 October 1991; the connection of Eastern and Western Switzerland to the European high-speed rail network; and noise reduction measures on the railways.
- Coordination of spatial planning and transport infrastructure development, with a specific focus in agglomeration policy on concentrating population and transport growth in those areas where non-motorized and public transport offer comparative advantages and to overcome and avoid further urban sprawl.
- Railway reform, providing increased flexibility for the railway companies and greater entrepreneurial freedom, making rail transport more productive and attractive.
- The Modal Shift Act of 8 October 1999 and supplementary measures: market-based measures and incentives will further improve the general framework for the railways, so that the transfer of freight from road to rail can be intensified and accelerated. In this context, the new freight transport policy was successfully implemented by 2001 with the aid of supporting measures such as the promotion of combined transport, with funding of more than CHF 1 billion for 10 years (see Section 4.3.4).

Current projections (FOSD 2004, 2005) for freight and passenger transport still show significant growth rates for the coming decades. Sustainable management of this growth represents a major challenge, with efforts focusing on passenger transport and growing traffic problems in agglomerations and on the management of scant road and rail infrastructure capacity. Switzerland has therefore improved its planning tools, with the development of agglomeration programmes. In principle, provision of funding is possible for both public and private transport. The aim is that each mode of transport should be used according to its ecological and economic advantages. The planning instruments are intended to help to relieve the pressure on cities and to overcome urban sprawl, which would lead to unwanted traffic growth and a reduced potential for public transport use. At the same time, the approach of ”internalization of external costs” has been developed further, with solutions for road passenger transport also being evaluated. New road pricing approaches are to be fleshed out and debated in public.

The AVANTI debate in Switzerland

The Swiss road organizations launched a popular initiative known as AVANTI, calling for a general expansion and upgrading of roads, and in particular a second St Gotthard road tunnel to increase the capacity of this important North-South link.

The federal council and the parliament put forward a counter-proposal to this initiative, calling for enlargement of the road network in agglomerations and alpine areas (e.g. St Gotthard) but also for investment in the expansion of public transport in agglomerations. Financing was to be derived from the mineral oil tax. On this basis, the AVANTI originators withdrew their own initiative, and only the parliament's proposal was submitted to the electorate. However, the proposal was rejected by the public in 2004. The rejection was interpreted as follows:

- There is a lack of public support for the enlargement of transalpine road capacity (St Gotthard), as this would contradict the national policy of transferring freight from road to rail.
- The public wishes to improve infrastructure capacities for road and rail transport. Specific road capacity expansions should be part of national road infrastructure plans.

The result of this referendum is an important basis for future infrastructure plans.

Based on the environmental and energy legislation described in the sections above, Swiss transport policy has developed several measures to reduce air pollution and the specific fuel consumption of passenger cars. These measures are supported by specific efforts under the 'SwissEnergy' action plan.

4.2.4.2. New aviation policy

The aviation sector has undergone an enormous upheaval in Switzerland after the grounding of Swissair in 2001, and after the general problems faced by the industry in the wake of 9/11. With the new airline 'Swiss', air traffic movements have been reduced by some 20% in a short time, leading to severe economic problems at Swiss airports. At the same time, environmental pressures caused by rapid growth in the late 1990s have eased somewhat (with the exception of aircraft noise, which remains a major concern around airports). The government has taken this opportunity to propose a new aviation policy, focusing on sustainable development of this sector.

In a fundamental report on Swiss aviation policy approved on 10 December 2004, the Federal Council presented its assessment of the current state of Swiss aviation, including an analysis of problems and a discussion of strategies for action (Swiss Federal Council, 2004). In this report, it expresses its support for a coherent, comprehensive and forward-looking aviation policy within a sustainable development framework. This report, which provides a broad basis for the debate on the future direction of Swiss civil aviation, will be considered by Parliament in 2005.

Within the context of national transport policy, the position of aviation is defined in the report as follows:

- For short distances (domestic transport), priority is essentially accorded to the railways.
- Within Europe, aviation is one element linking Switzerland to European centres, supplementing the high-speed rail network.
- In addition, the sector provides Switzerland with good intercontinental connections.

According to the Federal Council's fundamental report, the implications of sustainable development for aviation policy include the following:

- Both operating and external costs should be borne by the aviation sector itself, so that demand for mobility is based on the total economic costs.
- Technological options for the optimization of infrastructure and aircraft should be fully exploited.
- Swiss aviation policy should be coordinated with European aviation and transport policy. This also requires active efforts to promote a sustainable transport policy in Europe.

- To protect the natural environment, the adverse impacts of aviation should be reduced to a level that is acceptable over the long term, and resources should be conserved.

In sensitive environmental areas (noise and pollution), Switzerland has developed particular noise standards for some small aircraft as well as operating restrictions and incentive systems of its own (e.g. noise- and emission-dependent landing charges, emission ceilings at certain airports). These are to be maintained and further developed.

As a further element for aviation policy, the sectoral plan for aviation infrastructure was adopted on 18 October 2000 (FOCA, 2000). It states that environmental protection is to be taken into consideration in a comprehensive manner when aviation infrastructure is planned. The various modes of transport are to be developed according to their relative advantages. Moreover, under the sectoral plan for aviation infrastructure, the Federal Council is committed to limiting emissions of CO_2 and other air pollutants in the areas surrounding airports.

International cooperation

Switzerland joined the International Civil Aviation Organization (ICAO) in 1947. At the European level, it has been a member of the European Civil Aviation Conference (ECAC) since 1955. Under the air transport agreement between Switzerland and the EU which came into effect on 1 June 2002, Switzerland adopted all of the European civil aviation legislation that was in force when the agreement was concluded and is thus on an equal footing with EU members. In future, therefore, Switzerland's aviation legislation and policy will no longer be shaped solely by ICAO and ECAC regulations, but also by developments within the EU. Policy is to be coordinated with European aviation and transport policy. Switzerland's foreign relations are also governed by bilateral and multilateral agreements. Mention should be made here of the bilateral aviation agreements concluded with more than 130 countries.

4.2.5. Agricultural policy

At the end of the 1980s, the limits of contemporary agricultural policy – under which farmers enjoyed fixed prices and guaranteed markets in the interests of food security and increased self-sufficiency – became apparent. The costs arising from this system placed a growing burden on the federal budget, and the environmental shortcomings of the farming sector were evident. In addition, efforts to liberalize world trade led to increased pressure for the elimination of protectionist measures in agriculture. Accordingly, since the beginning of the 1990s, agricultural policy has been fundamentally reformed in a three-stage process. The centrepiece of this reform is a reduction in regulated prices and the introduction of non-product-related direct payments to compensate for public-interest and environmental services. The emphasis shifted from the security of food supplies to stewardship of the cultural landscape and preservation of natural resources. The staging of the reform process gave those concerned the opportunity to adapt to the new framework.

The reform received additional impetus from a new constitutional article that was approved by more than 75% of the Swiss electorate in 1996. Under this article, the federal government is required to ensure that, through sustainable and market-oriented production, agriculture makes a substantial contribution to the secure provision of food, the preservation of natural resources, stewardship of the cultural landscape, and decentralized settlement patterns. The key stages of the reform process to date are outlined below (FOAG 2004):

1. The core element of the first stage of the agricultural reform was the decision by Parliament to **introduce non-product-related direct payments** to compensate for public-interest and environmental services. This made it possible for income policy goals to be achieved henceforth not only through price regulation but increasingly also through non-product-related direct payments (decoupling of prices and incomes policy). The Federal Council implemented this fundamental decision by gradually reducing regulated prices and increasing non-product-related direct payments.

2. The key elements of the second stage of the reform process were the **elimination of all state-guaranteed prices and markets** and a reduction in market supports. Disbursement of direct payments was conditional on the required **standard of ecological performance** being met (cross-compliance). Thus, farmers only receive direct payments if they can demonstrate that an appropriate soil nutrient balance is maintained, a suitable proportion of farmland is managed as ecological compensation areas, a crop rotation system is in place, soil protection is given due consideration, crop protection agents are chosen and applied selectively, and livestock is kept in accordance with legal regulations and animal welfare requirements. The new legislation was adopted by Parliament on 29 April 1998 and came into effect in 1999.
3. The main element in the third stage of the reform is the decision to **abolish the milk quota system** in 2009. Other important changes include the introduction of auctioning of tariff rate quotas for meat and the establishment of additional instruments for structural improvement measures. On 20 June 2003, the partial revision of the Agriculture Act was approved by Parliament.

To date, the new agricultural policy has facilitated improvements in the environmental sphere (lower atmospheric emissions of ammonia, lower nitrate levels in groundwater, more ecological compensation areas, lower soil phosphorus concentrations, etc.), while leaving economic and social conditions (incomes, competitiveness) relatively stable.

Changes have resulted not only from agricultural policy instruments but also from improvements in efficiency and technological progress (increases in crop yields, milk yield and daily weight gains in livestock production). The above-mentioned measures and developments have thus led to a decrease in livestock populations, optimization of manure management and, in general terms, greener farming practices.

4.2.6. Forestry policy

There is a long tradition of forest protection in Switzerland. The first Federal Forestry Police Act came into force in 1876, but it only covered mountainous regions. 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, the forested area in Switzerland has increased by nearly 50% since the middle of the 19th century.

In 2004, the National Forest Programme was published, outlining the action plan for 2004–2015. It specifies five priority objectives:

- The forest's protective function is guaranteed
- The economic viability of the forestry sector is improved
- The wood value-added chain is strengthened
- Biodiversity is conserved
- Forest soils, trees and drinking water are not threatened.

The forestry sector, which is characterized by very small-scale ownership and management structures, has failed to react adequately to the changes occurring in its environment. The subsidy policy implemented up to now, adherence to tradition and a lack of entrepreneurial initiative have made it difficult to achieve far-reaching changes in the sector. The efficient supply and processing of wood is further hindered by the numerous small-scale operations and structures along the wood chain.

Making better use of timber is crucial to current Swiss forestry policy. The goal is to prevent further increases in growing stock and to help to improve and maintain the structure of forest stands in good condition, so that their social and economic functions are ensured. In view of the difficult economic situation, there are serious doubts as to whether this aim will be achieved or the annual increase in stock will be fully harvested. A further increase in the growing stock of Swiss forests is more likely. Under the National Forest Programme, public financial support will mainly be restricted to forest areas with protective functions against natural hazards.

4.2.7. Further implementation of climate policy: opportunities and risks

Budgetary problems at federal and cantonal level

Due to the increased federal budget deficits of recent years (see Section 2.6), the government has decided to launch specific savings programmes to balance the budget by 2008. This involves significant cuts in public expenditure, giving rise to opportunities and risks for the further implementation of climate policy. There is a certain risk that support programmes (e.g. SwissEnergy or measures to improve public transport) may be underfunded. At the same time, the budget debate helps to identify potentials for savings in other areas.

Rising energy prices

Recent increases in fossil fuel prices are stimulating efforts to enhance the efficient and economical use of energy. In the transport sector, increased demand for diesel cars may, at least in part, already be a result of higher fuel prices. If energy prices continue to rise, given the price sensitivity of consumers, there is a potential for further improvements in the effectiveness of measures such as the voluntary actions taken under the SwissEnergy programme. On the other hand, lower demand for fossil fuels is accompanied by lower revenues from mineral oil taxation. Where fiscal interests are in conflict with environmental objectives, innovative financing schemes – e.g. for the transport sector – need to be sought.

Economic obstacles

Growing pressure on the Swiss economy due to ongoing globalization has increased the sensitivity of competition-related issues. The most important current challenge is to lower price levels and to secure lower and more competitive wage levels while maintaining the high quality of Swiss products. The dilemma has been highlighted by the debate on the introduction of a CO_2 tax. An increase in Swiss prices due to a CO_2 tax is perceived by some business stakeholders as posing a threat to economic growth and the competitiveness of Swiss industry, especially at the SME level. Moreover, redistribution of revenues from a CO_2 tax in proportion of wages paid tends to benefit the service industry. Tax exemption to energy intensive industry dampens the distributional impact, though.

Developments in electricity markets

Liberalization and international competition make transport and energy markets more efficient, leading to lower prices. Within the energy sector, electricity and renewables should benefit from further liberalization. The positive effects for Swiss energy markets provide a further incentive to strive for the efficient and economical use of energy.

4.3. Policies and measures implemented

4.3.1. Cross-sectoral policies and measures

In the run-up to the World Summit on Sustainable Development held in Johannesburg, the Federal Council adopted a revised sustainable development strategy in the spring of 2002.

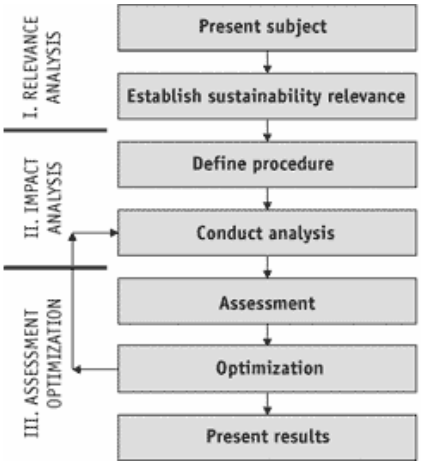
The strategy is based on the provisions of the Federal Constitution as revised in 1998 and aims to integrate the principles of sustainable development into as many policy areas as possible. It also lays down the content and procedural framework for the Federal Council's sustainable development policy over the coming years. In addition to conceptual guidelines, the strategy also contains a total of 22 measures in ten action areas (1: Economic policy and public services, 2: Financial policy, 3: Education, research, technology, 4: Social cohesion, 5: Health, 6: Environment and natural resources, 7: Spatial and settlement development, 8: Mobility, 9: Development cooperation and the promotion of peace, 10: Methods and instruments). The lead agency for sustainability policy is the Federal Office for Spatial Development (OSD).

The strategy was reviewed in 2004. The interim status report highlights the progress of implementation. As far as the Sustainable Development Strategy 2002 is concerned, the implementation of the 22 measures is, generally speaking, proceeding according to plan. It is, however, apparent that a number of measures have been subject to certain limitations as a result of the Confederation's tight budgetary situation. Regarding the status of commitment at the subnational level, it should be added that, by the end of 2003, 13 of the country's 26 cantons had launched concrete activities to promote sustainable development. At the local level, around 100 municipalities, representing over 25% of the Swiss population, have initiated a sustainable development process in line with Local Agenda 21. At the international level, Switzerland is actively pursuing the goals of sustainable development in various areas and different bodies in response to the challenges defined by the Johannesburg Plan of Implementation (JPOI), which was adopted by the international community at the 2002 World Summit on Sustainable Development.

The review report concludes by setting out some future-oriented recommendations. Regarding the Sustainable Development Strategy 2002, it is recommended that work on the implementation of the 22 measures should continue; in particular, the methodological instruments for incorporating sustainable development into federal policy as a whole (Monitoring of Sustainable Development and Sustainability Assessment) should be developed further, and the Strategy should be fully evaluated and updated ahead of 2007. In addition to the implementation of the Strategy, it is proposed that the links between sustainability policy, financial policy and growth policy should be clarified further, institutional refinements for cooperation within the Federal Administration (modus operandi of IDARio, the Committee in charge of the follow-up) should be examined, and sustainable development should be promoted through target-group and topic-specific dialogue. For the JPOI to be implemented, Switzerland's contributions to the UN's Millennium Development Goals must be laid down in concrete terms, and measures need to be taken in the areas of health, biodiversity, chemicals, sustainable consumption and production, as well as renewable energy sources.

Assessing Sustainability

In measure 22 of the Sustainable Development Strategy 2002, the Federal Council stated that options for conducting sustainability assessments on federal projects should be investigated. The Federal Office for Spatial Development (FOSD), coordinating sustainable development policy in Switzerland, has developed a conceptual framework and basic methodology for conducting sustainability assessments at the federal level (http://www.are.admin.ch/are/en/nachhaltig/beurteilen/index.html).



The purpose of the sustainability assessment framework is to evaluate and optimize federal projects and undertakings in relation to the goals of sustainable development. The assessment should make it possible – especially where different options are being considered – to identify imbalances and deficiencies between the dimensions of environment, society and economy, to highlight opportunities for improvement, and to attain a long-term equilibrium between the three dimensions.

In addition to determining a project's impact through a content-based matrix of criteria, guidelines were developed concerning the handling of conflicts of objectives and how specific individual effects are to be evaluated. These guidelines emphasize the crucial role of the biosphere's regenerative and absorption capacity, e.g. for CO_2.

Sustainability assessment targets strategic, programmatic and conceptual projects and undertakings, including legislation, instigated by the Confederation. Among the first sectors applying the method are transport infrastructure policy and agricultural policy. Others, such as spatial planning and public procurement policy, are planning to do so (Swiss Federal Council 2002; IDARio 2004).

4.3.2. Climate policy

At the time of writing, Swiss climate policy is at a turning point, where the status of measures may change from adopted or planned to implemented within only a few months. The following paragraphs should therefore be read in conjunction with Section 4.4.1.

Energy and CO_2 legislation provide for business organizations to be entrusted with the task of supporting and implementing voluntary measures. For this purpose, the Energy Agency for the Economy (EAEc) was founded in 1999. The activities of the EAEc are governed by a service agreement with the Swiss Federal Office of Energy (SFOE), which in return grants financial contributions of CHF 2 million per year to cover one third of the agency's operating costs. The rest is financed out of membership fees, amounting to CHF 6,000 per year per company, with discounts granted to SMEs in proportion to their size. The agency consists of a network of more than 50 industry experts, who support companies in identifying in-house measures to reduce energy consumption and in calculating reduction targets for their energy-related CO_2 emissions. For reasons of administrative efficiency, companies submit their proposals to the federal government in groups. Reduction proposals are subject to a formal audit procedure carried out by SAEFL and

SFOE with the aid of independent industry experts. EAEc aims to cover 40% of industry's CO_2 emissions.

As part of the purely voluntary measures envisaged by the CO_2 Act (see Section 4.2.2), a package of agreements was signed in April 2004 by 45 groups of companies (about 600 entities), accounting for 25% of industry's CO_2 emissions. Most of these companies are engaging in voluntary action with a view to being exempted from a CO_2 tax. This applies especially to energy-intensive companies operating in the following sectors: cement, ceramics, glass, pulp & paper, lime kilns, chemicals, sugar mills, food, transport, appliances, printing, textile finishing, foundries, aluminium, steel, plastics and machinery. As soon as a CO_2 tax is introduced, voluntary agreements will be transformed into legally binding commitments, and companies not complying with their reduction targets will be penalized, i.e. required to pay CO_2 tax retroactively for each tonne emitted since the introduction of the tax. Another 400 companies are in the process of negotiating agreements under the umbrella of the EAEc (as of the summer of 2005).

To facilitate compliance with CO_2 reduction targets, companies are given access to the national and international CO_2 market. Companies signing a commitment to limit their energy-related CO_2 emissions are allocated emissions allowances according to their CO_2 target for 2008–12. As of 2008, emissions allowances equalling the amount of CO_2 emitted are to be cancelled annually. An internet-based monitoring system for the submission of energy and emissions data in a standardized format is now operational. Emissions allowances not needed for compliance can be sold or carried over to future commitment periods beyond 2012. To cover excess emissions, allowances have to be acquired on the domestic or international market. The use of flexible mechanisms is generally restricted to 8% of the total allowances allocated. For specific cases (e.g. large new emitters) it is limited to 30%. The use of flexible mechanisms by companies which have signed a binding commitment should not exceed 400,000 tonnes of CO_2 per year. Whether companies observe the restrictions on the use of CO_2 credits from flexible mechanisms is monitored in the National Registry as part of the compliance review.

4.3.3. Energy policy

4.3.3.1. Evaluation of the SwissEnergy programme and measures implemented since 1990

The legal basis for evaluation is the Energy Act, which came into effect in 1998 and obliges the Federal Council to periodically examine implemented measures, publish the results of its studies and report to Parliament.

The impacts of SwissEnergy are analysed and published annually. Thanks to two detailed analyses encompassing the entire programme, it is possible to verify the degree to which SwissEnergy's objectives are being achieved, as required by the Energy Act:

- **Ex-post analysis**: This analysis is based on annual changes in energy consumption. The report analyses how consumption is influenced by external factors such as energy prices, size of population, number of cars, buildings, appliances, climate and policy. It also assesses the impacts of mandatory measures of SwissEnergy on energy consumption, employment and investments (Prognos 2004).
- **Impact analysis**: The second analysis examines the effectiveness of the programme's activities with regard to energy consumption, employment and investments. Here the focus is on voluntary measures (INFRAS 2004).

a) Ex-post analysis of mandatory measures and factors influencing energy consumption

The ex-post analysis attempts to evaluate the ongoing effects of the measures implemented in the energy sector for the period 1990–2004. The real changes in energy demand are compared with the modelled changes, considering the change in exogenous factors such as economic growth and world energy prices.

According to this long-term analysis, total energy consumption in 2004 had increased by 86 PJ (+10.9%) compared with 1990 (791.4 PJ). This increase includes marked shifts in the breakdown of energy sources: natural gas showed the greatest increase (42.5 PJ, +67.1%), with its share of total energy consumption rising by 3.7%. Also accounting for an increased proportion are electricity (+1.5%) and "others" such as municipal waste, industrial waste and the other renewables, which show significant (more than two-fold) growth, albeit from low initial amounts. Decreases were recorded for coal and heating oils. With regard to causal factors, overall consumption tended to be increased by quantitative components such as population growth (+9.8%), increases in treated floor areas (+21.2%) and industrial production (+24% rise in index) and growth in vehicle numbers (+27%) and vehicle-kilometres. The volume effects were counteracted by technological improvements in appliances and cars, and increased efficiency in the buildings sector due to energy/climate policy measures. According to modelling calculations, these factors reduced consumption by 63% of the consumption-increasing effect of volume growth. Viewed over the long term, climatic influences are largely averaged out. Energy price trends are of limited significance overall. However, it should be noted that over the long term the effects of relatively volatile price movements are not averaged out; instead, counterproductive effects are observed, with increased consumption resulting in particular from the easing of prices in the late 1990s.

The analysis shows that growth effects and energy price movements outweighed the energy-saving effects attributable to the measures implemented. Figure 4-2 shows the contributions of individual factors, based on the model estimations. Although the energy savings would have been 89 PJ since 1990, total energy demand increased, especially due to growth effects.

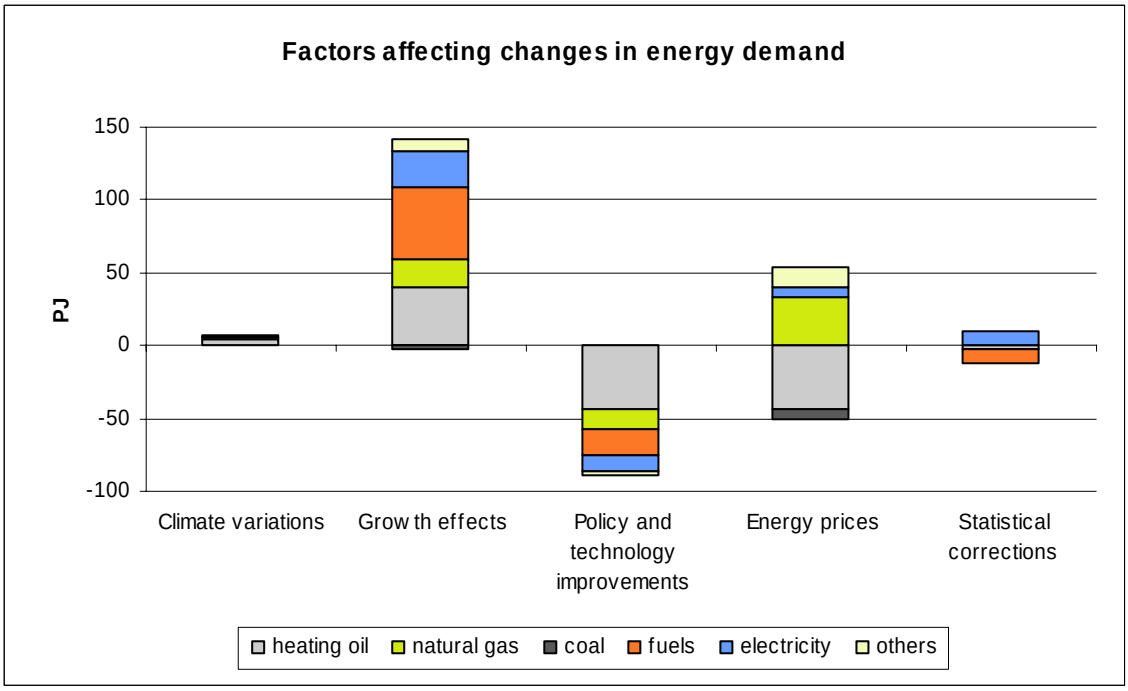


Figure 4-2: Ex-post analysis of changes in demand for energy sources between 1990 and 2004, as a function of individual factors (Prognos 2005)

b) Evaluation of voluntary measures

Figure 4-3 illustrates the impacts and cost/benefits ratios (in terms of SFOE funds per kWh saved) of the individual measures under the SwissEnergy programme in 2004. One striking finding is the rather low cost-effectiveness of several voluntary measures in the mobility sector. Selected measures are described in more detail below (see Section 4.3.3.2).

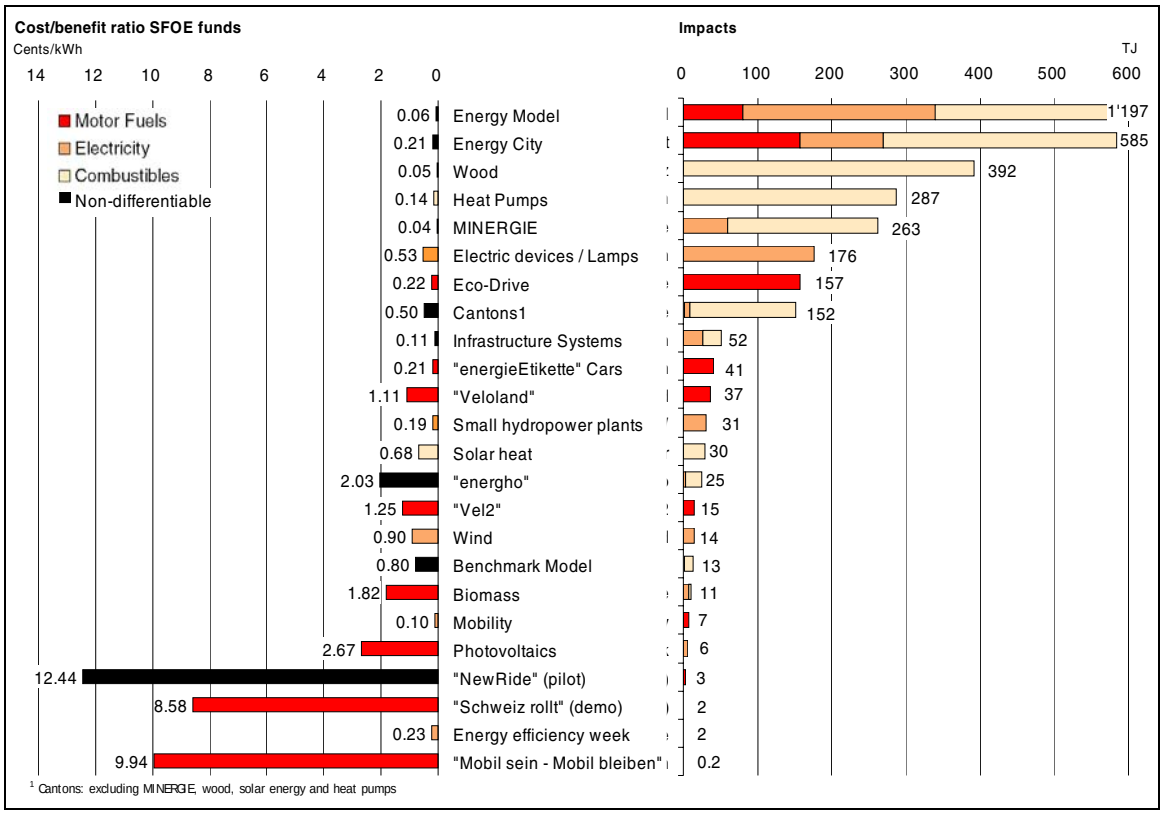


Figure 4-3: Impacts on energy consumption and cost/benefit ratios (costs per kWh saved) of the main measures implemented under the SwissEnergy programme (INFRAS 2005).

From 1990 to 2004, measures implemented under the two programmes achieved total sustainable savings estimated at around 28 PJ (3% of Switzerland's final energy consumption). During the same period, the impact on Switzerland's CO_2 emissions rose to 1.6 million tonnes per year.

The total savings yielded by the voluntary measures implemented under Energy 2000 and SwissEnergy are increasing year by year. In 2004, in spite of the reduction in the financial resources available the SwissEnergy programme (voluntary measures) achieved the highest increase in energy savings since it was started in 2001. The additional energy savings achieved in 2004 are estimated at around 3.4 PJ.

c) Overall effects of mandatory and voluntary measures 1990-2004

Table 4-4 shows the savings achieved in 2004 as a result of the various measures implemented from 1990 to 2004 (excluding electricity-related measures). The voluntary measures include the combined long-term effects of the Energy 2000 programme in the 1990s and of SwissEnergy in 2001–2004.

By 2004, the mandatory measures produced savings of more than 17 PJ, with CO_2 emissions being reduced by around 1.2 million tonnes. The voluntary measures yielded overall savings of more than 23 PJ, with CO_2 emission reductions of about 1.6 million tonnes. The energy savings also contribute to reductions in emissions of other gases.

In absolute terms, the impacts are greatest in the residential sector, while relative to energy consumption the greatest savings are seen in the services sector. The effects in the transport sector are less marked. Together, the mandatory and voluntary measures produced savings of almost 50 PJ (including electricity-related measures), which is equivalent to almost 6% of total energy consumption in 2004. In the absence of Energy 2000 and SwissEnergy, CO_2 emissions would now be at least 7% higher.

	Fossil fuel savings (PJ)	Percentage of total consumption	CO_2 emissions (mio. tonnes)
Total mandatory measures	**17.8**	**3.0**	**1.2**
Residential	6.9		
Services	3.4		
Industry	3.6		
Transport	2.6		
Total voluntary measures	**23.7**	**4.2**	**1.6**
Public sector and buildings	5.6		
Industry	6.3		
Transport	3.2		
Renewable energies	8.7		
Total savings (mandatory and voluntary measures)	**41.5**	**7.4**	**2.8**

Table 4-4: Savings due to mandatory and voluntary measures in 2004, compared with 1990 (Prognos 2005)

4.3.3.2. Public sector and buildings

In 2004, global subsidies from the federal government to cantons amounting to CHF 14 million generated an additional CHF 26 million in cantonal funds for programmes aimed at promoting efficient energy use and the utilization of renewable energies.

The funds were deployed for renewable energies (CHF 18.3 million), the promotion of efficient energy use (15.6 million) and increased use of waste heat (0.8 million). Promotion programmes currently exist in all cantons except Schwyz, Obwalden and St Gallen, since these cantons lack the necessary legal basis and/or promotion budget (SFOE annual report: Current Status of Cantonal Energy Policy). Important steps for strengthening cantonal energy policy included the introduction and implementation of SIA standard 380/1 ("Thermal energy in buildings"), the approval of the cantonal promotion model by the Conference of Cantonal Energy Directors (EnDK) and the initiation of the SwissEnergy buildings campaign.

Twenty cantons (80% of the Swiss population) have now implemented the basic module concerning cantonal regulations in the buildings sector, and eleven of these have also implemented the extended requirements for new buildings. By contrast, only eight cantons (33% of the population) have introduced mandatory consumption-based individual heating and hot water metering in existing buildings. In 2003, fifteen cantons carried out enforcement or quality controls concerning legal measures. The "MINERGIE" standard is being directly or indirectly promoted by eighteen cantons. A majority of the cantons have joined "energho", which supports the authorities in their efforts to optimize energy systems in their own buildings.

MINERGIE label for energy-efficient buildings

The concept of "MINERGIE" refers to the rational use of energy and renewables – with quality of life and competitiveness being improved and environmental impacts reduced at the same time:

- Since the end of the 1980s, buildings have been designed which use only a third of the total energy consumed by the average existing building, with increased stability of temperature and humidity, and lower concentrations of indoor air pollutants. An essential point is that the building is seen as an integrated system, comprising the shell and the domestic installations (heating, ventilation, hot-water systems).
- Building quality requirements are quantified primarily in terms of specific energy consumption (e.g. residential building: 42 kWh/m2), which permits reliable assessments. The only relevant consideration is the final energy supplied.

• Further information on the criteria applied for the "MINERGIE" standard is available in French and German at www.minergie.ch > standards.

During 2003, increasing interest was shown in "MINERGIE" by the private sector. As of the end of the year, the association numbered 176 members and 202 partners (prior-year figures, 143 and 146 respectively). Since 1 July 2003, the "MINERGIE" label can only be issued after the building concerned has been completed. This new quality assurance system has greatly improved the certification procedure. The number of houses awarded the "MINERGIE" label rose to approximately 3,000 by the end of 2003 (approx. 2.4 million square metres), and a total of 94 renovations were carried out on the basis of the "MINERGIE" standard (SwissEnergy funding in 2003: CHF 1 million; self-generated funds and third-party funding: CHF 0.8 million). In February 2003, "Minergie P" certification was introduced (P = Passive House), and a number of certificates were issued during the first few months. By the end of 2004, the number of labelled buildings reached nearly 4,000.

energho

This institution offers large-scale consumers a service aimed at reducing energy consumption in public buildings by at least 10% within five years. Subscriptions to this programme rose sharply during 2003, from 32 to 89, but the target of 140 subscriptions by 2003 was not met (Annual Report, "energho").

An evaluation of "energho" revealed that its products are well conceived and meet subscribers' needs, but that considerable improvements are required with respect to reaching out to the main target groups (federal government, cantons and local authorities) together with the other SwissEnergy partners concerned. The 2003 impact analysis, with 30 subscriptions (prior year 16), clearly demonstrates the successes achieved through this service, even though some of the subscriptions were less than a year old: on average, energy savings amounted to 4% (heating and electricity), and the costs in terms of SFOE funds per kWh saved were 1.99 Swiss cents (SwissEnergy funding in 2003: CHF 1.3 million; self-generated funds and third-party funding: CHF 1.9 million).

SwissEnergy for Local Authorities

Twenty new "Energy City" labels were awarded in the course of 2004, leading to a total of 121. At the end of 2004, almost 30% of the residents of Switzerland lived in an "Energy City". More than 50 towns and cities in Austria and Germany have started working with the same model. Swiss cities were amongst the first ones to receive the "European Energy Award Gold". By late 2005, this distinction had been conferred on six cities: Lausanne, Neuchâtel, Schaffhausen, Riehen, Zurich and Cham.

One of the main activities of SwissEnergy for Local Authorities is to provide the designated "Energy Cities" with consulting services: in 2003, some 250 local authorities benefited from these services of specialized consultants, and 97% of the "Energy Cities" received direct support. A total of 4,400 people participated in 51 events that were held to promote know-how transfer among the local authorities. Furthermore, some new products were successfully tested in pilot local authorities since 2003, e.g. "Factor 21" (evaluation of the sustainable development of a local authority) and so-called "energy/CO_2 declarations".

In the area of mobility, the main focus was on activities relating to traffic-free zones and roads with a speed limit of 30 km/h. More than 50 Swiss local authorities participate in the annual European mobility day "In town, without my car!", held every September. SwissEnergy also successfully launched a new "Getting to work without my car" campaign, involving 280 companies and more than 40,000 employees (SwissEnergy funding in 2003: CHF 2.3 million; self-generated funds and third-party funding: CHF 4.9 million).

Energy taxes in Basel-Stadt canton

Promotion tax

The canton of Basel-Stadt has operated a comprehensive promotion programme for 20 years. The programme is funded via a 4% surcharge on electricity bills ("electricity-saving cent"), with annual revenues of around CHF 10 million. Direct support is provided in the following areas: insulation of old buildings including replacement of windows, heat pumps, heat recovery systems, cogeneration, sorption cooling systems, systems utilizing solar and wind power and geothermal energy. At the beginning of 2003, the cantonal government increased the surcharge from 4% to 5% to finance the Deep Heat Mining project in Basel. This ring-fenced increase is limited to a four-year period and will generate additional revenues of approx. CHF 2 million per year.

At the same time, support is also provided for various indirect measures. In addition to energy consulting and pilot/demonstration plants, these include numerous campaigns designed to increase public awareness of energy issues.

Incentive tax

In 1999, Basel-Stadt became the first canton to introduce an incentive tax of 2.6–6.0 Swiss cents/ kWh on electricity (the rate varied depending on the type of charges applied for households and businesses). The revenues (CHF 47 million per year) are returned in full in the form of a rebate (independent of consumption) to households on a per-person basis and to businesses according to their wage bill. By means of the incentive tax, it was possible to keep electricity prices stable – despite a reduction in the supplier's charges. Major customers are exempted from the incentive tax. An initial evaluation indicated positive effects in line with the aims of the Energy Act.

4.3.3.3. Efficiency label for cars

Since March 2003, an energy efficiency label has been prominently displayed with every new car offered for sale. This measure is designed to enhance transparency for customers selecting or buying a new car. The information included on the label enables purchasers to give fuller consideration to energy aspects, which are increasingly relevant against the background of rising fuel prices. Current statistics from the first year of monitoring indicate that 93% of new cars on display are provided with an energy efficiency label. However, the label has been criticized for allowing a heavy car to obtain the best rating by neglecting the impact of car weight on absolute fuel consumption and, thus, absolute CO_2 emissions.

Tax exemption for energy-efficient cars in Geneva canton

People who purchase fuel-efficient, low-emission cars are exempted from vehicle tax in the first year, from the date of initial registration, and for the next two years. In 2003, the following conditions had to be met: passenger car, energy label category A, complying with EURO 4 emission standards. Under this measure, 268 vehicles had been exempted from tax by the end of 2004, corresponding to annual tax revenues of CHF 80,000.

4.3.4. Transport policy

EURO emission standards

Switzerland is following the European path of reducing air pollutants by introducing stricter Euro emission standards for new vehicles. For passenger cars, the Euro 3 standard has been in force since 2001; Euro 4 will be in force by 2006. For heavy goods vehicles, the Euro 3 standard has been in force since 2000; Euro 4 will be in force in 2005, and Euro 5 by 2008.

Realization of major railway infrastructure projects

The first phase of RAIL 2000 was introduced on 12 December 2004. Before this date, there had already been improvements to rail passenger transport. Nevertheless, it marked a milestone for

Swiss public transport, as rail service levels increased by 12% from one day to the next (more trains, faster connections between Swiss cities). In particular, travel time between Zurich and Berne has been reduced by 20%. This leap in performance has increased the attractiveness of public transport and is expected to consolidate the strong position of rail transport in Switzerland.

At the same time, work is progressing on the two transalpine base tunnels (St Gotthard, Lötschberg). Although the difficult alpine geology has posed major challenges for the tunnel construction operators, the first tunnel (Lötschberg) will open on schedule in 2008. This will increase capacity and attractiveness for both transalpine freight and passenger transport from Switzerland and Northern Europe to Italy. The new St Gotthard link is expected to open by 2015.

By improving connections to the European high-speed rail network, Swiss transport policy encourages the transfer of short-distance traffic from air to rail. Efforts are being made to shorten overall travel times between Switzerland and the cities of Munich, Stuttgart, Paris and Lyon.

Although there are severe budgetary constraints in general, the financing of the major infrastructure projects is secured on the legal basis of the 'FinÖV' public transport fund, which involves a cross-financing model (revenues from the HVF earmarked for rail infrastructure).

Heavy vehicle fee

The successful implementation of the new HVF from 1 January 2001, together with an increase in the weight limit up to 34 tonnes, has provided a strong incentive to increase average truck load factors, to reduce traffic volumes and to shift freight from road to rail. The HVF is applied to passenger and freight transport vehicles of more than 3.5 tonnes gross weight. The fee is calculated according to three criteria: the kilometres travelled on Swiss roads, the highest authorized gross weight, and the pollutants emitted by the vehicle, according to EURO classes.

The HVF is being implemented in three stages: the first stage in 2001 introduced a fee of 1.6 Swiss cents per kilometre and tonne, accompanied by an increase in the general Swiss weight limit from 28 to 34 tonnes per truck. With the second stage in 2005, the rate has been increased to 2.5 Swiss cents (average), together with an increase in the weight limit up to 40 tonnes. The final stage is to accompany the opening of the Lötschberg railway base tunnel (2008). Two thirds of the revenues are used to finance major railway infrastructure projects, and one third is transferred to the cantons' budgets.

Evaluation of the short-term effects of the Swiss heavy vehicle fee

Lower traffic levels

The impact of the new traffic regime (HVF and higher weight limits) was most clearly indicated by changes in traffic levels (truck-kilometres). Following a significant increase of 5–6% per year before the introduction of the fee, an average reduction of 5% was seen in each of the first two years. A study (FOSD, FOT, SFRA 2004) concluded that the reduction achieved was mainly due to the new regime, that the impact of the weak economy was relatively small, and that there were no signs of a shift to delivery vans, which are exempt from the fee (according to delivery van sales and fleet figures). The reduction in traffic is mainly based on increased efficiency, as the HVF and the higher weight limits led to increased truck load factor.

Positive effects on the environment

The fact that the level of the fee depends on the weight and emissions of the individual truck already prompted a significant move towards fleet renewal in the year before the HVF was introduced. The reduction in emissions per vehicle combined with lower traffic levels resulted in a substantial drop in the volume of pollutants attributable to heavy traffic. By 2007, according to model calculations (the amount of pollutants produced by heavy vehicles is difficult to measure in practice), the new traffic regime will result in a drop of about 6–8% in CO_2 and NO_x values, compared with the values expected under the old regime.

Modal shift of freight traffic from road to rail

In addition to the HVF, the policy of transferring traffic from road to rail includes the following elements to promote public transport. The Modal Shift Act sets a target of a maximum of 650,000 heavy goods vehicles per year crossing the Alps by road no later than two years after the opening of the first alpine base tunnel. This means that, compared with 1999 levels, half of the heavy vehicles crossing the Alps are to be eliminated by transferring freight from road to rail. Initial experiences are positive. The recent figures show a boost in combined transport volumes (nearly 30% within the last three years), while heavy vehicle traffic volumes have decreased by around 10% (Figure 4-4). This success is very important for the acceptability of a Swiss transport policy strongly focused on the potential of the railways.

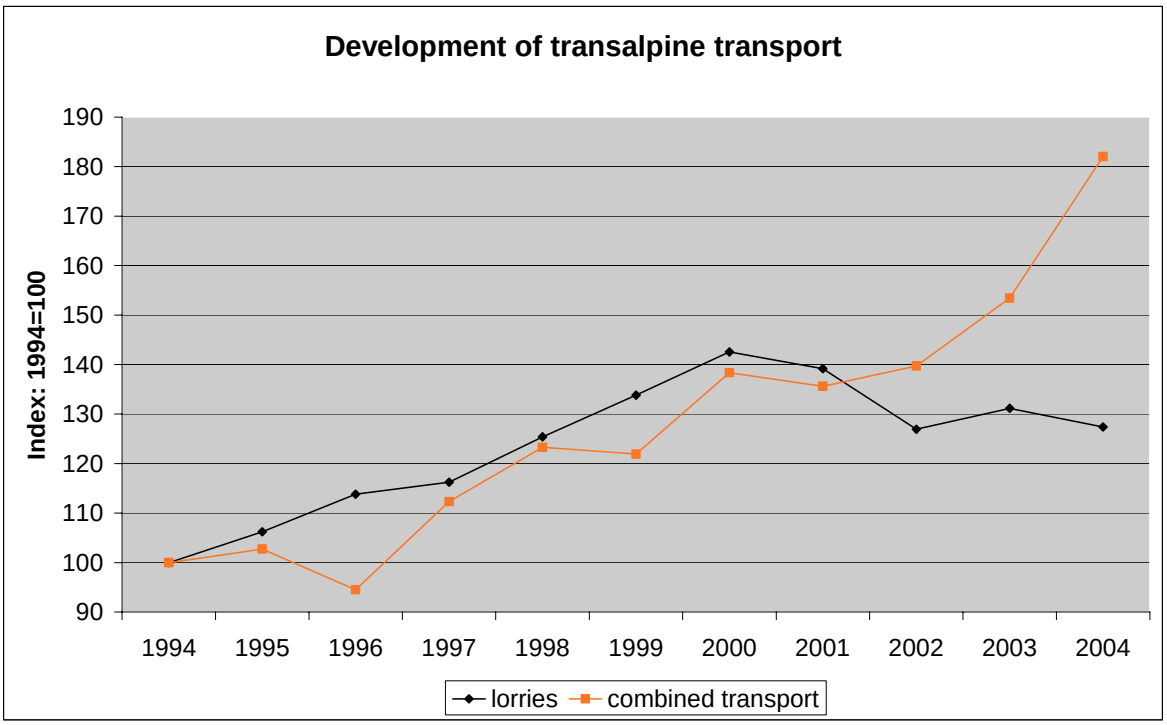


Figure 4-4: Development of transalpine freight transport for lorries (number of lorries) and combined transport (net tonnes) from 1994 to 2004; Index 1994=100.

The railway reform is an additional important element in increasing the efficiency of rail transport. The reform, which came into force on 1 January 1999, is designed to adapt the railways to meet the requirements of a modern transport system. It is one of the most important preconditions for ensuring that public transport in Switzerland is strengthened and gains an increasing share of the market. A second reform package is subject to parliamentary consultation. This package concerns a reorganization of the financing systems for rail infrastructure and operations.

Energy-saving programmes in the transport sector

The energy-related measures are mentioned in the section on energy policy (4.3.3). While a variety of measures are designed to reduce specific energy consumption, many of these are also part of the general transport policy approach of trying to reduce unnecessary motorized mobility, to shift traffic from roads to more environmentally friendly modes, and to improve intermodal transport chains and interconnectivity.

Agreement on fuel consumption with the Association of Swiss Automobile Importers

The aim of a target agreement concluded in February 2002 between DETEC and the Association of Swiss Automobile Importers ("auto-schweiz") is to reduce the fuel consumption of new motor cars by 24% between 2000 and 2008. SwissEnergy is supporting this effort with a compulsory energy label for new motor vehicles introduced in 2003 (see Section 4.3.3.3), and through a special campaign.

The average fuel consumption of new cars decreased in 2004 by 6.9% compared to 2000, and by 2.1% compared to 2003, and now lies for the second year below 8 litres/100 km (Figure 4-5). However, the agreed mid-term target of 7.4 litres/100 km was not met, despite the increase in diesel vehicles and technological improvements.

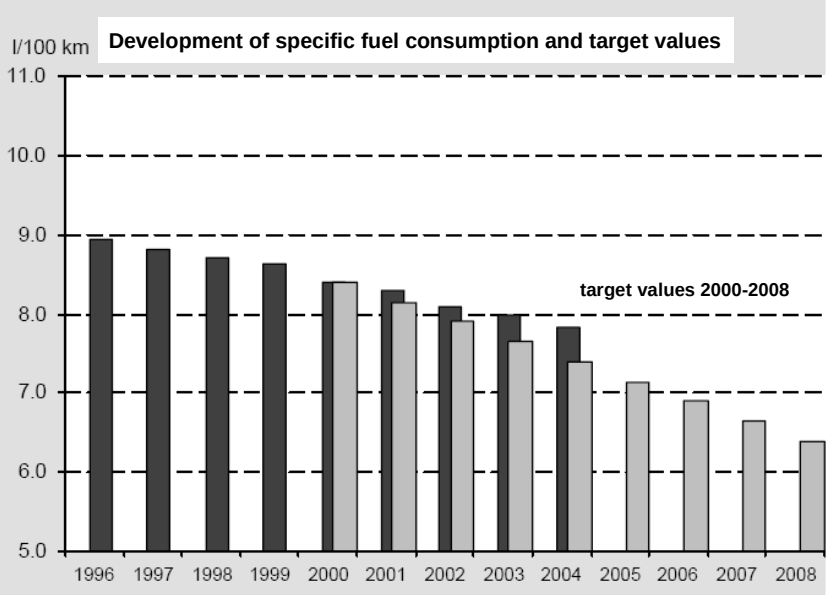


Figure 4-5: Specific fuel consumption trend (black columns) compared to the yearly targets set for 2000–2008 (grey columns) (SFOE 2005a)

Voluntary agreement on the use of biogas in the transport sector

In 2003, an agreement was concluded concerning the purchase, by gas distributors, of biogas from its producers. This is to be injected into the natural gas grid and marketed as motor fuel in pure or mixed form. Under this agreement, the biogas purchased by gas distributors is to account for at least 10% of all gas sold as motor fuel.

Measures at cantonal and communal level

The cantons are in charge of the implementation of the Ordinance on Air Pollution Control. Within the transport sector, the most important measures include speed reduction in city areas, parking measures and programmes for renewing bus fleets (fitting of CRT particle filters).

Some of the cantons apply a weight-dependent motor vehicle tax, which provides an incentive to buy and use cars that are more fuel efficient. In 1996, the canton of Lucerne introduced a motor vehicle tax based on a bonus system. The tax rate varies according to EURO standards, with rebates for fuel-efficient cars.

"Fahrleistungsmodell" in Berne canton

The "Fahrleistungsmodell" is a tool for limiting the amount of additional traffic (number of trips, kilometres travelled) generated by large infrastructure projects such as new shopping centres. Air quality targets and spatial development goals are pursued in parallel.

An analysis of measures required to reduce air pollution in the canton of Berne has indicated that air quality and climate protection targets can be met if kilometres driven by private cars do not grow by more than 8% (1.3 million kilometres per day) by 2015, compared to 2000 levels. About half of this growth allowance or "overall car trip credit" is reserved to accommodate general traffic growth within the canton's boundaries. The remaining half is allocated to large traffic-inducing projects.

The acceptable growth threshold of 8% is derived from the expected 16% reduction in specific CO_2 emissions from private cars per kilometre driven versus the 8% reduction target for CO_2 emissions from the transport sector. In choosing this approach, the canton of Berne is seeking to contribute to the objectives of the federal CO_2 Act.

Status of implementation

Since 2000, projects leading to more than 2000 additional car trips per day have only been authorized if they comply with spatial planning provisions and, in addition, allowances are available from the overall car trip credit. Several projects have been evaluated according to these criteria. Projects which have received authorization from the canton are now subject to monitoring procedures (car trip counts on access roads). By the end of 2005, a first general assessment and reporting on the implementation of the "Fahrleistungsmodell" is to be carried out.

Sample project

The planned Bern Brünnen shopping mall was allocated 57,000 car-kilometres per day from the overall car trip credit. This corresponds to 6000 trips of an average length of 9.5 kilometres. If monitoring measures indicate that this allowance is exceeded, the operators of the shopping mall may take measures on their own initiative (e.g. parking space pricing measures). If this does not have the desired effect, the cantonal authorities are entitled to take action (e.g. by levying a fee on the operators to finance improvements in the accessibility of the shopping mall by public transport). In 2003, the limit of 6,000 trips per day imposed by the canton was challenged by the promoters of the shopping mall. In 2005, the Federal Court took a final decision. It turned down their appeal and confirmed the conformity of the conditions linked to the building authorization with the canton's legal provisions on spatial planning and environmental protection.

Further information

- Berner Fahrleistungsmodell: Grundlagen und Anwendung; available for download at www.be.ch/luft > Luftreinhaltung (German only)
- SAEFL guidance on traffic planning through supply-side measures: Wegleitung für Strassenplanung und Strassenbau in Gebieten mit übermässiger Luftbelastung; available for download or order at: www.buwalshop.ch, order number VU-5022-D/F (German/French)

Contacts

- AGR (Office for Municipalities and Spatial Organisation), CH-3011 Berne
- beco (Directorate for Economic Affairs of the Canton of Berne), CH-3011 Berne

Aviation

In the domestic aviation sector, mineral oil tax is levied on kerosene, provided that there is no connecting flight to a destination abroad. For the time being, no further measures are in place addressing GHG emissions from domestic aviation. Within the ECAC and ICAO, Switzerland is lobbying for the implementation of internationally coordinated measures to limit and reduce GHG emissions from aviation.

4.3.5. Industry (including HFCs, PFCs and SF_6)

4.3.5.1. Fugitive fuel emissions

The CH_4 emissions in the fugitive fuel emissions sector are mainly CH_4 losses from the gas distribution network in Switzerland. Based on the revised Ordinance on Air Pollution Control (see Section 4.2.2), the emission standards for fuel distribution have been tightened, requiring vapour recovery units for petrol distribution. This has also had a positive impact on CH_4 emissions.

4.3.5.2. Other GHGs (HFCs, PFCs, SF_6)

In the industrial processes sector, the use of synthetic GHGs (called "substances stable in the air" and defined as halogenated VOCs with a half-life longer than two years, plus the non-VOCs SF_6 and NF_3) has been regulated in various areas through a climate-related amendment to the Ordinance relating to Environmentally Hazardous Substances of 9 June 1986 (see Section 4.2.2). This amendment was adopted in April 2003 and entered into force in stages between July 2003 and January 2004. The regulations cover the following areas:

Compressed gas containers

The mechanism of compressed gas containers intrinsically involves the emission of the propellant gas. In this area, emissions of synthetic GHGs can therefore only be limited by restrictions on use. An analysis of the current state of technology identified the following as the only applications for which exemptions are required: inhaler sprays for the treatment of chronic respiratory diseases, compressed gas containers for cleaning live electrical and electronic equipment, and polyurethane spray foam in certain situations where safety is critical. The state of technology will be defined in guidelines developed in collaboration with the professional circles concerned. For other applications where these substances may perhaps be required, e.g. for safety reasons, the state of technology is changing rapidly, and it seems more appropriate to use the option of granting temporary exemptions based on individual requests.

Furthermore, the Ordinance relating to Spray Cans of 26 June 1995 prohibits the use of HFCs or PFCs in most spray cans. It only allows the use of HFC-152a as a propellant in spray cans containing cosmetics and household products.

Foams

By 2010, in the absence of regulations, the plastic foams sector is likely to become one of the two main sectors emitting synthetic GHGs in Switzerland, responsible for nearly 25% of the total. Although, in most cases, these foams are of the closed-cell type and, in Switzerland, they are mainly disposed of by incineration, this sector is largely emissive (production, use, disposal). The only measures currently available in Switzerland to significantly limit synthetic GHG emissions from plastic foams involve restrictions on use. As insulating foams without fluorinated gases already account for well over half of the Swiss market, the regulations permit the use of synthetic GHGs in plastic insulating foams only where no environmentally superior alternative is available according to the current state of technology. However, since the technology is rapidly advancing, the state of technology and application criteria are to be clarified in guidelines developed and updated in collaboration with the producers and professional users, as well as with the cantonal authorities.

Solvents

The use of synthetic GHGs as solvents in commercial products is mainly emissive. Therefore, the only way to limit emissions is by restricting the use of such products. Solvents containing synthetic GHGs are currently used almost exclusively by industry, and some of them are still found to be necessary, depending on the state of technology. To ensure confinement, consumer goods containing such solvents have been banned and the current provisions of the Ordinance on Air Pollution Control applicable to professional uses have been slightly modified so that they cover all regulated substances. Consequently, synthetic GHGs will be subject to the same provisions as chlorinated organic substances, such as perchloroethylene. These regulatory provisions are accompanied by a 10-year deadline for bringing existing equipment into line.

Refrigerants

In 2010, without regulatory measures in the area of refrigeration and air conditioning, this sector would probably be the source of more than half the emissions of synthetic GHGs in Switzerland. The main sub-sectors responsible would be commercial and industrial refrigeration and mobile air conditioning. A mixed regulatory system has therefore been implemented, comprising: (a) a timetable of specific bans for certain categories of household appliances (refrigerators, freezers, air conditioners), accompanied by a system of individual exemptions when no alternatives are available; (b) a ban on the use of synthetic GHGs in mobile air conditioners, coming into force when permitted by the state of technology; (c) an authorization procedure, based on the state of technology and the quality of confinement, for fixed installations and for heat pumps working with more than 3 kg of synthetic GHGs; and (d) measures to reduce emissions (periodic checking for leakage, maintenance records, notification of installations) required for mobile and fixed installations containing more than 3 kg of refrigerant.

To ensure the transparency and proportionality of this relatively complex system, several technical guidelines relating to the relevant technology and to the implementation of the various measures to improve confinement have been developed in collaboration with the sector concerned, and with the cantonal authorities.

Fire protection

The 1996 ban on the supply and import of extinguishing agents made of synthetic GHGs and of appliances or stationary equipment containing such agents has been maintained and adapted.

SF_6 in electrical distribution equipment

The use of SF_6 is authorized in electrical distribution equipment that is hermetically sealed or constantly monitored, and which operates at more than 1 kV. This is governed by voluntary agreements established in 2003 by the sectors concerned. The level and the volume of emissions are limited, and the recovery of SF_6 from equipment is guaranteed.

Other application sectors

Among the former applications of PFCs and SF_6 in Switzerland, use in tyres and insulating windows is no longer authorized. Taking into account the particular situation in the area of sports shoes, a transitional exemption until 2006 has been granted. Other uses are authorized insofar as there is no environmentally superior alternative and when emissions are reduced to a minimum according to the best available techniques.

Furthermore, under Annex 2 of the Ordinance on the Movement of Toxic Waste, waste containing HFCs and PFCs counts as special waste. Thus, the movement of such waste is controlled, and it must be treated by licensed enterprises in an environmentally sound manner.

4.3.5.3. Precursors and SO_2

Many air pollution control measures can be beneficial to the climate due to their energy-saving potential and especially through the reduction of ozone, aerosols and their precursors. The Ordinance on Air Pollution Control regulates emissions for around 150 different pollutants and over 40 types of industrial and commercial equipment, and stipulates quality requirements for heating and motor fuels (limitation of sulphur content and introduction of lead-free petrol).

NMVOC tax

While revising the Environmental Protection Act in December 1995, the Swiss parliament approved an incentive tax on VOCs, to be levied on both imported and domestically produced NMVOCs. Since 1 January 2000, NMVOCs and products with a VOC content of more than 3% have been subject to an incentive tax of CHF 2 per kilogram. This rate was increased to CHF 3 in 2003. The tax revenues are returned to the population on a per capita basis. The introduction of the incentive tax led to a reduction in emissions of about 10% by 2001. The tax continues to reduce emissions and to stimulate the replacement of products and processes involving NMVOC use.

SO_2

Since the revision of the Ordinance on Air Pollution Control (1992), SO_2 emissions have decreased due to the lower limits specified for sulphur content, notably for diesel fuel (0.2% to 0.05% by weight) and for heavy fuel oil (1.5% to 1% by weight). In addition, the Swiss petroleum industry permanently reduced the sulphur content of light fuel oil (voluntary effort). Under the revised Environmental Protection Act, a tax on the sulphur content of light fuel oil (exceeding 0.1%) was introduced in July 1998. In 2000, the average sulphur content was 0.07% for light fuel oil and 0.7% for heavy fuel oil. Since 1 January 2005, the sulphur content of petrol and diesel fuel has been limited to 50 mg/kg.

NO_X and NMVOCs as precursors of ozone

In 1989, a strategy was adopted to avoid excessive concentrations of ozone, also in view of its role as a GHG. The target is to reduce concentrations of precursor gases (NO_X and NMVOCs) by 70–80% compared with emission levels in the mid-1980s. To date, reductions of 40–50% have been achieved. Further reductions are still necessary to avoid harmful summer smog.

Particulate matter

In 1998, a new air quality standard for PM10 was introduced in the Ordinance on Air Pollution Control. Since then, measures to cut emissions of PM and diesel soot (particulate filter trap systems) have been introduced or discussed for various types of vehicles, e.g. for construction machinery (Guideline in force since 1 September 2002).

4.3.6. Agricultural policy

Positive effects on agricultural GHG emissions have resulted from changes in the agricultural policy and economic framework (see Section 4.2.5) and, since 1992, from increasing compliance with the required standard of ecological performance (criteria now met by almost 100% of farms), – in particular, the requirement for maintenance of an appropriate soil nutrient balance.

Consistent application of the Water Protection Act, which sets the framework for the preservation of ground and surface water quality, has likewise had a moderating effect on livestock rearing and manure management practices and thus also reduced agricultural GHG emissions. To protect water quality, the Act defines a limit of 3 cattle manure units per hectare for the highest yielding areas. In environmentally sensitive or lower yielding areas, the cantonal authorities are required to set lower limits.

As a result of these limits, combined with the ecological performance requirements for appropriate soil nutrient balances and the establishment of ecological compensation areas, but also, in particular, as a result of progressively increasing yields and declining demand, the cattle population in Switzerland decreased from some 1.85 million in 1990 to 1.57 million in 2003.

At the same time, support is provided by the federal authorities in the form of targeted basic and applied research efforts, the findings of which are integrated into agricultural education and advice, thereby raising farmers' awareness of environmental concerns.

The substitution of farmyard manure for mineral fertilizers has led to a 30% reduction in the use of the latter, from 75,000 tonnes in 1990 to 53,000 tonnes in 2003. Consequently, N_2O emissions from fertilizer application decreased from 1.45 Gg in 1990 to 1.28 Gg in 2003. Total emissions of N_2O fell by 13% between 1990 and 2003. Over the same period, as a result of the reduction in livestock numbers, CH_4 emissions also dropped by 11% (SAEFL 2005).

Between 1990 and 2003, the overall decrease in CH_4 and N_2O emissions from the Swiss agricultural sector was around 550 Gg CO_2 equivalent, corresponding to a 13% share of the country's total reduction commitment (8%) under the Kyoto Protocol. Given the persistence of current trends, further – albeit lower – reductions in agricultural emissions can be expected by 2012. Additional scope exists in the area of carbon sinks, as carbon sequestration in the agricultural sector could potentially be enhanced by measures such as the optimization of soil management (no-till, direct seeding) or expansion of ecological compensation areas (Leifeld et al. 2003, Hediger et al. 2004). In the longer term, Swiss agriculture could make another contribution to the reduction of

GHG emissions in the energy sector through the production and use of carbon-neutral raw materials (see Section 4.4.4) (FOAG 2004).

4.3.7. Land-use change and forestry

The National Forest Programme of 2004 concluded that existing forest legislation is inadequate to deal with the current and future problems facing the forest. Therefore, the Forest Act is now under revision. The following principles with a long tradition in Switzerland's forestry will be maintained:

- Prohibition of deforestation, with strict regulations about exemptions, including the obligation to afforest an equal area or to take other measures to improve biodiversity.
- Devastated tracts and clear-cuts are legally kept as forest areas. From 2000 to 2003, subsidies of CHF 24.1 million per year were paid for reforestation of such areas in cases where natural regeneration was too weak and/or biodiversity had to be improved. 67,720 trees were planted annually (the subsidies had been temporarily increased due to the damage caused by Hurricane Lothar in December 1999).
- Forest management has to be strictly sustainable (for nearly 100 years the felling of timber has only been permitted at a sustainable rate).

In 2001, a 10-year wood promotion campaign was launched ('wood 21'). The objective is to increase the use of wood as an environmentally friendly and carbon-neutral construction material. After Hurricane Lothar, a temporary programme was carried out to promote the use of wood as a source of energy. This measure raised the consumption of fuelwood by about 100,000 m^3 per year, reducing CO_2 emissions from fossil fuels by 60 Gg per year.

In 2004, the third National Forest Inventory was started, with growing stock and deadwood being systematically recorded. However, surveys of soil carbon are not included.

Investigations have been started to establish how topographical maps, Swiss Area Statistics, the National Forest Inventory and satellite data can best be used to provide high-quality data on the area of the various land-use categories and land-use change according to UNFCCC reporting requirements.

Major carbon reservoirs such as bogs and fens are fully protected by the Federal Act on the Protection of Nature and Cultural Heritage. Nature and landscape protection legislation also calls for the establishment of ecological compensation areas – such as copses, hedges and natural vegetation on lake shores and river banks – within intensively used areas. The duty to enhance the ecological value of farmland has been supported by the promotion of greener agricultural practices over the past few years. Financial support for these activities has amounted to several million Swiss francs per year.

4.3.8. Waste management

Since 1991, under the Technical Ordinance on Waste Management, waste of all kinds has had to be treated in an environmentally sound manner. Since 2000, there has been a legal requirement that non-recycled combustible waste should be incinerated rather than disposed of at landfill sites, as the relatively low volumes of incineration residues present fewer problems. The cantons are responsible for implementation (planning capacity, installing, monitoring). By 2004, incineration capacities had reached a level at which the ban on landfilling could be fully enforced. In recent years, CH_4 emissions from waste have been significantly reduced, and emissions from existing landfills are expected to continue to diminish in the coming years.

The contribution of waste incineration to total national CO_2 emissions currently amounts to about 3% per year, which is lower than accumulated long-term CH_4 emissions from waste disposal in landfill sites. In addition, under Article 38 of the Technical Ordinance on Waste, plants have to be operated in such a way that the heat produced by incineration is reused. Consequently, 40% of the energy generated at waste incineration plants is used for district heating and electricity production.

On 5 April 2000, the Federal Council decreed the introduction of a new tax earmarked for contaminated site remediation. Since 1 January 2001, waste disposal at landfill sites in Switzerland has been taxed at a rate of CHF 15–20 per tonne, depending on the type of waste. Any exports of waste to landfill sites abroad are taxed at CHF 50 per tonne. Revenues are expected to amount to about CHF 30 million per year.

4.4. Policies and measures adopted or planned

4.4.1. Climate policy

On 23 March 2005, the Federal Council decided to introduce a CO_2 tax on heating/process fuels and to accept the Swiss Oil Association's proposal for a "climate cent" to be levied on transport fuels. On 22 June 2005, the Federal Council adopted the ordinances required to implement this decision. The first ordinance regulates CO_2 tax imposition, exemption and redistribution, and the second ordinance limits the use of the flexible mechanisms.

- For the **CO_2 tax** ordinance to come into force, the tax rate of CHF 35 per tonne of CO_2 needs to be approved by Parliament. The tax will therefore be levied from 1 July 2006 at the earliest. Existing voluntary agreements with companies qualifying for tax exemption will be transformed into legally binding commitments. It is estimated that the tax will reduce CO_2 emissions in the residential and industry sector by 700 Gg. Revenues of CHF 600–700 million are to be fully redistributed to the population (about CHF 50 per capita) and the business community (about CHF 110 per CHF 100,000 of wages paid). Companies exempted from the tax are not entitled to receive redistributed revenues.
- Being a voluntary measure, the "**climate cent**" on transport fuels does not require Parliament's approval. Moreover, the government has no say in how revenues are to be used. In late summer of 2005, DETEC will conclude an agreement which sets milestones to be met by the "climate cent" fund. The CO_2 impact of the "climate cent" (expected to be levied as of 1 October 2005) will depend on how the revenues of about CHF 100 million per year are invested. The intention is to fund mitigation projects in Switzerland and CDM/JI projects abroad. Funds will be managed by the newly established non-governmental "Climate cent" foundation. Should the foundation fail to meet the agreed milestones by 2007, a CO_2 tax will be introduced on petrol as of 2008.

Other measures designed to support the achievement of the reduction targets stipulated in the CO_2 Act are in preparation (see Sections 4.4.2 and 4.4.3).

4.4.2. Energy policy

4.4.2.1. SwissEnergy: Outlook for 2006–2010

In July 2005, the results of the first half of the SwissEnergy programme (2001–2005) were assessed. On the basis of this evaluation, five main areas have been identified which the programme is to focus on from 2006, namely

- modernization of the building stock,
- enhanced use of renewables (in particular wood/biomass, hydro, heat production),
- energy-efficient appliances and electric motors,
- rational energy use and ambient heat recovery in industry (including through additional target agreements under the umbrella of the EAEc),
- energy-efficient and low-emission mobility.

At the same time, the strategic committee of SwissEnergy set the target of raising the overall effectiveness of the programme by 25% for the period 2006–2010.

4.4.2.2. New law on electricity market liberalization

Following the rejection by the electorate of the proposed Electricity Market Act in the autumn of 2002, a new Federal Electricity Supply Act has been drafted in response to the various unresolved issues. The draft legislation is based on the following main considerations: the ruling by the Federal Supreme Court in mid-2003 that market liberalization is possible on the basis of the Cartels Act; the forthcoming full liberalization of the electricity market in the EU (as of 1 July 2007); and the EU Regulation on conditions for access to the network for cross-border exchanges in electricity that came into effect on 1 July 2004.

A further objective of the new Electricity Supply Act is to promote electricity generation from renewable energy sources. In line with EU Directives, a target is specified for the promotion of power generation from renewables, which is initially to be met through measures taken by electricity suppliers; in accordance with the subsidiarity principle, if the target is not met, the law is to make support instruments available to regulators. Under the proposed Federal Electricity Supply Act, the proportion of total final electricity consumption generated from renewables is to be increased from 67% to 77% by 2030. The baseline value of 67% represents average production from 1994 to 2003 as a proportion of final consumption. To calculate production, the expected level of hydropower generation is taken into account; actual production levels are applied for electricity from solar and wind power, geothermal energy and biomass, including the renewable proportion of waste in incineration plants (estimated value 50%). This mode of calculation ensures that the requirements for production of electricity from renewable sources increase in line with rising consumption, which is also in the interests of secure power supplies.

4.4.2.3. Energy performance of buildings

In line with the European Directive of 16 December 2002 on the energy performance of buildings (EPBD), the Swiss Society of Engineers and Architects (SIA) is developing a basis for Swiss regulations. The objective of the EPBD is to promote the improvement of the energy performance of buildings within the Community, taking into account outdoor climatic and local conditions, as well as indoor climate requirements and cost-effectiveness. The term “energy performance of a building” is defined as “the amount of energy actually consumed or estimated to meet the different needs associated with a standardised use of the building, which may include, *inter alia*, heating, hot water heating, cooling, ventilation and lighting”. The EPBD also calls for the introduction of energy certificates for buildings.

The energy performance certificate is primarily based on a rating and comparison of consumption between buildings. In this respect, the general direction of Swiss policy is different from that of the EU. Under current conditions, it would not be possible, for example, for an energy certificate similar to that planned in the EU to be enshrined in Swiss legislation by 2006. On the other hand, the question of whether and how some form of energy certificate should be established in the medium term is being considered by the SFOE. This will involve an examination of how such a certificate would relate to the MINERGIE label (see Section 4.3.3.2), which is of a different nature (label with a quality guarantee). In addition, existing experience in EU countries – especially Denmark and Germany – will need to be taken into account.

4.4.2.4. Ecological tax reform

Although an ecological tax reform was rejected by the electorate on 24 September 2000 and a popular initiative “for a secure AHV (state pension system) – taxing energy instead of employment” was rejected by the electorate on the recommendation of the Federal Council and Parliament, existing energy and climate policies will continue to be actively pursued. The idea of a sustainable energy supply underlies the SwissEnergy programme, the CO_2 Act, the Electricity Market Act (with additional measures to promote renewables and ensure secure energy supplies), the Nuclear Energy Act and – in the long run – the ecological tax reform.

The CO_2 tax on heating and process fuels (see Section 4.4.1) is a step towards an ecological tax reform. A more comprehensive ecological tax reform, shifting the tax burden from labour to energy, is recorded as a strategic goal of the Federal Council. However, since the electorate’s rejection of the proposed reform on 24 September 2000, no specific proposals have been

elaborated. Options for greening the existing tax system are also being examined by the Swiss Federal Tax Administration (FTA) in various ongoing tax reform projects.

4.4.2.5. The Swiss position regarding nuclear energy

Disposal of radioactive wastes

In several referendums, the Swiss electorate has approved the use of nuclear energy for power generation on the basis of existing plants. Accordingly, Switzerland must also assume responsibility for waste disposal. The Nuclear Energy Act which entered into force in February 2005 therefore essentially calls for domestic disposal of nuclear wastes. Preparations for a solution within Switzerland need to be made now.

Radioactive wastes have to be isolated from the environment for long periods, and appropriate technical approaches have been developed. At present, after conditioning, wastes are kept in above-ground interim storage facilities. National and foreign experts are, however, unanimous in the view that long-term safety can only be assured by disposal in deep geological layers.

The Swiss disposal scheme therefore envisages two deep geological repositories – one for low- and medium-level, and one for high-level radioactive wastes. These repositories are to be established in suitable deep geological layers, thereby ensuring that humans and the environment are protected from harmful effects for long periods.

Planning of new nuclear power plants

Switzerland's existing nuclear plants are approaching the end of their useful life. The first plant needing to be replaced from 2019 will be Beznau I. The replacement of nuclear plants and the need to meet future power requirements without producing high levels of CO_2 emissions are key energy policy issues. A renewed fundamental debate on nuclear power in Switzerland is to be expected. Consequently, the SFOE estimates that the legal procedure for the planning of a new nuclear plant will take at least fifteen years.

As an alternative mid-term solution, plans exist to replace the existing nuclear power plants with combined cycle gas turbine plants. This option would need to be carefully assessed in the light of its implications for the objectives of Swiss climate policy (see Section 5.5.1 on the Swiss 'Energy Outlook' for further information on the gap in supply of electricity expected around 2020).

4.4.3. Transport policy

4.4.3.1. Air pollution

Further development of exhaust gas limits

Exhaust gas limits for the various types of vehicles are in line with European limits and simultaneously implemented in Switzerland.

Particulate matter

Several measures to reduce PM and diesel soot emissions (particulate filter trap systems) have been introduced or are under discussion for various types of vehicles (city buses, construction machinery, etc.). The promotion of filter systems is envisaged, e.g. including fiscal incentives for purchasing new or retrofitting old engines (on import taxes or at the cantonal level on yearly taxes).

Ozone and PM

In 2005, at the international level, Switzerland will ratify the Gothenburg Protocol to Abate Acidification, Eutrophication and Ground-level Ozone. The implementation of this protocol and compliance with the prescribed national emission ceilings will contribute to the reduction of ozone and secondary particulate precursors. It also represents a contribution to the avoidance of GHGs not regulated by the Kyoto Protocol.

4.4.3.2. Promotion of low-carbon fuels and energy-efficient cars

Mineral oil tax reduction on biofuels and natural gas

From 2007, support in the form of tax relief is to be provided for clean fuels. With a proposed amendment to the Mineral Oil Tax Act, the Federal Council wishes to introduce tax incentives for clean fuels and thereby reduce CO_2 emissions from road traffic.

A tax reduction of 40 Swiss cents per litre of petrol equivalent for natural and liquefied petroleum gas (LPG) and complete tax exemption for biogas and other fuels from renewable sources should create a sufficient incentive to increase demand for clean fuels. Consumption of natural gas, LPG, biogas and other renewables is expected to rise.

The decline in revenues is to be fully offset by higher rates of tax on petrol. Petrol taxes are thus likely to rise by 1–2 Swiss cents per litre in 2007 and around 6 Swiss cents in 2010, provided the maximum technically feasible potential to add biofuels to petrol is exhausted.

Bonus/penalty system for cars

A system of bonuses/penalties for the retail prices of new cars is a classical economic instrument for promoting energy efficiency and environmental effectiveness. A system of this kind – using federal motor vehicle tax to promote energy-efficient and environmentally friendly cars – is currently being considered by an interdepartmental working group led jointly by the SFOE and the Federal Customs Administration. In parallel, the Swiss Federal Roads Authority has studied enlarged models considering also other environmental dimension (such as air pollution and noise). Under these schemes, a bonus would be offered as a reward for consumers who purchase "green", fuel-efficient cars, with bonus payments to be financed by an increase in vehicle tax (i.e. in a revenue-neutral manner).

4.4.3.3. Infrastructure planning and financing

In order to enhance coordination between transport and spatial development, the federal authorities are developing a transport plan, including a strategy for infrastructure policy and the main road and rail infrastructure projects.

- The strategy focuses on optimal capacity management of existing infrastructure, with the emphasis on sustainable spatial development – consolidating agglomerations and improving connectivity between Swiss cities and the European high-speed rail network. Top priority is accorded to improvement of the rail network.
- The road network is to be improved in areas of high traffic density where road capacity is critical and the risk of congestion is rising. The next extension of the rail network will also be capacity oriented. Specific critical links and nodes are to be improved. Parliament has already expressed its will to invest in the improvement of high-speed connections and appropriated CHF 1 billion.
- The plan also highlights regional priorities, with the greatest importance being attached to the reduction of capacity problems in urban areas. There is a strong link to the agglomeration programmes.
- The financing of future investments is only partly guaranteed: on the basis of the national "FinÖV" system, the financing of the transalpine rail tunnels and parts of the railway network expansion is secured. In the spring of 2005, the government presented its proposal for a new infrastructure fund and started a consultation process on this issue. The fund would provide the money required to secure the functionality of the national road network and to finance the needed infrastructure improvements and expansions required in urban areas. Revenues from mineral oil excise duties would be earmarked for the fund, which would allow cross-financing between road and rail to be further extended to a certain degree. Depending on the outcome of the consultation process, the government will present a formal draft proposal to Parliament in the autumn of 2005.

4.4.3.4. Further development of freight transport policy

Although the Swiss strategy to shift freight traffic from road to rail is on track, the final goals have yet to be achieved. The following measures have been adopted for the further development of this strategy.

- In 2005, in accordance with the bilateral agreements with the EU, the heavy vehicle fee (see Section 4.3.4) was increased by about 55%, with a parallel increase in the weight limit to 40 tonnes. A final step (a further 8% increase) is planned to coincide with the opening of the Lötschberg rail axis (scheduled for 2008). These measures are expected to lead to a reduction of around 5% in vehicle-kilometres and an acceleration in the changeover from road to rail transport (especially for transalpine routes).
- The promotion of combined transport is financially secured until 2010. With subsidies totalling more than CHF 1 billion, a further shift towards combined transport is expected. Total funding for the modal shift to rail amounts to over CHF 2.8 billion from 2001 to 2010.
- In line with the EU rail packages, Switzerland is liberalizing its railway markets so as to improve interoperability and the quality of transnational transport through increased access rights and competition between different operators.
- Through increased enforcement activities (speed limits, driver/rest times) and penalties, truck drivers are to be obliged to minimize distortions of competition between road and rail, which will also help to improve road safety.

The Federal Office of Transport is preparing new legislation for these measures.

4.4.3.5. Implementation of transport programmes

In the transport sector, the federal government has strengthened the strategic approach and elaborated several programmes.

- Agglomeration programmes are designed to provide suburban regions with financial resources for infrastructure projects aimed at promoting public and non-motorized transport. Several agglomerations have elaborated integrated transport schemes and have applied for federal funding for the most urgent projects.

Implementation of an Agglomeration Programme in Zurich canton

On 27 October 2004, the cantonal government adopted an *Agglomeration Transport Strategy*. One of the aims of this strategy is to support the development of high-quality urban landscapes in agglomeration regions. In line with existing plans for settlement development, it aims to establish in these areas an urban transport system with a substantially higher proportion of public and non-motorized transport. It thus complements at the regional level the strategies for higher-level, long-distance transport infrastructure (railways, arterial roads).

The cantonal government requested the relevant authorities to develop *regional integrated transport plans* on the basis of the Agglomeration Transport Strategy by the end of 2005. These will facilitate the coordination of traffic-planning development at the cantonal and local authority level and ensure that it is geared to consistent transport, spatial planning and environmental policy goals.

At present, only some of the required funding has been secured for the measures being developed under the regional transport plans. However, these plans will help to ensure that the scarce financial resources can be deployed in a coordinated, targeted and prioritized manner. Established on the basis of the regional transport plans and in coordination with the final work on the Arterial Roads Strategy, the cantonal agglomeration programme integrates settlement, environmental and transport concerns – a precondition of the provision of federal support for agglomeration transport measures. Following the positive outcome of the referendum of 28 November 2004 on the reform of financial equalization and task allocation (NFA), appropriate legal foundations are currently being prepared at the federal level to permit the payment of federal subsidies for transport infrastructure in agglomerations.

- Leisure transport programme: The strategy paper highlights a very dynamic transport segment and proposes several measures to reduce motorized leisure transport, involving various stakeholders, especially sports event managers and tourism agencies.
- Non-motorized transport programme: A similar strategy claiming that measures to promote non-motorized transport can be highly effective, proposes several measures (including financial mechanisms) for increasing the share of this environmentally friendly mode of transport.
- Traffic telematics programme: This federal programme aims to optimize traffic flows and capacity by improving information systems and traffic management in congested areas, thereby enhancing road use efficiency and postponing infrastructure expansion projects.

4.4.3.6. Aviation

According to the "Report on Swiss aviation policy 2004" (Swiss Federal Council, 2004), the Federal Council intends to consider to what extent revenues from current taxes on kerosene in domestic aviation, amounting to some CHF 60 million per year, could in future be used, *inter alia*, to finance environmental protection measures relating to aviation. In addition, it continues to support Switzerland's active involvement in aviation policy at the European and the global level (particularly through the ICAO).

4.4.4. Agricultural policy

Agricultural reform and adaptation to opening of markets

The key challenge for the next stage of the agricultural reform is to exploit the existing potential for productivity gains so as to improve competitiveness at all levels of the food industry and thus reduce costs to the economy. At the same time, this will mean that the agricultural sector can fulfil the tasks assigned to it by the Constitution, its reliance on protectionist measures will decrease and the basis for the implementation of future WTO commitments will improve. With further transfers of resources away from market support measures towards direct payments, the agricultural policy will continue consistently to follow the path taken by the reform process since the beginning of the 1990s.

Continuing tendency towards decreasing GHG emissions

As a result of the elimination of market support, domestic agricultural products are becoming less competitive; at the same time, the economic attractiveness of ecological compensation areas will increase as the prices of agricultural products fall, leading to an increase in these areas. In general, falling prices will tend to moderate the intensity of production. This trend can be expected to have additional positive impacts on agricultural GHG emissions (reduction in areas subject to fertilizer application and possibly a further decline in livestock populations as a result of the abolition of the milk quota system in 2009). Another instrument of Swiss agricultural policy is the implementation of projects specifically designed to address pressing regional environmental problems. The expansion of measures of this kind is currently under discussion.

Overall, however, the potential for additional reduction of agricultural GHG emissions is limited – firstly, because certain emissions within the agricultural system are inevitable, and also on account of the high costs of additional technological solutions (e.g. precision farming, georeferenced yield and soil maps to improve the allocation and timing of mineral fertilizer and manure application, etc.).

Biofuels: A medium-term option for agriculture

In the longer term, the agricultural sector could make an additional contribution to climate change mitigation in the area of biomass energy resources. A potential exists for the recovery of fuels from biomass – wastes such as liquid manure, crop residues and other unsaleable products.

This development will be driven by changes in the general conditions for the use of biomass energy resources at the national level (e.g. the CO_2 tax on heating fuels, or tax exemption for transport fuels from renewable resources from 1 January 2007 following the revision of the Mineral Oil Tax

Act). In addition, a parliamentary initiative is calling for guaranteed payments for electricity supplies from renewable sources fed into the grid, including the modification of spatial planning legislation to permit the construction and operation of installations for combined heat and power generation from biogas, biomass, waste wood and grasses in agricultural areas. The required preparations for the revision of spatial planning legislation are currently under discussion.

4.4.5. Land-use change and forestry

In 2004, on the basis of a parliamentary motion, the Swiss Parliament decided to elect forest management as an activity under Article 3.4 of the Kyoto Protocol. Case studies on several areas were started in various regions of the country. These should provide the basis for national rules for assessing and accounting for removals by sinks and emissions by sources in the forest management sector.

There is a certain discrepancy between the main objectives of the National Forest Programme (see Section 4.2.6) and the election of forest management under Article 3.4 of the Kyoto Protocol. Under the National Forest Programme, the main objective of Swiss forest policy is to promote the sustainable use of timber, with the aim of substituting for fossil fuels, rather than enhancing sink capacity. Under the prevailing economic conditions it may be difficult to increase the harvested volume. The National Forest Programme takes this into account by considering the contribution of forest carbon sinks to meeting the Kyoto target as a subsidiary goal. Nevertheless, implementation of the forest programme will lead to reduced carbon sequestration in forests.

4.4.6. Waste management

The *Guiding Principles for Swiss Waste Management* issued in 1986 have been largely implemented. The great majority of waste fractions are treated or disposed of in an environmentally sound manner. With a view to possible adaptations of the *Guiding Principles*, the federal authorities are currently assessing the effectiveness of the Swiss waste sector. The findings are expected to be published in late 2005.

4.5. Overview of policies and measures

a) Measures implemented (situation as in June 2005)

Name of policy or measure	Objective and/or activity affected	GHGs affected	Type of instrument	Status	Implementing entity or entities	Impact indicators
1 CO_2 Act	Setting targets and timeframe for reduction of energy-related CO_2 emissions (overall target: minus 10% by 2010 compared to 1990)	CO_2, precursors	Legal Voluntary, with option for economic incentive tax	In force since 1 May 2000; guidelines for voluntary action issued in July 2001, superseded by CO_2 Ordinance adopted in June 2005	SAEFL	Fulfilment of CO_2 requirements according to CO_2 Act (periodic monitoring of overall emissions; progress reports by players engaged in voluntary agreements)
2 Kyoto Protocol flexible mechanisms	The flexible mechanisms are understood to be primarily an instrument for the private sector. The major buyer of certificates in Switzerland is expected to be the "Climate cent" foundation.	CO_2	Economic	The necessary institutions have been established (legal framework, secretariat). For the time being, no budget allocated for investment in CDM/ JI projects.	SAEFL and SFOE with the aid of the Energy Agency for the Economy (EAEc)	Entities with binding commitments are allowed to cover up to 8% of their reduction target with emission certificates. Other actors (e.g. "climate cent") are allowed to cover up to 1600 Gg CO_2 eq./year through the flexible mechanisms. The total admissible contribution from flexible mechanisms corresponds to approx. 50% of the difference between base year and target.
3 Energy Act	Ensure secure energy supply, contribute to rational and efficient energy use	CO_2	Framework legislation - institutional - economic - regulatory	Implemented since 1998	SFOE, cantons	Development of overall energy consumption. Fossil fuel savings through mandatory measures in 2004: 17.6 PJ (1.2 million tonnes CO_2)
4 "SwissEnergy" action plan (successor to "Energy 2000" programme)	10% reduction in fossil fuel consumption from 2000 to 2010	CO_2	Voluntary agreements	Implemented since 2001 (follow-up to "Energy 2000").	SFOE, cantons and partners in the public and private sectors	Direct and indirect effects of the programmes since 1990 measured in terms of energy saved and reduction in CO_2 emissions (2004: 23.7 PJ and 1.6 million tonnes CO_2 respectively)
5 Cantonal and communal energy laws	Bring cantonal/ communal energy legislation in line with the federal Energy Act	CO_2	Framework legislation - institutional - economic - regulatory	Continuously implemented	Swiss cantons and local authorities	Status of cantonal/communal energy legislation
6 Energy efficiency programmes in the buildings sector, MuKEn modules (model cantonal energy provisions)	Introduce/promote SIA standards, MINERGIE label etc.	CO_2	Institutional Regulatory	Implemented since 2001 (follow-up to "Energy 2000")	SFOE, cantons and partners in the public and private sectors	Energy consumption in new and renovated buildings. Quantitative impact of activities largely corresponding to the effects of the Energy Act (see measure 3 above)

Name of policy or measure	Objective and/or activity affected	GHGs affected	Type of instrument	Status	Implementing entity or entities	Impact indicators
7 Energy efficiency programmes in the commercial and industrial sector	Voluntary agreements, models for large-scale consumers to fully exploit technological potential	CO_2	Voluntary agreements	Implemented since 2001	SFOE, partners in the public and private sectors	Energy consumption in commercial and industrial sector. 2.7 PJ of final energy saved in the period 2001–2004
8 Energy efficiency programmes in the transport sector	Agreement on targets with Association of Swiss Automobile Importers Energy efficiency label for cars	CO_2	Voluntary agreements	Implemented since 2001 (follow-up to "Energy 2000")	SFOE, partners in the public and private sectors	Energy consumption in transport sector 0.77 PJ of final energy saved in the period 2001–2004
9 Amendment to the Energy Act	Improved feed-in tariffs for renewable energy Guarantee of origin for electricity	CO_2 (at the global level*)	Regulatory	Implemented since 2005	SFOE, cantons and partners in the public and the private sectors	Increased generation of renewable electricity
10 Heavy vehicle fee (HVF)	Transfer of freight traffic from road to rail, reduction in trans-alpine road traffic	CO_2, precursors	Economic	Implemented since 2001	Customs authorities, Federal Roads Authority	Load factors, change in road/rail vehicle-kilometres Expected reduction in vehicle-kilometres for HGVs in 2005: 13.6–17.2%
11 Modal shift measures in the transport sector	Transfer of freight traffic from road to rail, reduction in trans-alpine road traffic (supporting the HVF); expansion of railway infrastructure and services	CO_2, precursors	Institutional Subsidies (combined transport)	Implemented since 2000	Federal Office of Transport	Reduction in vehicle-kilometres for HGVs, increase in combined transport, transalpine truck traffic volume Expected reduction in vehicle-kilometres for HGVs in 2005 (including effects of HVF): 18–21.7%
12 Sustainability and protection of forested area	Sustainable forest management, no reduction in forested area	CO_2	Regulatory	Implemented since 1993	SAEFL	Number of trees, and their CO_2 absorption
13 GHG gas mitigation in agriculture	Promotion of ecological practices on farms	CH_4, N_2O	Economic Voluntary	Implemented since 1993	FOAG	Reduction in cattle population, and in the use of mineral fertilizers
14 Amendment of the Ordinance relating to Environmentally Hazardous Substances	Reduction in use and emissions of synthetic GHGs in all main sectors	HFCs, PFCs, SF_6	Regulatory Voluntary	Implemented since 2004	SAEFL, cantons	Expected reduction of emissions growth: 100–500 Gg CO_2 eq. in 2010
15 NMVOC tax	Reduction in fugitive fuel emissions	Precursors	Economic	In force since 1999	SAEFL	Expected reduction: 27,000 tonnes of NMVOCs

*****Since power generation is almost carbon-free in Switzerland, renewable energy does not reduce CO_2 emissions directly in this country, but at the global level, e.g. if it is used to replace coal-based power.

Table 4-5: Most important measures implemented

b) Measures adopted or planned (situation as in June 2005)

Name of policy or measures	Objective and/or activity affected	GHGs affected	Type of instrument	Status	Implementing entity or entities	Impact indicators
1 CO_2 tax	Reduction of CO_2 emissions from heating/process fuels	CO_2, precursors	Economic	Adopted by Federal Council and submitted to Parliament for adoption	SAEFL	Fulfilment of CO_2 reduction target for non-transport fuels
2 "Climate cent"	Mitigation projects within and outside Switzerland	CO_2, precursors	Voluntary	Agreement concluded in 2005	"Climate cent" foundation	Fulfilment of CO_2 reduction target for transport fuels
3 Emissions trading	Scheme for companies engaged in legally binding reduction commitments	CO_2	Economic	Ordinance adopted by Federal Council, due to enter into force after adoption of CO2 tax rate by Parliament	SAEFL	Trading volume monitored in national registry
4 Bonus/penalty system for cars	Reduction in fuel consumption of new cars Improvement of general environmental performance	CO_2, precursors	Economic	Evaluation of models	SFOE, Swiss Customs Swiss Federal Roads Authority	Fuel consumption of new cars: general environmental performance of cars
5 Programmes in the transport sector	Infrastructure expansion in agglomerations; reduction of traffic growth, new attempts to shift from road to public/non-motorized transport	CO_2, precursors	Infrastructure	New financing options for infrastructure financing (road, rail) in consultation	DETEC	Implementation of infrastructure programmes in agglomerations
6 Electricity Market Act	Measures supporting the liberalization of electricity markets: promotion of renewable forms of energy	CO_2 (at the global level*)	Institutional Regulatory	Public consultation concluded; expected entry into force in 2007	SFOE	Share of renewable electricity
7 Revision of mineral oil tax legislation	Promotion of alternative fuels by tax reduction, and tax increase for petrol	CO_2, precursors	Economic	Public consultation concluded; expected entry into force in 2007	Swiss Customs	Share of alternative fuels
8 Decision by Parliament to account for sinks	Forest management to enhance and conserve sinks	CO_2	Not yet defined	Decided in 2004, implementation starting in 2008	SAEFL	Maximum contribution to Kyoto reduction objective: 1,835 Gg CO_2 per year (Decision 11/CP.7, Appendix)
9 Ecological tax reform	Shifting tax burden from labour to energy use	CO_2, other emissions	Economic	Suspended and reconsidered for post-2012 period	Federal Department of Finance	Model calculations

*****Since power generation is almost carbon-free in Switzerland, renewable energy does not reduce CO_2 emissions directly in this country, but at the global level, e.g. if it is used to replace coal-based power.

Table 4-6: Most important measures adopted or planned

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5. Projections and the total effect of measures

The projections have been completely updated and are no longer comparable to those given in NC3. For most sectors (except for agriculture), new or updated models have been used to calculate future trends. The new projections have also been made compatible with the inventory data, which was not the case in NC3.

5.1. CO_2

5.1.1. Energy-related sectors

a) Energy Outlook

In order to be able to estimate future changes in energy consumption and CO_2 emissions, the SFOE is currently updating the Swiss Energy Outlook (also known as Energy Perspectives). The previous comprehensive energy outlook for the various demand sectors dates back to 1996. The Energy Outlook is based on scenarios that reflect different changes in the basic conditions, and different effects of implemented and planned measures. In May 2005, forecasts of energy consumption in four demand sectors – private households, transport, industry, and services & agriculture – were published (www.energie-perspektiven.ch), considering **two policy scenarios**: a reference scenario with the measures already implemented, and a scenario with measures under consideration such as the CO_2 tax and exemption of biofuels from the mineral oil tax (SFOE 2005a, 2005b, 2005c, 2005d). The introduction of the CO_2 tax has since been decided by the Federal Council, evidencing the immediate interplay of the Energy Outlook with the policy making process. The results for the energy transformation sector (electricity generation) are not yet available.

Both scenarios, the scenario "with measures implemented" (see Section b) below) and the scenario "with additional measures" (see Section 5.5.2), are based on the following **assumptions**:

- The economic and demographic framework develops as expected (slow upswing in the economy: average yearly GDP growth below 2% from 2000 to 2015 and below 1% thereafter; population increase of 345,000 from 2000 to 2015).

	2000	2005	2010	2015	2020
Population (in thousands)	7,235	7,470	7,540	7,580	7,603
GDP growth (in % p.a.)		1.75	1.32	1.19	0.81
Industrial value-added (1990=100)	104	111	118	123	126
Industrial production (1990=100)	127	129	139	145	149
Treated floor area (in million m^2)					
- Households	416	444	472	498	522
- Services	140	147	155	162	169

Table 5-1: Economic and demographic assumptions for the reference scenario and the scenario with a CO_2 tax (SFOE 2005e)

- The world market price (real prices) for crude oil is constant until 2030 (USD 30/bl) and steadily increases up to USD 45/bl in 2050. The prices for the other energy sources are derived from the price for oil. Given the development of oil price levels since the definition of the scenarios, these assumptions are associated with significant uncertainties (see also Section 5.5.1 on sensitivity assessments).
- Energy policy is implemented gradually. The voluntary agreements with industry and the services sector will lead to CO_2 emission reductions of 300 Gg in 2010, compared to 2000. The measures contained in energy legislation and energy efficiency programmes will increase energy efficiency, in particular within the residential sector and in industry. However, due to economic growth, the CO_2 targets set in the CO_2 Act will not be reached on schedule. This is particularly the case for the transport sector.
- A gap in electricity supplies of 12 TWh (whole year) and 10 TWh (winter season only) is expected around 2020, when the first nuclear plant will have to shut down, having reached the end of its useful life. The supply gap will be especially appreciable in the winter season and therefore corresponds almost exactly to the demand for heat. In 2001, a study indicated that upgrading and extension of combined heat and power plants will have the potential to replace nuclear power for electricity generation, and even to exceed the electricity supply gap (Prognos 2001). However, a federal strategy to close the expected supply gap and at the same time to consider impacts on the development of CO_2 emissions has yet to be elaborated.
- In the transport sector, it is assumed that the increases achieved in energy efficiency will counteract the trend towards heavier and bigger vehicles. A slight, independent trend towards increased use of natural gas and biofuels as transport fuels is assumed, triggered by incentive systems, developments in the EU and technological opportunities. A trend towards more diesel vehicles is assumed, reducing "fuel tourism" in Switzerland.

The scenario calculations are based on **bottom-up models**. Energy demand is determined using separate models for private households, industry, transport, and services/agriculture. Cost analyses are worked out separately for each model, enabling the economic effects of individual measures to be assessed for different energy prices, and taking account of the assumptions concerning the degree of implementation of measures and instruments.

The individual models for the various sectors are as follows.

Households

Factors that are particularly considered are the number of flats and households; size and use of flats (permanently occupied or holiday flat); type, age and use of the building; type and technical standard of heating installations and water-heating equipment; the provision of households with electrical appliances and their energy properties and useful life; lighting.

Industry

Fifteen sectors of industry and six sub-sectors were studied, taking account of the number of employees, net industrial production, value-added, energy prices, the various treated floor areas, installations, etc. Thirteen energy sources were distinguished, and 143 industrial production processes were investigated (e.g. cooking and blanching in the food processing industry or pressing of sections, tubes and bars in the metalworking industry).

Transport

The transport sector is segmented into on-road traffic (passenger and freight traffic), off-road traffic (rail, water, aviation, other vehicles), and off-road non-traffic (agriculture and forestry, construction machinery and equipment). Tonne-kilometres, passenger-kilometres, vehicle-kilometres, specific energy use, and substitution effects (e.g. mode of driving, modal shifts between private and public transport) were determined on the basis of model estimations. The model gives priority to on-road traffic, as it is by far the greatest consumer of energy.

Services and agriculture

The model for energy demand in the services sector is split into heat and electricity. Various domains were investigated (e.g. retail trade; wholesale trade; banking and insurance; hotel trade;

schools; hospitals and homes; buildings in the transport sector; agriculture; culture and sport; other public buildings; auxiliary buildings).

b) Scenario "with measures implemented"

The scenario "with measures implemented" (in Swiss terminology: "reference scenario") takes into account all the measures that had come into force by the end of 2004. It shows the future trends to be expected from the continuation of existing policies. This scenario includes the effects of the following measures and assumptions:

- "Energy 2000" programme and continuation of the "SwissEnergy" programme (with constant funding),
- voluntary agreements with energy-intensive companies and car importers to enhance energy efficiency and reduce CO_2 emissions (no CO_2 tax),
- continuous tightening of energy requirements for buildings (SIA standard 380/1),
- heavy vehicle fee (HVF), improvements in car fuel efficiency.

According to this scenario, overall energy consumption will continue to grow, by 2.6% from 2000 to 2010 and by 0.8% from 2010 to 2020. It is estimated that, after 2020, there will be a further slight increase. A considerable shift from oil to gas was observed between 1990 and 2000, and it is assumed that this trend will continue. The sum of heating oil and natural gas (mainly used for heating purposes) had decreased slowly but continuously since 1995. Consumption of transport fuels increased between 1990 and 2000 but will remain roughly constant in future. Electricity consumption will increase steadily by almost 1% per year. Table 5-2 shows the changes in energy consumption by source of energy.

Energy demand projections (PJ)	**1990**	**1995**	**2000**	**2005**	**2010**	**2015**	**2020**
Heating oil	257.0	241.0	225.0	216.0	208.0	199.0	190.0
Transport fuels	209.0	205.0	228.0	226.0	226.0	224.0	223.0
Natural gas	62.5	81.6	98.1	104.0	110.0	114.0	116.0
Electricity	171.0	176.0	190.0	199.0	209.0	218.0	226.0
District heating	9.8	12.5	14.4	15.9	16.2	17.0	17.6
Wood	29.3	29.2	28.9	29.9	30.8	31.4	32.4
Coal	14.4	7.8	6.2	6.6	6.7	6.5	6.3
Waste	6.7	9.7	11.7	13.7	13.8	13.7	13.6
Other renewable forms of energy	1.6	2.7	3.8	5.3	7.0	8.5	10.0
Total	***762.0***	***766.0***	***807.0***	***817.0***	***828.0***	***833.0***	***835.0***
International air traffic	44.0	52.0	65.0	50.0	52.0	55.0	56.0

Table 5-2: Projections of energy demand (final energy consumption) between 1990 and 2020, trend scenario "with measures implemented" (Prognos 2005)

Energy consumption for international air traffic increased from 44 PJ in 1990 to 65 PJ in 2000, but decreased thereafter to an estimated value of 50 PJ (2005). The future trend is uncertain: an increase is to be expected, without reaching the dynamic growth rate of the 1990–2000 period.

The results of an evaluation of the effects since 1990 of the "Energy 2000" programme and its continuation in the "SwissEnergy" programme are documented in Sections 4.2.3.2 and 4.3.3.1.

5.1.2. Non-energy CO_2 sources

The trends presented are based on a published overview of the information available for all Kyoto Protocol gases for the period 1990–2010 (SAEFL 2005). In this Chapter, the results of this study are extended to 2020.

The most important source in this category is the cement industry. After a sharp decline (38%) in clinker production between 1990 and 1997, production has stabilized at the lower level and is expected to remain roughly stable until 2020.

Most of the CO_2 emissions in the waste sector are from incineration plants. The amount of municipal waste has remained roughly constant since the early 1990s, but as a result of greater amounts being burnt, CO_2 emissions increased by 24% from 1990 to 2000. Since 2000, landfilling of municipal solid waste has been prohibited in Switzerland, and the amount burnt will remain stable in the coming years.

Other smaller CO_2 sources from industrial processes are expected to remain constant as well.

CO_2 emissions from soils (reported in the LUCF sector) are constant. The area of former wetland organic soil used for agricultural purposes has not changed in recent years and is not expected to change in the coming years.

5.1.3. Removals by sinks and reservoirs

The Swiss National Forest Programme (NFP) aims to promote higher harvesting rates in Swiss forests, with the carbon neutrality of wood expected to encourage demand for wood products. The NFP states the following objectives:

- The demand for wood and wood products increases in all application areas and leads to increased value-added and a better CO_2 balance for Switzerland.
- The contribution of wood to the improvement in the CO_2 balance is rewarded through economic incentives.
- The companies involved in the wood chain are more productive and innovative and thus more competitive.

The competitiveness of the Swiss forestry sector has still to be improved. New suppliers on the wood market, especially from Eastern Europe, will pose a challenge. Therefore, it is very difficult to make any reliable predictions concerning CO_2 removal rates for Swiss forests in the future. In recent years, there has been a tendency towards increased storm damage and hot dry summer seasons, leading to high levels of bark beetle infestation. As a result of climate change, the incidence of natural disasters may remain high. This makes it reasonable to expect that woody biomass in Swiss forests will not increase as in the past, whereas the pool of deadwood will probably increase. Deadwood is being assessed in the ongoing Third National Forest Inventory, but a methodology for determining yearly changes has yet to be elaborated. For the time being, the removals by the LUCF sector are assumed to remain about constant (see Table 5-3). However, considerable uncertainties are linked to this assumption as at present only forests and organic soils are recorded in the national database. In addition, recent analysis indicates that the rate of removals by forests may decrease in the future.

5.1.4. Overview

Table 5-3 and Figure 5-1 present an overview of the CO_2 emissions scenario “with measures implemented” for 1990–2020. Total gross emissions will decrease by 2.1% between 1990 and 2010, with a further 3.0% reduction between 2010 and 2020. The most dynamic sector is transport, where an increase of 7.5% is expected between 1990 and 2010. In contrast, fuel combustion in commercial and institutional buildings and in households (“other sectors”) will decrease by 5% from 1990 to 2010.

CO_2 emissions (000 Gg)			**Inventories**		**Projections**			
IPCC		**Sector**	**1990**	**2000**	**2005**	**2010**	**2015**	**2020**
1		All energy	40.27	40.56	40.94	40.40	39.78	39.11
1A		*Fuel combustion*	*40.19*	*40.47*	*40.86*	*40.32*	*39.70*	*39.03*
	1	*Energy/transformation*[a]	*1.41*	*1.60*	*1.71*	*1.59*	*1.58*	*1.57*
	2	*Industry*[b]	*6.13*	*5.85*	*5.79*	*5.88*	*5.92*	*5.89*
	3	*Transport*	*14.19*	*15.59*	*15.34*	*15.26*	*15.00*	*14.81*
	4	*Other sectors*	*17.76*	*16.79*	*17.36*	*16.87*	*16.44*	*15.90*
	5	*Other (off road)*	*0.71*	*0.65*	*0.66*	*0.72*	*0.76*	*0.85*
1B		*Fugitive emissions*	*0.08*	*0.09*	*0.08*	*0.08*	*0.08*	*0.08*
2		Industrial processes	2.84	1.87	1.86	1.86	1.86	1.86
3		Solvent use[c]	n.o.	n.o.	n.o.	n.o.	n.o.	n.o.
4		Agriculture[d]	i.e.	i.e.	i.e.	i.e.	i.e.	i.e.
6		Waste	1.26	1.23	1.19	1.19	1.19	1.19
		Total emissions	**44.37**	**43.66**	**43.98**	**43.45**	**42.83**	**42.15**
5		Land use change/Forestry[e]	-1.27	0.15	(-1.60)	(-1.60)	(-1.60)	(-1.60)
1A3 ai		*International bunkers*	*3.23*	*4.77*	*3.68*	*3.82*	*3.99*	*4.13*

[a] including energy from waste incineration; [b] including waste used as fuel in cement production; [c] n.o. = not occurring; [d] i.e. = emissions from agricultural soils included under sector 5 LUCF; [e] brackets indicate a high degree of uncertainty.

Table 5-3: Inventory data and projections for CO_2 emissions between 1990 and 2020, trend scenario "with measures implemented"

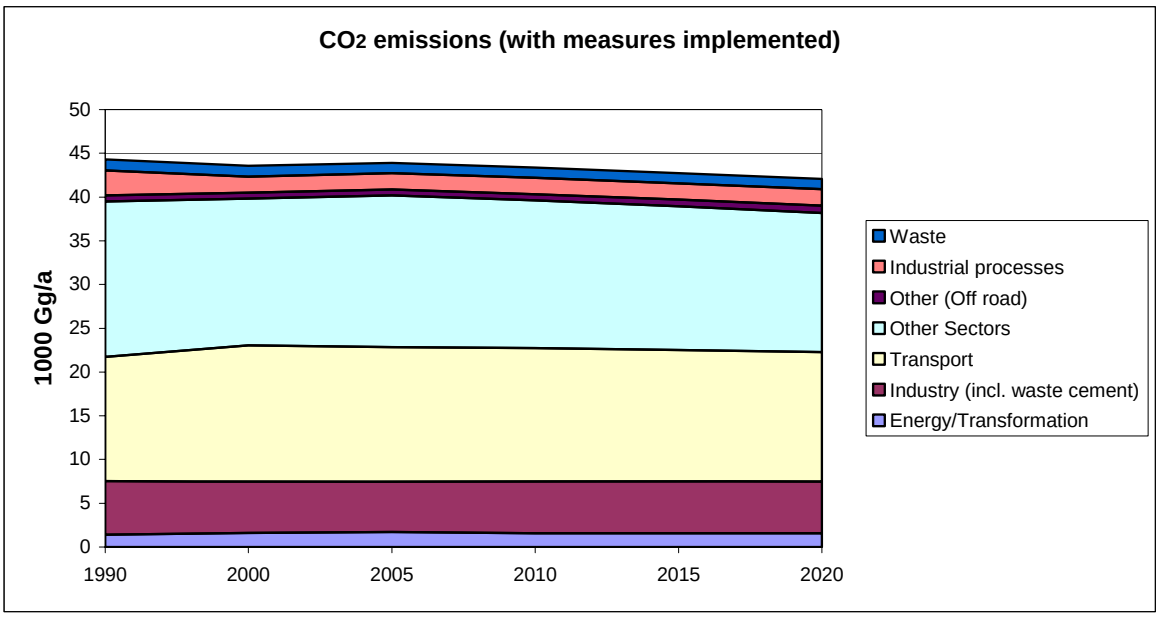

Figure 5-1: CO_2 emissions by sector from 1990 to 2020, "with measures implemented"

For a scenario "with additional measures", see Section 5.5.2.

5.2. CH_4

5.2.1. Agriculture

Emissions of methane (CH_4) from Swiss agriculture for the period 1990–2020 were calculated using the methodology described in detail in Minonzio et al. (1998). This so-called method 2 is based on the original IPCC method (1994), with specific adaptations for Switzerland. The energy intake requirements of animals for 2000–2020 was computed assuming that the energy requirements per head remain stable in comparison to 2003, in line with the most recent statistics (Schweizerischer Bauernverband 2004). The underlying number of livestock is shown in Table 5-4.

Livestock (thousand head)	**1990**	**1995**	**2000**	**2005**	**2010**	**2015**	**2020**
Mature cows	795	763	715	700	694	675	657
Non-dairy cattle	1,060	986	873	868	845	823	801
Pigs	1,787	1,446	1,498	1,420	1,420	1,420	1,420
Poultry	5,043	5,329	5,950	6,975	7,150	7,325	7,500
Sheep	395	387	421	420	420	420	420
Goats	68	53	62	60	60	60	60
Horses and mules	42	41	50	50	50	50	50

Table 5-4: Livestock populations (FOAG)

The annual emissions of methane from Swiss agriculture calculated for 1990–2020 are summarized in Table 5-5. After a substantial decrease between 1990 and 2000, methane emissions fell only slightly between 2000 and 2003. A further slight drop is expected. The projected decrease by 2010 is 11% compared to 1990. Assumptions concerning the future of Swiss agriculture are rather uncertain (best-guess estimates). The future trend was taken from Minonzio et al. (1998) and calibrated with the latest available emission data (2003 GHG inventory).

CH_4 emissions from agriculture (million tonnes CO_2 equivalent)	**1990**	**1995**	**2000**	**2005**	**2010**	**2015**	**2020**
Enteric fermentation	2.77	2.65	2.52	2.49	2.46	2.44	2.41
Manure management	0.46	0.43	0.41	0.41	0.40	0.40	0.39
Total	*3.22*	*3.08*	*2.93*	*2.89*	*2.86*	*2.83*	*2.80*

Table 5-5: Past and projected annual methane emissions from agriculture between 1990 and 2020

5.2.2. Waste

Municipal waste landfills are the second-largest source of methane emissions in Switzerland. Since 2000, landfilling of municipal solid waste has been prohibited in Switzerland. The existing sites will still emit methane in the future, but these emissions will decrease, as Table 5-6 shows. The data come from a waste site model which is in line with the IPCC 1996 guidelines (activity data from Swiss waste statistics (SAEFL 2004a) and SFOE 2003; emission factors from SAEFL 1995).

CH_4 emissions from landfills (million tonnes CO_2 equivalent)	**1990**	**1995**	**2000**	**2005**	**2010**	**2015**	**2020**
Landfills	0.71	0.53	0.41	0.32	0.20	0.14	0.09

Table 5-6: Past and projected annual methane emissions from landfills between 1990 and 2020

5.2.3. Other sources

Fugitive emissions from fuels are mainly losses from the gas distribution network (at present about 7% of total methane emissions in Switzerland). As this distribution network is constantly being upgraded, a 23% decrease in fugitive emissions is expected for the period 1990–2010 despite the rapid increase in gas consumption.

5.2.4. Overview

Table 5-7 and Figure 5-2 show overall trends for CH_4. Total emissions will decrease by 22.5% between 1990 and 2010. A further decrease of 5% is expected between 2010 and 2020.

CH_4 emissions (million tonnes CO_2 equivalent)			**Inventories**		**Projections**			
IPCC		**Sector**	**1990**	**2000**	**2005**	**2010**	**2015**	**2020**
1		All energy	0.47	0.37	0.35	0.34	0.34	0.34
1A		*Fuel combustion*	*0.17*	*0.11*	*0.11*	*0.10*	*0.10*	*0.10*
	1	*Energy/Transformation*	*< 0.00*	*< 0.00*	*< 0.00*	*< 0.00*	*< 0.00*	*< 0.00*
	2	*Industry*	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*
	3	*Transport*	*0.10*	*0.04*	*0.02*	*0.02*	*0.01*	*0.01*
	4	*Other sectors*	*0.06*	*0.05*	*0.06*	*0.06*	*0.06*	*0.06*
	5	*Other (off road)*	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*
1B		*Fugitive emissions*	*0.31*	*0.26*	*0.25*	*0.24*	*0.24*	*0.24*
2		Industrial processes	0.01	0.01	0.01	0.01	0.01	0.01
4		Agriculture	3.22	2.93	2.89	2.86	2.83	2.80
6		Waste	0.74	0.44	0.35	0.24	0.17	0.12
		Total emissions	**4.45**	**3.74**	**3.61**	**3.45**	**3.36**	**3.28**

Table 5-7: Inventory data and projections for CH_4 emissions between 1990 and 2020

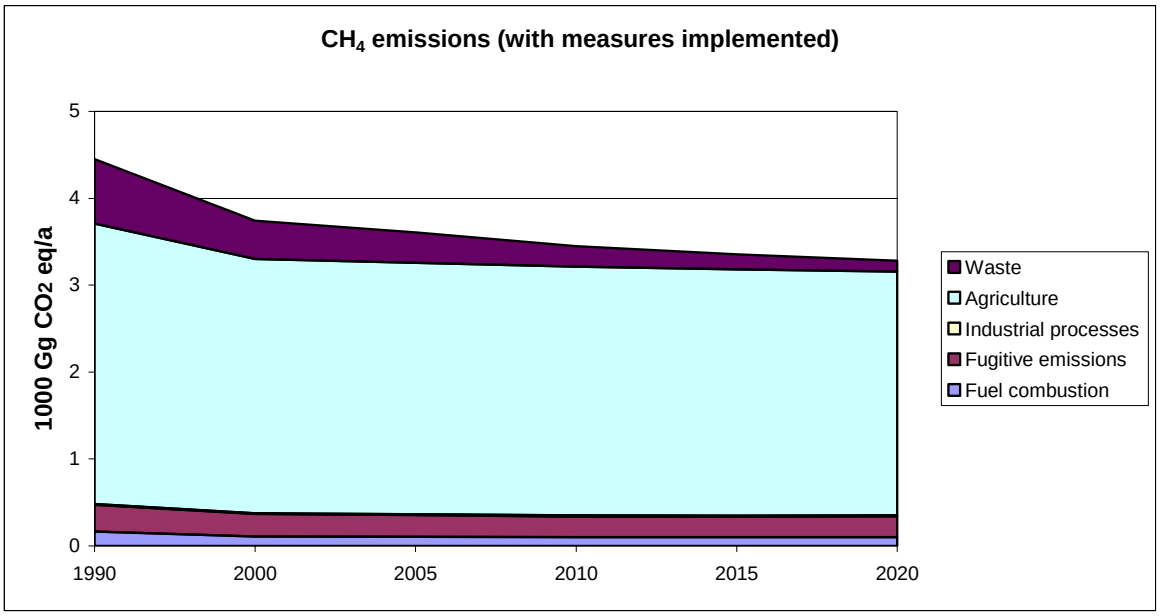

Figure 5-2: CH_4 emissions by sector from 1990 to 2020 ('Industrial processes' not visible due to their small contribution)

5.3. N_2O

5.3.1. Agriculture

Emissions of nitrous oxide (N_2O) from Swiss agriculture for 1990–2020 were calculated using the IULIA method (Schmid et al. 2000). This is based on the IPCC method (IPCC 1996) but attempts to remove some obvious inconsistencies. Moreover, it accounts for additional sources of nitrous oxide, such as biological nitrogen fixation and the decay of plant residues returned to the soil in meadows and pastures. The IPCC method only considers these emissions for arable crops. The emission factors used in the IULIA method are the same as those proposed by the IPCC. In addition to the number of livestock (Table 5-4), the IULIA method requires the total amount of fertilizers and crop production as additional input data (Table 5-8), as well as the area of meadows and pastures (Table 5-9). The future trend was taken from Schmid et. al (2000) but slightly modified to take into account the actual emissions of recent years.

Input data (thousand tonnes)	**1990**	**1995**	**2000**	**2005**	**2010**	**2015**	**2020**
Mineral N fertilizers	75	67	53	50	48	47	45
Legumes	10	14	14	20	26	29	31
Cereals	1,279	1,246	1,162	1,225	1,250	1,250	1,250
Root crops	2,074	1,705	2,383	2,240	2,305	2,305	2,305
Vegetables	360	307	350	350	350	350	350
Fruit	510	365	400	390	380	370	360
Wine	173	155	160	156	156	156	156
Tobacco	1	2	1	1	1	1	1
Energy crops	0	4	5	5	5	5	5

Table 5-8: Mineral fertilizer input and crop production (harvested biomass) between 1990 and 2020

Area	**1990**	**1995**	**2000**	**2005**	**2010**	**2015**	**2020**
(thousand hectares)	785	799	797	796	794	793	792

Table 5-9: Area of meadows and pastures between 1990 and 2020

The annual emissions of nitrous oxide from Swiss agriculture calculated for 1990–2020 are summarized in Table 5-10. The projected decrease by 2010 is 18%, relative to 1990. The decrease chiefly reflects the decline in the use of N fertilizers and, to some extent, the decrease in the population of mature cows and non-dairy cattle. Overall, the agricultural emissions of methane and nitrous oxide indicate that the agricultural reform has had positive effects on GHG emissions.

N_2O emissions from agriculture (million tonnes CO_2 equivalent)	**1990**	**1995**	**2000**	**2005**	**2010**	**2015**	**2020**
Agricultural soils	2.41	2.25	2.16	2.06	1.98	1.98	1.98
Manure management	0.45	0.42	0.41	0.39	0.37	0.37	0.37
Total	*2.86*	*2.67*	*2.57*	*2.45*	*2.35*	*2.35*	*2.35*

Table 5-10: Past and projected annual nitrous oxide emissions from agriculture between 1990 and 2020

5.3.2. Other sources

Small amounts of N_2O are emitted by many other sources. In the transport sector, N_2O is a by-product of the catalytic conversion of exhaust gases. These emissions increased from 1990 to 2000 but will decrease by 2010/20 as a result of more efficient catalytic converters. Other minor sources of N_2O are wastewater handling and waste incineration, industrial processes, fuel combustion, medical treatment, etc. These emissions will follow the general trend of the underlying activity data, which are more or less constant until 2010/20.

5.3.3. Overview

The main source of N_2O emissions is agriculture (85% of total in 1990, 82% in 2010). Table 5-11 and Figure 5-3 show that overall emissions are expected to decrease by 14% between 1990 and 2010.

N_2O emissions (million tonnes CO_2 equivalent)			**Inventories**		**Projections**			
IPCC		**Sector**	**1990**	**2000**	**2005**	**2010**	**2015**	**2020**
1		All energy	0.23	0.32	0.26	0.22	0.20	0.20
1A		*Fuel combustion*	*0.23*	*0.32*	*0.26*	*0.22*	*0.20*	*0.20*
	1	*Energy/Transformation*	*0.02*	*0.03*	*0.04*	*0.04*	*0.04*	*0.04*
	2	*Industry*	*0.05*	*0.04*	*0.03*	*0.03*	*0.03*	*0.03*
	3	*Transport*	*0.10*	*0.19*	*0.13*	*0.09*	*0.08*	*0.07*
	4	*Other sectors*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*
	5	*Other (off road)*	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*
1B		*Fugitive emissions*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
2		Industrial processes	0.10	0.10	0.10	0.10	0.10	0.10
3		Solvent use	0.11	0.12	0.13	0.13	0.13	0.13
4		Agriculture	2.86	2.57	2.45	2.35	2.35	2.35
6		Waste	0.05	0.08	0.09	0.09	0.09	0.09
		Total emissions	**3.34**	**3.19**	**3.03**	**2.88**	**2.87**	**2.87**

Table 5-11: Inventory data and projections for N_2O emissions between 1990 and 2020

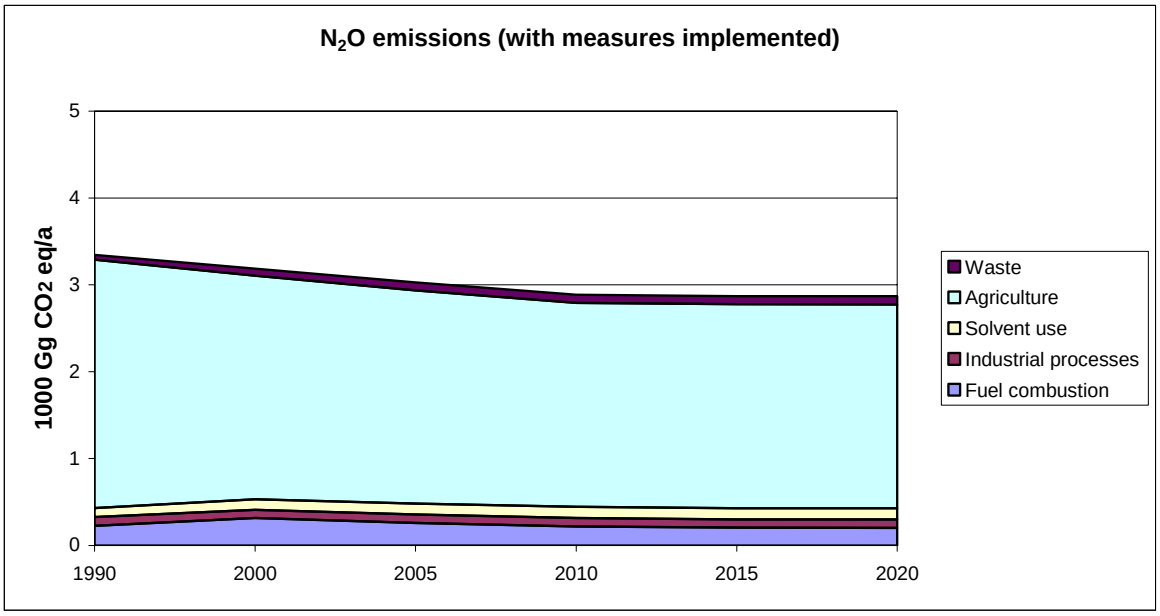

Figure 5-3: N_2O emissions by sector from 1990 to 2020

5.4. Other GHGs (HFCs, PFCs, SF_6)

Table 5-12 presents inventory data and projections for emissions of synthetic gases. The results are based on a model which calculates actual emissions for all relevant IPCC categories and covers the period from 1990 to 2010 (Carbotech 2005). The model is based on import statistics and supplemented by available information from the associations and companies concerned. Most of the synthetic gases are used in products. For these applications, the model makes assumptions about product lifetime and emission factors for assembly, operation and disposal. The following trends are assumed for the projections:

– refrigeration and air conditioning: increasing

– electrical equipment, solvents and foam blowing: steady

– aluminium production and use in aerosols and window insulation: decreasing.

The trend between 2010 and 2020 is highly uncertain. In the most important sectors (refrigeration and air conditioning), technological developments (e.g. use of CO_2 instead of HFC-134 as a refrigerant) may reduce HFC emissions. On the other hand, the foam sector might experience substantial growth. For this reason, it is impossible to indicate trends for HFCs after 2010 in Table 5-12. For PFCs and SF_6, as no major changes are expected, emissions can be expected to remain relatively stable even after 2010. The fact that the ordinance regulating synthetic GHGs only entered into force on 1st January 2004 and its mitigating effects are not yet measurable introduces another element of uncertainty regarding future emission trends.

Synthetic gas emissions (000 Gg CO_2 equivalent)	**1990**	**1995**	**2000**	**2005**	**2010**	**2015**	**2020**
HFCs	0.00	0.15	0.41	0.64	0.73	(0.73)[a]	(0.73)
PFCs	0.10	0.02	0.07	0.10	0.10	(0.10)	(0.10)
SF_6	0.18	0.10	0.20	0.16	0.16	(0.16)	(0.16)
Total emissions	**0.28**	**0.27**	**0.67**	**0.89**	**0.99**	**(0.99)**	**(0.99)**

[a] Brackets indicate a high degree of uncertainty.

Table 5-12: Projections for emissions of synthetic gases between 1990 and 2020

5.5. Aggregate effects of policies and measures

5.5.1. Overview of scenario "with measures implemented"

The aggregate effects of policies and measures on GHG emissions are illustrated in Tables 5-13 and 5-14 and Figure 5-4. The figures shown are the CO_2 equivalent emissions of CO_2, CH_4, N_2O, HFCs, PFCs and SF_6. The projections indicate an overall reduction of 3.16 million tonnes between 1990 and 2020. Between 1990 and 2010, the expected reduction is 1.68 million tonnes, or 3.2%. For this period, CO_2, CH_4 and N_2O decrease by 2%, 22% and 14%, respectively. Emissions of synthetic gases increase by a factor of 3.5.

The sink values reported for 1990 and 2000 are influenced by two storm events. For the period 2005–2020, values are extrapolated from the average for the period 1990-2003. Sink values include forest woody biomass and organic soils only. The estimates are uncertain and may be modified in the light of the results of the ongoing Third National Forest Inventory.

GHG emissions (million tonnes CO_2 equivalent)			**Inventories**		**Projections**			
IPCC		**Sector**	**1990**	**2000**	**2005**	**2010**	**2015**	**2020**
1		All energy	40.97	41.24	41.55	40.96	40.33	39.65
1A		*Fuel combustion*	*40.59*	*40.90*	*41.22*	*40.64*	*40.01*	*39.33*
	1	*Energy/Transformation*	*1.42*	*1.63*	*1.75*	*1.63*	*1.62*	*1.62*
	2	*Industry*	*6.19*	*5.90*	*5.83*	*5.92*	*5.96*	*5.94*
	3	*Transport*	*14.38*	*15.81*	*15.50*	*15.37*	*15.09*	*14.90*
	4	*Other sectors*	*17.87*	*16.89*	*17.47*	*16.98*	*16.55*	*16.01*
	5	*Other (off road)*	*0.72*	*0.66*	*0.68*	*0.73*	*0.78*	*0.87*
1B		*Fugitive emissions*	*0.38*	*0.35*	*0.33*	*0.32*	*0.32*	*0.32*
2		Industrial processes[a]	3.23	2.65	2.86	2.95	2.95	2.95
3		Solvent use	0.11	0.12	0.13	0.13	0.13	0.13
4		Agriculture	6.08	5.50	5.34	5.21	5.18	5.15
6		Waste	2.06	1.75	1.63	1.52	1.45	1.40
		Total emissions	**52.45**	**51.26**	**51.51**	**50.77**	**50.04**	**49.29**
5		Land use change/Forestry[b]	-1.27	0.15	(-1.60)	(-1.60)	(-1.60)	(-1.60)
1A3 ai		*International bunkers*[c]	*3.23*	*4.77*	*3.68*	*3.82*	*3.99*	*4.13*

[a] Including synthetic gases; [b] Brackets indicate a high degree of uncertainty; [c] CO_2 emissions only

Table 5-13: GHG emissions by sector between 1990 and 2020

GHG emissions (million tonnes CO_2 equivalent)	**1990**	**2000**	**2005**	**2010**	**2015**	**2020**
CO_2	44.37	43.66	43.98	43.45	42.83	42.15
CH_4	4.45	3.74	3.61	3.45	3.36	3.28
N_2O	3.34	3.19	3.03	2.88	2.87	2.87
HFCs	0.00	0.41	0.64	0.73	(0.73)[a]	(0.73)
PFCs	0.10	0.07	0.10	0.10	(0.10)	(0.10)
SF_6	0.18	0.20	0.16	0.16	(0.16)	(0.16)
Total emissions	**52.45**	**51.26**	**51.51**	**50.77**	**50.04**	**49.29**

[a] Brackets indicate a high degree of uncertainty.

Table 5-14: GHG emissions by gas between 1990 and 2020

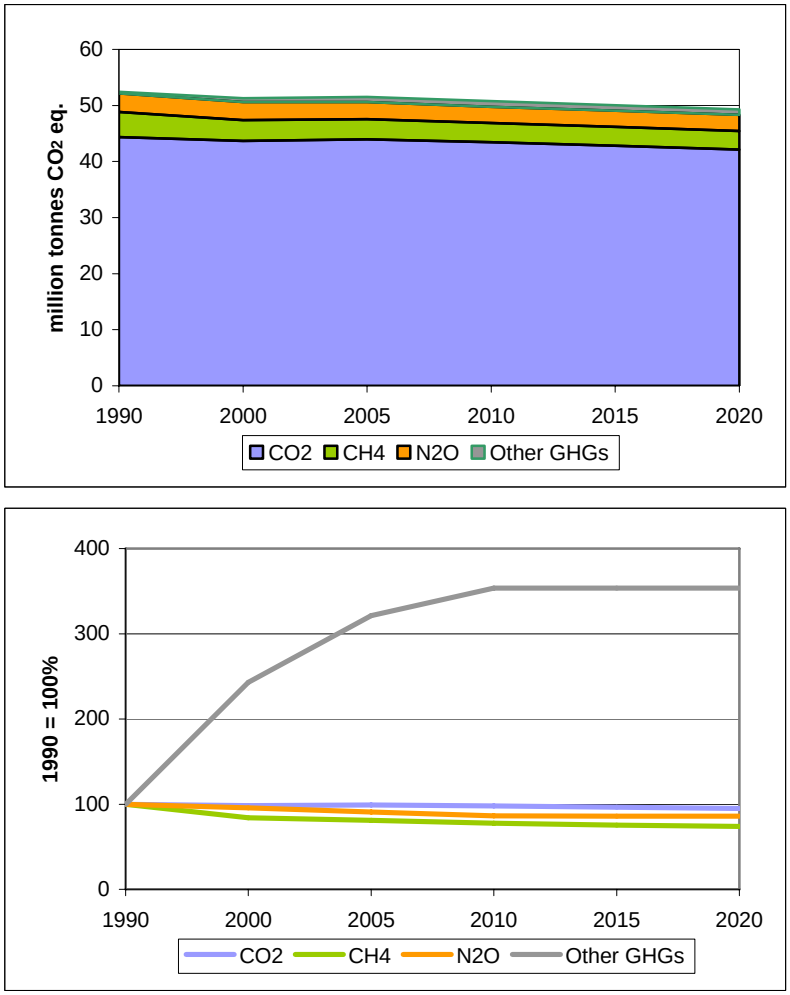

Figure 5-4: CO_2 equivalent emissions from 1990 to 2020, based on energy scenario "with measures implemented" (HFC, PFC and SF_6 emissions are kept constant after 2010). Top: Emissions in million tonnes CO_2 equivalent; bottom: Index 1990 = 100%

Kyoto Protocol target shortfall

Under the Kyoto Protocol, Switzerland's target for CO_2 equivalent GHG emissions in the first commitment period (2008–2012) is 48.25 million tonnes per year – a reduction of 8% below 1990 levels. The projections without additional measures show annual emissions of 50.8 million tonnes. The target shortfall is thus 2.5 million tonnes, as shown in Table 5-15.

Kyoto target shortfall (million tonnes CO_2 equivalent)	
Base year emissions (1990)	52.45
Kyoto target (average 2008–2012)	48.25
Total projected gross GHG emissions (average 2008–2012)	50.8
Target shortfall	*2.5*

Table 5-15: Kyoto target shortfall

Sensitivity analysis

A sensitivity analysis was carried out for the 2010 projection, with the following factors being varied: economic scenarios (influencing CO_2 emissions), winter temperatures (influencing the use of heating fuels), projected cattle populations (influencing methane emissions) and projected HFC emissions.

The sensitivity analysis indicates a margin of ±2.1 million tonnes of CO_2 equivalent for 2010 (±4%) (SAEFL 2005). This means that the target shortfall may range from 0.4 to 4.6 million tonnes of CO2 equivalent.

For CO_2, a detailed sensitivity analysis is available in Prognos (2002). The sensitivity was calculated for GDP growth, energy prices, traffic growth, building-insulation standards and a combination of these factors. GDP growth is the most sensitive parameter. A 0.5% higher GDP growth per year will lead to an emission increase of 0.8 million tonnes of CO_2 in 2010. Higher prices for fossil fuels (15% to 20% higher end-user prices for light fuel oil and natural gas, 5% higher transport fuel prices) will lead to a reduction in CO_2 emissions of 0.6 million tonnes by 2010. Although the effect of short-term fluctuations in energy prices was not estimated, it will be less than that of permanently higher energy prices.

5.5.2. Scenario "with additional measures"

In March 2005, the Swiss government decided to introduce additional measures in order to reach the goals of the CO_2 Act and the Kyoto Protocol (see Sections 4.2.1 and 4.4.1).

The following additional measures are planned:

- An incentive tax of CHF 35 per tonne of CO_2 on combustibles (light and heavy fuel oil, coal and natural gas). The revenues will be redistributed to the population and companies.
- "Climate cent" to be levied on transport fuels (petrol and diesel). The revenues will be used for national projects to reduce CO_2 emissions and for buying emission certificates abroad under the flexible mechanisms of the Kyoto Protocol.
- Bonus/penalty system for energy-efficient and environmentally friendly cars.
- Preferential treatment of alternative transport fuels (biogas, bioethanol, natural gas, etc.) in mineral oil tax legislation.

The potential effects of these additional measures in 2010 are shown in Table 5-16. As the additional domestic measures are not sufficient to make up the Kyoto target shortfall, part of the "climate cent" funds will have to be used to subsidize projects abroad generating emission certificates.

Additional measures	**Estimated annual reduction potential by 2008–2012** (million tonnes CO_2 equivalent)
Incentive CO_2 tax on heating and process fuels	0.7
"Climate cent": domestic projects	0.2
Bonus/penalty system + preferential treatment of alternative fuels	0.4
Total effect of additional domestic measures	*1.3*
"Climate cent": international projects (certificates)	1.6
Total	*2.9*

Table 5-16: Estimated reduction potential of additional measures (Prognos 2005)

The additional measures are designed to make up the CO_2 Act target shortfall (2.9 million tonnes), which is somewhat larger than the Kyoto target shortfall (2.5 million tonnes). The Kyoto target will thus be met if the goals of the CO_2 Act are achieved.

Supplementarity of the use of the flexible mechanisms

With this combination of measures, the supplementarity condition of the Kyoto Protocol is fulfilled as follows:

Of a total reduction commitment of 4.2 million tonnes (Mt) of CO_2 equivalent per year

- 2.2 Mt (minimum) is achieved through domestic measures,
- 1.6 Mt (maximum) may be acquired abroad by the "Climate cent" foundation,
- 0.4 Mt (estimate) is available in the form of emissions certificates for compliance purposes under the CO_2 Act to companies signing a binding commitment, with the real value depending on the quantity of emissions actually covered by binding commitments.

As projections always involve uncertainties (see sensitivity analysis above), **policy options** are required **for alternative future developments**. These are as follows:

If the target shortfall is larger than expected, Switzerland has two options.

- Taking sinks into account. In Switzerland, forest management is the most important activity creating a CO_2 sink. The cap defined in the Marrakech Accords for use of this activity is 1.8 million tonnes of CO_2 per year.
- Intensified use of the flexible mechanisms (buying more emission certificates).

If the target shortfall is smaller than expected, Switzerland has several options.

- Carry-over of emission rights for use during a second commitment period.
- Buying fewer emission certificates.
- Selling emission rights.

5.6. Precursors

Inventory data and projected emissions of precursors for 1990–2020 are shown in Tables 5-17 to 5-19 and Figure 5-5. The overall reductions are expected to be as follows:

- NO_X emissions: 63%
- CO emissions: 66%
- NMVOC emissions: 65%.

Owing to the introduction of the Euro 3 and Euro 4 emission standards, road transport emissions will decline rapidly. In 1990, NO_x emissions predominantly derived from the transport sector (share of 62%). By 2020 these are expected to fall to 40%. "Other sectors" (mainly residential and commercial or institutional), which accounted for 13% in 1990, are expected to contribute about 20% in 2020.

NO_X emissions (Gg)			**Inventories**		**Projections**			
IPCC		**Sector**	**1990**	**2000**	**2005**	**2010**	**2015**	**2020**
1		All energy	148.64	92.19	76.69	66.57	58.42	54.25
1A		*Fuel combustion*	*148.49*	*92.15*	*76.64*	*66.50*	*58.35*	*54.18*
	1	*Energy/Transformation*	*3.04*	*2.32*	*1.95*	*2.11*	*2.07*	*2.06*
	2	*Industry*	*16.36*	*9.02*	*9.62*	*9.39*	*9.09*	*9.10*
	3	*Transport*	*99.06*	*56.25*	*42.91*	*33.53*	*26.91*	*23.97*
	4	*Other sectors*	*21.40*	*16.98*	*15.23*	*14.66*	*13.76*	*12.75*
	5	*Other (off road)*	*8.64*	*7.57*	*6.92*	*6.81*	*6.53*	*6.30*
1B		*Fugitive emissions*	*0.15*	*0.04*	*0.05*	*0.07*	*0.07*	*0.07*
2		Industrial processes	0.46	0.32	0.32	0.31	0.31	0.31
3		Solvent use	0.04	0.05	0.05	0.05	0.05	0.05
4		Agriculture	5.19	4.46	4.26	4.06	4.06	4.06
6		Waste	5.15	3.30	2.32	2.32	2.31	2.31
		Total emissions	**159.49**	**100.31**	**83.63**	**73.30**	**65.13**	**60.97**

Table 5-17: Inventory data and projections for NO_x emissions between 1990 and 2020

Three sectors are chiefly responsible for CO emissions, namely transport (75% in 1990 and 34% in 2020), “other sectors” (11% in 1990, 26% in 2020) and “other”, i.e. mainly off-road vehicles (7% in 1990, 25% in 2020).

CO emissions (Gg)			**Inventories**		**Projections**			
IPCC		**Sector**	**1990**	**2000**	**2005**	**2010**	**2015**	**2020**
1		All energy	708.1	446.0	366.9	304.1	259.6	249.7
1A		*Fuel combustion*	*708.1*	*446.0*	*366.9*	*304.1*	*259.6*	*249.7*
	1	*Energy/Transformation*	*0.5*	*0.6*	*1.0*	*1.9*	*1.8*	*1.8*
	2	*Industry*	*16.1*	*15.1*	*15.9*	*16.2*	*16.2*	*16.4*
	3	*Transport*	*559.3*	*310.3*	*227.8*	*156.4*	*105.5*	*87.7*
	4	*Other sectors*	*83.0*	*71.5*	*69.8*	*72.0*	*76.0*	*79.3*
	5	*Other (off road)*	*49.2*	*48.5*	*52.4*	*57.7*	*60.1*	*64.4*
1B		*Fugitive emissions*	*< 0.0*	*< 0.0*	*< 0.0*	*< 0.0*	*< 0.0*	*< 0.0*
2		Industrial processes	14.9	11.5	12.5	13.2	13.2	13.2
3		Solvent use	0.1	0.1	0.1	0.1	0.1	0.1
4		Agriculture	5.9	5.9	5.9	5.9	5.9	5.9
6		Waste	12.0	2.7	1.6	1.6	1.6	1.6
		Total emissions	**741.0**	**466.2**	**387.0**	**324.9**	**280.4**	**270.4**

Table 5-18: Inventory data and projections for CO emissions between 1990 and 2020

Emissions of NMVOCs are dominated by the sectors of solvent use and transport. While the transport sector contributed 33% in 1990 and will contribute 11% in 2020, the contribution of solvent use will rise from 50% in 1990 to 63% in 2020.

NMVOC emissions (Gg)			**Inventories**		**Projections**			
IPCC		**Sector**	**1990**	**2000**	**2005**	**2010**	**2015**	**2020**
1		All energy	131.46	53.41	39.45	32.46	28.49	26.86
1A		*Fuel combustion*	*113.17*	*46.85*	*33.12*	*26.11*	*22.14*	*20.51*
	1	*Energy/Transformation*	*0.11*	*0.06*	*0.07*	*0.08*	*0.08*	*0.08*
	2	*Industry*	*0.47*	*0.46*	*0.43*	*0.44*	*0.44*	*0.44*
	3	*Transport*	*97.73*	*34.79*	*21.70*	*15.07*	*11.62*	*10.61*
	4	*Other sectors*	*7.54*	*5.52*	*5.23*	*5.08*	*4.96*	*4.72*
	5	*Other (off road)*	*7.32*	*6.03*	*5.69*	*5.44*	*5.04*	*4.67*
1B		*Fugitive emissions*	*18.28*	*6.56*	*6.33*	*6.35*	*6.35*	*6.35*
2		Industrial processes	8.22	7.27	7.56	7.85	7.85	7.85
3		Solvent use	147.00	71.65	65.00	65.00	65.00	65.00
4		Agriculture	4.22	4.22	4.22	4.22	4.22	4.22
6		Waste	3.10	0.52	0.27	0.27	0.22	0.22
		Total emissions	**294.00**	**137.07**	**116.50**	**109.81**	**105.78**	**104.15**

Table 5-19: Inventory data and projections for NMVOC emissions between 1990 and 2020

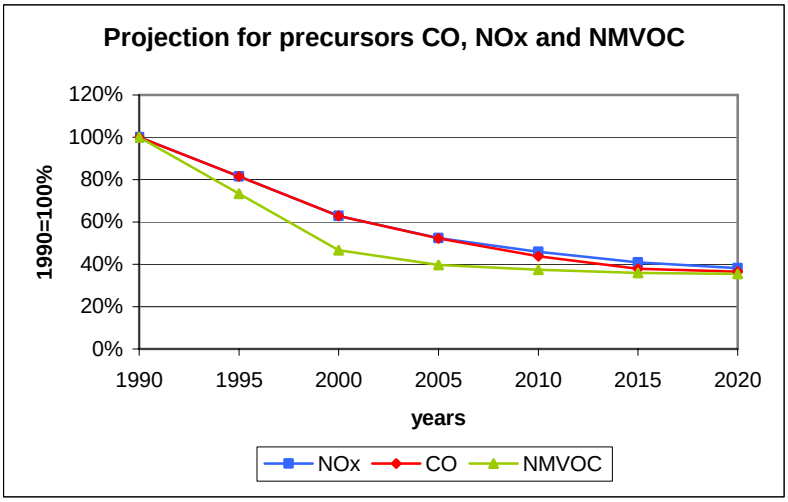

Figure 5-5: Past and projected emissions of the precursor gases NO_x, CO, and NMVOC relative to 1990

5.7. SO_2

Fuel combustion (small-scale combustion and industry) is the main source of SO_2 emissions in Switzerland. SO_2 emissions in the energy sector are directly influenced by energy consumption and the sulphur content of fossil fuels. The latter has decreased constantly since 1980.

Emissions in the energy sector will decline as a result of air pollution control measures. An overall reduction of 63% is expected between 1990 and 2020, as indicated by the projections for SO_2 emissions shown in Table 5-20 and Figure 5-6.

SO_2 emissions (Gg)			**Inventories**		**Projections**			
IPCC		**Sector**	**1990**	**2000**	**2005**	**2010**	**2015**	**2020**
1		All energy	35.08	13.01	11.98	11.79	11.49	11.01
1A		*Fuel combustion*	*35.08*	*13.01*	*11.98*	*11.79*	*11.49*	*11.01*
	1	*Energy/Transformation*	*3.09*	*1.35*	*1.46*	*1.43*	*1.39*	*1.24*
	2	*Industry*	*11.66*	*3.65*	*3.80*	*3.91*	*3.85*	*3.75*
	3	*Transport*	*3.88*	*1.72*	*0.23*	*0.23*	*0.27*	*0.27*
	4	*Other sectors*	*15.98*	*6.12*	*6.30*	*6.02*	*5.77*	*5.51*
	5	*Other (off road)*	*0.47*	*0.18*	*0.19*	*0.20*	*0.21*	*0.23*
1B		*Fugitive emissions*	*< 0.00*	*< 0.00*	*< 0.00*	*< 0.00*	*< 0.00*	*< 0.00*
2		Industrial processes	5.81	3.50	3.55	3.55	3.55	3.55
3		Solvent use	0.03	0.04	0.04	0.04	0.04	0.04
4		Agriculture	0.02	0.02	0.02	0.02	0.02	0.02
6		Waste	3.81	1.76	1.79	1.82	1.82	1.82
		Total emissions	**44.75**	**18.32**	**17.38**	**17.22**	**16.91**	**16.43**

Table 5-20: Inventory data and projections for SO_2 emissions between 1990 and 2020

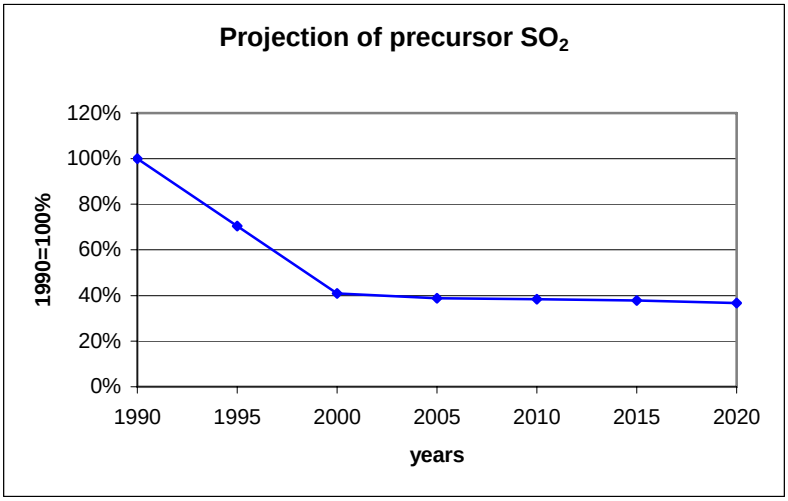

Figure 5-6: Past and projected emissions of the precursor gas SO_2 relative to 1990

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6. Impacts, vulnerability assessment and adaptation

This chapter outlines the current state of knowledge of the potential impacts of climate change in Switzerland, and the adaptation measures currently implemented to tackle the adverse effects of such impacts. As yet, vulnerability to climate change has not been studied to the same extent for all sectors, and in certain sectors adaptation measures have not yet been envisaged or relevant strategies are only loosely connected to climate change considerations.

6.1. Observed and expected impacts of climate change

6.1.1. Temperature and precipitation trends

For the period since the inception of national climate measurements in Switzerland in 1864, analysis of trends shows **temperature** increases ranging from 0.9ºC to 1.1ºC/100 years in the regions North of the Alps, while increases on the southern side of the Alpine main crest are somewhat smaller (0.6ºC/100 years). Looking at trends in different seasons, stations at higher elevations reveal the most marked warming trends in autumn, ranging from 0.8ºC to 1.3ºC/100 years. The largest temperature increase for stations at lower elevations is found in winter, ranging from 0.9ºC to 1.6ºC/100 years. Stations south of the Alps show the least marked trends, independent of the season (Begert et al. 2005).

Figure 6-1 illustrates results from analysis of homogenized data from the 20th century for 12 stations. A warming of about 1.4ºC can be observed for most parts of Switzerland, as compared to 0.6ºC at the global scale (OcCC 2003).

The temperature increase since 1970 has been 0.4–0.6ºC per decade for Switzerland as a whole (MeteoSwiss 2004), and has been similar for the summer and winter seasons. This warming is about three times higher than the global average. The trend is also in agreement with those for other Alpine regions and Central Europe. Temperature trends earlier in the 20th century were more heterogeneous, showing less warming in the southern part of the country and a reduced warming trend during the summer compared with the winter season (Begert et al. 2005).

For **precipitation** in the period from 1864 to 2000, there is no indication of a significant (at the 95% confidence level) increase or decrease during spring, summer or autumn. However, significant precipitation trends are observed at most sites for the winter and in some cases for the yearly totals (see Table 2-2). A significant increase in yearly values is visible at the stations of the Swiss Plateau and at Chaumont station, representing the Jura mountains. The trends range from a 7% to a 10% increase per 100 years. These positive trends are strongly influenced by recent years, with relatively high annual precipitation amounts. In winter, positive trends of 16–37% per 100 years are found for the stations north of the Alpine main crest. The strongest increase is observed in the northwestern part of Switzerland (Schmidli et al. 2002, Begert et al. 2005).

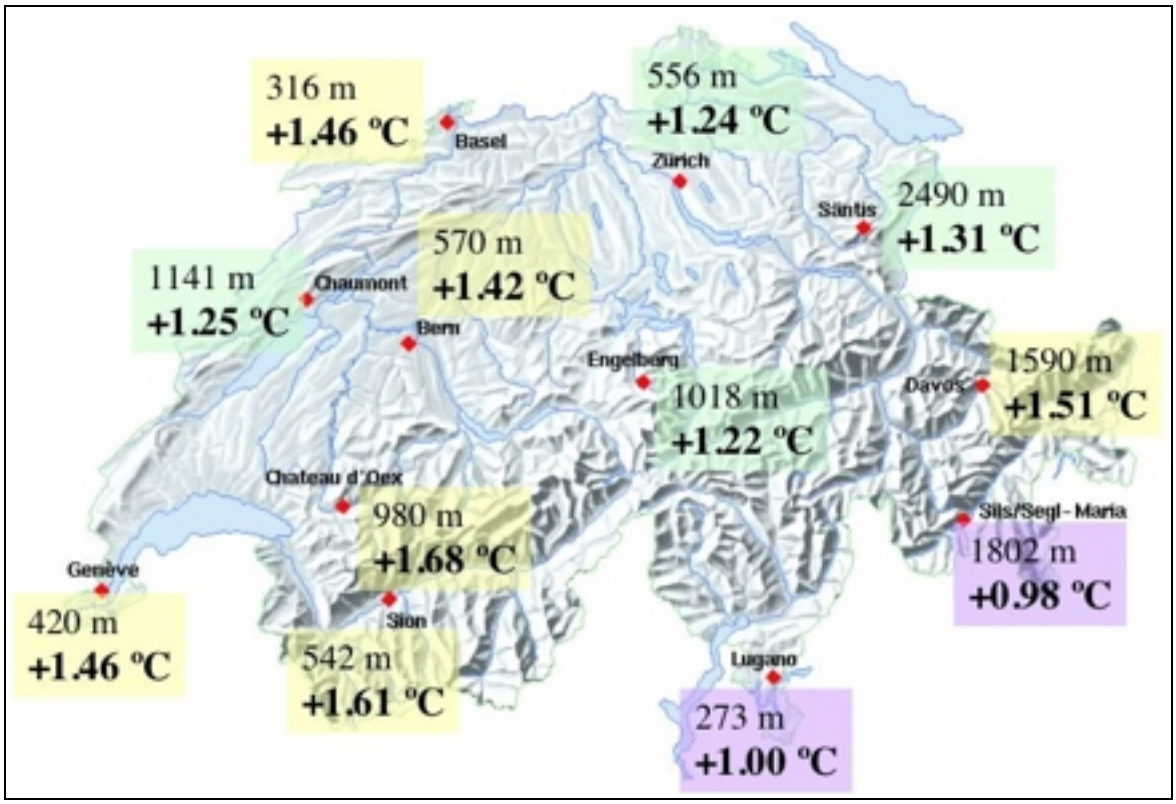


Figure 6-1: Annual temperature trends for the 20th century. Trends are given as degrees Celsius per 100 years. Station altitudes are given in metres above sea level (MeteoSwiss/ ProClim-)

In the course of the 20th century (period 1901-2000), precipitation increased during the winter in northern and western regions by 20–30%, while it decreased by the same amount during the autumn in the southern part of the country (Frei and Schär 2001). In winter, significant increases are found for precipitation strength and occurrence. In autumn, statistically significant increases are found only for heavy precipitation, whereas precipitation frequency and spell-length statistics show little systematic change (Schmidli and Frei 2005).

Expected changes

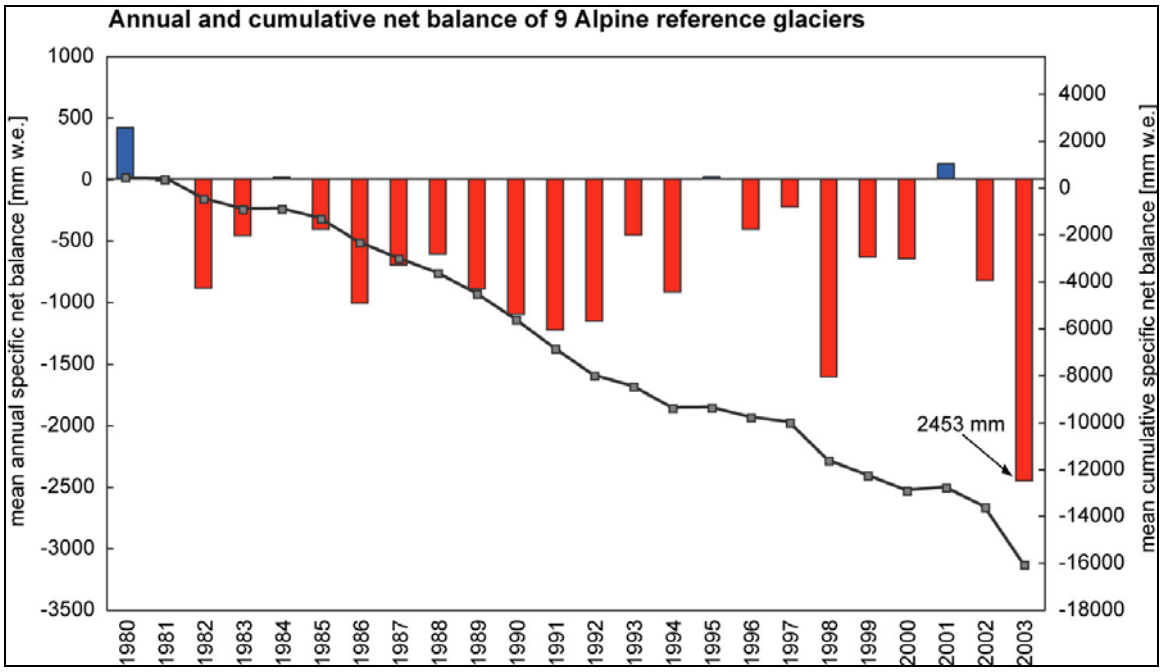
According to the findings of the Swiss National Center of Competence in Research on "Climate Variability, Predictability and Climate Risk" (NCCR Climate), numerous other Swiss research groups and the assessment reports of the Swiss Advisory Body on Climate Change (OcCC), a warmer climate will cause noticeable changes in Switzerland (OcCC 2002, 2003).

Within the framework of the EU PRUDENCE project, temperatures in Switzerland are projected to rise by about 1–5ºC in summer and about 1–3ºC in wintertime by 2050, compared to 1990 (the projected global average increase for the same period is 0.7–2.6ºC) (see also Table 2-1, Section 2.5).

Precipitation is projected to increase by about 5–25% in wintertime and to decrease by about 5–40% in summertime. This means that the seasonal distribution of precipitation would change substantially (OcCC 2003) (see also Table 2-2, Section 2.5).

6.1.2. Cryosphere (snow, glaciers, permafrost)

Melting of perennial surface and subsurface ice in the Alps has continued in recent years, with a clear tendency towards acceleration (Watson and Haeberli 2004). According to the new glacier inventory for the Swiss Alps, completed around 2000 as a pilot project for worldwide inventory compilation, roughly 25% of the glacier volume in the Alps has been lost since the mid-1970s (Paul et al. 2004). The extremely hot and dry summer of 2003 eliminated an additional 5–10% of Alpine glacier volume within the space of one year. The mass loss during this exceptional year was about 50% greater than the previous record loss (in 1998) and about three times greater than the high average recorded for 1980–2000 (Figure 6-2). It exceeded the mean value for the 20th century by roughly one order of magnitude.



mm w.e. = millimetres water equivalent

Figure 6-2: Annual and cumulative net balance of 9 Alpine reference glaciers in Switzerland (Frauenfelder/World Glacier Monitoring Service)

Owing to increasingly rapid vertical thinning, many glacier tongues are starting to waste away and collapse rather than retreating. Lakes are forming in front and on the surface of several vanishing glaciers. Thus, for instance, a large debris flow from a moraine lake caused serious damage to a village in the Zermatt region in 2001.

Warming and degradation of permafrost now clearly appears to be much faster in bedrock with low ice content than in ice-rich debris on flatter slopes. In 2003, many rockfall events from steep rock walls (Matterhorn in July) with warm permafrost were observed (Gruber et al. 2004). Boreholes on selected mountain peaks indicate that thermal anomalies from 20th century atmospheric warming (around 1°C) have penetrated to depths of several tens of metres. Continued rock warming and propagation of existing thermal anomalies to greater depths increases the probability of large-scale mass movements from slopes at high altitudes. Modern approaches using remote sensing, geoinformatics, digital terrain information and numerical models have been developed to assess hazards in high mountain areas under conditions of rapid climate change (Huggel et al. 2004, http://snowflake.ch/guests/glacierhazards/).

Swiss Alpine snow cover shows large variability on the year-to-year and decadal time scale. However, in the late 1980s and the 1990s large decreases in snow pack were observed, especially for low-lying stations (Scherrer et al. 2004). Recent decreases in snow cover can be attributed mainly to an increase in temperature. The influence of precipitation trends is small and does not substantially affect recent snow cover trends.

6.1.3. Hydrological cycle and water management

There seems to be a scientific consensus that a global increase in average temperature will lead to an intensified hydrological cycle and more frequent heavy precipitation events (>30 mm/day) in Switzerland, in particular during the winter half-year. This mechanism may be especially relevant to the southern side of the Alps, where heavy precipitation events are frequent and are related to large-scale moisture transport (Frei et al. 1998). Such heavy precipitation events may lead, in turn, to more frequent rockfalls, flooding, mudflows and landslides. Generally speaking, erosive processes will tend to accelerate under this scenario.

With an average reduction of over 50% in snowfall and snow cover duration in the Alps at elevations around 2,000 m above sea level, hydrological regimes will be significantly impacted, as the seasonality and the amount of water in alpine catchments will change (Beniston et al. 2003, Schädler 2003, Kleinn et al. 2005). Improvements in the quality of regional climate model results have also improved the quantification of shifts in the components of the hydrological cycle. The suggested increase of wintertime runoff and sharp decline of summer runoff in river basins such as the Rhine and the Rhone implies an increased flood risk in winter and a higher probability of drought at the end of the summer. Dry river beds are a rare occurrence in the northern Alps because glacier meltwaters ensure a minimum discharge in rivers during warm and dry periods of the summer, even when snowmelt no longer contributes to runoff. In the future, however, with glaciers rapidly retreating and 50–90% of the current ice mass probably disappearing (Haeberli and Beniston, 1998), glacial meltwater will no longer substantially contribute to runoff. Future discharge characteristics may have implications for the management of water resources, e.g. for hydropower in the Alps. Furthermore, water supplies to industry, agriculture and households will be affected in the lowland areas of Western and Central Europe through which rivers originating in the Alps flow.

Effects on aquifers, including the chemistry and quality of groundwater resources, are expected to be negligible even if atmospheric CO_2 concentrations double, and most of the major porous aquifers in Switzerland appear to be relatively insensitive to climatic variations (Bouzelboudjen et al. 1998).

Since 1950, water temperatures in rivers and near the surface of lakes in Switzerland have in some cases increased by more than 2°C (Figure 6-3). In some lower-lying Swiss rivers, there is evidence suggesting that the maximum temperature that can be tolerated by local species of trout is now being exceeded (Hari et al. 2005).

Much of the long-term increase in water temperature at all depths is associated with the continued tendency for the North Atlantic Oscillation (NAO) to stay in its positive phase, resulting in warmer winters in much of Europe. Long-term winter warming also causes a reduction in the duration of ice cover in alpine lakes (Livingstone 1997b). However, warmer summers, such as that of 2003, have also produced extremely high surface water temperatures and thermal stability in Swiss lakes, with a corresponding drop in deep-water oxygen concentrations (Jankowski et al., 2005).

Storage lakes can be affected by higher rockfall and landslide potential in the mountains (due to the melting of glaciers and permafrost), as well as more intense rainfall events. The effects would include the initiation of flood waves and increased accumulation of bedload, requiring more frequent lake bottom cleaning. Moreover, the likely shift of runoff from summer into wintertime (Figure 6-4) also has implications for lake filling schedules.

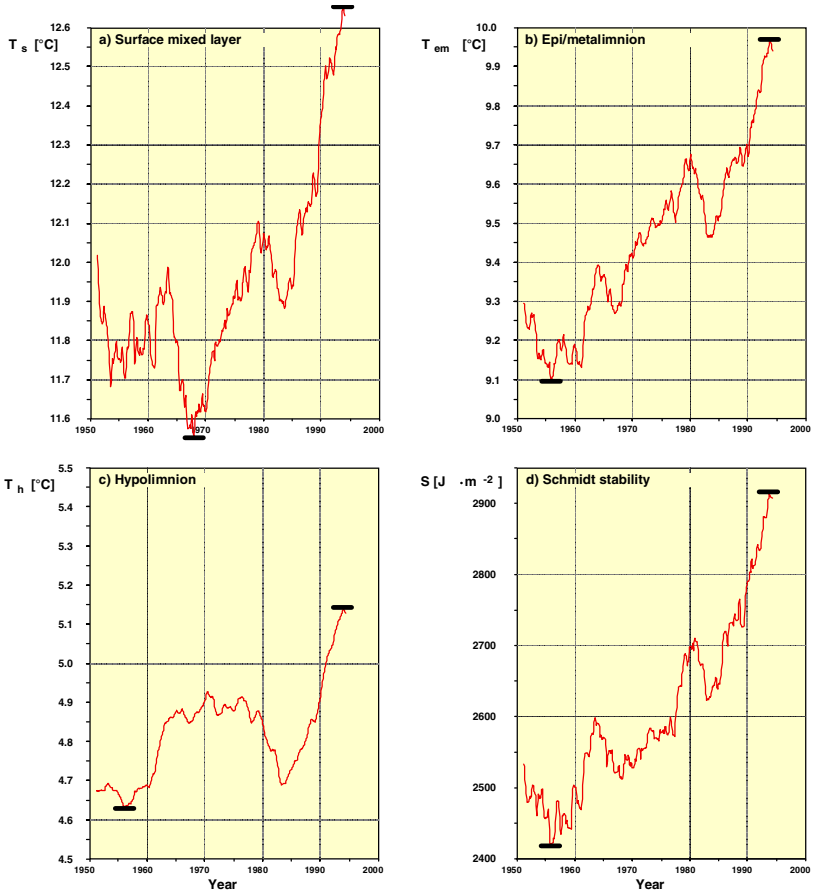


Figure 6-3: Secular changes and decadal variability in Lake Zurich water temperatures: (a) mean temperature (T_s) of the surface mixed layer (0–2.5 m); (b) mean temperature (T_{em}) of the epi/metalimnion (0–20 m); (c) mean temperature (T_h) of the hypolimnion (20–136 m); (d) Schmidt stability (S). All curves shown are centred decadal (120-month) running means. The horizontal bars show the minimum and maximum decadal means of the series. Adapted from Livingstone (2003).

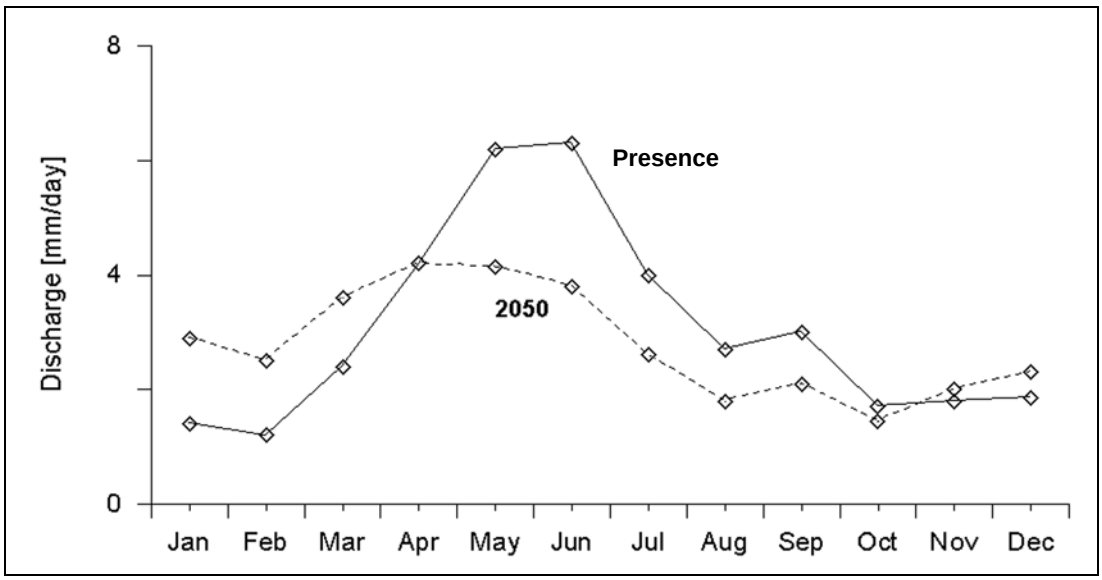


Figure 6-4: Model simulation of daily mean discharge for the alpine catchment basin Stein/Thur under present climate conditions (continuous line) and under conditions of a climate scenario for 2050 (broken line). (Gurtz, 2005)

6.1.4. Ecosystems (including forests)

Phenological observations show a trend towards an earlier onset of biological spring of about 1.5 – 2.5 days per decade while there are no significant trends in autumn (Defila and Clot 2001, Defila and Clot 2005, Studer et al. 2005). One example, typical of several long-term observation series, is the blossoming of cherry trees near Basel, which has clearly shifted to earlier dates, especially since 1980 (see Figure 6-5). Because of milder winters during the past two decades, palm trees can now grow not only at higher altitudes south of the Alps but also in gardens north of the Alps. Over the last century, the upper limit for the occurrence of pine mistletoe (*Viscum album* ssp. *austriacum*) has risen by 250 metres.

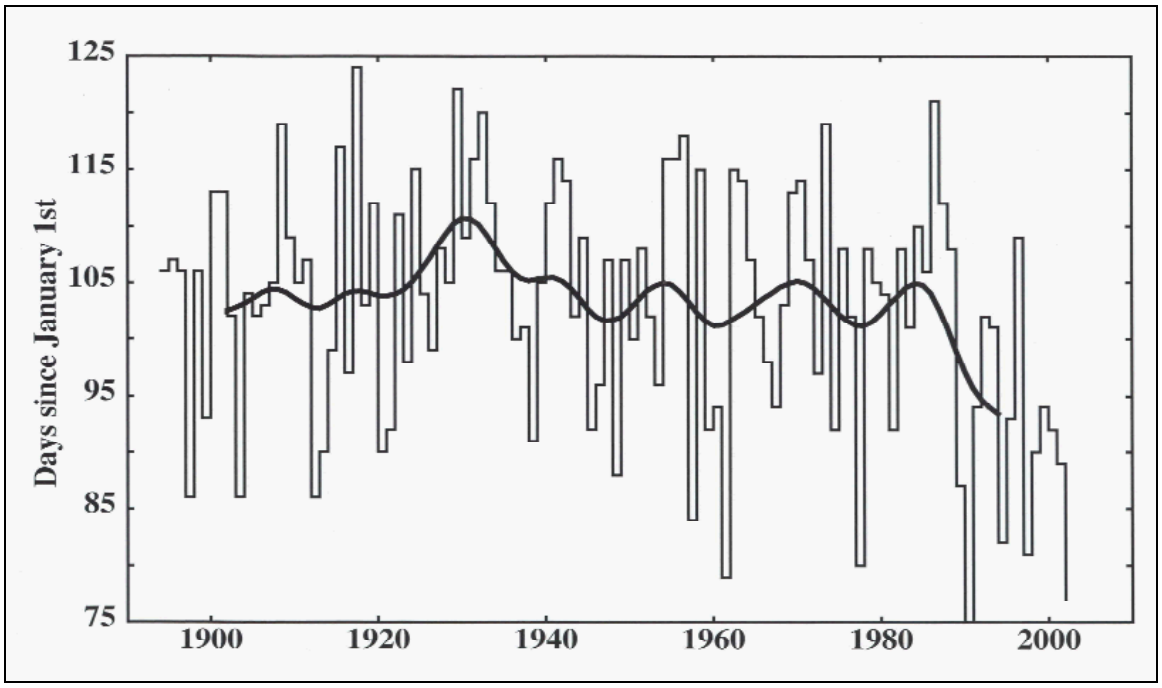


Figure 6-5: Start of blossoming of cherry trees at Liestal 1894–2002 (Defila, MeteoSwiss)

The arrival of many migratory birds is 1–2 weeks earlier than in the past, and breeding is also taking place earlier. However, the response of migratory birds is complex and does not allow simple projections, as shown by analysis of data for nearly 350,000 birds of 65 different species (Jenni and Kéry 2003).

Recent research using dynamic forest models (e.g. Bugmann 1999) suggests that warmer conditions will lead to an upward shift of forest communities in some areas, while in other areas communities will form that have no analogues under current climatic conditions. Thus, for example, in the montane/subalpine belt, conifers may be replaced by broad-leaved species, while in the colline/submontane belt beech-dominated communities may give way to oak and hornbeam-dominated communities. Areas above the current alpine treeline could become afforested, while some forests may be replaced by open woodland or steppe vegetation, particularly in the dry central alpine valleys. Static equilibrium models of the distribution of plant communities (Kienast et al. 1996) and individual tree species (Bolliger et al. 2000) yielded broadly similar results. For example, with warming of 1–1.4°C, between 30% and 55% of the Swiss forest inventory points would be expected to have a different vegetation type. However, shifts in vegetation may be less marked if simultaneously conditions get wetter.

Recent studies based on the RHESSys (Regional Hydro-Ecologic Simulation System) model (Zierl et al. 2005, Zierl & Bugmann 2005) have focused on the joint impacts of climate change and increased atmospheric CO_2 concentrations on selected catchments of the Swiss Alps. The results suggest small changes in carbon storage at the catchment scale, with higher elevations tending to act as carbon sinks (because of higher temperatures) and lower elevations tending to turn into

carbon sources (because of increasing drought). The impact of land use changes (abandonment of pastures, decreased intensity of forest management, or even deforestation) on carbon storage is likely to be larger than the effects of increased atmospheric CO_2 concentrations and climate change (Zierl & Bugmann 2005). An explanation is offered by the Swiss Canopy Crane project, the first free air CO_2 enrichment experiment in a mature natural forest (Pepin and Körner 2002), which is now in its fourth year of operation. The project has so far revealed that the "water savings" response of adult forest trees in a CO_2 enriched atmosphere is species-specific. The occurrence of water savings and perhaps increased runoff will thus depend on the presence of certain species (e.g. in a catchment). Sap flux responses and soil feedback are still poorly understood, and it is possible that with elevated CO_2 concentrations periodically wetter soils permit even higher rates of transpiration, thereby reducing net "water savings".

Another important factor is soil-moisture feedback to the regional climate. During the summer of 2003, it was observed that strongly reduced soil moisture can have a stabilizing effect on hot and dry conditions. Species-specific evapotranspiration (as a function of elevated CO_2) is likely to play a very important role.

6.1.5. Agriculture

The most direct impact of climate change on agriculture relates to crop productivity. As discussed in Fuhrer (2003), elevated atmospheric CO_2 concentrations will generally lead to higher rates of assimilation (the so-called CO_2 fertilization effect) and thus higher potential crop yields. However, by accelerating growth and ripening, increasing temperatures will negatively affect the productivity of cereals and other determinate crops. In contrast to annual crops, the projected rise in mean temperatures will have positive effects on the potential productivity of perennial grasslands and pastures, as the length of the growing season will increase more or less proportionally.

Whether the actual productivity of crops is close to its potential value or not depends very much on the availability of soil water during the growing season. Significant reductions in crop productivity can occur when the average soil moisture content drops below critical levels, with agriculture suffering the most dramatic consequences in the case of droughts.

A recent reconstruction of summer mean soil moisture levels over the period 1900–2003 at representative sites on the Swiss Plateau (Calanca 2004) shows no significant trends for the past 100 years (Figure 6-6). On the other hand, application of the same method to the climate scenarios generated within the framework of the EU PRUDENCE project (Calanca in preparation) suggests more or less substantial alterations in the distribution of summer mean soil moisture contents (Figure 6-7). In particular, the assumption of a 5ºC increase in summer mean temperatures, combined with a 30–40% decrease in summer precipitation, implies a reduction in summer river discharge and a significant rise in the frequency of droughts.

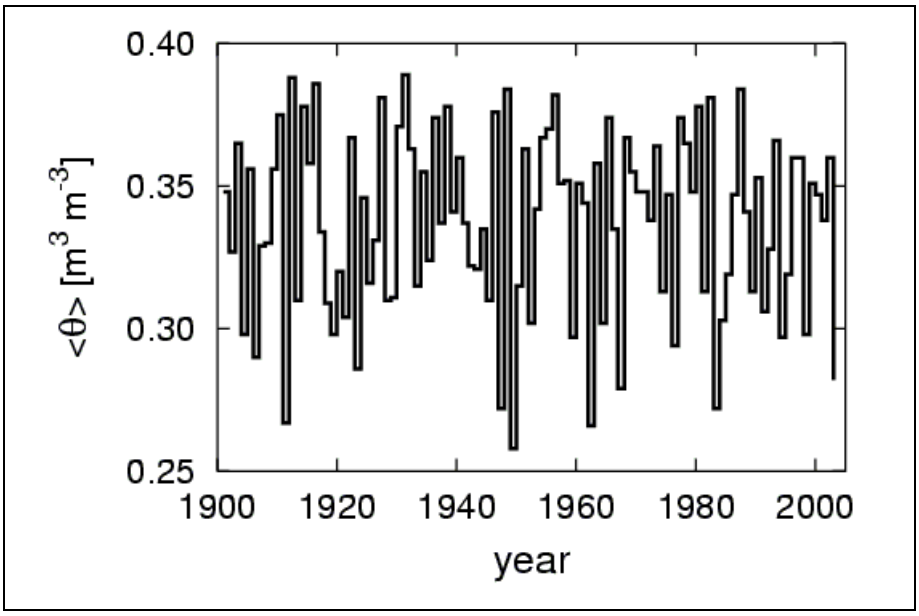


Figure 6-6: Reconstruction of summer mean soil moisture levels ⟨θ⟩ in a sandy-loam soil of the Swiss Plateau (Calanca 2004).

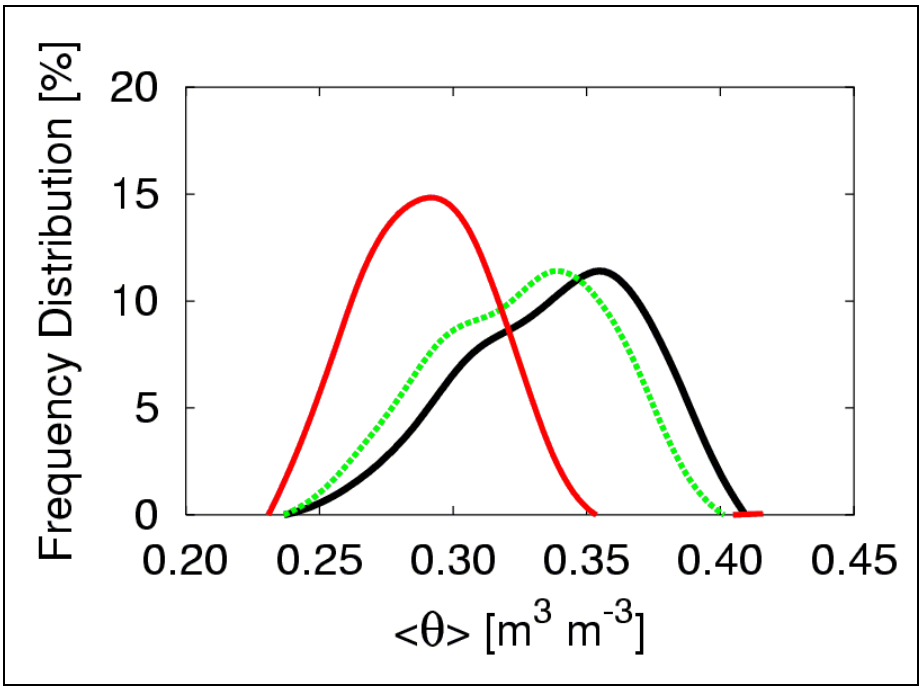


Figure 6-7: Computed distribution of summer mean soil moisture levels ⟨θ⟩ in a sandy-loam soil of the Swiss Plateau: (a) present climatic conditions (black line), (b) future climatic conditions characterized by a temperature increase of 1ºC and a 10% decrease in precipitation frequency (green line) and (c) future climatic conditions characterized by a temperature increase of 5ºC and a 30% decrease in precipitation frequency (red line) (Calanca, in preparation)

6.1.6. Tourism

The most significant impacts of climate change are expected for winter tourism due to its dependency on adequate snow cover. Today, 85% of Switzerland's larger ski resorts and 40% of small resorts can be considered to be snow-reliable, i.e. they have adequate snow cover to allow cost-effective operation of ski facilities. If the altitude line of snow reliability were to rise from presently 1,200 m to 1,500 m above sea level as a result of climate change – a situation that might occur within three to four decades – the overall proportion of snow-reliable ski resorts would drop to 63%. If this line rises to 1,800 m a.s.l. (corresponding to a temperature increase of 4ºC), then only 44% of larger ski areas and 2% of small ski resorts would remain snow-reliable (Buerki 2000).

6.1.7. Health

Public health is affected by a warmer climate: the most evident consequences are the direct and indirect effects of exceptionally high temperatures. The heatwave of the summer of 2003 – which is likely to become the norm during the second half of this century if social, economic and technological trends develop in line with the IPCC SRES A2 scenario (Schär et al. 2004, see also Figure 6-8 below) and no significant emissions reductions are achieved internationally – led to an increase in mortality of around 7% in Switzerland (Grize et al. 2005). Excess mortality was very significant in the region north of the Alps, affecting mostly inhabitants of cities and suburban areas. It was particularly pronounced among the elderly and the inhabitants of the cities of Basel, Geneva and Lausanne, which experienced the highest temperatures north of the Alps (Grize et al. 2005). Warmer temperatures will also lead to higher levels of ground-level ozone, with associated short-term impacts (summer smog).

Apart from heatwaves, other extreme events may have a direct effect on health by causing injuries or death. Impacts can be expected in the event of more frequent flooding, landslides, and possibly storms (see Section 6.1.8).

Changes in environmental conditions could pose the risk of an increased incidence of vector-borne and waterborne diseases. However, an increase in the number of vectors does not necessarily lead to more cases of illness. Changes in the geographical distribution of vectors are more likely to have an impact, with diseases occurring in previously unaffected regions. Tropical diseases such as malaria or dengue fever might become more frequent in Switzerland, although climate is not the most important factor determining their incidence. Other vector-borne diseases such as tick-borne borreliosis or viral meningitis could spread to higher altitudes. Rising temperatures can also increase the efficiency of vectors, leading to shorter incubation times. Finally, food-borne diseases could become more widespread because of more frequent spoilage in a warmer climate (Thommen 2004).

6.1.8. Extreme events

Considerable progress has been made in understanding and simulating various forms of extreme climate events, in particular hot and cold spells, wind storms and heavy precipitation. Because such events are costly in human and economic terms, a key challenge for research is to assess whether the frequency and/or intensity of climatic extremes is likely to increase as the global climate changes. In a system characterized by significant non-linearities and largely unknown critical thresholds, it is difficult to relate rare and short-lived weather episodes to long-term warming trends in a statistically meaningful manner (Rial et al. 2004). Because anthropogenic climate forcing is superimposed on natural climate variability, it is unclear whether changes in extremes observed in various parts of the world are directly related to the enhanced greenhouse effect or whether they are influenced by specific features of phenomena such as El Niño/Southern Oscillation or the North Atlantic Oscillation (Beniston & Jungo 2002).

Current knowledge of the relationship between climate change and extreme events in Switzerland is summarized in a report prepared by the OcCC (2003), which draws the following conclusions:

- At present, natural catastrophes are observed to occur more frequently. This could either be accidental, the result of natural long-term climate change, or of climate change from anthropogenic causes. It is difficult, or may even be impossible, to identify or exclude a statistically valid trend in the frequency of rare extreme events. Indeed, it may not prove possible to positively identify long-term changes in the frequency of extreme events until their extent has become very considerable and extensive damage has been caused.
- In contrast, statistical predictions are possible for trends in 'intensive' events. It can be shown, for example, that heavy precipitation events (which do not usually lead to damage) have become more frequent since the beginning of the last century. Also, the volume of precipitation in winter has increased substantially in almost all parts of Switzerland since the beginning of the last century.
- Our present knowledge of meteorological processes suggests that the frequency and intensity of certain extreme events (heatwaves, heavy precipitation and floods in the lower regions during the winter months, drought to the south of the Alps in summer and in the inner Alpine valleys, and landslides) will increase with the change in climate. This anxiety is corroborated by calculations using climate models. In contrast, the frequency of days with frost and very cold periods will decrease.
- The probability and geographical distribution of extreme events will alter gradually with the change in climate. The extent and character of the changes will differ depending on the location and character of the extreme events. It is not at present possible to give a quantitative assessment of these effects.

On the basis of the information currently available, the following changes are predicted for the future:

- *Heavy precipitation, floods and landslides:* Current knowledge of meteorological processes and the results of simulations point to an increase in the intensity of heavy precipitation and faster runoff in the winter months. The summer season of torrents and mudflows will probably start earlier in spring and end later in autumn, as the duration of winter snow cover with its water-retaining function is reduced. The situation will be further aggravated if the atmospheric circulation system in the northern hemisphere is changed by global warming; this would increase the frequency of extreme precipitation events, particularly in the winter months.
- *Heatwaves:* Higher temperature extremes are likely to occur as a result of climate change. It may be expected that higher mortality will result from the more frequent occurrence of extremely high temperatures. It has been suggested (Schär et al. 2004, Beniston 2004) that heatwaves such as the one occurring in the summer of 2003, which was exceptional relative to mean climatic conditions over the past 100 years, could become rather common during the second half of the 21st century. In addition to a shift in mean temperature, climate simulations suggest an increase in interannual variability (Schär et al. 2004), with an expected enhancement of extreme summer conditions.

  Figure 6-8 illustrates the historical and the projected distribution of temperature extremes, showing: a) the frequency distribution of the mean summer temperatures for 1864–2003 (blue lines), compared to the hot summer of 2003 (red line); b) the expected frequency distribution for the period 1961–1990 based on model runs; and c) the modelled values for 2071–2100 (Schär et al. 2004). It can be seen that summer temperature variability is expected to increase, with average values at the end of this century close to the hot summer of 2003.

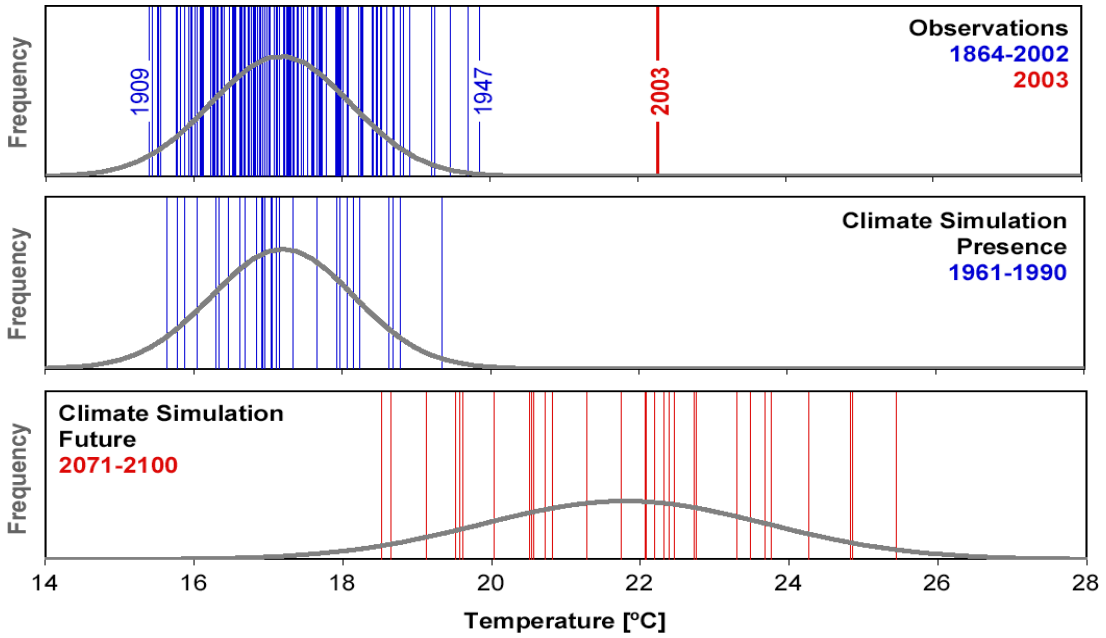


Figure 6-8: Past and future range of summer mean temperatures in Northern Switzerland: observations (top panel) and climate simulations for current (mid panel) and future climatic conditions (bottom panel). Each year is indicated by a vertical bar. The widening of the statistical distribution in the bottom panel corresponds to an increase in year-to-year variability (Schär et al. 2004)

- *Glaciers/Permafrost:* The retreat of glacial ice and subterranean ice (permafrost) due to the higher temperatures may make hazardous local situations more critical. The shrinking of the ice cover will enlarge the areas of bare rubble at high altitudes. This may during a transitional period give rise to major mudflow incidents. Greater hazards will also arise from the instability of slopes. The incidents which occur are basically not expected to become more extreme, but their frequency and annual pattern will probably change. The increase in temperature will lead to receding permafrost. Slope stability will be reduced in the affected areas.
- *Frost:* The frequency of days on which frost occurs is likely to decrease with the change in climate. Since the effects of this are dependent both on temperature and vegetation cover, it is not at present clear how these will change. In general, under the assumption that sowing and planting times remain the same, the risk of frost damage is likely to decline.
- No assessment is at present possible of future trends in *forest fires, föhn, winter storms, hail* or *avalanches*. It will be important to follow research developments carefully in these areas. Concerning winter storms over Europe, simulations by Goyette et al. (2001, 2003) have paved the way for assessments of future shifts in storm intensity, frequency and location.

6.1.9. Infrastructure

Infrastructure is mainly affected by extreme events (floods, mudflows, storms, etc.; see Section 6.1.8) and by melting of snow and permafrost (see Section 6.1.2). Flood risks affect the large riverside landscapes on the Central Plateau. Extreme events especially affect infrastructure in alpine valleys, where there is not enough room to site buildings at a sufficient distance from rivers to protect them from floods, and where storms can often be made more severe through local terrain effects.

Infrastructure on mountains (buildings, transport systems) which is anchored in permafrost ground might lose its stability as a result of subsurface melting. Melting of glaciers and permanent snow cover will release more and more loose rock and bed-load, thus increasing the exposure of buildings and road infrastructure in alpine environments to the risks of mudflows and rockfalls.

6.1.10. Insurance business

The insurance business and government insurance (and relief) schemes are unique indicators of the potential socioeconomic impacts of climate change, as they reflect effects experienced in all other sectors. The effects are likely to be manifested by changes in the geographical distribution, frequency and intensity of ordinary and catastrophic weather events, such as storms, flooding and droughts. Claims due to natural disasters have risen constantly over the past decades, although quantitative attribution to climate change has not been possible. Higher losses are primarily due to increases in infrastructure and economic assets in vulnerable areas. A potential shift in the intensity and frequency of extreme weather events may also have an impact. Figure 6-9 shows the increase in global annual insured losses due to natural catastrophes over the past 30 years. Insured and economic weather-related losses increased by factors of 7 and 24, respectively, between the 5-year periods 1970–1974 and 2000–2004. The (7-fold) increase in insured weather-related losses was twice that recorded for insured man-made and non-weather-related losses (Swiss Re sigma database 2004).

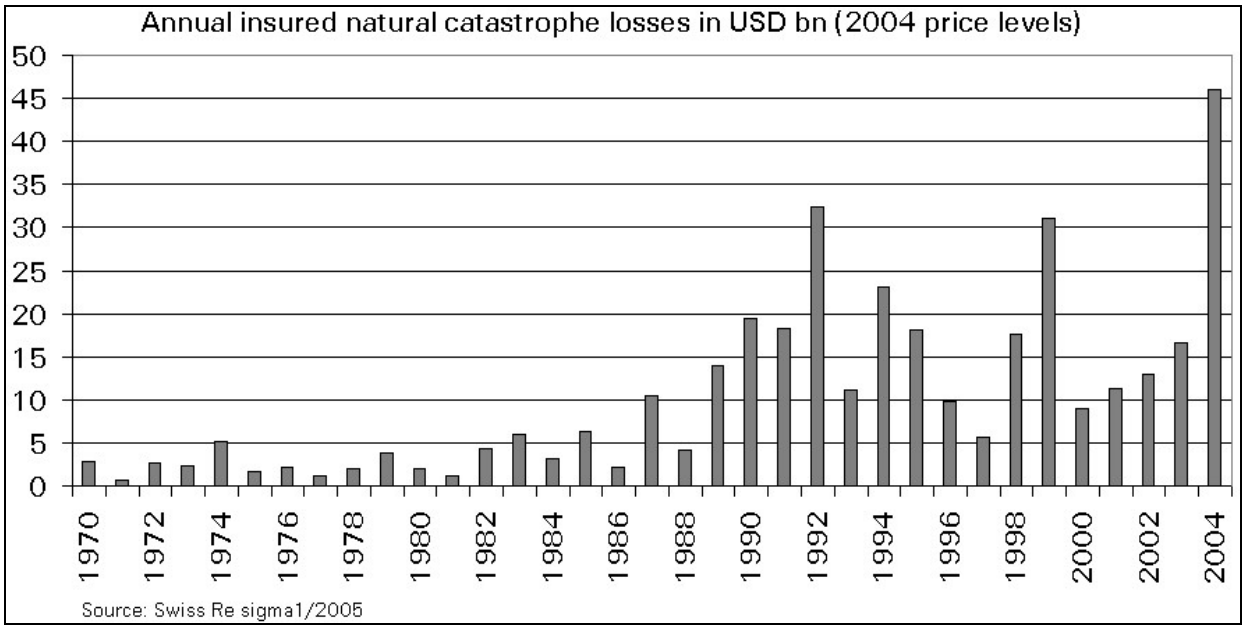


Figure 6-9: Annual insured natural catastrophe losses worldwide between 1970 and 2004

6.2. Vulnerability assessment

Vulnerability depends on the sensitivity of a system to climate changes and the degree to which the system can adapt, either spontaneously, in the case of pristine ecosystems, or purposefully, through concerted efforts. At the moment, the OcCC and ProClim- are preparing an assessment of the climate vulnerability of various natural and human systems in Switzerland. The report assesses different sectors on the basis of a regional climate change scenario for 2050. The sectors investigated are ecological systems, water resources, agriculture, human health, energy, insurance, tourism and infrastructure. The report will be completed in 2006.

The information available today indicates that the following systems may be particularly vulnerable to climate change.

6.2.1. Ecosystems (including forests)

In general, plant and animal communities that are already living at their ecological limits (temperature, precipitation requirements) would tend to be vulnerable to climate change. Vulnerability also depends on other pressures acting on a given ecosystem, such as pollution levels, habitat fragmentation, and soil and water quality, as well as many other natural and human factors. Ecosystem fragmentation due, e.g., to deficiencies in spatial organization or rural planning might be a major problem. Adaptation to climate change may require migration corridors.

Forests

Climate warming promotes the introduction of new forest pests and mass reproduction of existing ones. This is likely to become a key issue for the future of Swiss forests. Problems arise when the provision of important services such as protection against natural hazards is threatened. Given also the changing requirements of forestry services and reductions in the available public funding, the development of a strategy for dealing with forest damage represents a major challenge.

The incidence of heavy storms affecting Swiss forests increased in the last decade of the 20th century. In 1990, Hurricane Vivian damaged a volume of 4.9 million m^3 of wood. Forest damage due to Hurricane Lothar at the end of 1999 was the most severe ever recorded: 13.8 million m^3 of timber was felled (compared with a normal annual harvest of 4.5 million m^3), and an area of about 46,000 hectares was severely affected. From 2000 to 2003, the federal government provided funds of CHF 393 million for measures to prevent bark beetle infestation of the remaining stands and to restore destroyed forests. A similar level of support was provided by the cantons.

Heavy storms may lead to a loss in the protective functions of forests for downslope areas. The need for temporary artificial protective measures cannot be judged in general terms but must be assessed case by case, depending on the local situation and the potential damage involved. In many cases, leaving the trees lying on the devastated area can ensure sufficient protection for a limited time. Under the present conditions of low demand for wood, this way of managing storm damage has become more common.

The heat wave of the summer of 2003 aggravated bark beetle infestations. In addition, the area affected by forest fires increased. The effects of Hurricane Lothar and the 2003 heat wave on bark beetle infestations and forest fires are quantified in Table 6-1.

Year	Dead trees caused by bark beetle (million m^3 of timber)	Forest area devastated by forest fires (ha)
1999	0.1	9
2000	0.2	36
2001	1.3	37
2002	1.2	410
2003	2.0	564

Table 6-1: Forest damage caused by bark beetle and forest fires following Hurricane Lothar in December 1999 and the heat wave of 2003

The role of large-scale disturbances such as wildfires has rarely been considered in climate impact research for northern Switzerland, because these agents are of low importance under current climatic conditions. Schumacher (2004) investigated the interactions between climate, vegetation patterns and the wildfire regime with a novel landscape model (Schumacher et al. 2004). She found that under a state-of-the-art Regional Climate Model scenario for 2070–2100 (Schär et al. 2004), wildfires would become quite important even in mountain catchments not affected today, such as the Dischma (canton of Graubünden) and Gantertal (canton of Valais) areas. Intensified natural disturbance regimes could have considerable impacts on the protective function of many mountain

forests, and thus more emphasis should be placed on investigating indirect effects of climate change, i.e. wildfires, plant pathogens (e.g. bark beetles), and windthrow (see Figure 6-10).

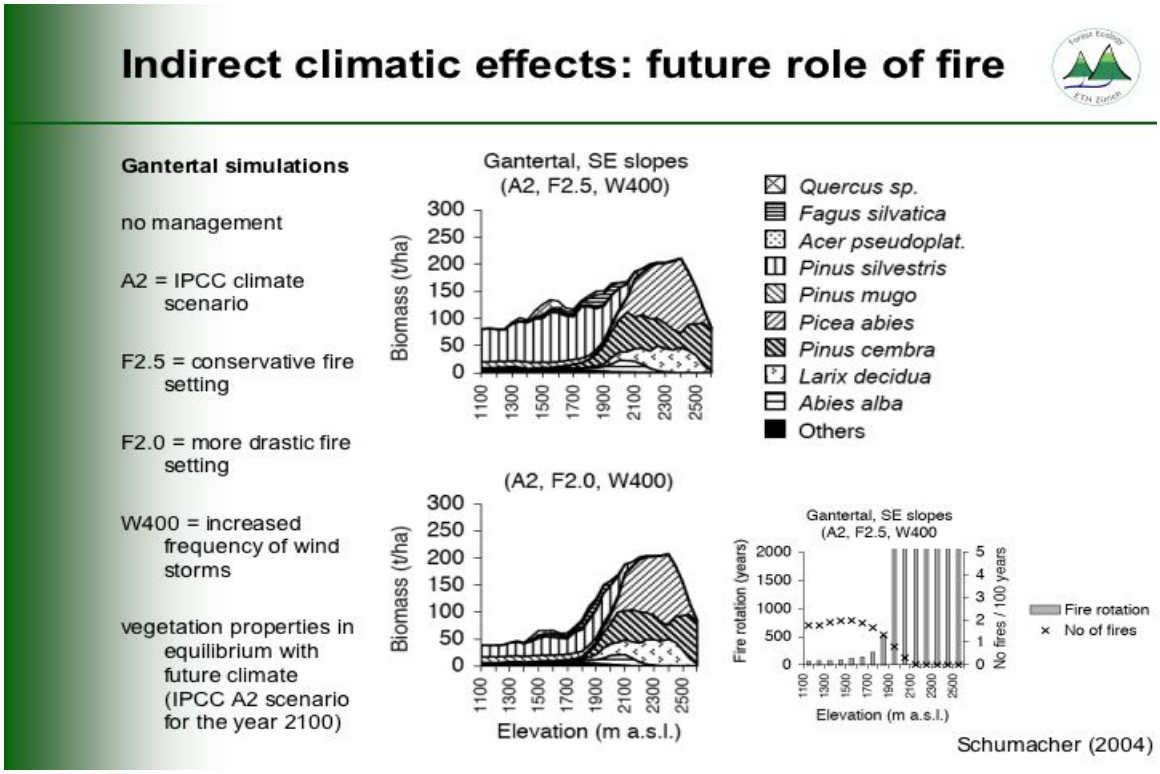


Figure 6-10: Future role of wildfires in a changed climate (Schumacher 2004)

Freshwater ecosystems

Temperature increases have a major impact on the partial pressure of gases in water ecosystems and thus on the activity of organisms. Reduced oxygen concentrations may create conditions that are toxic to aquatic plants and animals. Lake temperatures are increasing most rapidly in the upper water layers. This results in a long-term increase in thermal stability and a shortening of the circulation period (Livingstone 2003), which in turn has adverse effects on deep-water oxygen concentrations (Livingstone and Imboden 1996). Results from Lake Zurich show that long-term trends and short-term variability in near-surface water temperatures reflect night-time rather than daytime air temperatures (Livingstone 2003). This is important because night-time air temperatures are increasing faster than daytime air temperatures.

Mountain ecosystems

High-alpine plants, which have been documented to be shifting upwards (e.g. Grabherr et al. 1994) are likely to be the most vulnerable. However, recent studies of alpine treeline dynamics suggest that the treeline-alpine ecotone is unlikely to be a sensitive indicator of the ecological impacts of global changes (Bugmann and Pfister 2000).

6.2.2. Hydropower

In Switzerland on average about 60% of electricity is produced by hydropower. The reports of the Intergovernmental Panel on Climate Change (IPCC 2001) note that climate change would have an impact on energy supply and demand. Hydropower generation is the energy source most likely to be affected, as it is sensitive to the amount, timing, and geographical pattern of precipitation, as well as temperature (rain or snow, timing of melting of snow and ice). Where reduced streamflows occur, they are expected to have an adverse impact on hydropower production; greater

streamflows, if they are timed correctly, might help hydroelectric production. In some regions, hydropotential may be increased more in the winter by changes of streamflow timing (from spring to winter) than it is reduced in the spring and summer. Hydroelectric projects are generally designed for a specific river flow regime, including a margin of safety. Projected climate changes are expected to change flow regimes. What is known suggests more intense rainfall events, greater probability of drought in summer (less hydroelectric production), and less precipitation falling as snow (less water available during warm months). Reduced flows in rivers and higher temperatures also reduce thermal power generation capacity.

In Switzerland, annual hydropower production in lowland rivers may be almost unaffected. In general, a shift from the summer to the winter season is probable, due to an increase in winter precipitation and winter temperatures. Compared to the natural variability of water resources, this additional variation will be relatively small.

Most hydropower is generated in the alpine power plants, with water stored in large reservoirs. The reduction in the volume of glaciers in the coming years will increase discharges into reservoirs during this time. As many of the reservoirs have a drainage area well above the winter snowline and the amount of rainfall will – in most regions – even be slightly larger, hydropower production is not expected to change markedly. However, Schaefli et al. (2004) and Horton et al. (2005) found for a Central Alpine reservoir that hydropower production could decrease sharply as a result of lower rainfall and higher evaporation.

6.2.3. Agriculture

Swiss agriculture faces a number of challenges: the opening up of markets, the pressure for best environmental practices and environmentally friendly products, the loss of income from secondary occupations (e.g. winter tourism), and a decreasing demand for some domestic products. Climate change could accelerate ongoing structural changes through direct effects on agriculture, or indirect effects on related sectors.

In Switzerland, agriculture is practised at elevations ranging from 300 to 2,500 m above sea level, with large differences in meteorological, topographical and soil conditions. Climate change may affect agriculture by increasing or decreasing crop and grassland productivity, and by altering the need for irrigation, and for weed and pest control. These effects are likely to show regional differences. Projections emerging from our current understanding of the evolution of the global climate system and its regional aspects show that what lies ahead may well exceed past adaptive capacities, thus posing major challenges for agriculture. Increased precipitation in the form of rain during winter and spring may lead to an increased runoff and associated loss of topsoil. Excess soil moisture due to prolonged intense rainfall during the early part of the growing season may delay work in the fields. Strongly reduced soil moisture is expected during summer and early autumn, when soil water content may fall to 50% of its average value under current conditions (Jasper et al. 2004), as observed in 2003. Total losses caused to Swiss agriculture by the heatwave that struck large parts of Western Europe during the summer of 2003 have been estimated at roughly CHF 500 million. With shorter return times of extreme events, costs for government interventions would increase dramatically. Considering the long replacement times of infrastructure (approx. 30 years) or land use (roughly decadal), it may turn out to be increasingly difficult and costly to ignore the changes in climatic risks.

6.2.4. Tourism

For many alpine areas of Switzerland, winter tourism is the most important source of income, and snow reliability is one of the key elements attracting tourists. In 2003, tourism contributed CHF 22.2 billion in income for Switzerland (about 5.2% of GNP) and accounted for 12.6% of export income, making it the third-largest export sector in Switzerland (STV 2004). Tourism-related activities provide 9% of all jobs (300,000 jobs) nationwide and a much higher proportion in mountain regions.

Meier (1998) put the potential annual costs of climate change in Switzerland at CHF 2.3–3.2 billion by 2050; CHF 1.8–2.3 billion would be accounted for by tourism. Even if numerous reservations could be expressed regarding these calculations, they nevertheless show that tourism is the economic sector that would be most affected by climate change in Switzerland.

However, climate change is only one factor affecting tourism. Others are the growing international competition, oversupply, a general decline of winter tourism, and low economic growth. Economic hardship due to 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 sectors particularly vulnerable to climate change (small single lifts and ski areas in the Jura mountains, the canton of Ticino, and the Eastern and Central Swiss Alps) (Abegg 1996, Meier 1998, Buerki 2000).

Important factors for the success of tourism have been the snow cover, good weather conditions, the length of season and the scenic value of glacial landscapes. But the crucial factor for the long-term survival of mountain cableway companies is the frequency and regularity of winters with good snow conditions (Buerki et al. 2003). Large parts of mid-altitude ski resorts will be particularly jeopardized by global warming. The ski regions of Valais and the Grisons will experience virtually no major problems, since the mean altitude of the cableway terminals in these regions is higher than 2500 m above sea level. Climate change will lead to a new pattern of favoured and disadvantaged ski tourism regions (see Section 6.1.6).

Tourist infrastructure such as cable-car masts or stations may be put at risk by the melting of permafrost. In 2004, the Federal Office of Transport has requested safety checks for four stations located in permafrost areas. According to rough estimates, several dozens of the country's 200 cable-railway facilities may be affected by melting permafrost. Infrastructures may need to be replaced, and in some cases it may even be difficult or extremely costly to find solid ground for rebuilding.

Summer tourism may benefit from stronger heatwaves in the Mediterranean area in the future, in that tourists may prefer to go to the cooler mountain regions during the hot season. At the same time, opportunities for summer activities at higher altitudes might generally increase. However, it is difficult to estimate whether the common habit of seaside holidays will be noticeably influenced by higher temperatures in the long term.

Tourism and the associated infrastructure could also be affected by increasing impacts of extreme events, such as heavy precipitation, landslides, or rockfall due to melting permafrost and glaciers (Noethiger 2003). The 2003 summer heatwave showed that increased temperatures could substantially affect summer alpinism by making many alpine tours too dangerous.

6.2.5. Infrastructure

The alpine environment of Switzerland is increasingly threatened by the growing potential for natural disasters due to climate change. The melting of permafrost, glacial retreat, heavy precipitation events, and shifts in the form of precipitation will aggravate the situation of alpine settlements and affect infrastructure (e.g. roads, bridges, railway lines and ski-lifts). River valleys are vulnerable to flood disasters because villages and infrastructure (roads, railways and motorways with numerous bridges) are frequently situated close to the river in a narrow valley bottom. Floods are primarily hazardous in four ways (Petrascheck and Schädler 1992):

1. Vertical and lateral erosion of riverbanks, in combination 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.

6.2.6. Insurance business and financial services

Increasingly, the financial sector is building up or supporting scientific research teams in order to develop a forecast system, providing timely, cutting-edge knowledge. Efforts have been aimed at combining insurance industry models with climate models. A project at the Swiss Federal Institute of Technology (ETH) Zurich studying the development of insured losses since 1970 has revealed a clear trend towards higher losses (Schwierz et al., in preparation). This rise can, for the most part, be explained by economic, demographic and geographical factors. In view of the projected future climate changes and the potential increase in certain extreme events (see Section 6.1.8), it is of the utmost interest to quantify the impacts of these atmospheric changes on insured losses. The goal of this project is to compare windstorm losses for a European market portfolio under current and future climate conditions. Regional climate simulations of present-day conditions as well as global GHG scenario climate simulations (run by ETH) will be used as input to the loss model. This will allow quantification of the contribution of present and future climate trends to loss figures. The problem arises mainly for businesses with a long-term investment horizon of about 30 years or more (e.g. insurance, but also pension funds), which might be left with non-insurable risks in the event of insurance sector instability.

The banking divisions that would be acutely affected by climate change are project finance, real-estate finance, corporate banking, asset management and corporate finance services related to the sectors of the economy that would be most heavily affected. Economic impacts on the banking transactions of individual sectors such as ski tourism and insurance are already visible today. Need for adaptations is also to be expected in pension fund investment strategies.

6.3. Adaptation measures

6.3.1. Swiss strategy to improve protection against natural hazards

In May 1997, the Swiss government established the National Platform for Natural Hazards PLANAT (www.planat.ch) in order to fill gaps in legislation and to ensure that preventive efforts are not duplicated in the area of natural hazards and that synergies are exploited. PLANAT is organized as an extra-parliamentary commission. The expert bodies involved take a holistic and interdisciplinary approach to protection – flooding, rockfalls, landslides and avalanches are not viewed in isolation.

The coordinating role played by PLANAT is facilitated by its composition: it brings together representatives of federal government, the cantons, the research community, professional associations, business and the insurance sector. In 1999, the Federal Council commissioned PLANAT to elaborate an overarching, interlinked strategy to improve protection against natural hazards. Comprehensive risk management was to ensure broadly uniform protection standards throughout Switzerland, with the aim being to protect humans, natural resources and substantial material assets.

On 20 August 2003, the Federal Council took note of the PLANAT report “Protection against Natural Hazards in Switzerland – Vision and Strategy”. This strategy corresponds to the Federal Council’s sustainability policy.

PLANAT subsequently prepared a synthesis report, consisting of:

- a summary estimate of the means and resources used for protection against natural hazards;
- an evaluation of basic principles and methods for handling risks;
- an action plan to effectively anchor the strategy in the minds of those responsible for implementation and the public, which was approved by the Federal Council on 18 May 2005.

The strategy comprises the following six principles (United Nations World Conference on Disaster Reduction 2005, PLANAT 2005):

A) Integrated disaster reduction approach

On country or community level the integrated disaster reduction approach:

- addresses all hazards, vulnerabilities and risks,
- considers the disaster cycle,
- includes all stakeholders in the process,
- takes into account the principles of sustainability,
- is based on international solidarity.

B) Hazards, vulnerabilities and risks

The risk concept considers an in-depth assessment of all prevailing hazards (natural, technological) and of the respective vulnerabilities. Hazard maps and related products are indispensable instruments to visualize the conditions on the ground. The definition of protection goals is based on the existing risks and on an economic and socio-political evaluation of these risks (risk dialogue). Residual risks require special attention.

C) Disaster reduction mechanisms

An integrated disaster reduction approach equally addresses the three disaster reduction mechanisms of the disaster cycle: (1) prevention/mitigation – (2) response – (3) recovery. The implementation of preventive and preparedness measures to reduce hazards, vulnerabilities and risk, includes

- Planning (e.g. land-use planning, zoning, building codes),
- Protective structures (e.g. dikes and dams, retrofitting),
- Preparedness (e.g. early warning systems, emergency services),
- Biological measures (e.g. reforestation, eco-engineering).

D) All actors including affected people

Disaster risk reduction is an important task which involves actors of many sectors and levels. Only a joint effort from local to national authorities, of private sector entities, particularly the insurance sector, civil society, regional organizations, the international community and the public at large guarantees success. It is important that people affected by natural disasters commit into disaster risk reduction. A risk dialogue among all stakeholders including the affected populations increases the overall awareness.

E) Sustainability of efforts

All activities in the field of disaster risk reduction obey the principles of sustainability. Measures are environmentally sound, consider societal preferences and are cost effective. Disaster risk reduction is also part of the sustainable use of natural resources and of sustainable development, and therefore, is considered a cross-cutting issue.

F) Solidarity

Natural disasters hit often unannounced and on such a scale that the local coping mechanisms are largely overwhelmed. External assistance, when required, to those affected during the disasters, in response and recovery is important. The support is based on locally generated knowledge about risks and its reduction as well as on internationally acquired understanding of disaster risk reduction. Therefore, the exchange of expertise, experience and lessons learnt on a regional and international level is necessary.

Example 1: Adapting land use

Guidelines and recommendations on taking natural hazards into account in spatial planning are now available. When drawing up master plans, cantons have to establish which regions are significantly exposed to natural hazards. These requirements have been lent additional weight by the revised Hydraulic Engineering Act and Forestry Act, both of which came into effect on 1st January 1993. According to these two laws, cantons are now obliged to prepare hazard registers and hazard maps as a safeguard against natural disasters, and to adapt land use accordingly. These instruments facilitate zoning and re-zoning, the preparation of site protection measures and evacuation planning.

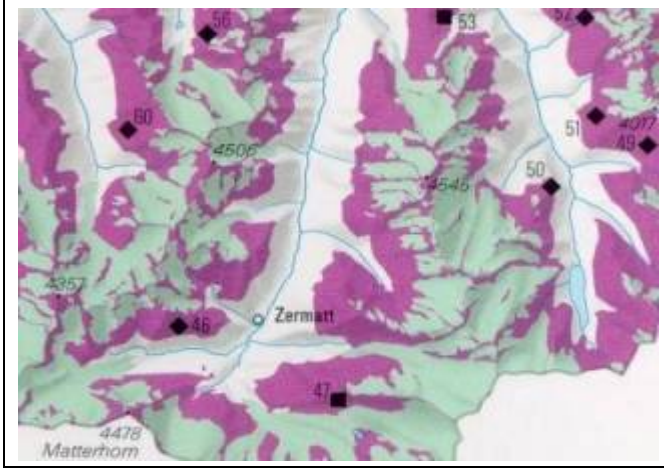
A new GIS instrument named ShowMe provides the federal and cantonal authorities with an overview of existing hazard map coverage in the three categories: flooding, avalanches and mass movements (landslides, rockfalls, debris flows).

Example 2: Permafrost mapping

The main objective of PERMOS is the long-term scientific documentation of the state of permafrost and its changes in the Swiss Alps. PERMOS is based on three elements:

1) Recording permafrost temperatures and thermal changes in boreholes and, depending on the situation at the borehole, horizontal and vertical borehole deformation.

2) Bottom temperature of the snow cover, ground surface temperature and the development of the snow cover (duration and thickness).



3) Aerial photographs taken periodically of selected areas, to permit the monitoring of surface changes in general. Additionally, both analogue and digital terrain information serve as a basis for photogrammetric studies of rock glaciers, as well as the documentation of geomorphological, hydrological and biological changes in permafrost environments.

A 1:500,000 map of permafrost distribution in Switzerland is available as part of the hydrological atlas of Switzerland.

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Example 3: Giandains avalanche and debris flow dam

For more than 100 years, the town of Pontresina has been a pioneer with regard to permafrost and avalanche safety. In 2003, a large dam was completed, providing protection against avalanches and risks associated with the slowly thawing permafrost above the village.

The construction covers a total area of 6.3 ha and required the clearance of over 3 ha of forests. The project cost the Pontresina community alone CHF 1.875 million, with 75% of total costs being borne by the federal and cantonal authorities.

6.3.2. Climate change, water and water management

Since the beginnings of concern over the possible consequences of global warming, it has been widely recognized that changes in the cycling of water between land, sea and air could potentially have very significant impacts across many sectors of the economy, society and the environment. Alpine aquatic systems – streams, rivers, small and large lakes, ground water, water in pores and fractures of the soil – are part of the global water cycle. Through evaporation and precipitation, this cycle links atmospheric, soil, vegetation and aquatic systems. The water cycle is affected by climate and weather, but climate is also a function of the water cycle – an enormously complex system of feedback loops. Additionally, humans interfere with these loops and cycles through water management, e.g., water is retained in reservoirs or diverted to different watersheds; large tracts of agricultural land are irrigated; wetlands are drained; and groundwater levels are raised and lowered. Water is fundamental to human life and many activities – most obviously agriculture, but also industry, power generation, transportation and waste management.

Switzerland expressed its position on water resource management in the context of climate change as follows (see: Nijmegen Declaration, 4-5 December 1997, http://www.sghl.ch/pdf/rhein.pdf):

- The expected hydrological changes are so large that they should be considered explicitly in long-term integrated river basin management. This includes policy fields such as spatial planning, environment and agriculture.
- The appropriate management response is to adopt the "no-regret and flexibility" principle. Long-term plans should be flexible and adaptable. Anticipatory measures, which serve different goals should be undertaken in combination with already on-going activities, like reservation of sufficient room for the rivers in combination with ecological rehabilitation. "Wait and verify" is not an appropriate strategy for sustainable river basin management.
- Some of the derived impacts cannot be sufficiently quantified at present. Therefore future research should focus at integrated approaches, especially links between climate, hydrological and ecosystem models. Research should also aim at the evaluation of strategies to sustain and improve development of the river and its basin in a changing environment.
- The river basin is the unit to address impacts and policy options in view of water resources management. In such an approach, international co-operation including free and unrestricted access to data and information is a pre-requisite.
- In view of these recommendations, all decision makers are called upon to actively define, support and participate in activities, which address high priority water-related topics in transboundary river basins.

Vision for the future of Switzerland's watercourses

It is obvious that different interests are involved in integrated management of rivers. Therefore, it was necessary to develop a common framework or vision for dealing with waters that are under pressure from different actors. As watercourses are a vital natural resource for humans, wildlife and plants, they need to be protected and their functions safeguarded in the long term. It is essential that future measures should be coordinated so as to realize the vision of near-natural Swiss watercourses.

In the "Guiding Principles for Swiss watercourses" – issued by SAEFL, the FOWG, the FOAG, and the FOSD – the goals for the development of the country's watercourses are defined (see: http://www.bwg.admin.ch/themen/wasser/e/pdf/lbfg_e.pdf):

Emphasis is placed on three development goals:

- adequate space for watercourses,
- adequate water flows,
- adequate water quality.

These goals can be achieved by complying with the principles of sustainability – specifically, by giving equal weight to the social, ecological and economic aspects of watercourse management. In the long term, this will lead to the preservation of natural watercourses.

Watercourses fulfil many different functions: they shape landscapes, and transport water and sediment. They serve as life-giving arteries in our landscapes and help to maintain the natural balance of our ecosystems. They replenish groundwater resources. First and foremost, however, they are living, dynamic entities, which carve out their own path, sometimes overflowing their banks in the process. But they have often been straitjacketed by humans.

As a result of human interventions, watercourses may no longer be able to fulfil their various functions, e.g., confined channels and reinforced banks can increase the risk of flooding, and over-intensive industrial or agricultural land use too close to the water can adversely affect water quality. These insights are reflected by national legislation in the areas of hydraulic engineering, water protection, spatial planning and agriculture. It is now possible to reconcile demands for adequate watercourse corridors, effective flood protection and the maintenance of water quality.

The success of this integrated approach has been demonstrated in practice. The examples of good practice that can already be found throughout Switzerland should now increasingly be followed. There is no lack of knowledge – but action is now required to implement it.

Flood Protection Strategy

In Switzerland, two thirds of all communes have experienced flooding in the last 30 years. The total loss during this period amounts to CHF 8 billion. In view of the integrated approach to disaster reduction, an integrated flood protection strategy has been developed. The cornerstones of this strategy are:

- **Analysis and documentation of the existing danger**
  Hazard maps serve as a basis for prevention measures.
- **Safeguard of the required space for flowing water**
  Sufficient space for extreme quantities of runoff water simultaneously guarantees space for the ecological function of watercourses.
- **Integral action planning**
  It is imperative that the principles of sustainability be taken into account for planning and organisational measures as well as for technical safety constructions.
- **Minimisation of damage**
  Maintenance of watercourses (= maintaining the existing safety conditions) as well as measures for spatial planning (= preventing a rise in the potential for damage by keeping space free or restricting the use of space) are of paramount importance.
- **Emergency planning**
  Good preparation (forecasting, alerting and mobile measures etc.) can minimise the ever present residual risks. In addition, insurances can help make damages bearable.
- **Flood protection as a federal task**
  Interdisciplinary cooperation among experts from all areas and inclusion at a sufficiently early stage of the political authorities as well as the concerned population are a precondition for sustainable protection policies.

The new strategy is currently being implemented by the cantonal authorities. Based on the legal framework, a handbook (FOWG 2001), guidelines (KOHS, 2004) and various examples of good practice (FOWG 2004) have been published. Additionally, training courses for civil engineers have been organized on topics such as debris flow modelling, flood protection design and quality assurance in flood management design.

Example 4: Flood early warning systems

In close coordination with Germany and the Netherlands, the Flood Early Warning System for the River Rhine "FEWS-Rhine" has been developed by a Swiss-Dutch-Swedish consortium. This system enables the FOWG to issue flood forecasts and flood warnings for the River Rhine and its tributaries, and also for the big lakes in the Swiss part of the River Rhine basin. The forecasts from Switzerland are transferred into the FEWS of the warning centres further downstream for integration into their forecasting systems.

For the River Rhône, which is heavily influenced by many reservoirs, diversions and power plants, a forecasting and flood management system known as MINERVE is being developed. The flood management model proposes an original solution for the reduction of flood damage. The objective of the proposed method is to reduce the peak flow by storing the water in the reservoirs of existing hydropower schemes in catchment areas. This can be a valuable solution for regions such as the Valais, where numerous major hydropower schemes exist. It is then necessary to consider different fields in the project, such as meteorology, hydrology, hydroelectric economy and hydropower scheme management, as well as multi-objective optimization.

(For further information see: www.bwg.admin.ch > Themes > Water; www.iksr.org > Floods.)

Example 5: Flood retention in Mattmark reservoir

Whereas most dams and reservoirs were built for hydropower purposes only, there is increasing discussion of their use as multi-purpose facilities. Today, a certain proportion of the water storage capacity in the Mattmark reservoir in the canton of Valais is to be reserved for the retention of water for flood protection. For this purpose, it was necessary to increase by 2 m the height of the crest of the existing side spillway in order to ensure effective flood routing without endangering the Mattmark earthfill dam. For operational purposes, it will be necessary to manage this reserved flood retention volume using adequate and precise inflow forecasts (see Example 4 above).

6.3.3. Hydropower

Although there is some concern about climate change on the part of the hydropower industry, a strategy has yet to be developed. According to a workshop held in 2003 (see Section 9.3 > 'Special events'), fluctuations in the energy market and the coming changes in the energy market in Europe (liberalization, increasing importance of wind power) are considered to have a much stronger influence on the management of hydropower production than the relatively slow changes in climate.

Glacier retreat and permafrost degradation could substantially increase sediment transport into the reservoirs. This has to be taken into account in the management of reservoirs (e.g. rinsing measures).

Example 6: Integrated flood protection – the river Flaz

With the implementation of a new flood protection project, Samedan (the capital of the Upper Engadine) has achieved three goals: safety, quality of life and conservation. Despite initial dam construction works, floods continued to affect the village, causing extensive damage. Climatic changes leading to shrinkage of the glacier and retreat of the snowline were also contributory factors.

The new project involved diversion of the Flaz river to eliminate the risk of flooding in residential areas. An overwhelming majority of the electorate in Samedan supported the most ecologically sound diversion. Comprehensive ecological findings as well as state-of-the-art computer-supported models were used in the implementation of the project. Walkers and hikers are now able to reach the new river landscape via a new path network. In the upper section, the Flaz flows through a cut with no dams, while water-meadows have been created in the near-natural middle section of variable width. The Flaz is now separated from the plains by a flat longitudinal dam. The costs of this project amounted to CHF 28 million. The new Flaz river bed went into operation in the autumn of 2004.

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6.3.4. Agriculture

Adaptation measures to cope with increasing temperature and decreasing precipitation, and the associated risk of droughts, could include the selection of alternative crops, the selection of cultivars with a higher temperature requirement, or, more simply, shifts in the sowing dates. An obvious adaptation to reduce the impact of droughts on Swiss agriculture would be the extension of irrigation over larger areas. However, the feasibility of this measure will largely depend on the competition for water among different economic sectors, and on the prices of this resource and of irrigation equipment.

The choice of specific adaptation measures for the different regions of Switzerland will require careful consideration of local agricultural production conditions (evaluation of orographic and soil characteristics, local climate and cultivation techniques). Due to continuous improvements in the available climate scenarios, periodic reconsideration of the adaptation measures will also be essential. However, adaptation options will also be influenced by political developments, especially the WTO regulations (e.g. open markets), and/or the importance of multifunctional aspects of agriculture, such as landscape management.

6.3.5. Forests and forestry

Historical development and models of changes in vegetation with time suggest that forests will be affected by climate change, though the mode of transition is uncertain. Impacts will vary between different regions. Damage must be expected from storms, drought, atmospheric pollution, and (according to the level of warming) new or more prevalent pests and diseases. During the 20th century, increasing forest damage due to extreme climatic events was reported. Only limited adaptation measures exist to prevent such effects, but appropriate legal provisions allow for public

assistance, where necessary, to counteract damage to forests and their protective functions. In addition, a number of measures are in place to serve the objective of damage prevention.

1. Addressing ecological imperatives through forestry:
   - Clear-cutting limited to small areas.
   - Regeneration practices imitating the natural behaviour of a "virgin" forest (near-natural forest management).
   - Sustainable forestry with financial support for forest management, logging and hauling of timber, since the total costs of near-natural forest management are high. Average annual subsidies of CHF 57.8 million were provided in the period 2000–2003 (CHF 65.2 million from 1996 to 1999).
2. To maintain the vitality of forests, average annual subsidies of CHF 69.65 million were provided between 2000 and 2003 (CHF 51.5 million from 1996 to 1999) for the following measures:
   - Measures to prevent and combat pests and parasites.
   - Repairing damage where forest conservation might be threatened.

   Special emphasis has been placed on re-establishing well-adapted stands in the forested areas destroyed by the Hurricane Lothar. For this purpose, a decision-making guide has been prepared for storm-damaged areas.
3. Conservation of the genetic resources of forests (CHF 1.5 million average annual subsidy for 2000–2003) using the following measures:
   - Establishment of a national register of seed tree stands on the basis of internationally defined parameters.
   - Launching of 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.

6.3.6. Tourism

Global warming will lead to more winters with limited snow, rendering low-lying ski resorts particularly vulnerable. The most common adaptive responses are to install snow-making equipment, to move ski stations to higher altitudes or glaciers, or to diversify the type and seasonal focus of the activities offered. It is not clear to what extent the lack of snow can be counteracted by artificial snow. It is, first of all, not possible to produce artificial snow if temperatures are too high. Secondly, artificial snow production requires substantial water, energy and thus financial resources. Moreover, the Swiss experience shows that skiers tend to discount the possibility of skiing if there is no snow in lowland areas. In general, there is a tendency to create facilities for alternative activities; but there is no long-term strategy for adapting to climate change.

Areas with better prospects will be those with transport facilities providing access to altitudes higher than 2000–3000 m above sea level. As long as rough weather conditions do not impede the operation of facilities, the regions at higher altitudes may experience greater demand, prompting further expansion, and the pressure on ecologically sensitive high-mountain regions will increase.

Since climate change is a relatively long-term development in comparison to other trends in tourism, tourism managers and tourists will have every opportunity to adjust to the different constraints and adopt the corresponding strategies and measures (Figure 6-11). Tourism operators will not ignore the threats posed by climate change. They are already reacting to the deteriorating snow conditions and changes in demand.

One of the most important questions will be how young people can start skiing/snowboarding if there is a lack of snow in big towns, and if the small, cheap ski lifts suitable for families at nearby resorts are dismantled due to climate change. Although indoor skiing is a growing industry in

European towns, whether small ski resorts for beginners in the foothills can be replaced by snow domes remains uncertain.

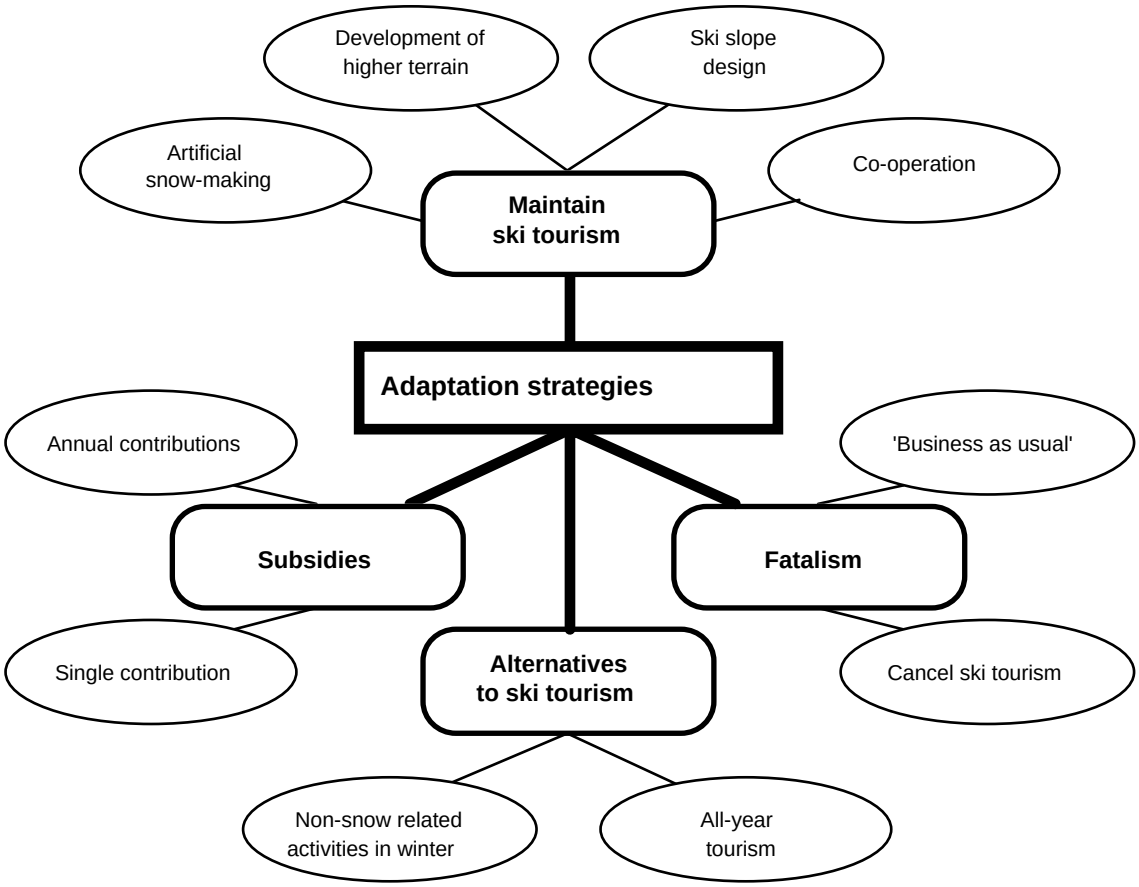

Fig. 6-11: Adaptation strategies (Buerki et al. 2003)

6.3.7. Insurance business

Insurers will attempt to manage the increased risks associated with a changing climate by applying the precautionary principle and the best scientific information available about the expected damages. New developments in weather and climate research promise to help refine specific components of risk models. New climate data may allow for improved forecasts of how future storm or flood activity might differ from the long-term average. Improved short-term forecasts will influence the trading of catastrophe bonds and other capital market products (Malmquist and Michaels 1999).

The insurance industry can also conduct business in such a way as to provide incentives for behavioural changes, e.g. by deploying risk-adequate rates and insurance conditions to encourage loss prevention. It can lobby for regulatory changes necessary to reduce risks; for example, the insurance industry was responsible for the first building and fire codes in the US. Or it can help to create new markets with respect to CO_2 emission trading, e.g. by providing insurance and financial products.

6.3.8. Weather hazard alerts

Several online systems have been launched in recent years offering information and warnings concerning weather hazards, e.g. storms, heavy rain or heat waves. Alerts are distributed by e-mail, fax or text message. These services include:

- MeteoSwiss, the Swiss national weather service (in German, French and Italian): MeteoSwiss provides the cantonal authorities and individual subscribers with regionalized alerts; see www.meteosuisse.ch > Prévisions > Dangers météorologiques
- Alarme météo / Wetteralarm (in French and German): A cooperation between the meteo office of the Swiss Television Company SFDRS, the cantonal insurance company GVB and the Swiss Association of Houseowners HEV; see: www.alarme-meteo.ch.
- Meteoradar (in German): This private company offers alerts tailored to each of the 2500 Swiss communities. The alerts are distributed by e-mail, fax and text message; see: www.meteoradar.ch.

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7. Financial resources and transfer of technology

7.1. Introduction/institutional arrangements

Two federal offices are responsible for the planning and implementation of development aid: the **Swiss Agency for Development and Co-operation (SDC)**, part of the Federal Department of Foreign Affairs, and the **State Secretariat for Economic Affairs (seco),** which is part of the Federal Department of Economic Affairs. The principal instruments at their disposal are technical co-operation, financial aid, economic and trade measures, and humanitarian aid.

The Swiss Agency for Development and Co-operation (SDC) is responsible for the following four areas of activities: bilateral development co-operation, multilateral development co-operation, humanitarian aid and technical co-operation with Eastern Europe. The UN Millennium Development Goals (MDGs) are becoming increasingly relevant as a general framework for action. In the climate field, the SDC focuses on institutional and human development issues and know-how transfer. The SDC facilitates the dialogue among stakeholders with a view to developing climate policies in line with local sustainable development goals. Since 2001, the SDC has included vulnerability and adaptation issues in its agenda.

The **State Secretariat for Economic Affairs (seco)** determines economic and commercial measures for development co-operation, including infrastructure financing (e.g. by mixed credits involving both the Confederation and the financial sector), balance of payments assistance, trade and clean technology promotion, and investment promotion. A substantial share of these measures is destined for countries of Eastern Europe and the CIS. The seco is also the main actor in the scheme to reduce the debt burden for the most heavily indebted countries. Because of its focus on co-operation with the private sector, the seco's priorities in the context of climate change relate to the flexible mechanisms, which entails capacity building, technology transfer and policy support, in order to ensure a level playing field for the future carbon markets.

The **Swiss Agency for the Environment, Forests and Landscape (SAEFL)** is responsible for planning and implementing environmental policy at the national and international level. In this capacity, SAEFL is leading and co-ordinating the implementation of the UNFCCC and the Kyoto Protocol. In addition, SAEFL is responsible for Swiss policies and contributions to the Global Environment Facility (GEF).

With **REPIC (Renewable Energy Promotion in International Co-operation),** an interdepartmental platform has been established, bringing together the efforts of the four federal agencies SAEFL, SDC, seco and SFOE. This body strengthens and coordinates federal activities for the promotion of renewable energy in international cooperation at a strategic level. It further promotes new partnerships with private enterprises and Swiss civil society in order to contribute to the deployment of renewable energy systems in developing and transition countries through financial support for the realization of projects using Swiss technology and know-how.

7.2. Bilateral assistance

7.2.1. General orientation

From 2000 to 2003, Switzerland's official development aid for developing and transition countries amounted to about CHF 6.4 billion. Most of this has been provided through bilateral assistance projects involving the SDC and seco. As a fundamental principle, Switzerland's bilateral assistance is committed to – environmental, social and economic – sustainability and poverty reduction, as further outlined in the MDGs. Moreover, Swiss bilateral assistance includes many programmes aimed directly at environmental and climate protection.

Switzerland's grant financing to support basic infrastructure projects can be taken as an example: priority fields of Swiss infrastructure financing in Eastern Europe and Central Asia are the environment and energy sector, e.g. construction of sewage treatment facilities, refurbishment of hydropower plants, support for public transport systems, etc. A particularly important and relevant sector in this region is the rehabilitation of district heating systems, which traditionally suffered poor maintenance and high losses. Pre-insulated pipes, co-generation and building insulation, together with tariff reforms, have contributed considerably to climate protection. These projects include the transfer of technology to partner countries (see Section 7.4).

Other areas of Swiss expertise and assistance are emission reduction programmes for the transport sector (e.g. Central America, Peru, Indonesia), soil protection, forest and watershed management, and cleaner production (see Section 7.4).

New priority issues in Swiss development cooperation

In development cooperation, climate change is of increasing relevance. SDC is further defining its role and future action in addressing climate change through mitigation and adaptation measures. In doing so, it takes into account the scientific background on climate change, the current state of international negotiations within the UNFCCC, needs and options for coordination with other government agencies, and the objectives of the Global Environmental Programme. The results of the latest review are summarized in the report 'Addressing Climate Change through Development Cooperation – An Orientation on Climate Change Issues in the field of Natural Resource Management, Livelihoods and Food Security', SDC 2005 (http://www.deza.admin.ch/ressources/deza_product_en_1434.pdf).

According to SDC's general mandate, activities addressing change through development cooperation are oriented towards poverty alleviation, participation and empowerment, as well as democratization of society. Within the scope of its Strategy 2010, SDC supports programmes and projects in the field of food security, natural resource management and local livelihoods. These should integrate measures that address one or several of the following objectives:

- ***Adaptation***: Understand and reduce vulnerability to climate change in poor livelihoods with special consideration of extreme events, natural disasters, resource availability, biodiversity loss and reduction of carrying capacity for food production;
- ***Mitigation***: Promote equitable participation of the rural poor, including gender issues and small scale farmers, in opportunities emerging from the implementation of the mitigation strategy, with special regard of their need to increase capacity to participate in the flexible mechanisms;
- ***Sustainable development***: Ensure that the implementation of mitigation and adaptation projects promotes sustainable development in poor rural areas.

In the field of adaptation, SDC has started an analysis of the impacts of climate change on selected operational work: 'Understanding the effects of programs and projects on vulnerability and adaptation to Climate Change and Climate Variability in India.' A report is already available: "Livelihoods and Climate Change – combining disaster risk reduction, natural resource management and climate change adaptation in a new approach to the reduction of vulnerability and poverty" (http://www.eldis.org/static/DOC15217.htm). SDC has also launched a new project, details of which are given in Table 7-2.

SDC also promotes collaboration among Swiss NGOs and research centres with a focus on ***Coping Strategies and Adaptation***. Synergies between science, policymaking and fieldwork expertise create an appropriate framework to address climate change in the field of natural resource management, livelihoods and food security.

In addition, SDC has developed a policy framework for ***Addressing Energy Issues in SDC***. Technology transfer is recognized as an important means to provide adequate energy for economic development and poverty alleviation in the South without creating adverse environmental effects. Energy is seen as a change agent and a driving force to achieve sustainability in a broader context. Energy sector interventions are intended to improve living and working conditions of the people and – as a win-win effect – contribute to global environmental benefits. Guiding principles emphasize a learning process with primacy of the local level, action research and a multi-partnership approach. Tables 7-3 and 7-4 illustrate a selection of projects in more detail.

Guiding principles in technology transfer

Swiss development co-operation considers the following principles relevant when transferring environmentally sound technologies from (mostly) industrialized to developing countries, especially when aiming at an increase of private sector participation:

Building up knowledge-based skills and capacities

- Technical, engineering, and managerial capabilities, which are expected to help in technology absorption and diffusion on a continuous basis by the participating partners in developing countries, have to be strengthened and institutionalized.
- This also applies for adequate, appropriate indigenous research, and R&D capabilities.

Facilitate making informed decisions and choices

Enhance the capabilities of participating partners in developing countries to effectively exploit the diversity of available technological options and services by:

- The dissemination of information and the exchange of experience through seminars and workshops, technical visits, papers, and reports.
- International networking with qualified, committed research institutions and suppliers of state-of-the-art technology.
- Creation of infrastructure for adaptive research and pilot testing.

Support technology adaptation and ownership

- The need for technology adaptation according to local circumstances is crucial. This can be facilitated by providing blueprints and assuring intellectual property rights when technology transfer is completed.
- Collaborating governments have an important role to play in e.g. facilitating project agreements and exempting the equipment and materials from customs duties, taxes, port and other charges.

Build partnerships based on trust and confidence

- Strong but voluntary partnerships based on trust and confidence between collaborating governments, industries and research partners are a key factor for successful technology transfer.

7.2.2. Bilateral assistance to developing country parties

The Global Environmental Programme

In 1992, Switzerland launched a bilateral Global Environmental Programme (GEP), the objective of which is to support the efforts of developing countries in the implementation of multilateral environmental agreements. The GEP has three focal areas: climate change/energy, biodiversity and sustainable management of natural resources. More information is available at: www.sdc.admin.ch. In the focal area of climate change, the priority themes are as follows:

- Elaboration of policies and action plans;
- Human and institutional development;
- Policy dialogue nationally, regionally and internationally;
- Promotion of renewable energy and energy efficiency;
- Cross-cutting issues (climate/forestry/land management, positive interactions between agreements).

The main goal of all these activities is primarily the promotion of local socio-economic development, with the global environmental benefits considered as added value, and not the other way around.

During the period 2001–2004, 25 projects (see Table 7-1) received a total of CHF 26.3 million in the sectors of energy, transport and industry. Tables 7-2, 7-3 and 7-4 illustrate in more detail two projects in the area of bilateral co-operation with developing country parties.

SDC programmes and climate change

In addition to the GEP, other SDC projects contribute significantly to climate change mitigation and adaptation. However, their impacts in this regard cannot be explicitly documented, since the relations between activities and effects are indirect and not monitored. As well as complying with the general requirement for all projects to diminish environmental degradation and pollution, many projects are aimed at sustainable resource management, which automatically implies a positive contribution to climate change mitigation and adaptation.

Overview of GEP projects and programmes supported between 2001 and 2004							
Recipient	**Funded project/programme**	**Sector**	**Software (S) Hardware (H)**	**Disbursements (in CHF)**			
				2001	**2002**	**2003**	**2004**
Bolivia	Clean air	Transport	(S)(H)	0	0	240'000	660'000
Central America	Clean air	Transport	(S)	1'217'325	446'623	163'679	28'006
Chile	Clean air	Transport	(S)	256'867	157'572	321'061	527'167
Chile	Air quality monitoring in 4 cities	Transport	(S)	577'500	0	0	0
China	City of Kunming Masterplan public transport	Transport	(S)	220'180	228'359	292'061	400'716
Cuba	Efficient lighting (RECIC)	Energy	(S)(H)	76'868	73'000	1'111'673	550'000
Ecuador	Clean air	Transport	(S)	290'801	339'888	696'000	270'008
Global	Renewable Energy Platform (REPIC)	Energy	(S)	0	0	0	150'000
Global	UNDP/GEF: National Communication Support	Adaptation	(S)	420'715	526'684	304'030	119'245
India/Cuba	Sustainable Building Practice	Energy	(S)	0	0	54'371	116'494
India	Promotion of solar photovoltaics (PV)	Energy	(S)	128'536	84'288	52'203	78'061
India	Ecological refrigeration ECOFRIG	Industry	(S)(H)	378'967	395'777	216'341	0
India	Hybrid rickshaws	Industry	(S)(H)	141'242	0	9'204	0
India	Energy efficiency in industry clusters	Industry	(S)(H)	344'120	702'540	694'726	685'366
India	Adaptation in semi-arid areas	Adaptation	(S)	51'444	101'939	30'252	52'186
Indonesia	Clean air	Transport	(S)	1'590'440	1'519'338	1'448'707	850'000
Mali	Rural energy promotion	Energy	(S)(H)	39'794	25'432	0	167'287
Maroc	Rural electrification (hydro and PV)	Energy	(S)(H)	0	151'233	261'613	445'787
Nepal	Energy efficiency in brick industry (VSBK)	Industry	(S)SH)	0	124'196	954'683	996'516
Nicaragua	UNDP/GEF Small hydro promotion	Energy	(S)(H)	0	0	0	1'610'000
Peru	Clean air	Transport	(H)	0	72'269	364'250	1'088'391
Vietnam	Energy efficiency in brick industry	Industry	(S)(H)	3'312	561'820	500'000	654'770
Vietnam	Clean air	Energy	(S)	0	0	0	285'000
Vietnam	Atmospheric Brown Cloud Asia	Energy	(S)	0	0	0	130'000
West Africa	Bush fire control	Forestry	(S)	21'559	123'671	51'600	29'596
Total				***4'542'345***	***5'188'006***	***7'362'775***	***9'206'590***

Table 7-1 Overview of GEP projects and programmes supported between 2001 and 2004

Project / programme title: Vulnerability assessment and enhancing adaptive capacity to climate change in semi-arid India ("V&A" programme)

Goal: Securing the livelihoods of rural poor and vulnerable communities by promoting adaptation measures that enhance their capacity to better cope with adverse impacts of climate change, and by improving their disaster preparedness.

Purposes: Strengthening local, rural institutions with regard to climate change knowledge and promoting decentralisation as an important frame condition. This includes:

- empowering the local population through improved access to inputs and services including resources, appropriate technologies and information through effective policy advocacy
- providing inputs from the local level institutions in semi-arid areas to the climate change negotiation process in India and at the international level.

Recipient country	Sector	Total funding	Years in operation
India	Global environment, agriculture, water management, rural energy	CHF 2.6 million	2005–2008

Description: The goal and focus of the programme have been articulated through **three specific objectives** that integrate the local community, the state/district as well as the Indian national and international level, i.e.:

- identifying key elements and social processes relevant for adaptation to climate change and building community level capacities with regard to best practices and technologies in the agriculture, water and energy sector,
- improving the service delivery system for an efficient integration of climate change adaptation at the regional level and optimising the service delivery system and services at selected sites of Andhra Pradesh and Rajasthan,
- improving advocacy and negotiation skills at different levels and promoting the use of existing platforms in policy making related to climate adaptation. The V&A programme shall also be linked up with the 2nd National Communication process in India.

The V&A programme is based on cooperation between various national and international actors and will foster partnerships based on the principle of complementarity. It is led by a National Consortium of three partners whereas a Swiss Consortium of partners will provide advisory and backstopping services upon request of the National Consortium or SDC.

Expected added value of the programme

This proposed SDC programme on V&A in India is a unique climate change adaptation pilot type initiative at the global and local level as it:

- Shall use the demonstration of best practices and technologies in agriculture and water management as lever for the improvement of existing service delivery mechanisms. The related communication and extension set up shall be tested at a micro scale as "stage 3" adaptation measure.
- Aims at translating insights gained in this "adaptation learning mechanism" at the local level to policy advocacy at the national as well as at the international climate change institution level.
- Intends to seize opportunities and unlock potentials by joining hands with competent partners and thus encourage and promote collaborative actions among them.
- Is geared to contribute to an enhanced dialogue between development and environment communities at the national level.

Technology transferred:

- Capacity building in tools and techniques for climate adaptation in the agriculture, water and rural energy sector,
- Transfer of best practices and improvement of service delivery systems in these sectors with regard to climate change adaptation, e.g. through demonstration and training.

Impact on greenhouse gas emissions/sinks:

Not quantified

Table 7-2: Enhancing the adaptive capacity of vulnerable communities to adverse effects of climate change in semi-arid India

Project / programme title: Reducción del Consumo de Electricidad por Iluminación en Cuba (RECIC)

Goal: Reducing CO_2 emissions through widespread application of energy efficient lighting systems in Cuba's productive and service sectors.

Purposes:

- Mitigating shortages in electricity supply by reducing electricity consumption for lighting and cooling
- Improving working conditions in industrial enterprises and social institutions through higher quality of lighting
- Enhancing socio-economic development through a significant and sustainable reduction of expenses on electricity
- Establishing a revolving fund for energy efficient lighting systems in Cuba

Recipient country	Sector	Total funding	Years in operation
Cuba	Electricity/ Clean air	CHF 1.8 million (2001–2004)	Since 2001

Description: Key approach of the energy saving program RECIC is the establishment of a "pay-as-you-save" financing mechanism in connection with a revolving fund. Hereby, investment and installation cost for energy efficient lighting systems initially funded by RECIC are gradually repaid by the users through their savings on costs for electricity. The funds repaid by the users are collected in a revolving fund for further distribution of energy efficient lighting systems. During the first phase the functionality of the "pay-as-you-save" mechanism has already been proven. First experience showed that energy and cost savings that can be realized by the users of energy efficient lighting systems are 50% on average, and in some cases can reach 67%. Starting in 2005, the second phase focuses on training and supervision for the installation of energy efficient lighting systems, on funding for the procurement of a limited number of energy efficient lighting systems, as well as on technical assistance in designing and establishing a revolving fund. The main issues to be tackled are:

- Increasing the number of installed energy efficient lighting systems in order to reach the critical mass that is necessary to optimise transaction cost and sustainability of the envisaged financing mechanisms for further dissemination beyond the duration of RECIC.
- Inclusion of sectors which operate with non-convertible currency in order to expand the reach of the project and its benefits.
- Increase awareness on energy efficient lighting systems and saving potentials through marketing activities.
- Develop institutional capacity of local financing institutes in view of establishing and managing the revolving fund.

Factors which led to the project's success:

- Straightforward approach and technology: The project's objective and approach are easy to comprehend for beneficiaries and other relevant stakeholders. Moreover, replacement of existing lamps with energy efficient lighting systems is simple and requires no sophisticated technology.
- No investment required by local beneficiaries beyond current expenses: The unique "pay-as-you-save" financing mechanism in connection with the revolving fund allows beneficiaries participating in the project to introduce energy efficient lighting systems without upfront investment.
- Project is in line with energy sector policy in Cuba: The project enjoys support by the local counterpart as it is in line with the Cuban Government's efforts to stabilize the country's energy sector by introducing energy saving measures under the Programa de Ahorro de Energía de Cuba (PAEC).

Technology transferred:

- Training on installation of energy efficient lighting systems
- Capacity building for establishing and managing a revolving fund
- Creating of awareness on energy efficient lighting systems

Impact on greenhouse gas emissions/sinks: During the period 2002 – 2004 GHG emissions in the amount of around 1,000 tonnes of CO_2 have been avoided due to the introduction of energy efficient lighting systems. Considering a potential market of at least 1,000,000 illumination systems in the country a reduction of CO_2 emissions in the amount of 88,000 tonnes annually could be realized. The cumulated potential for avoided CO_2 emissions is estimated to amount to 300,000 tonnes by the year 2015.

Table 7-3: Facilitating and/or financing the transfer of, or access to, environmentally sound technologies: energy efficient lighting systems in Cuba

Project / programme title: Vertical Shaft Brick Kiln (VSBK) Technology Transfer Programme in Nepal

Goal: Environmental responsibility and social equity in the brick sector are significantly improved

Purposes: Small and medium enterprises have access to sustainable (environment and socially friendly) brick production systems

Recipient country	Sector	Total funding	Years in operation
Nepal	Construction sector: Clean brick production	CHF 1.4 million (2003–2004)	Since 2003

Description: The objective of the first phase was to transfer the energy and environment friendly brick firing VSBK technology to Nepal and to contribute to the reduction of air pollution, especially in the Kathmandu valley. The technology was the vehicle to initiate social changes, to build up empowerment of workers, in particular women, and to improve working and living conditions in the brick-making sector. The implementation of the VSBK technology transfer is based on business principles, in cooperation with the private sector, and is fully anchored in the local context. The programme consists of the following five components:

- **Environment and Technology**: Adjustment of the VSBK technology regarding construction and operation of the kiln that would lead to substantial savings of 50% of energy consumption and 85% of emissions as compared to the conventional movable chimney BTKs (Bull Trench Kilns).
- **Economics**: TT to partners of the private sector, aiming at: producing all technology elements locally; improving the brick-making process, in particular the production of green bricks through simple mechanisation (Extruder, Pugmill); reducing initial investments for construction by developing design options; introducing professional business administration practices; and training workers in manufacturing good quality bricks.
- **Social:** Development of a win-win situation for both workers and entrepreneurs, resulting in better working and living conditions. The outcome of social activities in fields such as health, education, and in particular empowerment, resulted in basic elements for a national policy formulation / adjustments.
- **Institutions**: Development of a local support and supply service network that would sustain the VSBK technology without external intervention. Support of government agencies in the development of appropriate standards and policies, and licensing systems.
- **Knowledge management**: Local capacity building by proper knowledge management of local, regional, international expertise to firmly anchor the VSBK technology in Nepal. A rich documentation of technology action packages, which facilitates the wider dissemination in other parts of Nepal, in particular the Terai, has been compiled covering all project components, and is ready for use in Phase 3 (2005–07).

Factors which led to the project's success:

Key success factors are: A well planned, stepwise process (pre- and feasibility study, participatory project design, pilot projects with in-built learning loops), the application of a holistic approach (environmental, social, institutional, economical) that takes into account the local context, in particular with regard to locally available resources and capacities, anchoring of the process, knowledge and skills in the local context (including government agencies), flexible but timely utilization of appropriate regional and international professional consultancy capacities. During its two years of implementation, the VSBK programme has produced promising results in the fields of **energy saving** with ecological as well as financial implications, **public awareness** on needs and potentials of clean brick production, **local anchoring** with growing independence of local entrepreneurs, **profitability** of production, **industrial set up** and **social improvements** favouring good working conditions and better livelihoods.

Technology transferred:

- Holistic package, containing also social, economical and institutional components (besides the energy and environment friendly technology).
- Design, construction and operation of VSBK
- Energy and emission (air) monitoring
- Metal part production (screw and unloading trolley)
- Refractory brick masonry training
- Training of trainers
- Training in the development of skill-based training manuals

Impact on greenhouse gas emissions/sinks: It is estimated that a complete shift to VSBK could save as much as 100'000 tonnes of CO_2 carbon annually (approx. 200 kilns in the Kathmandu valley).

Table 7-4: Facilitating and/or financing the transfer of, or access to, environmentally-sound technologies: clean brick production in Nepal

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

The countries of Central and Eastern Europe require enormous financial resources to meet the costs of adapting, renewing and rebuilding their industries and infrastructure. Swiss bilateral co-operation with Central and Eastern Europe is based on three framework credits approved by the federal parliament in 1990, 1992 and 1999, and an extension of the third credit in 2004. Of the total amount of CHF 2.95 billion, CHF 1.9 billion was allocated for financial co-operation. Over the last ten years, the emphasis of the co-operation has shifted from Central and Eastern Europe to South Eastern Europe and the CIS. Bilateral financial co-operation with Switzerland is primarily based on two instruments: grants and credit guarantees.

Grants
Switzerland uses grant financing to support priority projects that cannot be financed commercially, because their earning power is insufficient, if the Swiss economy can provide equipment and services for their implementation on competitive terms. The priority field of application is basic infrastructure, particularly in the environment and energy sectors. The partner country is expected to bear local cost components of the projects as far as possible.

Credit guarantees
Credit guarantees are used to finance the export of Swiss goods and services to manufacturing companies or for infrastructure projects, the profitability of which allows commercial financing. Such guarantees are used in countries where the Swiss export risk guarantee (ERG) does not apply, or applies only in part. The environmental dimension is taken into account at the application stage. These mechanisms have sometimes promoted the importation of goods which have a direct impact on air quality.

7.2.4. Specific support for both developing and transition countries

The Swiss AIJ Pilot Programme (SWAPP) was officially launched in April 1997, when the SWAPP Secretariat took up its work. The SWAPP was established to allow Switzerland to participate in the pilot phase for AIJ ("activities implemented jointly"), which was initiated in March 1995 under the UNFCCC, to gain experience with the joint implementation (JI) of climate protection projects across national borders. In December 2001, seco decided to extend SWAPP by a maximum of 4 years.

In order to take full advantage of the AIJ pilot phase, the SWAPP undertakes a broad range of activities:

- **Government financing of AIJ projects**: Switzerland's first AIJ/JI project with Romania has been implemented. In the so-called Swiss Thermal Energy Project (STEP), district heating systems were renovated in two cities (Buzau and Pascani). The project involved the installation of combined heat and power generation units and the renovation of residential buildings to increase energy efficiency and to gain efficiency from individual metering and thermal insulation. In addition, the rehabilitation of a district heating network in Bucharest is currently being implemented as a Joint Implementation (JI) project.
- **Designing incentives for private sector investment**: One of the main objectives of the SWAPP is to encourage private sector investment in the AIJ component of GHG reduction projects (e.g. in the form of co-financing), even though the most obvious incentive (crediting) is explicitly excluded during the pilot phase. Initiating discussions with players in the private sector to develop the necessary incentives is a priority.
- **Contribution to methodological progress**: In parallel with the implementation of AIJ investment projects under the Swiss programme, and in co-operation with partner (host) countries, an effort is made to find operational solutions to the various methodological challenges associated with the AIJ/JI/CDM instruments. Actions include studies by consultants or NGOs, support for methodological workshops, reviews of experience with AIJ, and case studies of existing projects ("simulation studies").

- **Capacity-building activities, networking and information**: The AIJ pilot phase, by its nature, is a learning experience for all participants, and capacity-building activities are an integral component of the SWAPP. The targeted dissemination – to the private sector and NGOs – of information concerning the AIJ pilot phase, the flexible instruments and the Swiss AIJ pilot programme, both domestically and in conjunction with potential host countries, is a high initial priority.
- **CDM Executive Board**: The programme manager of SWAPP contributed very actively for three years (2002–2004) to the CDM as an alternate Member and in 2005 as a full Member of the UNFCCC CDM Executive Board. The CDM Executive Board administers and supervises the operation of the CDM subject to the authority and guidance of the COP/MOP.

7.3. Multilateral activities

Since the establishment of the Global Environment Facility (GEF) – now the financial mechanism of the Convention – Switzerland has consistently contributed to its replenishment. In 1991, the Swiss 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 Decree of 13 March 1991). This enabled Switzerland to play a major role in the GEF and to set up a programme of bilateral cooperation in the global environment field. Between 1991 and 2002, Switzerland contributed CHF 203 million to the GEF. For the period 2003–2006, CHF 99 million has been committed to the GEF.

Switzerland and the World Bank jointly launched the National Strategy Study (NSS) programme in September 1997. The aim of the programme was to assist non-Annex I countries in defining their negotiation positions and to develop national strategies regarding emerging international market incentive instruments which will facilitate technology transfer to developing and transition countries. Since 1997, Switzerland supported the NSS programme of the World Bank with USD 4 million. This Swiss financing covered 13 national CDM/JI strategies in Latin America (Colombia, Bolivia, Peru), Africa (South Africa, Zimbabwe, Egypt), Asia (China, India, Uzbekistan) and Eastern Europe (Slovakia, Czech Republic, Russia, Ukraine). Thus, it helped to build up institutional capacities for CDM/JI in these countries and to structure the project pipeline. For a more detailed description of an example, see Table 7-5.

The Climate Investment Partnership (www.climateinvestors.com), a non-profit association of public and private financial organizations, has been supported by seco in 2003/04 with start-up funding. The partnership seeks to provide upfront financing for climate-friendly projects. It operates as a matchmaking programme that establishes a market place for high-quality GHG projects and investments and that reduces processing costs and risks. The programme offers a way for project developers from developing countries to participate in the carbon market and to obtain access to investment funds.

Table 7-6 gives an overview of Switzerland's total multilateral assistance from 2001 to 2004.

Project title: National Strategy Study on the Application of the Clean Development Mechanism in China

Goal: The National Strategy Study will significantly contribute to determine the CDM potential in a Chinese context as well as the opportunities and benefits for China, under the CDM regime.

Objectives:

- Build up practical experience with respect to technology options and CDM methodology, based on case studies within selected sectors.
- Assess China's overall certified emission reduction potentials and economic benefits under the CDM regime.
- Determine the role China can play in the emerging global carbon offset market.

Recipient country	Sector	Total funding	Years in operation
China	Clean electric power generation/ thermal power plants and large-scale/ on-grid renewable energy generation	CHF 0.8 million (= Swiss contribution)	December 2001 – June 2004

Description: The Government of Switzerland and the World Bank launched in 1997 in close co-operation with other governments a capacity building initiative on Flexible Mechanisms – the so called National Strategy Studies (NSS) Programme – designed to assist the developing countries in their responsible role. The China CDM study was co-financed by four principal sponsors: The World Bank, the Chinese Ministry of Science and Technology, the German Technical Cooperation GTZ and the Swiss State Secretariat for Economic Affairs (seco). The China CDM study analyzes key methodological issues related to the Clean Development Mechanism from China's perspective. It includes six case studies of potential CDM projects - five power generation projects, and one landfill natural gas project - and evaluates China's CDM potential through 2010. Based on the assessment of the significance of CDM opportunities for China, the study considers barriers to CDM project implementation, including needs for capacity building based on China's special circumstances and interests. In addition, the study makes a number of recommendations for decision makers regarding:

- China's CDM strategy, policy, and implementation plans: adopt a proactive and sustainable CDM policy.
- Urgent steps to facilitate CDM transactions: provide basic services to allow CDM in China; ensure that critical capacity is developed; and encourage CDM project identification and implementation.
- Longer-term considerations: consolidate results/enhance synergies across CDM initiatives and undertake follow-up analysis on key issues.

Combining a top-down with a bottom-up approach, the study sought to analyze China's real circumstances. The study presents a comprehensive package of conclusions and recommendations to the Chinese Government, potential project proponents, and the interested national and international audience. The study report can be downloaded from http://lnweb18.worldbank.org/ESSD/envext.nsf/46ByDocName/ProgramsandPartnershipsNationalStrategyStudiesProgramCompletedNationalStrategyStudies

Expected added value of the programme

- Awareness raising and diffusion of the knowledge on CDM;
- Guidelines and check-list for easy implementation of CDM projects;
- Contacts between project proponents, service and technology providers, government officials and international investors;
- Triggering the implementation of actual CDM projects in China.

Technology transferred:

- Capacity building and technical advice on the application of the CDM methodology.

Impact on greenhouse gas emissions/sinks:

Not quantified. However, with the entry into force of the Kyoto Protocol by February 2005, the NSS China was published at the most opportune moment. The NSS "Clean Development Mechanism in China – Taking a Proactive and Sustainable Approach" has been downloaded from the World Bank's website over 50,000 times. Internationally, China – together with other emerging markets such as Brazil and India – belongs to the CDM-markets with the highest potential. China's booming economy, with an energy supply based to a large extent on fossil fuels, offers many interesting CDM investment opportunities. Making China's economy less dependent on fossil fuels will play an important role for any global climate change mitigation strategy.

Table 7-5: Swiss contribution to the National Strategy Study on CDM in China

	Multilateral contributions (million CHF)			
	2001	**2002**	**2003**	**2004**
Global Environment Facility	16.25	16.25	24.75	24.75
Multilateral institutions:				
International Bank for Reconstruction and Development (IBRD)	3.4	2.4	2.0	0.1
International Development Association (IDA)	140.0	-	176.9	176.9
African Development Bank (BAD)	1.9	1.8	1.8	1.7
African Development Fund (FAD)	46.0	46.0	71.6	35.8
Asian Development Fund (ADF)	13.9	13.9	13.9	13.9
European Bank for Reconstruction and Development (EBRD)	9.0	9.9	9.6	9.3
Inter-American Development Bank (IADB)	1.6	1.5	1.3	1.1
United Nations Development Programme (UNDP)	52.0	52.0	52.0	52.0
World Bank (NSS Programme)	3.4			
UNFCCC	0.5	0.5	0.5	0.6
Multilateral scientific programmes:				
Consultative Group on International Agricultural Research (CGIAR)	11.0	10.9	10.8	11.5
International Fund for Agricultural Development (IFAD)	17.7	-	-	7.1
International Union for the Conservation of Nature (IUCN)	1.2	1.8	0.7	0.8
WMO Programmes	0.8	0.8	0.9	0.8
European Co-operation in the Field of Scientific and Technical Research (COST)	7.7	8.0	8.1	9.0
OECD Climate Change	0.05	0.05	0.05	0.05
IPCC		0.1	0.1	0.1
Multilateral technology programmes:				
UNIDO	1.8	1.9	1.8	1.9
Ozone Fund UNEP	3.1	3.0	4.0	3.9
UNEP	3.7	3.7	3.5	3.5
World Bank Climate Funds			0.4	0.6
Multilateral training programmes:				
UNITAR (climate, law and environment)	0.6	0.6	0.6	0.6
Total	**335.6**	**175.1**	**385.3**	**356.0**

Table 7-6: Financial contributions to the operating entity of the financial mechanism, to regional and to other multilateral institutions and programmes (2001-2004)

7.4. Activities relating to transfer of technology and adaptation

7.4.1. Technology transfer

Switzerland's understanding of "technology transfer" includes, in addition to incentives and activities directed at the provision of technical equipment in the industrial and infrastructure sector, capacity building, technology transfer in the health sector and development of administrative institutions. Therefore, Switzerland provides incentives in numerous sectors and is actively engaged in the field of training and research activities contributing to sustainable development.

Switzerland also supports programmes in the field of energy efficiency which are aimed at mitigating CO_2 emissions globally and controlling air pollution locally. These projects are related to the traffic and transportation sector and to small and medium size industries (e.g. foundry, glass and brick industries). The main objective is to strengthen local partners (capacity building) and to pool international expertise in order to develop locally adequate solutions (technology packages). These pilot programmes are then evaluated, documented and disseminated at the national level.

In the framework of economic co-operation, Switzerland seeks to strengthen the international rules by supporting developing and transition countries in their efforts to negotiate and to comply with and/or benefit from trade relevant rules in the Rio conventions. The main goal of these activities is to strengthen sustainable growth in these countries by helping them to benefit from integrating into the world trade system. Therefore, special emphasis is given to supporting the efforts of the partner countries to define their own policies and strategies in order to improve acceptance and foster implementation of international environmental agreements. Another priority is the promotion of the transfer of environmentally sound technologies. Switzerland's economic co-operation covers the following relevant fields:

Strengthening of environmental information systems and legislation

- Locating and disseminating general information on environmental technologies available in industrialized countries/Switzerland and advising on specific applications
- Consulting services for government agencies on the drafting of environmental policy guidelines and the application of laws
- Intermediary and liaison services for the arrangement of business opportunities between companies in developing countries and in industrialized countries

Technical assistance and training

- Conducting demonstration projects in selected industrial sectors
- Introducing environmental management systems (using ISO 14000 series)
- Conducting life cycle analyses (product and operations analysis)
- Introducing eco-efficient production methods and minimizing generation of waste
- General risk analysis for the prevention of chemical and physical industrial accidents
- "On the job" training in demonstration projects
- Conducting specific seminars and workshops on environmental pollution in companies

Financial facilities and infrastructure project financing

- Support in formulation of (private) environmental investment projects and in the search for sources of financing
- Co-financing public environmental infrastructure projects, and supporting sector reforms, in important sectors such as hydropower, district heating, water treatment
- Support in structuring and implementing public-private partnerships

- Provision of venture capital funds, and specialized facilities for SMEs, including for environmental investments.

Particular mention should be made of the following programmes in this context:

- In recent years, Switzerland concentrated much effort on promoting the transfer of environmentally sound technologies. A comprehensive programme for the establishment of so-called **Cleaner Production Centres** was set up. The aim of the centres is to offer private companies and the public sector a wide range of services including general information, in-plant assessments, workshops, demonstration projects, capacity building and support for the preparation of bankable projects. The Centres provide these services with the support of Swiss and other developed country WTO members' technical institutes, universities and industries. Switzerland supports Cleaner Production Centres in Costa Rica, El Salvador, Guatemala, Bolivia, Colombia, Peru, Brazil, Morocco, South Africa, Jordan, Romania, China, India, Vietnam, Laos and Cambodia (see Table 7-9).
- The **Green Credit Lines** (Peru, Colombia) work as a special financing facility for environmental investments in SMEs.
- The **Swiss Organisation for Facilitating Investments (SOFI)** is a specialized institution to mobilize Swiss investments in countries with developing and transition economies (www.sofi.ch).
- **OSEC Business Network Switzerland** promotes Swiss exports, including environmental technologies.
- **The Swiss Thermal Energy Project (STEP)** – a district heating project based on co-generation – was Switzerland's first AIJ/JI project with **Romania** (CHF 6.5 million), now followed by the Bucharest district heating JI project (CHF 11.5 million), (see Table 7-7).
- With the aid of a Swiss mixed credit, from 2003 to 2004 **Colombia** purchased and installed **meteorological and hydrological equipment** for about CHF 12 million, allowing digital registration and satellite transmission of weather and climate data (see Table 7-8).
- Promotion of domestic and commercial **hydrocarbon refrigerators** in **India**
- Furthermore, Switzerland is one of the main sponsors of the **International Tropical Timber Organisation** (ITTO). Switzerland has financed the first sink project in the framework of the ITTO in Colombia, with other projects ongoing in Brazil and Peru.

For additional information, please refer to: www.seco-cooperation.ch

Global Atmosphere Watch

In the framework of the Global Atmosphere Watch (GAW) programme of the World Meteorological Organization (WMO), the **Swiss Federal Office of Meteorology and Climatology (MeteoSwiss)** is supporting and maintaining the Mount Kenya GAW station. The goal of the GAW programme is to monitor, on a long-term basis, the changing composition of the atmosphere. The GAW network consists of stations which, being remote from pollution sources and sinks, can provide background data. The Mount Kenya station is situated in the Mt Kenya national park at an elevation of 3697 m above sea level. It is the only such station on the equator. The ozone balloon soundings which are part of the measurement programme of the Mount Kenya station are performed at the radiosonde station of Nairobi.

MeteoSwiss is providing support worth CHF 60,000 per year for the ozone balloon soundings, in the form of consumables and capacity building. For 2002 to 2005, total funding was CHF 240,000.

The MeteoSwiss experts who visit the station each year provide expendables and staff training, with instrument upgrading and instrument intercomparisons.

Project / programme title: Swiss Thermal Energy Project (STEP), Romania

Goal: Reconstruction of two district heating systems in the Romanian cities Buzau and Pascani to improve the energy efficiency and to reduce the emission of greenhouse gases.

Purposes:

- The cities have the ability to deliver the needed heat; they feed electricity into the power system and are therefore paid according to the supply-agreement; they are able to maintain the system.
- The inhabitants are provided reliably and economically with heating-circuit and hot water.
- Various environmental impacts will be reduced: CO_2, carbon black, noise

Recipient country	Sector	Total funding	Years in operation
Romania	District heating, energy efficiency, global environment	CHF 6.65 million	1997–2003

Description: The STEP project was developed in concert with a larger investment program co-financed by EBRD and aiming at improving the energy efficiency of district heating in 5 Rumanian cities. The Swiss contribution focused on two cities out of the five EBRD cities and selected separate service areas in this area. By this the Swiss project (STEP) was technically and financially completely detached from the EBRD project.

The goal and focus of the programme have been articulated through **nine specific objectives**:

- Reduction of CO_2 emissions
- Improved comfort for the population
- A temperature increase from 17°C to 20°C in the apartments
- Permanent hot water supply
- Improved energy efficiency (reduction of production costs)
- Reduction of polluting emissions.
- Reduction of water losses
- Technology transfer (incl. know-how training)
- Employment creation

Expected added value of the programme

STEP was the first Swiss project to be registered under the Activities Implemented Jointly (AIJ) according to the climate convention. STEP could be converted into a Joint Implementation (JI) project. Thus an added value of this programme would be to gain experience with the JI instrument and to generate Emission Reduction Units that qualify under Art. 6 of the Kyoto Protocol.

Technology transferred:

- Two small gas-powered co-generation units, supplying a neighborhood with heat and feeding electricity into the grid (in the past, Romania knew co-generation from large thermal power stations)
- Pre-insulated pipes, based on the two-pipes concept (before, Romania‘s standard was four pipes);
- Corrosion resistant heat-exchanger substations at each building;
- Metering, connecting pipes in buildings, automatic control; installation.

Impact on greenhouse gas emissions/sinks:

Taking over of the new equipment took place in 2003. The CO_2 reduction is estimated at 139’000 t for the first 14 years of operation and is confirmed by monitoring so far.

Follow-up activities:

The positive results of the STEP project encouraged Switzerland to approve a CHF 11.5 million grant contribution to the Bucharest District Heating project, as a co-financing of a larger EBRD program with the Municipality of Bucharest. It is intended to register this project as JI. The project aims at automation of the heat supply in the world’s second largest district heating system. Automatic control and heat regulation in almost 600 substations will considerably reduce the energy losses.

Furthermore, the Swiss-Romanian counterpart fund is financing a pilot program for building insulation, with a total contribution of over CHF 2 million. Large public owned buildings in 11 cities have been completely rehabilitated. The experience shows that investments of roughly € 3000 per apartment result in approximately 30% lower energy demand. This project perfectly complements the STEP and Bucharest district heating projects – focussed on efficient heat supply – by urgently needed measures on the demand side.

Table 7-7: Swiss Thermal Energy Project (STEP), Romania

Project / programme title: Fortalecimiento de la red Ambiental de Colombia (FORAC)

Goal: Adequate skills, know-how and information are available in Colombia to establish, update and implement environmental policies and instruments and create environmental awareness.

Purposes: The reliability, accuracy, currency and attractiveness of data provided by the environmental monitoring network operated by the Institute of Hydrological, Meteorological and Environmental Studies (IDEAM) is increased and its products for business, science, individuals and policy makers are improved. This includes:

- Modernisation and extension of the existing environmental monitoring and alert networks and Environmental Laboratory capacities of IDEAM through financial assistance under a Swiss mixed credit line.
- Strengthening of IDEAM in providing quality services through scientific cooperation with Swiss research institutions.

Recipient country	Sector	Total funding	Years in operation
Colombia	Environmental services	CHF 11.6 million (mixed credit); CHF 0.4 million (scientific cooperation)	2001–2004 (mixed credit) 2004–2006 (scientific cooperation)

Description: The programme includes two main components:

- Financial support to IDEAM for upgrading and extending the existing national environmental monitoring network. Financial assistance is being provided under a mixed credit (a soft loan which includes a grant element). The equipment supplied under the project includes geodesic survey instruments, 235 specialized state-of-the-art monitoring platforms for meteorology, hydrology, ecosystems, and glaciology with satellite transmission of data and 355 automatic hydrology stations. It also included equipment for a laboratory on environmental chemistry and mobile units for air quality monitoring in urban areas. Delivery of equipment was started in 2002 and has been completed in 2004. Installation is in progress and is expected to be completed by end of 2005.
- To strengthen IDEAM in making optimum use of the new network a program for scientific cooperation with specialized Swiss institutions is under implementation. This includes strengthening of modeling skills, data handling and product development in the areas of Glaciology and Climate Change, Hydro-logy and GIS and data warehouse management. It also includes support to IDEAM in communication on the project to the local public and potential customers of the services as well as support in commercialisation of specialized products such as weather forecasts, real time data access, etc.

The direct project partner on the Colombian side is the Instituto de Hidrología, Meteorología y Estudios Ambientales (IDEAM). Local universities and other governmental bodies such as INGEOMINAS are involved in the scientific cooperation program to the extent possible. The project implementation is coordinated through seco and with external support from INFRAS, Zurich. Swiss partners for the program on Scientific Cooperation are the Glaciology and Geomorphodynamics Group of the University of Zurich, the Laboratoire Hydrologie et Aménagements – HYDRAM of the EPFL Lausanne and METEODAT Ltd, Zurich.

Achievements of the programme:

The programme implementation is still ongoing. The modernized network is providing IDEAM and its custom-mers new opportunities with regard to real time access to environmental data which allows for alert networks in various areas. This also assists the transition process within IDEAM towards generation of additional revenues from sales of products which supports sustainable institutional development. The new equipment replaces mostly very old, unreliable and outdated manual equipment, which thus enhances data quality and reliability of the network. Environmental information has a high priority in Colombia due to the large variety of climatic zones, the unmatched biodiversity, the role of Colombian ecosystems in global climate change and important economic sectors which depend on environmental factors (e.g. agriculture, energy production, mining, etc.). Through the scientific cooperation with Swiss institutes IDEAM has better access to international research networks and will be enabled to increase the scientific profile of the Institute.

Technology transferred:

- State-of-the-art environmental monitoring equipment, including multi-purpose data acquisition platforms with satellite transmission for real time data, environmental laboratory equipment, mobile equipment for environmental monitoring in urban areas.
- Capacity building in scientific know-how and modeling techniques in hydrology, water quality, glaciology, climate change and data processing.

Impact on greenhouse gas emissions/sinks: Not quantified

Table 7-8: Financing the strengthening of the environmental monitoring network in Colombia

Disbursements by seco to Cleaner Production Centres (CPC) 2002–2004 (in CHF)			
	2002	**2003**	**2004**
CPCs in general for Corporate Social Responsibility (via ILO)	2,100,000		
CPC South Africa	875,000		540,000
CPC Eastern China	1,460,000	522,106	1,400,159
CPC Jordan			465,977
CPC Laos			810,000
CPC Cambodia		450,000	405,000
CPC Columbia	203,009		410,000
CPC Central America	865,156	1,800,000	1,822,500
CPC Brazil	297,539	678,450	437,793
CPC Peru	603,750	594,542	317,511
CPC Vietnam	1,018,768		1,620,000
CPC Morocco	729,653		364,500
Green Credit Line Colombia		7,500,000	
Green Credit Line Peru			6,750,000
TOTAL	8,152,875	11,545,098	15,343,440

Table 7-9: Disbursements to Cleaner Production Centres, 2002-2004

7.4.2. Adaptation

Since 2001, Switzerland has provided financial support for the National Communication Support Programme (NCSP), which was established in 1999 by UNDP and UNEP, in cooperation with the UNFCCC Secretariat and the GEF. For the period 2001–2007, a total financial contribution of USD 968,000 has been committed under three trust fund agreements to NCSP. A large part of this funding was utilized to develop the Adaptation Policy Framework, which is designed to help to improve the vulnerability and adaptation assessments in non-Annex I National Communications.

7.5. Contributions to dedicated funds under the UNFCCC

At COP 6bis, Switzerland signed a **political declaration** issued jointly with the EU, Iceland, Norway, New Zealand and Canada, committing itself to payments to the Special Climate Change Fund (SCCF) on the basis of an emissions-based burden-sharing formula originally proposed by the President of COP 6bis. The Swiss share of 1990 Annex I emissions is 0.3%. The base amount committed jointly by Switzerland and the other countries is USD 410 million, payable as of 2005, resulting in a Swiss share of USD 1.23 million per year. Switzerland made a statement at COP 7, announcing the Swiss payment modality. This payment modality was subsequently approved by the Parliament. Switzerland has already contributed CHF 400'000 in 2003 for the Least Developed Countries Fund and CHF 600'000 in 2004 for the Special Climate Change Fund.

8. Research and systematic observation

8.1. Research

The descriptions given in Section 8.1.1 below refer to research on global change, and not specifically to climate research. The data are based on the Research-InfoSystem of ProClim-, the Forum for Climate and Global Change of the Swiss Academy of Sciences. ProClim- constantly updates research activities, publications and the list of experts on climate research. More specific studies and analysis of the research activities can found online at http://www.proclim.ch.

8.1.1. Climate and global change research

8.1.1.1. Research structures and funding

Climate research in Switzerland can be divided into several categories:

- National Centres of Competence in Research (NCCR)
- Contributions to international research programmes (EU, COST, WCRP, IHDP, IGBP)
- Contributions to international research centers and organizations (ECMWF, EUMETSAT, WMO)
- Individual research projects (funded by the National Science Foundation (NFS) or governmental institutions)
- Energy and transport research (mainly funded by the government)

Distribution of research projects by research area

In 2004, about 300 research projects were in progress on climate and global change and on related human aspects. The distribution of research projects funded by the National Science Foundation (about 140) is shown in Table 8-1 (in % of all projects, for EU-funded projects see 8.1.1.3). Not all projects are classified, and multiple selections can be made for a project (e.g. research on atmosphere and hydrosphere). The statistics are approximate, as only about two thirds of the projects were classified by research area. The others are assumed to follow more or less the same distribution.

Paleoclimate	45
Ecosystems and Landscape	30
Atmosphere, Atmospheric Chemistry, Aerosols	30
Socioeconomics	18
Biodiversity	9

Table 8-1: Distribution of NSF-funded research projects on climate and global change by research area (in %, including projects allocated to more than one area)

Funding

Swiss research is mainly funded by the National Science Foundation (programme research and individual projects), by the EU (EU research projects) and COST (projects in the framework of COST actions).

In 2004, National Science Foundation funding for about 140 projects (including NCCR) on climate and global change amounted to some CHF 16.2 million. It has to be noted that many of these projects started or ended during 2004. The average funding per project is about CHF 115,000 per year. The distribution of the funding by area is listed in Table 8-2 (only including the main topics).

	Funding (million CHF)
Paleoclimate	4.5
Ecosystems and Landscape	2.3
Atmosphere, Atmospheric Chemistry, Aerosols	2.3
Socioeconomics	1.8
Biodiversity	0.55
Other	0.7
NCCR Climate (in addition to projects included above)	0.73
NCCR North-South	3.3

Table 8-2: Distribution of NFS funding by area in 2004

In 2004, the funding provided for EU projects in the same fields was about CHF 10 million (about 100 projects), and for COST projects (around 50, mostly non-resource-intensive coordination projects) about CHF 1.7 million.

8.1.1.2. National Centres of Competence in Research

Two National Centres of Competence in Research (NCCR) are concerned with climate change issues – the NCCR Climate and the NCCR North-South.

NCCR Climate

The NCCR Climate (www.nccr-climate.unibe.ch) was created by a government decision in April 2001 with an intended duration of 12 years. The second 4-year period began in April 2005, albeit with some cutbacks (about 20%) in financial resources. The NCCR Climate brings together experts from a wide range of universities. It will address broader issues of natural climate variability and predictability by combining the contributors from relevant disciplines into an integrated network of competence. This network includes expertise from the physical, chemical, biological, economic and sociological disciplines. It is active on several research fronts and its functions are as follows.

- First, disciplinary work in the individual research groups to ensure continuous cutting-edge progress and to facilitate access to and sharing of latest results and methods through international co-operation (e.g. EU projects).
- Second, research within the various modules to provide thematic co-ordination of research and the integration of results.
- Third, a university-based, long-term Swiss centre of competence on basic issues of natural climate variability, extreme events, climate projections and processes, and the attendant ecological and economic processes relevant for improved predictive capability and risk assessment.

The overall goals of the NCCR Climate are to:

- Acquire a better understanding of climate system processes, variability and predictability and the complex inter-relationships between climate, economic and societal driving factors.
- Adapt and refine scientific tools and knowledge acquired for Switzerland, considering specific characteristics in physical, chemical, biological, geographical, economic and societal factors.
- Transfer and apply the knowledge to assess the future cost and risks of expected climate change, and to provide a basis for adaptation strategies.
- Educate young scientists of all disciplines with an emphasis on interdisciplinarity, in order to prepare a young generation of decision-makers for the future. The management will establish a regular series of thematic summer schools and forms of participatory teaching.
- Investigate new financial and economic tools to hedge against the increased probability of extreme events.

NCCR North-South

The NCCR North-South (www.nccr-north-south.unibe.ch) focuses on international research cooperation and promotes high-quality disciplinary, interdisciplinary and transdisciplinary research with the aim of contributing to an improved understanding of the status of different syndromes of global change, of the pressures these syndromes and their causes exert on different resources (human, natural, economic), and of the responses of different social groups and society as a whole.

By identifying the potential of social systems to mitigate syndromes, by considering their dynamics, and by adopting existing innovative solutions, the NCCR North-South primarily aims to help design ways to mitigate syndromes. The NCCR North-South enables Swiss research institutions to enhance partnerships with institutions in developing and transition countries, thereby building the competence and capacity of research on both sides to develop socially robust knowledge for mitigation action.

Individual projects are focused on one of the following themes.

- IP1: Conceptual Framework and Methodologies
- IP2: Natural Resources and Ecology
- IP3: Environmental Sanitation
- IP4: Health and Well-being
- IP5: Social practices and empowerment in urban societies
- IP6: Institutional Change and Livelihood Strategies
- IP7: Conflict Transformation
- IP8: Governance, Human Development and Environment

8.1.1.3. Research in EU projects

On 16 January 2003 Switzerland and the EU signed a research agreement, giving Switzerland the status of an “associate country” in the 6th EU research framework programme from 1 January 2004. Rather than participating in EU research on a research ”project by project” basis, Switzerland now contributes to the overall EU research budget. Thus, Swiss projects are financed directly by the EU research institutions. At the same time, Swiss researchers can now take on a leading role in any EU project. All the former restrictions on project activities have been suspended.

In the period 2002–2004, more than 100 projects in the field of climate and global change were pursued in the framework of EU research. The funding volume for projects carried out during (part of) this period was about CHF 30 million. The main general topics of EU-related Swiss projects are

- Biodiversity (13 projects)
- Atmospheric chemistry/aerosols (12 projects)
- Natural hazards (10 projects)

- Paleoclimate/climate variability (8 projects)
- Ecosystems/landscape (7 projects)
- GHG emissions, carbon cycle (7 projects)

Minor topics include measurement methods, clouds, economy/Kyoto mechanisms, and traffic/ mobility.

8.1.1.4. Activities in world research programmes

Switzerland makes a major contribution to the World Climate Research Programme (WCRP) through individual research projects, research conducted at federal institutes and within co-ordinated programmes (NCCRs) and the operation of monitoring stations and networks, as well as calibration and data centres (for monitoring see Section 8.2). It also plays a leading role in several regional climate research programmes.

Switzerland also contributes significantly to the International Geosphere-Biosphere Programme (IGBP), both directly and through relevant research activities. The Core Project Office for the IGBP Past Global Changes (PAGES) project is located in Berne and is jointly financed by Switzerland and the US. Swiss scientists are engaged in the PAGES and Global Change and Terrestrial Ecosystems (GCTE) projects, and also participate in most other Core Projects. 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. Swiss researchers are active in fields relevant to the IHDP and have also made important contributions to the United Nations University over the years.

Of the projects funded by the National Science Foundation, about 80 were from the field of IGBP, about 40 from that of WCRP, about 25 from IHDP and about 10 from DIVERSITAS.

8.1.1.5. Individual research projects

The majority of research projects are individual projects funded by the Swiss National Science Foundation or by government agencies such as SAEFL. For a breakdown of research fields and for information on funding, see Section 8.1.1.1.

8.1.1.6. Research highlights from NCCR Climate, period 2001–2005

Swiss research contributes substantially to worldwide knowledge of climate change in various fields, especially the past climate, analysis of the present climate and modelling of future climate behaviour, thus improving understanding of the climate system; ecological impacts of climate change; and possible economic, social and political mitigation and adaptation measures.

Some research highlights of the last few years are listed below.

Grid-based seasonal (or monthly) **reconstructions of temperature and precipitation** have been completed for the last 500 years, based on observational and documentary data. This demonstrated the exceptional European summer of 2003, the hottest (with 95% certainty) and the second-driest in the past 500 years (Luterbacher et al. 2004). Two 1000-year-long tree ring series were completed, permitting the reconstruction of summer temperatures. The late Maunder Minimum climate changes were quantified in an ensemble simulation, using a comprehensive climate model. A clear multi-year response of the North Atlantic Oscillation to volcanic eruptions was identified. Signs of human activity were detected in lake sediments from the Engadine and in Alpine ice cores. Swiss researchers contributed substantially to the EPICA project, which allowed the reconstruction of the climate of the last 800,000 years from an Antarctic ice core (EPICA 2004).

Comprehensive **climate change scenarios** were developed using global and regional climate models, as well as probabilistic techniques. A multi-year regional climate change scenario indicates that under certain assumptions regarding future GHG emission levels European summers might dramatically increase in variability, while summer 2003 conditions will become normal by the end of this century (Schär et al. 2004). **Observational techniques to observe atmospheric water vapour** were improved. MIAWARA is one of the first instruments in the world which allows the

measurement of water vapour profiles up to 80 km above ground. Integrated water vapour and integrated liquid water measurements revealed remarkable agreements with ECHAM T106 model and ERA40 reanalysis data. The analysis of the world radiation network data has isolated **a trend reversal in surface solar radiation** around 1990, and thus the end of the "global dimming" process detected in several earlier studies (Wild et al. 2004, 2005).

Significant progress was made in the field of processes of the **dynamics and predictability of interannual variability** (e.g. blocking indicators) and operational tools for seasonal forecast and forecast of extreme events using ensemble prediction techniques. Studies on the role of land-surface processes suggest an increase in summer interannual variability in response to greenhouse gas forcing.

Impact studies included experimental and modelling work. A globally unique experiment with a multi-species natural forest provides data for the *in situ* water flux from several tree species under ambient and elevated atmospheric pCO_2. Together with other data, this information documents the interannual variation in water balance, and the reaction of forest trees to the 2003 drought (Leuzinger et al. 2005). The influence of land use and other site characteristics on the response of soilwater to climate change was identified by analysing results from model simulations, and a new forest model was tested. A set of climate scenarios was used to force a crop model and to investigate the impact of climate change on maize productivity.

A techno-economic top-down (GEMINI-E3) and bottom-up (MARKAL) model for Switzerland was implemented, with first experiments in coupling of the two in order to assess **economic aspects** of Swiss climate policy. Original and efficient (oracle-based) techniques for the coupling of fully-fledged climate models with economic growth models have been developed. The social acceptability of climate policy instruments both at the Swiss and international levels has been investigated (Viguier 2004, Viguier et al. 2004).

8.1.2. Energy research

In Switzerland, as in other industrialized countries, energy research represents an important pillar of energy policy. In this country, the authorities spend some CHF 173 million per year on energy research. The objectives are to create a secure and sustainable energy supply, to maintain the high quality of Swiss research, and to strengthen Switzerland's position as a technological hub. High priority is accorded to the implementation of research results.

Regarding energy policy and socio-economic energy research, the "Energy policy fundamentals research programme" at the SFOE (www.ewg-bfe.ch) is of particular importance. Its main task is to develop the basis for new energy policy instruments.

Details of the energy research supervised by the authorities are presented in the Swiss Federal Energy Research Master Plan, which is updated every four years by the Federal Commission for Energy Research (CORE). This Master Plan is divided into subject categories and includes all stages, from research through to market introduction. The public is informed at regular intervals about the status of energy research and the deployment of public funds.

The Swiss Federal Energy Research Master Plan for 2004–2007 serves as a guide for federal decision-making bodies and for cantonal and local authorities. It documents how public funding is allocated to research activities to achieve politically defined goals (SFOE 2004).

The Master Plan also outlines energy activities included in the programme for "Promotion of Education, Research and Technology 2004–2007", presenting the background, vision, short- to mid-term goals, strategies and applications of energy research. The Master Plan seeks to preserve and strengthen the scientific and economic competitiveness of Switzerland.

Swiss energy research is committed to long-term sustainability. In this context, the main goal is a massive reduction of CO_2 emissions. This is also the goal of the "2000-watt society", a vision addressing the need to reduce pollution resulting from energy systems (see Section 4.2.3.3). However, these goals cannot be achieved through technical solutions alone: success will also depend on personal decisions, and individuals are influenced by socioeconomic factors.

The Swiss Federal Energy Research Master Plan encompasses four areas:

- **Rational Use of Energy:** This is particularly relevant in the buildings and transportation sectors, where final energy consumption is greatest. Substantial savings could be achieved through a better understanding of combustion processes and by increasing the efficiency of electricity storage and consumption. Also important are optimum cogeneration of heat and power, and the use of environmental heat (heat pumps).
- **Renewable Energy Sources:** Much of the energy produced in Switzerland originates from renewable sources, thanks to plentiful hydropower and wood. Research is helping to improve the cost-effectiveness, public acceptance and user-friendliness of systems. Examples include solar thermal systems, use of environmental heat, photovoltaics and biomass (with priority given to wood). Support is also provided for the technical development of geothermal energy, wind power and small hydro plants, as well as longer-term research in the area of solar chemistry (including hydrogen).
- **Nuclear Energy:** This topic is divided into nuclear fission and fusion (a long-term option). Safety and disposal of radioactive waste are the main research topics in the fission area. For fusion the focus is on experiments, making use of the facilities and expertise within the framework of international projects. The goal is to deliver high-quality contributions to this collaboration.
- **Energy Policies & Economics:** This research directly serves energy policy by clarifying how possible measures and scenarios might affect the overall economy. Economic, ecological and societal consequences of energy technology developments are explored in order to better anticipate social acceptance and possible outcomes. Bridging the gap between research and applications is also promoted.

Coordinating and overseeing publicly funded energy research are responsibilities of the Swiss Federal Office of Energy (SFOE), which is advised by CORE on research and putting research results into practice. Attention is given to involving the SwissEnergy programme, collaborating with privately funded research, networking with international research projects and producing reports. These activities are closely linked to related work funded by the Commission for Technology and Innovation (CTI/KTI). This constellation has proven effective and should be preserved in the future.

Important contributions to policy-relevant energy research in Switzerland stem from the Center for Energy Policy and Economics (CEPE) at the Swiss Federal Institute of Technology in Zurich (www.cepe.ethz.ch). Work package 4 of NCCR Climate (see above) is concerned with energy policy aspects as well.

8.1.3. Transport research

Swiss transport research is mainly carried out by the Federal Administration, the Federal Institutes of Technology in Zurich (ETHZ) and Lausanne (EPFL), and regionally by the cantonal universities. Outside government, private research institutions such as consulting and engineering offices also conduct extensive research. Much of this research is coordinated by the Association of Swiss Road and Traffic Engineers (VSS). The Federal Offices conduct, support, coordinate, monitor and fund strategic research. National priorities of transport research are within the fields of external costs of transport, sustainable transport and road infrastructure construction. The following research activities are mainly linked with the aims of climate change policy:

- Internalization of external costs: Based on numerous research studies, Switzerland has updated figures for external costs (and benefits) of transport. These results are currently being used for the evaluation of different road pricing schemes at the national and regional level.
- Decoupling: Strategic studies are being carried out, looking for optimal policy mixes to decouple transport from economic growth.
- Many research activities have analysed the interrelation between transport and spatial development. On the basis of these studies, strategies for steering spatial organization (also based on market instruments) have been elaborated.

- Leisure traffic: An important field of investigation is the development of ever-increasing leisure traffic and possible instruments for curbing growth rates.
- Sustainable aviation: The Federal Office for Civil Aviation has started a research programme to develop strategies for the aviation sector, focusing on instruments to ensure balanced development, taking into consideration ecological (especially climate change), economic and social aims.

8.2. Systematic observation

Many agencies in Switzerland engage in the systematic observation of elements of the climate system. The Federal Office of Meteorology and Climatology (MeteoSwiss) is the lead agency for most meteorological and atmospheric observations, with significant contributions from other agencies.

Switzerland has a comprehensive observational coverage of its territory. It also contributes to shared international programmes. It has a long instrumental temperature record, as well as the longest glacier monitoring records.

Swiss climate observation in the atmosphere and the related terrestrial systems forms part of general environmental monitoring. Federal agencies and research institutes contribute to worldwide and national monitoring efforts.

8.2.1. Meteorological and atmospheric observation

The composition of the Swiss synoptic and climatological network is shown in Table 8-3.

Type of station	Number of stations	Remarks
Automatic stations	67	5 additional stations with tower measurements
Automatic stations with reduced programme (mainly wind)	44	
Conventional climate stations	25	
Raingauge stations	345	75 additional accumulative raingauges mainly in the alpine region

Table 8-3: Swiss synoptic and climatological network

A new measurement and planning concept for all MeteoSwiss-run stations was published in 2002, with a vision for 2010 according to user requirements. In 1999, MeteoSwiss launched a project called SwissMetNet concerning the renewal of its presently operational networks. The general goals have been:

- To take into consideration the requirements of all the existing and potential users as defined within the general framework of the “Concept for a new network”.
- To cover the needs for modernization of infrastructure and processes according to operators’ requirements, while meeting the following objectives:
  - eliminate the recognized problems,
  - preserve well-known and running instruments,
  - adapt the networks to technologies of the 21st century,
  - reduce the operating costs.

The preliminary phases have been completed. The backbone (Automatic Weather Stations and Central Data Acquisition System) provider was selected in 2002 following an international WTO call for tenders (Almos Systems).

A pilot phase started in 2002 has been concluded. This involved the installation and operation of 3 pilot stations located at 2 sites representative of the Central Plateau and harsh mountain environments respectively for about one year.

Additionally, two "model" stations were installed in 2003 (lowland) and 2004 (mountain) in order to test the installation procedures together with newly developed mobile stations (Figure 8-1).

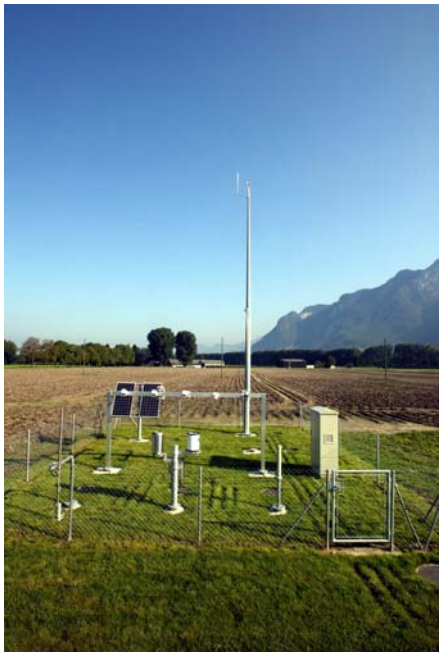

Figure 8-1: New SwissMetNet station near Aigle (MeteoSwiss)

The project has now entered the implementation phase, and construction work for the replacement of the old station network started in April 2005. It is planned to renew about 20 automatic stations in 2005. Additionally, about 30 visual observation stations will be renewed and a new network of 25 stations with automated camera images will be installed as part of the SwissMetNet project in 2005.

The weather stations and the central server are run with dedicated software (MetConsole), which allows for high-level control of the whole network: remote programming and diagnostics of the weather stations, full control of transmission availability, high-level network diagnostic capabilities, integration of quality control algorithms at the weather station level and at the central server, instantaneous transmission of alarms, etc. The modernity and impressive potential of this new network at the QA/QC level will ultimately lead to novel control procedures, and consequently to the renewal of the monitoring facilities.

In 2002 a new project was also launched to design and implement a corporate software and database architecture for the management and processing of climatological and meteorological data. Data warehouse technology was chosen, as it offers advantages for the handling of large quantities of sensor data, statistical analysis and extraction of meaningful trends.

The following elements were requested and have been successfully implemented to date.

- Central and integrated storage of data from different sources, such as automatic weather stations, human observers, synoptic observations delivered by the Global Telecommunication System and others.
- Migration of historical data, which is now available in the central database.

- Data extraction and visualization tools which can – based on this integrated database – display combinations of data from different sources.
- Most surface data passes through a process chain including at least three levels of quality control: 1) data collection and quality control (level 1) → quality control, calculation of derived quantities and ingestion (level 2) → quality control and error removal (automatic and interactive) (level 3) → homogenization (level 4).
- For all data undergoing quality control (i.e. all kinds of surface data), the same test procedures are used, based on the "Guide on the Global Data-processing System" published by the WMO in 1993 (WMO no. 305).
- All calculations and aggregations of values of a higher temporal resolution use the same functions.

The core components of Switzerland's long-term climate observation efforts are shown in Table 8-4.

Type of station	**Number of stations**	**Remarks**
GCOS surface network (GSN)	12 reference stations with long time series (since 1864)	
GCOS upper air network (GUAN)	1 sounding station in Payerne	
Atmospheric constituents (GAW)	2 ozone stations (Arosa, Payerne) 1 aerosol station (Jungfraujoch)	
Radiation (GAW, BSRN, ASRB)	4 Swiss Atmospheric Radiation Monitoring (CHARM) stations	
	1 Baseline Surface Radiation Network (BSRN) station (Payerne)	Central BSRN archive is held by the Swiss Federal Institute of Technology
	11 ASRB stations	Alpine Surface Radiation Budget (ASRB) network will be integrated into the MeteoSwiss networks

Table 8-4: Details of the GCOS, GAW and radiation monitoring networks

GAW Station Information System (GAWSIS) is an initiative by the Quality Assurance Science Activity Centre (QA/SAC) Switzerland in collaboration with the WMO Secretariat, the GAW World Data Centers and other GAW representatives to improve the management of information about the GAW network of ground-based stations. QA/SAC Switzerland is hosted by the Swiss Federal Laboratories for Materials Testing and Research (EMPA). GAWSIS was also linked to GOSIC (Global Observing Systems Information Center) during 2004 (www.gosic.org).

Switzerland's intention to support a Global GAW station at Jungfraujoch was confirmed by the WMO in February 2005. The existing regional station Jungfraujoch was therefore upgraded to a global station. This announcement by Switzerland adds the twenty-third station to the planned minimum of 30 global GAW stations worldwide.

The transition of the Alpine Surface Radiation Budget (ASRB) research project into a fully operational MeteoSwiss network is under way. To this effect, new funds were made available by the Swiss government following the ratification of the Kyoto Protocol. This commitment should guarantee the high quality and impact of this network as a long-term undertaking.

8.2.2. Terrestrial observations

Terrestrial and ecological observations cover a broad range of activities, as shown in Table 8-5. The Federal Office for Water and Geology (FOWG) is responsible for hydrological monitoring. The Swiss Federal Institute for Snow and Avalanche Research (SLF) runs a network of stations for avalanche forecasting and climatological investigations. The Swiss Glacier Monitoring Network is run by the Swiss Federal Institute of Technology, and the PERMOS network by the Swiss Academy of Sciences. Ecological observations are carried out by the Swiss Federal Institute for Forest, Snow and Landscape Research (WSL).

Type of station	Number of stations	Remarks
Hydrological observation	213 water level in rivers	
	34 water level in lakes	
	75 crest stage gauges	
	189 discharge in rivers	
	18 water quality in rivers	
	71 water temperatures in rivers	increase of more than 30 stations due to increased monitoring for global change aspects
	12 suspended sediments in rivers	
	21 isotopes in rivers, ground-water and precipitation	
	5 radioactivity in river water	
	41 groundwater level	
	50 groundwater quality	
Snow observation	104 automatic stations (IMIS)	
	108 manual stations	
Glacier and permafrost networks (GTN-G, GTN-P)	110 glacier monitoring sites 11 permafrost drill sites with several boreholes per site 8 permafrost distribution pattern areas 1 flight for aerial photographs (annually)	
Ecological observing systems for climate	16 long-term forest ecosystem research network (LWF)	
	16 pollen stations	
	161 phenological stations	

Table 8-5: Overview of the main Swiss terrestrial observation facilities

8.2.3. National GCOS structure

Until 2004, MeteoSwiss acted as the national focal point for the Global Climate Observing System (GCOS) due to its role as the national permanent WMO representative. In 2005, the national focal point was upgraded to a Swiss GCOS Office with a permanent new position for this task. This new Office is designed to enhance the coordination of the various climatological observation activities of federal agencies, universities and research institutes. For this purpose, a national GCOS round table was established, with the first meeting held in the autumn of 2004. An action plan for the coming years has been developed.

The responsibilities of the new Swiss GCOS Office included participation at the GCOS regional workshop for Central and Eastern Europe in Leipzig/Germany, with MeteoSwiss acting as a sponsor of this meeting in support of members from countries in transition.

MeteoSwiss has also actively supported and reviewed the implementation plan for the Global Observing System for Climate in support of the UNFCCC (GCOS-92). Additionally, since the first Earth Observation Summit in Washington D.C., Switzerland has taken part in all the activities of the Group on Earth Observations (GEO) and financially supported the implementation of the Global Earth Observation System of Systems (GEOSS) secretariat at the WMO in Geneva.

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Relevant websites

http://www.meteoswiss.ch (Federal Office of Meteorology and Climatology)

http://www.proclim.ch (Forum for Climate and Global Change)

http://www.gosic.org (Global Observing Systems Information Center)

9. Education, training and public awareness

Generally speaking, there is a high level of public awareness of the issue of climate change in Switzerland. This may be partly due to the fact that Switzerland has traditionally played an active and sometimes even a pioneering role in developing measures to protect the environment. In addition, natural hazards are a familiar phenomenon and in many parts of the country people have been affected at one time or another by extreme events such as flooding or major landslides. Furthermore, the Swiss political system with its many elements of direct democratic participation promotes widespread debate on matters of general interest, with referendums being held several times a year.

The media take a great interest in the climate change issue, maintaining public awareness of its potential implications. Aside from the almost daily news reports on extreme events, research findings or political debate at the national or international level, some of the most widely read publications in Switzerland periodically devote extensive coverage to new findings on climate change, its consequences for Switzerland, and options for action on the part of individuals and businesses.

Information and awareness do not automatically imply a change in behaviour. There are many competing issues on the public and private agenda that influence people's decisions as consumers, citizens, employers or employees. In Switzerland, in recent years, concerns about job security, rapidly rising healthcare costs and financing of the old-age pension scheme have gained in importance (see Section 2.2). Thus, it does not come as a surprise that some important votes on climate policy issues were affected by shorter-term priorities highlighted in pre-referendum debates. Nevertheless, by providing well-targeted information activities and opportunities for personal involvement, several government agencies, scientific and educational institutions, and a wide range of NGOs continually contribute to public understanding of the climate issue and the need to take action.

The following sections focus on some of the more important activities linked to climate protection and GHG emissions, disregarding to a large extent those that are more generally concerned with sustainability and the protection of the environment (e.g. Agenda 21 activities, training centres for environmental professionals in businesses and the administration).

Federal government activities often involve the participation of cantons or local authorities. Even though the contribution of the latter is of great importance to the successful implementation of policy programmes, they are not reported on in detail.

9.1. Climate-related activities by federal, state and local authorities

On the occasion of the annual Conference of the Parties to the UNFCCC, SAEFL produces documentation for the media, taking stock of the most important issues and developments relating to climate policy at the national and international level. At the same time, updates are produced regarding emissions trends and the state of knowledge in climate science.

Important reports by the IPCC are presented to the public in collaboration with specialized institutions such as ProClim- and the OcCC and Swiss scientists involved in the IPCC process (see

further below). By supporting the translation of IPCC summaries into German, Switzerland contributes to the wider dissemination of IPCC results.

9.1.1. Federal level

- **SAEFL Climate website**
  The SAEFL Climate website (mostly in German and French) is continually developed in order to offer up-to-date information on climate change-related topics of public interest. English content is accessible at: www.environment-switzerland.ch/climate. The site complements the personal information services offered by SAEFL staff to individuals and NGO representatives interested in the topic of climate change and its effects on Switzerland. In addition, the web platform www.climatereporting.ch contains official submissions and documents in English relating to the implementation of reporting commitments under the UNFCCC and the Kyoto Protocol.
- **SAEFL quarterly "Environment" magazine**
  This publication regularly features articles on climate change and climate policy issues. It is distributed to over 30,000 subscribers with a personal or professional interest in environmental affairs. The magazine (published in German, French, Italian and occasionally English) is also available online at www.environment-switzerland.ch > Media > Environment magazine; then select language.
- **MeteoSwiss website**
  The Climate Change Information Centre of the Federal Office of Meteorology and Climatology (MeteoSwiss) provides information on meteorological and climatological topics and, upon request, prepares reviews and background reports on the functioning of the climate system. Several analytical documents are available on climate trends in Switzerland as well as on extreme weather events (mostly in German at www.meteoschweiz.ch). The site also provides forecasts concerning hazards such as heat waves, storms etc.
- **FOWG website**
  A large selection of information (mostly in German) on Swiss hydrology and water resources management, as well as management of natural hazards, is available at: http://www.bwg.admin.ch/e/index.htm. The Federal Office for Water and Geology (FOWG) hosts the National Platform for Natural Hazards (PLANAT), an expert group created by the Federal Council which is responsible for coordinating activities in the field of prevention against natural hazards (http://www.planat.ch).
- **- "Climate in human hands"** (SAEFL 2002, in German, French, Italian and English),
  - "Climate change" (special issue no. 2/2003 of SAEFL quarterly "Environment", in German, French and Italian).
  The two brochures contain general information on climate change, its global and national consequences, and political responses. Due to high demand, both publications had to be reprinted within one to two years.
- **SFOE "energeia" magazine**
  This publication addresses a broad audience of stakeholders from politics, economics, administration and academia. Its goal is to inform about the pivotal role that science, technology and innovation play in the field of energy. "energeia" is published six times a year (www.energie-schweiz.ch/internet/00238/index.html?lang=de).
- **ECO_2 calculator**
  A web-based tool developed with the support of several federal and cantonal bodies to assist individuals in assessing their energy consumption and CO_2 emissions is available at: www.ecospeed.ch/ie/d/privat.html (in German and French). This offers various features for comparison of individual values with reference values and for assessing the effect of specific behaviour changes on emissions.
- **Publications on extreme events and climate hazards**
  A growing number of reports by federal agencies (SAEFL, FOWG/PLANAT, SFOPH) and other institutions have been concerned with the assessment of recent extreme climatic events

such as the Hurricane Lothar (1999), the 1999 and 2000 floods, and the 2003 heat wave. These reports help the public authorities and specialized institutions to evaluate and adapt their ways of dealing with disasters and inform politicians and the general public about impacts, disaster management and related costs. For a bibliography of Swiss publications on natural hazards, extreme events and disaster prevention, see www.planat.ch/shop.php.

- **Information campaign "bien-construire.ch"**
  A special campaign by the SFOE and SwissEnergy promoting energy efficiency in the building sector (renovation, maintenance, construction). In German (www.bau-schlau.ch), French (www.bien-construire.ch) and Italian (www.costruire-bene.ch).
- **Information campaign "Stay cool on hot days"**
  In the early summer of 2005, based on an in-depth analysis of the detrimental health effects of the 2003 heat wave, the SFOPH and SAEFL launched an information campaign to raise awareness about the dangerous effects heat can have. Material containing recommendations for those with a personal or professional responsibility for caring for people most at risk, in particular the elderly, was widely distributed through the appropriate channels and made available online (www.canicule.ch; www.hitzewelle.ch). It is planned to regularly bring the issue to the attention of the target audiences in the future.

Education and training

The SAEFL, the SFOE and MeteoSwiss make their expertise available by preparing educational materials for various institutions and a wide range of target audiences. The SDC supports the Foundation Education and Development, which focuses, amongst other topics, on education for sustainability (see www.globaleducation.ch). For details of activities in the energy sector, see Section 9.2 below.

Special events

- **"Climate Policy: the Responsibility of Political Circles and of Business"**
  In March 2005, SAEFL and the World Economic Forum (WEF) jointly organized a conference to promote dialogue on climate change and the role of business. The conference included presentations on examples of best entrepreneural practice as well as an exchange of views on climate policy in the short and longer term. A publication summarizing the highlights of this event is available at SAEFL.
- **Parliamentary group on "Climate Change"**
  Since 1996, this group has met three to four times a year. Its aims are to encourage the flow of information about the impacts of climate change and response measures, and to stimulate political debate on the issue. The meetings give background information and examples of business opportunities created by forward-looking strategies, presented both by leading scientific experts and by decision makers from the private sector. In the second part, the politicans have the opportunity for questions and discussions. SAEFL and a reinsurance company act as sponsors of these events.

9.1.2. State (canton) level

The cantons of Berne and Graubünden have played a pioneering role in addressing the impacts of natural hazards and extreme events in the context of climate change. The following brochures and leaflets document precautionary action taken and challenges for the future:

- "Faits et scénarios relatifs au changement climatique et aux dangers naturels dans le canton de Berne"/"Fakten und Szenarien zu Klimawandel und Naturgefahren im Kanton Bern" (2002)
- "Klimaänderung in Graubünden" (2002)
- "Naturgefahren bedrohen den Menschen seit Jahrtausenden" (2003)

9.1.3. Local level

- **The Climate Alliance** (www.klimabuendnis.ch)
  21 cities representing around 15% of the Swiss population have made a public commitment to work towards lower GHG emissions. Local activities include public awareness raising, energy conservation, promotion of renewables and energy efficiency programmes, promotion of public and non-motorized transport, monitoring of emissions, etc. In order to reliably assess emission trends, several climate alliance members have supported the development of an emissions calculator for cities and regions. In 2004, the city of Winterthur received the "Climate Star" award from the international Climate Alliance.
- **"Aktion Klimafrühling"** (www.klimafruehling.ch)
  In 2004, the city of Zurich invited its inhabitants to assess their personal CO_2 emissions with the aid of the ECO_2 calculator (see Section 9.1.1) and formally commit themselves to reducing their emissions. The response to the project was very disappointing. A thorough evaluation of the project produced valuable lessons regarding ways to get the public involved in emission-reducing activities.

9.2. Selected government-supported activities in the energy sector

Note: The following paragraphs summarize information and awareness-raising activities within the SwissEnergy programme in the years 2002/2003 (excerpt from the SwissEnergy annual report 2003/2004).

Marketing and communication

Presentations at trade fairs and exhibitions, press releases and reports, publication of newsletters, energy infoline, booklets, guides, etc. were the main communication activities at the Programme level in 2002–2003. The thematic priority was the campaign to promote the compulsory energy label for new motor cars that was introduced on 1 January 2003. This label, which is based on a similar concept to that for household appliances, provides information about the fuel consumption and CO_2 emissions of the car model concerned. Around 46% of the population were already aware of this label as of June 2003. In view of its success (the TV advert was awarded the "Golden OttoCar" prize) and the strong support from partners of SwissEnergy, it was decided to extend the campaign until June 2004.

At the same time, preparatory work was initiated concerning the two year buildings campaign "bien-construire.ch" (2004/2005). The aim here is to exploit the high potentials for efficiency gains and the use of renewable forms of energy in buildings. The campaign focuses on decision makers at various levels (cantons, house-owners, architects, the building industry, etc.). The main components are presentations at trade fairs, an Internet portal (winner of the 2004 award for the best Swiss web site) and a comprehensive advertising campaign. The concept calls for close collaboration with a variety of partners, which draw attention to specific topics (e.g. renovation in accordance with the "MINERGIE" standard), and thus directly benefit from their participation in the campaign.

For activities regarding the "Energy City" project in the context of the SwissEnergy programme, see Section 4.3.3.2.

Education and training

Through its network of players active in the fields of renewable energy and energy efficiency the SwissEnergy programme offers various training and further education activities. A special programme is directed to construction specialists and instructors at all levels. The programme encompasses around 15 to 20 courses, and focuses on supporting new courses and teaching aids. A CD-ROM on the topic of energy in vocational education was completed in the middle of 2003. 36

courses were held within the scope of the PENTA PROJECT, a further education programme produced by industry associations and trade organisations on the topic of renewable forms of energy. SwissEnergy's internal funding for training and further education amounted to CHF 0.8 million in 2003. This was supplemented by CHF 0.5 million from the cantons and CHF 0.7 million from third parties (including trade and industry, educational institutions, industry associations and networks).

9.3. Further activities with government support

Information

- **ProClim-: Swiss Academy of Sciences' Forum for Climate and Global Change**
  Progress in science normally circulates well within the corresponding disciplines. What is needed, however, are broad discussions not only across scientific disciplines but also on specific topics with policy makers outside the scientific community. To provide professional support and co-ordination to groups who crucially need to understand each other's views, the Swiss Academy of Sciences established ProClim- in 1988. To be able to reach out to hundreds of scientists, ProClim- runs a web-based information system (www.proclim.ch). The website provides not only information on experts (including details of publications, research programmes and projects) and a calendar of events, but also a wide range of background information and publications on topical climate issues. ProClim- products include:
  - Global Change Abstracts: Overview of recent Swiss research on climate and global change (3 issues per year)
  - ProClim-Flash: Newsletter containing, news, meeting reports, calendar of upcoming events and other information (3 issues per year)
  - Climate Press: Background information on climate change issues, prepared for the media
  - IPCC assessment reports: German translations of the summaries for policymakers
  - Two databases on climate change and its impacts (www.climate-change.ch and www. proclim.ch/Facts.html), which are also of great value for educational purposes.

  With a broad network of experts, ProClim- also serves as the voice of the Swiss global change research community, organizes workshops and public forums, and encourages the participation of scientists in the political decision-making process. ProClim- serves as the secretariat of the parliamentary group on "Climate Change" (see above) and of the OcCC (see below).
- **OcCC – Swiss Advisory Body on Climate Change**
  The Swiss Advisory Body on Climate Change (OcCC) was installed by the Federal Department of Home Affairs and formed under the auspices of the Swiss Academy of Sciences in 1996. It is funded by SAEFL. It operates independently of the federal administration and thus guarantees a non-governmental view. The OcCC issues assessment reports and position papers on specific climate change topics. The latest report "Extreme Events and Climate Change" provides a summary of current knowledge of the influence of climate change on the magnitude and frequency of extreme events in Switzerland (www.occc.ch/reports_e.html).

  The latest OcCC project is concerned with the impacts of climate change in Switzerland in 2050. A probabilistic climate scenario will be used to assess the effects of climatic conditions on various vulnerable sectors, e.g. ecology, agriculture, human health, and energy. Initial results are expected in 2006.

Special Events

- **Swiss Global Change Day**: The annual Swiss Global Change Day provides an opportunity for the whole global change community to meet and discuss ongoing problems in a transdisciplinary manner. The aim is to present recent highlights in global environmental change research, as well as to identify challenges for future research. The event also provides

an opportunity for people from governmental institutions and business and political circles to ask questions and explain their needs and views on the topics presented.

- **Workshop on Impacts of climate change on hydro-energy production systems**: In 2004, ProClim-, together with the Association of Swiss Electricity Companies, the NCCR Climate and SAEFL, organized a dialogue on "Hydropower and Climate Change". More than 70 experts from industry, research, governmental institutions and political circles formulated visions for the future. It was shown that climate change could lead to major changes in alpine runoff regimes over the coming decades. The discussion showed a conflict of interest between the benefits of hydropower in reducing CO_2 emissions in energy production and the disadvantage of ecological impacts. The participating experts unanimously emphasized that the continuation of such discussions is important and necessary.

Education and training

A variety of material closely linked to the climate issue was recently prepared by the research programme NCCR Climate:

- Educational package "Klimaforschung und 4 fürs Klima" (in German).
- Teaching material on climate and anthropogenically-induced climatic change and its impacts on extreme events and hazards related directly or indirectly to hydrological systems (including an English learning unit at www.nccr-climate.unibe.ch).

At www.nunu.ch, the Nationwide University Network for Undergraduates, a database in German and French offers information on climate change-related education and training opportunities in Switzerland. The website was established by the NCCR Climate.

9.4. Private sector initiatives

Information

- **Alliance for a responsible climate policy**
  48 Swiss organizations from civil society, including environmental, religious, consumer, union and development aid NGOs, have joined forces in support of a credible and effective climate policy. These organizations' members and supporters number 1.8 million people, or 25% of the Swiss population. The Alliance provides information for the media and policy makers.
- **WWF Switzerland**
  WWF has a long track record on energy and climate issues. In 2003, an information campaign was launched together with 14 local radio stations. "Climate day" was also used to collect a total of 40,000 signatures for a petition calling on the Federal Council to introduce a CO_2 tax by 1 July 2004 and to come up with a long-term climate master plan.

  WWF has also produced teaching materials and successfully addressed 20,000 teachers on the introduction of climate change elements into the classroom. The WWF education centre also offers adult courses and excursions focusing on climate change.

  Young people are addressed through the campaign www.zeroemission.ch, which also includes a carbon-neutral open-air festival: to offset the extra emissions generated by the festival, participants commit themselves to making changes in their lifestyle to reduce their personal CO_2 emissions. Individuals, youth groups and also schools are addressed with separate tools.

  As part of the international WWF campaign "PowerSwitch!", various efforts are under way to increase public awareness and education on climate change. These include a guide to energy-efficient appliances, the promotion of www.topten.ch, a petition urging industry to reduce standby losses, and street events.

  The quarterly WWF magazine distributed to over 200,000 households usually includes at least one article on climate change. The website (www.wwf.ch) also provides useful facts and figures on climate change.

- **Greenpeace Switzerland**
  In addition to general educational activities, Greenpeace has focused in particular on the issue of quality with regard to certified emission reductions and CDM projects. It commissioned CDM Watch to carry out a study entitled "*The Clean Development Mechanism (CDM) as an option for Swiss climate policy*". The study concluded that quality criteria are required for carbon credits, and this position was advocated to the authorities and in the consultation procedure.

  Greenpeace is also committed to practical solutions, e.g. by promoting solar power in Switzerland. Examples of contributions to specific projects include the new soccer stadium in Berne (www.solarstadion.ch) and the Youth Solar Project (www.jugendsolarprojekt.ch), in which more than 5000 young people to date have participated in the construction of more than 100 solar power facilities.

  Awareness-raising campaigns run by the organization have highlighted the impacts of transport on the climate and health, and the already visible and perceptible consequences of climate change in Switzerland (www.greenpeace.ch/klima).

- **Swiss Transport and Environment Association**
  The Swiss Transport and Environment Association (VCS) has sought to promote human-oriented and environmentally sound mobility since 1979. As Switzerland's second-largest transport association, it lobbies for a sustainable transport policy.

  Each year, as part of its commitment to climate policy, the association publishes the VCS environmental guide for car buyers (German: www.autoumweltliste.ch; French: www.ecomobiliste.ch), which rates various models by CO_2, pollutant and noise emissions. As well as an environmental assessment of over 500 models and best-buy lists, the publication provides a wide range of advice and information for prospective buyers. A supplementary CD-ROM offers environmental assessments of a total of 1000 types of car and more than 100 types of van.

- **Swiss Association for Environmentally Conscious Management**
  The Swiss Association for Environmentally Conscious Management (ÖBU) encompasses some 300 Swiss companies of all sizes and from all economic sectors. One of its top priorities is climate change. By anticipating future developments concerning natural resources, needs of society and changes in the legal framework, ÖBU strengthens the competitiveness of its members in the long run. At two conferences in October 2001 and September 2003, Swiss companies learned about the potential business opportunities arising from the pressures and restrictions associated with climate change. In 2004, the ÖBU carried out a web-based survey on the four options proposed by the Swiss Federal Council for compliance with the CO_2 reduction target. More than 80% of the 137 companies that responded voted for the CO_2 tax, indicating a very strong commitment to long-term solutions.

Education

Amongst other informative or educational materials, WWF Switzerland has elaborated a comprehensive teachers' aid on climate and climate change (in German, French and Italian).

Greenpeace Switzerland regularly offers camps and projects with school classes, e.g. for the installation of solar power devices.

Special events

- **"Achtung Klimawandel!" exhibition**
  An exhibition on the causes and impacts of climate change in Switzerland and ways to deal with this challenge was developed in collaboration with the University of Berne and supported by numerous governmental and non-governmental institutions. Following its very successful presentation at a museum in Berne in 2003, the exhibition was displayed at several other locations in Switzerland.

9.5. Public participation

In June 2005, 22 stakeholder organizations – NGOs, semi-private and private organizations and associations from business, scientific and environmental circles – were invited to comment on a draft version of the present report. Nine organizations provided feedback in their own name, while 7 organizations coordinated their position within an NGO representing 48 Swiss environmental, religious, consumer, union and development aid organizations from civil society (see Annex 3).

Many valuable comments were received concerning the structure and content of the report, and additional text elements were provided highlighting the activities of individual organizations of relevance to climate policy. The stakeholder review contributed significantly to the completeness and accuracy of the report and the balanced presentation of information.

Annex 1: Swiss greenhouse gas inventory 2003 – summary and trend tables

Excerpt from the Swiss 2005 GHG inventory submission to the UNFCCC secretariat. For the full inventory, see www.climatereporting.ch > Annual GHG Inventories.

TABLE 10 EMISSION TRENDS (CO_2) (Sheet 1 of 5) Switzerland 2003 /Submission 2005

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year[1]	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
	(Gg)														
1. Energy	**40'267.29**	**40'267.29**	**42'351.37**	**42'449.12**	**40'186.57**	**39'326.76**	**40'229.13**	**40'976.25**	**40'389.56**	**41'593.99**	**41'673.89**	**40'561.17**	**41'371.15**	**40'596.39**	**41'721.17**
A. Fuel Combustion (Sectoral Approach)	40'192.58	40'192.58	42'282.63	42'382.23	40'114.40	39'245.39	40'145.91	40'884.32	40'300.52	41'502.79	41'581.02	40'472.47	41'278.31	40'504.65	41'641.12
1. Energy Industries	1'406.30	1'406.30	1'755.03	1'848.85	1'539.20	1'557.58	1'614.60	1'793.22	1'743.17	1'971.87	1'765.76	1'599.26	1'704.99	1'720.42	1'710.43
2. Manufacturing Industries and Construction	6'133.15	6'133.15	6'053.78	5'839.85	5'658.47	5'734.12	5'832.00	5'620.27	5'578.84	5'821.44	5'856.52	5'848.77	5'984.62	5'887.56	5'887.70
3. Transport	14'187.39	14'187.39	14'689.92	14'985.56	13'934.74	14'125.52	13'812.97	13'864.09	14'449.94	14'677.15	15'290.48	15'587.19	15'298.18	15'214.83	15'409.36
4. Other Sectors	17'756.85	17'756.85	19'079.02	19'007.09	18'285.10	17'135.29	18'197.47	18'926.01	17'855.99	18'367.87	18'011.94	16'789.08	17'640.03	17'029.04	17'978.51
5. Other	708.89	708.89	704.89	700.89	696.88	692.88	688.88	680.73	672.59	664.45	656.31	648.16	650.49	652.81	655.13
B. Fugitive Emissions from Fuels	74.71	74.71	68.74	66.89	72.17	81.36	83.23	91.94	89.04	91.19	92.87	88.70	92.84	91.74	80.05
1. Solid Fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2. Oil and Natural Gas	74.71	74.71	68.74	66.89	72.17	81.36	83.23	91.94	89.04	91.19	92.87	88.70	92.84	91.74	80.05
2. Industrial Processes	**2'841.13**	**2'841.13**	**2'498.20**	**2'341.33**	**2'076.08**	**2'234.14**	**2'101.18**	**1'917.46**	**1'738.65**	**1'748.10**	**1'749.91**	**1'869.14**	**1'903.37**	**1'844.91**	**1'814.82**
A. Mineral Products	2'567.62	2'567.62	2'240.91	2'101.45	1'909.54	2'100.18	1'980.74	1'786.63	1'606.66	1'607.40	1'605.81	1'722.28	1'754.29	1'688.59	1'652.58
B. Chemical Industry	13.28	13.28	13.28	13.28	13.28	13.28	13.28	13.28	13.28	13.00	13.00	13.00	13.00	13.00	13.00
C. Metal Production	259.23	259.23	243.01	225.60	152.26	119.67	106.16	116.55	117.71	126.71	130.10	132.86	135.08	142.32	148.24
D. Other Production	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
E. Production of Halocarbons and SF_6															
F. Consumption of Halocarbons and SF_6															
G. Other	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3. Solvent and Other Product Use	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
4. Agriculture	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
A. Enteric Fermentation	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
B. Manure Management	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
C. Rice Cultivation	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Agricultural Soils [2]	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE
E. Prescribed Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
F. Field Burning of Agricultural Residues	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
G. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
5. Land-Use Change and Forestry [3]	**-1'273.29**	**-1'273.29**	**-1'339.29**	**-1'423.62**	**-2'387.95**	**-2'391.62**	**-2'354.95**	**-2'507.12**	**-2'673.95**	**-2'602.45**	**-2'255.95**	**149.38**	**450.05**	**305.21**	**-1'766.45**
A. Changes in Forest and Other Woody Biomass Stocks	-1'886.50	-1'886.50	-1'952.50	-2'036.83	-3'001.17	-3'004.83	-2'968.17	-3'120.33	-3'287.17	-3'215.67	-2'869.17	-463.83	-163.17	-308.00	-2'379.67
B. Forest and Grassland Conversion	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
C. Abandonment of Managed Lands	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE
D. CO_2 Emissions and Removals from Soil	613.21	613.21	613.21	613.21	613.21	613.21	613.21	613.21	613.21	613.21	613.21	613.21	613.21	613.21	613.21
E. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
6. Waste	**1'263.70**	**1'263.70**	**1'172.65**	**1'152.28**	**1'109.17**	**1'075.52**	**1'038.42**	**1'027.98**	**1'022.51**	**1'096.16**	**1'131.51**	**1'225.91**	**1'183.19**	**1'208.25**	**1'187.76**
A. Solid Waste Disposal on Land	154.88	154.88	122.39	117.84	106.33	87.55	75.06	59.30	53.06	46.59	39.91	22.50	10.50	3.00	1.50
B. Waste-water Handling	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
C. Waste Incineration	1'108.82	1'108.82	1'050.27	1'034.44	1'002.84	987.97	963.36	968.67	969.45	1'049.56	1'091.60	1'203.41	1'172.69	1'205.25	1'186.26
D. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
7. Other (*please specify*)	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Total Emissions/Removals with LUCF [4]	**43'098.83**	**43'098.83**	**44'682.94**	**44'519.11**	**40'983.87**	**40'244.80**	**41'013.78**	**41'414.57**	**40'476.76**	**41'835.79**	**42'299.35**	**43'805.61**	**44'907.76**	**43'954.76**	**42'957.29**
Total Emissions without LUCF[4]	**44'372.12**	**44'372.12**	**46'022.22**	**45'942.73**	**43'371.82**	**42'636.42**	**43'368.73**	**43'921.69**	**43'150.72**	**44'438.25**	**44'555.30**	**43'656.23**	**44'457.72**	**43'649.55**	**44'723.74**
Memo Items:															
International Bunkers	**3'225.83**	**3'225.83**	**3'143.30**	**3'355.78**	**3'485.47**	**3'583.69**	**3'808.17**	**3'959.99**	**4'099.82**	**4'285.09**	**4'588.77**	**4'766.14**	**4'488.57**	**4'096.45**	**3'671.66**
Aviation	3'225.83	3'225.83	3'143.30	3'355.78	3'485.47	3'583.69	3'808.17	3'959.99	4'099.82	4'285.09	4'588.77	4'766.14	4'488.57	4'096.45	3'671.66
Marine	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Multilateral Operations	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
CO_2 Emissions from Biomass	**2'247.28**	**2'247.28**	**2'459.41**	**2'472.24**	**2'523.54**	**2'453.93**	**2'695.80**	**2'932.01**	**2'770.27**	**2'796.37**	**2'826.60**	**2'825.62**	**3'012.29**	**3'058.13**	**3'058.13**

TABLE 10 EMISSION TRENDS (CH_4) (Sheet 2 of 5) Switzerland 2003 / Submission 2005

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year[1]	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
	(Gg)														
Total Emissions	**211.94**	**211.94**	**211.28**	**204.99**	**202.09**	**192.39**	**192.73**	**189.25**	**186.12**	**183.22**	**182.66**	**178.19**	**179.07**	**175.39**	**174.70**
1. Energy	**22.55**	**22.55**	**22.37**	**21.54**	**20.54**	**19.49**	**18.81**	**18.75**	**18.24**	**18.04**	**17.83**	**17.42**	**17.30**	**16.99**	**16.91**
A. Fuel Combustion (Sectoral Approach)	7.91	7.91	7.91	7.40	6.78	6.22	6.05	6.06	5.67	5.56	5.45	5.17	5.13	4.92	4.96
1. Energy Industries	0.05	0.05	0.07	0.07	0.06	0.06	0.07	0.08	0.07	0.08	0.07	0.06	0.07	0.07	0.07
2. Manufacturing Industries and Construction	0.33	0.33	0.34	0.34	0.35	0.35	0.38	0.39	0.37	0.38	0.38	0.39	0.40	0.42	0.43
3. Transport	4.53	4.53	4.22	3.85	3.23	2.85	2.50	2.32	2.20	2.03	1.94	1.77	1.59	1.44	1.33
4. Other Sectors	2.67	2.67	2.95	2.80	2.80	2.61	2.76	2.93	2.67	2.72	2.69	2.57	2.70	2.63	2.78
5. Other	0.33	0.33	0.34	0.34	0.34	0.35	0.35	0.36	0.36	0.36	0.37	0.37	0.37	0.38	0.35
B. Fugitive Emissions from Fuels	14.64	14.64	14.46	14.14	13.76	13.27	12.76	12.69	12.57	12.48	12.38	12.26	12.17	12.07	11.95
1. Solid Fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2. Oil and Natural Gas	14.64	14.64	14.46	14.14	13.76	13.27	12.76	12.69	12.57	12.48	12.38	12.26	12.17	12.07	11.95
2. Industrial Processes	**0.43**	**0.43**	**0.43**	**0.42**	**0.41**	**0.41**	**0.40**	**0.41**	**0.41**	**0.42**	**0.43**	**0.43**	**0.44**	**0.45**	**0.45**
A. Mineral Products	0.03	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
B. Chemical Industry	0.39	0.39	0.39	0.38	0.38	0.37	0.37	0.37	0.38	0.39	0.39	0.40	0.41	0.41	0.41
C. Metal Production	0.0001	0.0001	0.0001	0.0001	0.0001	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Other Production	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
E. Production of Halocarbons and SF_6															
F. Consumption of Halocarbons and SF_6															
G. Other	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
3. Solvent and Other Product Use	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
4. Agriculture	**153.57**	**153.57**	**154.06**	**149.64**	**150.60**	**145.16**	**146.65**	**144.20**	**141.93**	**140.89**	**141.59**	**139.32**	**141.66**	**139.20**	**137.99**
A. Enteric Fermentation	131.75	131.75	132.27	128.35	129.29	124.71	125.97	124.40	122.38	121.18	121.93	119.77	121.86	119.66	118.67
B. Manure Management	21.54	21.54	21.51	21.02	21.04	20.18	20.41	19.52	19.27	19.43	19.37	19.28	19.52	19.26	19.04
C. Rice Cultivation	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Agricultural Soils	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
E. Prescribed Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
F. Field Burning of Agricultural Residues	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28
G. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
5. Land-Use Change and Forestry	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
A. Changes in Forest and Other Woody Biomass Stocks	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
B. Forest and Grassland Conversion	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
C. Abandonment of Managed Lands	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. CO_2 Emissions and Removals from Soil	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
E. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
6. Waste	**35.39**	**35.39**	**34.42**	**33.39**	**30.54**	**27.33**	**26.87**	**25.89**	**25.54**	**23.87**	**22.82**	**21.01**	**19.67**	**18.75**	**19.36**
A. Solid Waste Disposal on Land	33.69	33.69	32.71	31.68	28.81	25.62	25.15	24.17	23.84	22.21	21.18	19.40	18.05	17.11	17.71
B. Waste-water Handling	1.35	1.35	1.38	1.40	1.43	1.45	1.48	1.51	1.52	1.53	1.53	1.54	1.55	1.57	1.58
C. Waste Incineration	0.36	0.36	0.34	0.31	0.29	0.27	0.24	0.21	0.17	0.14	0.11	0.08	0.07	0.07	0.07
D. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
7. Other *(please specify)*	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Memo Items:															
International Bunkers	**0.39**	**0.39**	**0.34**	**0.35**	**0.41**	**0.41**	**0.32**	**0.33**	**0.27**	**0.28**	**0.30**	**0.28**	**0.27**	**0.23**	**0.23**
Aviation	0.39	0.39	0.34	0.35	0.41	0.41	0.32	0.33	0.27	0.28	0.30	0.28	0.27	0.23	0.23
Marine	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Multilateral Operations	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
CO_2 Emissions from Biomass															

TABLE 10 EMISSION TRENDS (N_2O) (Sheet 3 of 5) Switzerland 2003 / Submission 2005

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year[1]	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
	(Gg)														
Total Emissions	**10.79**	**10.79**	**10.87**	**10.87**	**10.77**	**10.69**	**10.48**	**10.65**	**10.32**	**10.30**	**10.24**	**10.28**	**10.18**	**10.15**	**9.93**
1. Energy	**0.73**	**0.73**	**0.82**	**0.89**	**0.89**	**0.93**	**0.96**	**1.00**	**1.02**	**1.02**	**1.04**	**1.02**	**1.00**	**0.96**	**0.94**
A. Fuel Combustion (Sectoral Approach)	0.73	0.73	0.82	0.89	0.89	0.93	0.96	1.00	1.02	1.02	1.04	1.02	1.00	0.96	0.94
1. Energy Industries	0.055	0.055	0.062	0.068	0.068	0.072	0.081	0.085	0.091	0.096	0.102	0.108	0.120	0.129	0.134
2. Manufacturing Industries and Construction	0.17	0.17	0.16	0.14	0.14	0.14	0.14	0.13	0.12	0.12	0.12	0.13	0.13	0.13	0.13
3. Transport	0.32	0.32	0.40	0.47	0.49	0.53	0.55	0.59	0.61	0.61	0.62	0.60	0.56	0.52	0.49
4. Other Sectors	0.17	0.17	0.18	0.18	0.17	0.16	0.17	0.18	0.17	0.17	0.17	0.16	0.17	0.16	0.17
5. Other	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
B. Fugitive Emissions from Fuels	0.00006	0.00006	0.00006	0.00006	0.00006	0.00006	0.00006	0.00006	0.00006	0.00006	0.00006	0.00007	0.00007	0.00007	0.00008
1. Solid Fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2. Oil and Natural Gas	0.00006	0.00006	0.00006	0.00006	0.00006	0.00006	0.00006	0.00006	0.00006	0.00006	0.00006	0.00007	0.00007	0.00007	0.00008
2. Industrial Processes	**0.32**	**0.32**	**0.32**	**0.32**	**0.32**	**0.31**	**0.31**	**0.31**	**0.31**	**0.31**	**0.31**	**0.31**	**0.31**	**0.31**	**0.31**
A. Mineral Products	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
B. Chemical Industry	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31
C. Metal Production	0.006	0.006	0.006	0.006	0.004	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Other Production	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
E. Production of Halocarbons and SF_6															
F. Consumption of Halocarbons and SF_6															
G. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**0.35**	**0.35**	**0.35**	**0.36**	**0.37**	**0.38**	**0.38**	**0.38**	**0.39**	**0.39**	**0.39**	**0.39**	**0.39**	**0.40**	**0.40**
4. Agriculture	**9.22**	**9.22**	**9.21**	**9.13**	**9.01**	**8.88**	**8.62**	**8.75**	**8.40**	**8.36**	**8.27**	**8.30**	**8.21**	**8.20**	**7.98**
A. Enteric Fermentation	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
B. Manure Management	1.45	1.45	1.44	1.42	1.42	1.39	1.37	1.38	1.35	1.34	1.31	1.32	1.29	1.29	1.28
C. Rice Cultivation	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Agricultural Soils	7.77	7.77	7.77	7.71	7.60	7.48	7.25	7.37	7.05	7.02	6.95	6.98	6.92	6.90	6.70
E. Prescribed Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
F. Field Burning of Agricultural Residues	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
G. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
5. Land-Use Change and Forestry	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
A. Changes in Forest and Other Woody Biomass Stocks	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
B. Forest and Grassland Conversion	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
C. Abandonment of Managed Lands	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. CO_2 Emissions and Removals from Soil	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
E. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
6. Waste	**0.17**	**0.17**	**0.18**	**0.18**	**0.19**	**0.19**	**0.20**	**0.20**	**0.21**	**0.22**	**0.23**	**0.26**	**0.26**	**0.29**	**0.30**
A. Solid Waste Disposal on Land	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
B. Waste-water Handling	0.06	0.06	0.06	0.06	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
C. Waste Incineration	0.11	0.11	0.11	0.12	0.12	0.13	0.13	0.13	0.14	0.15	0.16	0.19	0.19	0.21	0.22
D. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
7. Other *(please specify)*	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Memo Items:															
International Bunkers	**0.10**	**0.10**	**0.10**	**0.11**	**0.11**	**0.11**	**0.12**	**0.13**	**0.13**	**0.14**	**0.15**	**0.15**	**0.14**	**0.13**	**0.12**
Aviation	0.10	0.10	0.10	0.11	0.11	0.11	0.12	0.13	0.13	0.14	0.15	0.15	0.14	0.13	0.12
Marine	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Multilateral Operations	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	NO	NO
CO_2 Emissions from Biomass															

TABLE 10 EMISSION TRENDS (HFCs, PCF, SF_6) (Sheet 4 of 5) Switzerland 2003 / Submission 2005

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year[1]	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
	(Gg)														
Emissions of HFCs[5] - CO_2 equivalent (Gg)	**0.02**	**0.02**	**0.36**	**7.19**	**14.31**	**33.70**	**151.13**	**185.45**	**230.79**	**300.86**	**349.31**	**405.56**	**471.33**	**483.10**	**529.26**
HFC-23	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0001	0.0002	0.0002	0.0002
HFC-32	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0003	0.0007	0.0015	0.0024	0.0033	0.0044	0.0050	0.0059
HFC-41	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
HFC-43-10mee	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0001	0.0000	0.0000	0.0000
HFC-125	0.0000	0.0000	0.0000	0.0001	0.0005	0.0015	0.0031	0.0056	0.0084	0.0115	0.0166	0.0225	0.0273	0.0298	0.0359
HFC-134	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
HFC-134a	0.00002	0.00002	0.0003	0.0050	0.0080	0.0175	0.0995	0.1105	0.1322	0.1721	0.1850	0.2026	0.2326	0.2296	0.2370
HFC-152a	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0302	0.0319	0.0320	0.0301	0.0236	0.0243	0.0163	0.0127
HFC-143	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
HFC-143a	0.0000	0.0000	0.0000	0.0001	0.0006	0.0018	0.0034	0.0057	0.0080	0.0101	0.0139	0.0185	0.0221	0.0236	0.0284
HFC-227ea	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0002	0.0008	0.0006	0.0001	0.0011	0.0015
HFC-236fa	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
HFC-245ca	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Emissions of PFCs[5] - CO_2 equivalent (Gg)	**100.21**	**100.21**	**84.70**	**69.26**	**29.69**	**17.66**	**14.69**	**17.22**	**23.87**	**28.40**	**30.56**	**67.81**	**29.13**	**35.84**	**66.04**
CF_4	0.0133	0.0133	0.0112	0.0092	0.0039	0.0022	0.0017	0.0020	0.0021	0.0024	0.0023	0.0079	0.0020	0.0024	0.0031
C_2F_6	0.0015	0.0015	0.0012	0.0010	0.0004	0.0002	0.0002	0.0002	0.0009	0.0011	0.0015	0.0015	0.0015	0.0019	0.0017
C_3F_8	0.00001	0.00001	0.00002	0.0001	0.0001	0.0002	0.0002	0.0003	0.0003	0.0003	0.0003	0.0003	0.0004	0.0005	0.0004
C_4F_{10}	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0031
$c\text{-}C_4F_8$	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
C_5F_{12}	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
C_6F_{14}	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0008
Emissions of SF_6[5] - CO_2 equivalent (Gg)	**178.91**	**178.91**	**180.83**	**182.75**	**148.44**	**125.84**	**103.57**	**98.24**	**169.15**	**155.95**	**142.52**	**198.92**	**220.03**	**187.26**	**169.43**
SF_6	0.0075	0.0075	0.0076	0.0076	0.0062	0.0053	0.0043	0.0041	0.0071	0.0065	0.0060	0.0083	0.0092	0.0078	0.0071

TABLE 10 EMISSION TRENDS (SUMMARY) (Sheet 5 of 5) Switzerland 2003 / Submission 2005

GREENHOUSE GAS EMISSIONS	Base year[1]	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
	CO_2 equivalent (Gg)														
Net CO_2 emissions/removals	43'098.83	43'098.83	44'682.94	44'519.11	40'983.87	40'244.80	41'013.78	41'414.57	40'476.76	41'835.79	42'299.35	43'805.61	44'907.76	43'954.76	42'957.29
CO_2 emissions (without LUCF) [6]	44'372.12	44'372.12	46'022.22	45'942.73	43'371.82	42'636.42	43'368.73	43'921.69	43'150.72	44'438.25	44'555.30	43'656.23	44'457.72	43'649.55	44'723.74
CH_4	4'450.73	4'450.73	4'436.83	4'304.83	4'243.87	4'040.22	4'047.32	3'974.22	3'908.60	3'847.65	3'835.78	3'741.89	3'760.42	3'683.09	3'668.72
N_2O	3'344.43	3'344.43	3'370.87	3'370.42	3'338.86	3'313.47	3'247.61	3'301.18	3'199.50	3'192.64	3'172.89	3'186.38	3'155.83	3'147.95	3'078.55
HFCs	0.02	0.02	0.36	7.19	14.31	33.70	151.13	185.45	230.79	300.86	349.31	405.56	471.33	483.10	529.26
PFCs	100.21	100.21	84.70	69.26	29.69	17.66	14.69	17.22	23.87	28.40	30.56	67.81	29.13	35.84	66.04
SF_6	178.91	178.91	180.83	182.75	148.44	125.84	103.57	98.24	169.15	155.95	142.52	198.92	220.03	187.26	169.43
Total (with net CO_2 emissions/removals)	**51'173.13**	**51'173.13**	**52'756.53**	**52'453.56**	**48'759.04**	**47'775.69**	**48'578.09**	**48'990.88**	**48'008.68**	**49'361.28**	**49'830.41**	**51'406.17**	**52'544.51**	**51'492.00**	**50'469.29**
Total (without CO_2 from LUCF) [6] [8]	**52'446.42**	**52'446.42**	**54'095.81**	**53'877.18**	**51'147.00**	**50'167.31**	**50'933.05**	**51'498.00**	**50'682.64**	**51'963.74**	**52'086.36**	**51'256.79**	**52'094.46**	**51'186.79**	**52'235.74**

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year[1]	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
	CO_2 equivalent (Gg)														
1. Energy	40'967.72	40'967.72	43'074.39	43'175.99	40'892.67	40'024.67	40'922.19	41'679.80	41'087.63	42'289.82	42'369.55	41'242.57	42'045.14	41'251.95	42'367.55
2. Industrial Processes	3'228.00	3'228.00	2'871.66	2'707.98	2'375.18	2'516.65	2'475.71	2'323.62	2'267.85	2'338.82	2'377.98	2'647.29	2'729.85	2'657.26	2'685.67
3. Solvent and Other Product Use	107.57	107.57	109.74	111.91	114.39	116.56	118.73	119.04	119.66	120.28	120.90	121.21	121.21	122.76	124.00
4. Agriculture	6'082.08	6'082.08	6'090.07	5'971.76	5'956.47	5'800.56	5'753.22	5'741.57	5'585.14	5'549.39	5'535.79	5'497.75	5'519.94	5'464.07	5'372.41
5. Land-Use Change and Forestry [7]	-1'273.29	-1'273.29	-1'339.29	-1'423.62	-2'387.95	-2'391.62	-2'354.95	-2'507.12	-2'673.95	-2'602.45	-2'255.95	149.38	450.05	305.21	-1'766.45
6. Waste	2'061.05	2'061.05	1'949.95	1'909.54	1'808.28	1'708.86	1'663.20	1'633.98	1'622.36	1'665.42	1'682.14	1'747.97	1'678.31	1'690.75	1'686.11
7. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO

SUMMARY 1.A SUMMARY REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES (TABLE 7A) (Sheet 1 of 3)

Switzerland 2003 / Submission 2005

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 emissions	CO_2 removals	CH_4	N_2O	HFCs[1]		PFCs[1]		SF_6		NO_x	CO	NMVOC	SO_2
					P	A	P	A	P	A				
	(Gg)				CO_2 equivalent (Gg)				(Gg)					
Total National Emissions and Removals	**44'723.74**	**-1'766.45**	**174.70**	**9.93**	**1'972.07**	**529.26**	**118.14**	**66.04**	**NA**	**0.007**	**90.07**	**411.36**	**122.43**	**18.76**
1. Energy	**41'721.17**		**16.91**	**0.94**							**83.09**	**391.61**	**43.82**	**13.40**
A. Fuel Combustion — Reference Approach [2]	41'822.89													
A. Fuel Combustion — Sectoral Approach [2]	41'641.12		4.96	0.94							83.04	391.60	37.64	13.40
1. Energy Industries	1'710.43		0.07	0.13							1.83	0.59	0.06	1.29
2. Manufacturing Industries and Construction	5'887.70		0.43	0.13							8.99	14.82	0.46	4.16
3. Transport	15'409.36		1.33	0.49							48.04	258.75	25.78	1.14
4. Other Sectors	17'978.51		2.78	0.17							17.01	66.57	5.51	6.68
5. Other	655.13		0.35	0.02							7.18	50.86	5.83	0.14
B. Fugitive Emissions from Fuels	80.05		11.95	0.00008							0.05	0.012	6.18	0.0004
1. Solid Fuels	NO		NO	NO							NO	NO	NO	NO
2. Oil and Natural Gas	80.05		11.95	0.00008							0.05	0.012	6.18	0.0004
2. Industrial Processes	**1'814.82**		**0.45**	**0.31**	**1'972.07**	**529.26**	**118.14**	**66.04**	**NA**	**0.01**	**0.32**	**12.05**	**7.31**	**3.53**
A. Mineral Products	1'652.58		0.02	NO							0.01	2.17	2.77	2.34
B. Chemical Industry	13.00		0.41	0.31	NO	NO	NO	NO	NO	NO	0.01	1.24	0.30	0.57
C. Metal Production	148.24		NO	NO				11.89		0.001	0.20	3.07	0.30	0.45
D. Other Production [3]	IE										IE	IE	IE	IE
E. Production of Halocarbons and SF_6						NO		NO		NO				
F. Consumption of Halocarbons and SF_6					1'972.07	529.26	118.14	54.15	0.016	0.006				
G. Other	1.00		0.018	NO	NO	NO	NO	NO	NO	NO	0.10	5.58	3.93	0.17

P = Potential emissions based on Tier 1 approach of the IPCC Guidelines.

A = Actual emissions based on Tier 2 approach of the IPCC Guidelines.

[1] The emissions of HFCs and PFCs are to be expressed as CO_2 equivalent emissions. Data on disaggregated emissions of HFCs and PFCs are to be provided in Table 2(II) of this common reporting format.

[2] For verification purposes, countries are asked to report the results of their calculations using the Reference approach and to explain any differences with the Sectoral approach. Where possible, the calculations using the Sectoral approach should be used for estimating national totals. Do not include the results of both the Reference approach and the Sectoral approach in national totals.

[3] Other Production includes Pulp and Paper and Food and Drink Production.

Note: The numbering of footnotes to all tables containing more than one sheet continue to the next sheet. Common footnotes are given only once at the first point of reference.

SUMMARY 1.A SUMMARY REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES (TABLE 7A) (Sheet 2 of 3)

Switzerland 2003 / Submission 2005

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 emissions	CO_2 removals	CH_4	N_2O	HFCs [1]		PFCs[1]		SF_6		NO_x	CO	NMVOC	SO_2
					P	A	P	A	P	A				
	(Gg)				CO_2 equivalent (Gg)						(Gg)			
3. Solvent and Other Product Use	**NO**			**0.40**							**0.05**	**0.09**	**66.82**	**0.04**
4. Agriculture (1 year average)	**IE**	**IE**	**137.99**	**7.98**							**4.29**	**5.88**	**4.22**	**0.02**
A. Enteric Fermentation			118.67											
B. Manure Management			19.04	1.28							2.54		NO	
C. Rice Cultivation			NO										NO	
D. Agricultural Soils	[4] IE	[4] IE	NO	6.70							1.71		3.97	
E. Prescribed Burning of Savannas			NO	NO							NO	NO	NO	
F. Field Burning of Agricultural Residues			0.28	NO							0.03	5.88	0.25	0.02
G. Other			NO	NO							NO	NO	NO	NO
5. Land-Use Change and Forestry	[5]	[5] **-1'766.45**	**NO**	**NO**							**NO**	**NO**	**NO**	**NO**
A. Changes in Forest and Other Woody Biomass Stocks	[5]	[5] -2'379.67												
B. Forest and Grassland Conversion	NO		NO	NO							NO	NO	NO	
C. Abandonment of Managed Lands	[5] IE	[5] IE												
D. CO_2 Emissions and Removals from Soil	[5] 613.21	[5]												
E. Other	[5] NO	[5] NO	NO	NO							NO	NO	NO	NO
6. Waste	**1'187.76**		**19.36**	**0.30**							**2.33**	**1.72**	**0.26**	**1.77**
A. Solid Waste Disposal on Land	[6] 1.50		17.71								0.04	0.16	0.02	0.01
B. Wastewater Handling			1.58	0.07							0.50	0.41	0.01	1.29
C. Waste Incineration	[6] 1'186.26		0.07	0.22							1.78	1.15	0.21	0.47
D. Other	NO		NO	NO							NO	0.002	0.03	NO
7. Other *(please specify)*	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**

[4] According to the IPCC Guidelines (Volume 3. Reference Manual, pp. 4.2, 4.87), CO_2 emissions from agricultural soils are to be included under Land-Use Change and Forestry (LUCF). At the same time, the Summary Report 7A (Volume 1. Reporting Instructions, Tables.27) allows for reporting CO_2 emissions or removals from agricultural soils, either in the Agriculture sector, under D. Agricultural Soils or in the Land-Use Change and Forestry sector under D. Emissions and Removals from Soil. Parties may choose either way to report emissions or removals from this source in the common reporting format, but the way they have chosen to report should be clearly indicated, by inserting explanatory comments to the corresponding cells of Summary 1.A and Summary 1.B. Double-counting of these emissions or removals should be avoided. Parties should include these emissions or removals consistently in Table8(a) (Recalculation - Recalculated data) and Table10 (Emission trends).

[5] Please do not provide an estimate of both CO_2 emissions and CO_2 removals. "Net" emissions (emissions - removals) of CO_2 should be estimated and a single number placed in either the CO_2 emissions or CO_2 removals column, as appropriate. Please note that for the purposes of reporting, the signs for uptake are always (-) and for emissions (+).

[6] Note that CO_2 from Waste Disposal and Incineration source categories should only be included if it stems from non-biogenic or inorganic waste streams.

SUMMARY 1.A SUMMARY REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES (TABLE 7A) (Sheet 3 of 3)

Switzerland 2003 / Submission 2005

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 emissions	CO_2 removals	CH_4	N_2O	HFCs		PFCs		SF_6		NO_x	CO	NMVOC	SO_2
					P	A	P	A	P	A				
	(Gg)				CO_2 equivalent (Gg)				(Gg)					
Memo Items: (7)														
International Bunkers	**3'671.66**		**0.23**	**0.12**							**18.04**	**4.24**	**0.21**	**0.98**
Aviation	3'671.66		0.23	0.12							18.04	4.24	0.21	0.98
Marine	NO		NO	NO							NO	NO	NO	NO
Multilateral Operations	**NO**		**NO**	**NO**							**NO**	**NO**	**NO**	**NO**
CO_2 Emissions from Biomass	**2'077.36**													

(7) Memo Items are not included in the national totals.

SUMMARY 1.B SHORT SUMMARY REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES (TABLE 7B) (Sheet 1 of 1)

Switzerland 2003 / Submission 2005

GREENHOUSE GAS SOURCE AND SINK CATEGORIES		CO_2 emissions	CO_2 removals	CH_4	N_2O	HFCs[1]		PFCs[1]		SF_6		NO_x	CO	NMVOC	SO_2
						P	A	P	A	P	A				
		(Gg)				CO_2 equivalent (Gg)				(Gg)					
Total National Emissions and Removals		**44'723.74**	**-1'766.45**	**174.70**	**9.93**	**1'972.07**	**529.26**	**118.14**	**66.04**	**NA**	**0.007**	**90.07**	**411.36**	**122.43**	**18.76**
1. Energy		**41'721.17**		**16.91**	**0.94**							**83.09**	**391.61**	**43.82**	**13.40**
A. Fuel Combustion	Reference Approach[2]	41'822.89													
	Sectoral Approach[2]	41'641.12		4.96	0.94							83.04	391.60	37.64	13.40
B. Fugitive Emissions from Fuels		80.05		11.95	0.00008							0.05	0.012	6.18	0.0004
2. Industrial Processes		**1'814.82**		**0.45**	**0.31**	**1'972.07**	**529.26**	**118.14**	**66.04**	**NA**	0.007	**0.32**	**12.05**	**7.31**	**3.53**
3. Solvent and Other Product Use		**NO**			**0.40**							**0.05**	**0.09**	**66.82**	**0.04**
4. Agriculture [3]		**IE**	**IE**	**137.99**	**7.98**							**4.29**	**5.88**	**4.22**	**0.02**
5. Land-Use Change and Forestry		[4]	[4] **-1'766.45**	**NO**	**NO**							**NO**	**NO**	**NO**	**NO**
6. Waste		**1'187.76**		**19.36**	**0.30**							**2.33**	**1.72**	**0.26**	**1.77**
7. Other		**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Memo Items:															
International Bunkers		**3'671.66**		**0.23**	**0.12**							**18.04**	**4.24**	**0.21**	**0.98**
Aviation		3'671.66		0.23	0.12							18.04	4.24	0.21	0.98
Marine		NO		NO	NO							NO	NO	NO	NO
Multilateral Operations		**NO**		**NO**	**NO**							**NO**	**NO**	**NO**	**NO**
CO_2 Emissions from Biomass		**2'077.36**													

P = Potential emissions based on Tier 1 approach of the IPCC Guidelines. A = Actual emissions based on Tier 2 approach of the IPCC Guidelines.

[1] The emissions of HFCs and PFCs are to be expressed as CO_2 equivalent emissions. Data on disaggregated emissions of HFCs and PFCs are to be provided in Table 2(II) of this common reporting format.

[2] For verification purposes, countries are asked to report the results of their calculations using the Reference approach and to explain any differences with the Sectoral approach in document box of Table1.A(c). Where possible, the calculations using the Sectoral approach should be used for estimating national totals. Do not include the results of both the Reference approach and the Sectoral approach in national totals.

[3] See footnote 4 to Summary 1.A.

[4] Please do not provide an estimate of both CO_2 emissions and CO_2 removals. "Net" emissions (emissions - removals) of CO_2 should be estimated and a single number placed in either the CO_2 emissions or CO_2 removals column, as appropriate. Please note that for the purposes of reporting, the signs for uptake are always (-) and for emissions (+).

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS (Sheet 1 of 1)

Switzerland 2003 / Submission 2005

CATEGORIES	CO_2 equivalent (Gg)						
Total (Net Emissions) [1]	**42'957.29**	**3'668.72**	**3'078.55**	**529.26**	**66.04**	**169.43**	**50'469.29**
1. Energy	**41'721.17**	**355.04**	**291.34**				**42'367.55**
A. Fuel Combustion (Sectoral Approach)	41'641.12	104.09	291.32				42'036.53
1. Energy Industries	1'710.43	1.45	41.41				1'753.29
2. Manufacturing Industries and Construction	5'887.70	8.93	39.51				5'936.14
3. Transport	15'409.36	28.01	150.86				15'588.23
4. Other Sectors	17'978.51	58.45	52.18				18'089.14
5. Other	655.13	7.25	7.36				669.73
B. Fugitive Emissions from Fuels	80.05	250.95	0.02				331.02
1. Solid Fuels	NO	NO	NO				NO
2. Oil and Natural Gas	80.05	250.95	0.02				331.02
2. Industrial Processes	**1'814.82**	**9.41**	**96.72**	**529.26**	**66.04**	**169.43**	**2'685.67**
A. Mineral Products	1'652.58	0.38	NO				1'652.95
B. Chemical Industry	13.00	8.65	96.72	NO	NO	NO	118.37
C. Metal Production	148.24	NO	NO		11.89	28.68	188.81
D. Other Production	IE						IE
E. Production of Halocarbons and SF_6				NO	NO	NO	NO
F. Consumption of Halocarbons and SF_6				529.26	54.15	140.75	724.16
G. Other	1.00	0.38	NO	NO	NO	NO	1.38
3. Solvent and Other Product Use	**NO**		**124.00**				**124.00**
4. Agriculture (1 year average)	**IE**	**2'897.76**	**2'474.65**				**5'372.41**
A. Enteric Fermentation		2'492.07					2'492.07
B. Manure Management		399.86	396.68				796.55
C. Rice Cultivation		NO					NO
D. Agricultural Soils [2]	IE	NO	2'077.97				2'077.97
E. Prescribed Burning of Savannas		NO	NO				NO
F. Field Burning of Agricultural Residues		5.82	NO				5.82
G. Other		NO	NO				NO
5. Land-Use Change and Forestry [1]	**-1'766.45**	**NO**	**NO**				**-1'766.45**
6. Waste	**1'187.76**	**406.52**	**91.84**				**1'686.11**
A. Solid Waste Disposal on Land	1.50	371.84					373.34
B. Wastewater Handling		33.20	22.28				55.48
C. Waste Incineration	1'186.26	1.48	69.56				1'257.29
D. Other	NO	NO	NO				NO
7. Other *(please specify)*	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Memo Items:							
International Bunkers	**3'671.66**	**4.92**	**36.16**				**3'712.74**
Aviation	3'671.66	4.92	36.16				3'712.74
Marine	NO	NO	NO				NO
Multilateral Operations	**NO**	**NO**	**NO**				**NO**
CO_2 Emissions from Biomass	**2'077.36**						**2'077.36**

[1] For CO_2 emissions from Land-Use Change and Forestry the net emissions are to be reported. Please note that for the purposes of reporting, the signs for uptake are always (-) and for emissions (+).
[2] See footnote 4 to Summary 1.A of this common reporting format.

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 emissions	CO_2 removals	Net CO_2 emissions / removals	CH_4	N_2O	Total emissions
Land-Use Change and Forestry	CO_2 equivalent (Gg)					
A. Changes in Forest and Other Woody Biomass Stocks	7'989.67	-10'369.33	-2'379.67			-2'379.67
B. Forest and Grassland Conversion	NO		NO	NO	NO	NO
C. Abandonment of Managed Lands	IE	IE	IE			IE
D. CO_2 Emissions and Removals from Soil	613.21	NE	613.21			613.21
E. Other	NO	NO	NO	NO	NO	NO
Total CO_2 Equivalent Emissions from Land-Use Change and Forestry	8'602.88	-10'369.33	-1'766.45	NO	NO	-1'766.45

Total CO_2 Equivalent Emissions without Land-Use Change and Forestry [a]	52'235.74
Total CO_2 Equivalent Emissions with Land-Use Change and Forestry [a]	50'469.29

[a] The information in these rows is requested to facilitate comparison of data, since Parties differ in the way they report emissions and removals from Land-Use Change and Forestry. Note that these totals will differ from the totals reported in Table 10s5 if Parties report non-CO2 emissions from LUCF.

Annex 2: Policies and measures – fact sheets

The following fact sheets give a brief overview of some of the most relevant contributions to climate policy at the federal level.

1 Federal Act on the Reduction of CO_2 emissions
2 CO_2 tax
3 Climate cent
4 Energy Act
5 'SwissEnergy' action plan (general framework)
5.1 'SwissEnergy' action plan – renovation of buildings
5.2 'SwissEnergy' action plan – economy
5.3 'SwissEnergy' action plan – energy-efficient mobility
5.4 'SwissEnergy' action plan – renewable energy
6 Electricity Supply Act
7 Distance-related heavy vehicle fee (HVF)
8 Modal shift measures
9 Increase and protection of forested area; sustainability in forest management
10 Greenhouse gases in agriculture
11 Regulation of the use of synthetic GHGs

1	**Federal Act on the Reduction of CO_2 emissions**	Sector: **Energy (all)** GHGs mainly affected: **CO_2**

Relevant federal authority:

Swiss Agency for the Environment,
Forests and Landscape
CH-3003 Berne
Tel: +41-31-322 93 11; contact person: Mrs A. Burkhardt
email: climate@buwal.admin.ch
www.environment-switzerland.ch/climate

Level of implementation: national

Brief description of measure or policy:

Law stipulates legally binding CO_2 reduction targets by 2010 compared to 1990: all fossil fuels 10% reduction, heating/process fuels 15% reduction, transport fuels 8% reduction.
If these targets cannot be met by voluntary action and other CO_2-related measures alone, a CO_2 tax is to be introduced. The tax rate is to be set by the Federal Council according to the shortfall, but must not exceed CHF 210 per tonne of CO_2 and needs Parliament's approval. Industries affected by the tax burden can obtain tax exemption if they commit themselves to reduce their energy-related CO_2 emissions.

Objective(s):

Swiss response and contribution to the challenge of climate change. Quantified reduction of CO_2 emissions from combustion of fossil fuels. Compatible with the Kyoto reduction commitment of Switzerland.

Schedule and status of implementation:

Law in force since 1 May 2000. Voluntary agreements to reduce energy related CO_2 emissions signed with over 600 entities by 2004, some 400 more agreements are underway.
In view of the need for the CO_2 tax, confirmed by updated emissions projections, the Federal Council decided to introduce a CO_2 tax in the heating and industry sector (see fact sheet 2) and to accept the private-sector climate cent (see fact sheet 3). The Federal Council adopted ordinances relevant to implementation and submitted the tax rate for decision to Parliament in June 2005.

Indicator(s) of success or estimate of impact:

Periodically updated energy and emissions projections as well as annually published energy and CO_2 statistics are tools to assess the impact of the energy and climate policy on CO_2 emissions.
Number of entities and CO_2 reduction covered in the voluntary action scheme indicates success of voluntary agreements.

Documentation available from the SAEFL, Economics and Climate Section, CH-3003 Berne:

- Federal Act on the Reduction of CO_2 Emissions (CO_2 Act), see: www.environment-switzerland.ch/climate > Swiss climate policy
- Message relatif à la loi fédérale sur la réduction des émissions de CO_2, 1997
- Ordonnance sur la taxe sur le CO_2 et commentaires relatifs, 2005.
- Ordonnance régissant l'imputation des réductions d'émissions opérées à l'étranger et commentaires relatifs, 2005.
- Message concernant l'approbation du montant de la taxe sur le CO_2 appliquée aux combustibles, 2005.

2	**CO_2 tax on heating/process fuels**	Sector: **Energy (all)** GHGs mainly affected: **CO_2**

Relevant federal authority:

Swiss Agency for the Environment,
Forests and Landscape
CH-3003 Berne
Tel.: +41-31-322 93 11; contact person: Mrs A. Burkhardt
email: climate@buwal.admin.ch
www.environment-switzerland.ch/climate

Level of implementation: national

Brief description of measure or policy:

Incentive tax levied on fossil heating and process fuels. Revenues of approx. CHF 650 million p.a. are fully redistributed to the population on a per capita basis (CHF 50 p.a. refunded through health insurers) and to the business community as a proportion of wages paid (CHF 110 p.a. per CHF 100,000 refunded through old-age pension funds). Companies can apply for tax exemption in exchange for a legally binding CO_2 reduction commitment. Required targets are geared to a company's technically feasible and economically viable reduction potential. Companies exempted from the CO_2 tax are not entitled to redistribution of the revenues.
CO_2 tax sets the compliance regime to establish a cap-and-trade emissions trading scheme among tax-exempted companies. Emissions allowances are allocated according to cap for 2008–12.

Objective(s):

Tackle shortfall in the buildings and industry sector to meet target of minus 15% by 2010 compared to 1990, by creating an incentive to enhance energy efficiency.

Schedule and status of implementation:

Decided by the Federal Council on 23 March 2005. Ordinances regulating tax imposition, exemption, redistribution of revenues, emissions trading, use of the flexible mechanisms were adopted on 22 June 2005, together with the message to Parliament for approval of the tax rate.

Indicator(s) of success or estimate of impact:

CO_2 reduction of 0.7 Mt is expected by 2010. Impact observed in annually published energy and CO_2 statistics.

Documentation available from the SAEFL, Economics and Climate Section, CH-3003 Berne:

- Ordonnance sur la taxe sur le CO_2 et commentaires relatifs, 2005.
- Ordonnance régissant l'imputation des réductions d'émissions opérées à l'étranger et commentaires relatifs, 2005.
- Message concernant l'approbation du montant de la taxe sur le CO_2 appliquée aux combustibles, 2005.

3	**Climate cent**	Sector: **Energy (all)** GHGs mainly affected: **CO_2**

Relevant federal authority:

Swiss Federal Office of Energy
CH-3003 Berne
Tel.: +41-31-322 56 11; contact person: Mr M. Kaufmann
e-mail: office@bfe.admin.ch
www.swiss-energy.ch

Level of implementation: national

Brief description of measure or policy:

Initiative by the Swiss Oil Association as a voluntary measure by the private sector to comply with CO_2 target in the transport sector. Retailers levy 1.3 to 1.9 Swiss cents per litre to fund mitigation projects. Funds are managed by the "Climate cent" foundation set up under private law.

Objective(s):

Tackle shortfall in the transport sector to meet target of minus 8 % by 2010 compared to 1990 by funding mitigation projects within and outside Switzerland (the latter by means of the flexible mechanisms).

Schedule and status of implementation:

The Federal Council decided on 23 March 2005 to accept the "climate cent". An agreement between DETEC and the "Climate cent" foundation was prepared for conclusion in August 2005. By 2007, the foundation must prove that the required CO_2 reductions of 1.8 Mt CO_2 (with a minimum of 0.2 Mt to be achieved within Switzerland) can be delivered on average over the period 2008–12.

Indicator(s) of success or estimate of impact:

Monitoring and effectiveness analysis by SwissEnergy standards for mitigation projects within Switzerland and CO_2 credits acquired by means of flexible mechanisms provided for in the Kyoto-Protocol.

Documentation available at

http://www.stiftungklimarappen.ch

4	**Energy Act**	Sector: **Energy (all)** GHGs mainly affected: **CO_2**

Relevant federal authority:

Swiss Federal Office of Energy
Worblentalstr. 32, Ittigen
CH-3003 Berne
Tel.: +41-31-322 56 11; contact person: Mr P. Previdoli
e-mail: office@bfe.admin.ch
www.swiss-energy.ch

Level of implementation: national

Brief description of measure or policy:

The law allows the following measures to be implemented: establish procedures and energy consumption targets for appliances and vehicles, individual metering mandatory for heating and hot water, regulations on the connection to the electricity grid and for the buy-back tariff for electricity producers, encourage information and training courses related to energy savings, fund research and development, and demonstration projects, extensive co-operation with the private sector giving priority to voluntary measures as compared with regulations, fund cantons that have established programmes favouring energy efficiency and renewable forms of energy, assess whether supply can be met by renewable forms of energy, and whether there is a possibility of recovering heat when building a fossil fuel power plant.

Objective(s):

The aims of the Energy Act are to ensure a secure energy supply that is environmentally compatible and economically feasible, to secure the production and delivery of a sufficient amount of energy under optimal economic and environmental conditions, to contribute to rational and efficient use of energy and to encourage domestic and renewable energy sources.

Schedule and status of implementation:

Implemented since 1998

Indicator(s) of success or estimate of impact:
The development of energy demand is measured by ex post analysis of energy consumption and by specific monitoring activities within the 'SwissEnergy' action plan.

Documentation available from Swiss Federal Office of Energy, CH-3003 Berne:

- Energy policies of Switzerland 1999 review, OECD/IEA 1999
- periodic ex post analyses of energy consumption (German only)

5	**'SwissEnergy' Action Plan (formerly 'Energy 2000' Action Plan)**	Sector: **Energy (all)** GHGs mainly affected: **CO_2**

Relevant federal authority:

Swiss Federal Office of Energy
Worblentalstr. 32, Ittigen
CH-3003 Berne
Tel.: +41-31-322 56 11; contact person: Mr M. Kaufmann
e-mail: office@bfe.admin.ch
www.swiss-energy.ch

Level of implementation: national, regional

Brief description of measure or policy:

The action plan involves extensive co-operation with the cantons and the private sector. Concluding voluntary agreements with private energy agencies and organizations, funding measures to promote energy savings and renewables, and promoting renewable energy, research, training courses and dissemination of information are the main tasks of the action plan. The four main topics are buildings, economy, transport, and renewable forms of energy and energy efficiency (see fact sheets 5.1 – 5.4).

Objective(s):

10% reduction in the consumption of fossil fuels between 2000 and 2010. Reduction in CO_2 emissions of 10% by 2010 compared with 1990. Increase of less than 5% in electricity consumption; increase of 3 TWh (= 3% of total heat production) in renewable heat production and 0.5 TWh (= 0.8% of overall electricity production) in renewable electricity production (2000–2010).

Schedule and status of implementation:

'SwissEnergy' started in 2001, following on from the 'Energy 2000' action plan. The strategy for the period 2006–2010 has been formulated and was presented to the public in July 2005.

Indicator(s) of success or estimate of impact:

The previous 'Energy 2000' action plan saved 4.6% of total energy consumption, and led to the production of 2 TWh (= 2% of total heat production) of heat from renewable sources, and 0.4 TWh (= 0.6% of overall electricity production) of electricity from renewable sources.
With the voluntary measures under the new SwissEnergy programme, a total of 9.4 PJ of final energy was saved in the period 2001–2004 (including 6.5 PJ heating fuels, 1.2 PJ vehicle fuels and 1.6 PJ electricity).

Documentation available from Swiss Federal Office of Energy, CH-3003 Berne:

- SwissEnergy Strategy 2006–2010 (in French, German and Italian) and other publications related to the SwissEnergy action plan: http://www.energie-schweiz.ch/internet/02178/index.html?lang=en
- Final Report on the 'Energy 2000' action programme and 10th Annual Report, April 2001 (in German and French): http://www.energie-schweiz.ch/internet/00345/index.html?lang=en

5.1	**'SwissEnergy' Action Plan – Renovation of buildings**	Sector: **Energy (small-scale combustion)** GHGs mainly affected: **CO_2**

Relevant federal authority:

Swiss Federal Office of Energy
Worblentalstr. 32, Ittigen
CH-3003 Berne
Tel: +41-31-322 56 11; contact person: Mrs N. Zimmermann
e-mail: office@bfe.admin.ch
www.swiss-energy.ch

Level of implementation: regional

Brief description of measure or policy:

The cantons are the main actors for efficient energy use in buildings. Their action is ensured by the energy laws of the cantons. The energy laws regulate the permitted heating of buildings, which is developed in accordance with the standards of the Association of Swiss Engineers and Architects. The measures are co-ordinated in co-operation between the cantons and the federal authorities.
The 'Minergie' standard is used to promote energy-efficient buildings in the public and private sectors.

Objective(s):

- Additional impact through strengthening of the cantonal measures, including renovations according to the 'Minergie' label
- Increased efficiency of electrical appliances
- In cooperation with the "Climate cent" foundation: building renovation programme
- Energy aspects in building renovation are systematically taken into account

Schedule and status of implementation:

Implemented in general.
Constant adaptation of measures to new technologies and new standards.

Indicator(s) of success or estimate of impact:

The activities within the previous 'Energy 2000' action plan saved about 2–3% of annual energy consumption in the building sector. The 'Minergie' label, which is awarded to buildings with very good insulation, has been very successful. With the voluntary measures in the building sector (including public entities), a total of 2.8 PJ of final energy was saved in the period 2001–2004 (including 1.8 PJ heating fuels, 0.32 PJ vehicle fuels and 0.64 PJ electricity).

Documentation available from Swiss Federal Office of Energy, CH-3003 Berne:

see fact sheet 5

5.2	**'SwissEnergy' Action Plan – Economy**	Sector: **Energy (industry/commercial services)** GHGs mainly affected: **CO_2**

Relevant federal authority:

Swiss Federal Office of Energy
Worblentalstr. 32, Ittigen
CH-3003 Berne
Tel: +41-31-322 56 11; contact person: Mr A. Mörikofer
e-mail: office@bfe.admin.ch
www.swiss-energy.ch

Level of implementation: national

Brief description of measure or policy:

The private "Energy Agency for the Economy" is the main partner of federal offices in efforts to decrease energy use and CO_2 emissions in industry and commercial services, by means of voluntary agreements. Groups of companies, and companies with high energy consumption agree their future energy savings and reporting procedures with the federal authorities. They are themselves responsible for defining how the reduction goals are to be reached. If the targets are not met, the companies will have to pay the future CO_2 tax. The exchange of know-how and individual measures by companies to achieve the objectives support this measure.

Objective(s):

Decrease energy consumption and CO_2 emissions in the business sector according to voluntary agreements, in particular:

- 50% of CO_2 emissions from the industry and service sector are covered by voluntary agreements
- 20% market share of highly efficient electric motors (electric motors in industry account for approximately 25% of Swiss electricity consumption)
- 10 efficiency programmes for small and medium size companies are in place

Schedule and status of implementation:

The implementation of the corresponding energy and CO_2 laws is ongoing. In spring 2001 the negotiations on the agreements were initiated. See also fact sheet no.1 (Federal Act on the Reduction of CO_2 Emissions).

Indicator(s) of success or estimate of impact:

The previous 'Energy 2000' action plan saved about 5–6% of annual energy consumption in the industrial and commercial services sector.
With the voluntary measures in the private economy, a total of 2.7 PJ of final energy was saved in the period 2001–2004 (including 1.75 PJ heating fuels, 0.12 PJ vehicle fuels and 0.83 PJ electricity).

Documentation available from Swiss Federal Office of Energy, CH-3003 Berne:

see fact sheet 5

5.3	**'SwissEnergy' Action Plan – Energy-efficient mobility**	Sector: **Transport** GHGs mainly affected: **CO_2, precursors**

Relevant federal authority:

Swiss Federal Office of Energy
Worblentalstr. 32, Ittigen
CH-3003 Berne
Tel: +41-31-322 56 11; contact person: Mr H. Scherrer
e-mail: office@bfe.admin.ch
www.swiss-energy.ch

Level of implementation: national

Brief description of measure or policy:

Several measures support the efforts to decrease energy consumption by transport. These include promoting environmentally efficient ways of driving, which means fuel savings of up to 15 % (EcoDrive®), supporting the Mobility car-sharing programme and promoting human-powered vehicles.
In addition, regulations relating to the energy efficiency of new cars may be introduced if voluntary approaches do not succeed.

Objective(s):

- Reduce average CO_2 emissions of new cars to 140g/km by 2010
- Increase the number of natural gas vehicles to 30,000 units and hybrid cars to 20,000 units by 2010
- From 2008 on, all new drivers are familiar with the core elements of EcoDrive.

Schedule and status of implementation:

In general implemented, institutional strengthening under way.

Indicator(s) of success or estimate of impact:

The previous 'Energy 2000' action plan saved about 2% of annual fuel consumption in the transport sector.
The Mobility car-sharing programme involves over 40,000 users and is currently based on 1,450 cars and 900 locations in 350 municipalities.
With the voluntary measures in the transport sector, a total of 0.77 PJ of final energy (fuels) was saved in the period 2001–2004.

Documentation available from Swiss Federal Office of Energy, CH-3003 Berne:

see fact sheet 5

5.4	**'SwissEnergy' Action Plan – Renewable Energy**	Sector: **Energy (all)** GHGs mainly affected: **CO_2**

Relevant federal authority:

Swiss Federal Office of Energy
Worblentalstr. 32, Ittigen
CH-3003 Berne
Tel.: +41-31-322 56 11; contact person: Mr H. U. Schärer
e-mail: office@bfe.admin.ch
www.swiss-energy.ch

Level of implementation: national

Brief description of measure or policy:

Promotion of biomass, ambient heat, solar energy, wind, geothermal energy and small hydropower plants in collaboration with the private 'Agency for Renewable Energy and Energy Efficiency', and networks in these fields. The Federal Office of Energy supports the players in many ways, such as developing and implementing quality management, overall marketing, financial contribution to training courses, research and development funds.

Objective(s):

By 2010, increase renewable heat production by 3 TWh (= 3% of total heat production) and renewable electricity production by 0.5 TWh (= 0.8% of overall electricity production), compared to 2000.
The following sub-targets can be distinguished:

- Space heating: increased share of renewables in buildings
- Electricity: focus on the most effective technologies, such as biogas and wood
- Hydropower: awareness raising and increased share of small hydro
- Biomass: wood and biomass become central themes

Schedule and status of implementation:

Implementation ongoing.

Indicator(s) of success or estimate of impact:

The previous 'Energy 2000' action plan led to the production of 2 TWh (= 2% of total heat production) of renewable heat and 0.4 TWh (= 0.6% of overall electricity production) of renewable electricity. For renewable electricity production, the goals were exceeded, and for heat they were 70% attained.
With the voluntary measures regarding renewable energy, a total of 3.3 PJ of final energy (mainly heating fuels) was saved in the period 2001–2004.

Documentation available from Swiss Federal Office of Energy, CH-3003 Berne:

see fact sheet 5

6	**Electricity Supply Act**	Sector: **Energy conversion** GHGs mainly affected: **CO_2**

Relevant federal authority:

Swiss Federal Office of Energy
Worblentalstr. 32, Ittigen
3003 Berne
Tel.: +41-31-322 56 11; contact person: Mr M. Renggli
e-mail: office@bfe.admin.ch
www.swiss-energy.ch

Level of implementation: national

Brief description of measure or policy:

The Electricity Supply Act is the instrument for electricity market liberalisation in Switzerland. It also serves to promote the generation of renewable electricity and to guarantee a functioning distribution network, including international electricity transport.

Objective(s):

The objective of the Electricity Supply Act is to guarantee basic supply and security of supply, as well as legal security for investors in an open market environment. To accomplish this, the existing legislation is adapted to new economic and technical developments.

Schedule and status of implementation:

The public consultation was concluded in January 2005. The law will be discussed in both chambers of the Parliament by the summer of 2006. The law is expected to enter into force in January 2007.

Indicator(s) of success or estimate of impact:

- Free choice of electricity supply for all actors, increased use of domestic sources, in particular renewables, and guaranteed international electricity exchange.
- Increase of share of renewable energy in electricity production by 10% (5.4 TWh) by 2030.

Documentation available from the Swiss Federal Office of Energy, CH-3003 Berne:

see http://www.energie-schweiz.ch/internet/00061/index.html?lang=en

7	**Distance-related heavy vehicle fee (HVF)**	Sector: **Transport** GHGs mainly affected: **CO_2, precursors**

Relevant federal authority:

Federal Office of Spatial Development
Kochergasse 10
CH-3003 Berne
Tel.: +41-31-322 40 60; contact person: Mr Ch. Albrecht
e-mail: christian.albrecht@are.admin.ch
www.are.admin.ch

Level of implementation: national (Swiss Customs Authority)

Brief description of measure or policy:

The distance-related heavy vehicles fee is calculated on the basis of
- the kilometres driven
- the maximum weight of the vehicle permitted
- the emission class of the vehicle.

Since 1 January 2001, the distance-related fee has replaced the previous flat rate fee, which did not comply with the polluter-pays principle.

Objective(s):

True cost pricing (including external costs) for heavy vehicles (more than 3.5 tonnes) leading to the use of less greenhouse gas emitting heavy vehicles.

Schedule and status of implementation:

The implementation follows three steps: The first step 2001 introduced a fee with a level of 1.6 Swiss cents per km and tonne. This was accompanied by an increase in the general Swiss weight limit from 28 to 34 tonnes per truck. With the second stage in 2005 the rate has been increased up to 2.5 Swiss cents (average) with an increase in the weight limit up to 40 tonnes in parallel. A last stage is foreseen at the opening of the Lötschberg railway base tunnel (end of 2007).

Indicator(s) of success or estimate of impact:

By far the biggest impact of the new traffic regime with the HVF and higher weight limits was observed in the development of traffic levels (truck kilometres). Following a significant increase of 5–6% per year before the introduction of the fee, there was an average reduction of 5% in each of the first two years since introduction.

The full impact of the HVF is best appreciated in combination with the modal shift measures (see fact sheet no. 8 on “Modal shift measures”).

Documentation available from the Federal Office of Spatial Development, CH-3003 Berne:

- HVF – in concrete terms, Swiss Customs Authority, Berne, 2000
- Fedeal Office for Spatial Development (FOSD), Department of the Environment, Transport, Energiy and Communications (DETEC) 2004: Fair and efficient, The Distance-related Heavy Vehicle Fee (HVF) in Switzerland, December 2004.
- Through the Alps, transalpine freight traffic by road and rail, Federal Office for Spatial Development, Berne, 2001
- Message relatif à une loi fédérale concernant la redevance sur le trafic des poids lourds liée aux prestations, Berne, 1996
- Message relatif à l’approbation des accords sectoriels entre la Suisse et l’UE, Berne, 1999
- Federal Office of Transport: Swiss Traffic no. 12, Berne, June 1999
- Federal Office for Spatial Development (FOSD), Federal Office of Transport (FOT), Swiss Federal Raods Authority (SFRA) 2004: Entwicklung des Strassengüterverkehrs nach Einführung von LSVA und 34t-Limite, Analyse der wichtigsten Einflussfaktoren (summary in English), November 2004.

8	**Modal shift measures**	Sector: **Transport** GHGs mainly affected: **CO_2, precursors**

Relevant federal authority:

Federal Office of Transport

CH-3003 Berne
Tel.: +41-31-322 57 11; contact person: Mr K. Moll
www.bav.admin.ch/index_e.cfm

Level of implementation: national

Brief description of measure or policy:

A modal shift towards rail transport is encouraged by the following main instruments of transport policy:

- the distance-related heavy vehicle fee (HVF), see previous fact sheet no. 6
- the modernization of railway infrastructure (New Rail Link through the Alps) and
- specific economic instruments such as financial contributions to combined transport solutions (rolling motorway and unaccompanied combined transport) and track pricing subsidies.

Objective(s):

Transfer of as much transalpine heavy goods traffic from road to rail as possible, leading to reductions in greenhouse gas emissions from HGVs. The law fixes the goal of allowing a maximum of 650,000 heavy goods vehicles per year to cross the Alps by road, at the latest two years after the opening of the first of the two new rail tunnels.

Schedule and status of implementation:

1994: acceptance of the Alpine protection initiative, constitutional mandate
1999: railways reform came into force
2001: Federal Act on the Transfer of Transalpine Goods Traffic to rail and supporting measures comes into force (preliminary)
2001: HVF comes into force (different steps of increasing the fee and the maximum weight limit for lorries.
2006: Final legislation comes into force (in preparation)
2008: opening of the first New Rail Link through the Alps
2015: opening of the second New Rail Link through the Alps

Indicator(s) of success or estimate of impact:

The numbers of HGVs crossing the Alps have been periodically monitored. In addition, a specific monitoring report is requested by the law every two years (socalled 'Verlagerungsbericht'). The second assessment (2004) shows first positive results. The level of transalpine lorries has decreased between 2000 and 2004 by 12%, whereas combined transport shows growth rates for the same period of 30%.

Documentation available from the Federal Office of Transport, CH-3003 Berne:

- Message sur la construction et le financement des infrastructures des transports publics du 26 juin 1996, Berne, 1996
- Message relatif à l'apporbation des accords sectoriels entre la Suisse et la CE du 23 juin 1999 (Loi fédérale du 8 octobre 1999 visant à transférer sur le rail le trafic de marchandises à travers les Alpes ou Loi sur le transfert du trafic), Berne, 1999
- Fair and efficient, the distance-related heavy vehicle fee (HVF) in Switzerland, Bureau for Transport Studies, Federal Department of the Environment, Transport, Energy and Communications (DETEC), Berne, 2000
- Grenzquerender Strassengüterverkehr 1998 (including French summary), GVF-Auftragsbericht Nr.317, Bureau for Transport Studies, DETEC, Berne, 2000
- Bericht über die Verkehrsverlagerung (Verlagerungsbericht) des Bundesrates an die parlamentarische Kommission (2002, 2004)

9	**Protection of forest area; sustainability in forest management**	Sector: **Forestry** GHGs mainly affected: **CO_2**

Relevant federal authority:

Swiss Forest Agency
Swiss Agency for the Environment, Forests and Landscape
CH-3003 Berne
Tel.: + 41-31-322 93 11; contact person: Mr R. Volz
e-mail: richard.volz@buwal.admin.ch
http://www.environment-switzerland.ch > Forest

Level of implementation: national

Brief description of measure or policy:

Any surface covered by trees or woody shrubs, regardless of their use or origin, is defined as woodland. New, naturally established tree or shrub cover on abandoned land is legally treated as woodland after twenty years of growth.
The forested area must not be reduced. Deforestation is prohibited. In the case of exceptions, an equivalent compensation area located in the same region or special measures for nature protection have to be executed.
Forests must be managed in a sustainable manner. Their ability to perform their protective, economic and social functions must be ensured. For reasons of adaptation and biodiversity, natural regeneration has first priority in forest management.

Objective(s):

Maintain the forested area and the productivity of forests.

Schedule and status of implementation:

1878: First Forest Act for mountainous regions protecting the forested area, sustainability principle in timber use. Beginning of large afforestations.
1902: Second Forest Act for the whole country protecting the forested area, principle of sustainability in the use of timber. Pursuit of afforestation.
1993: Entry into force of new federal Forest Act; sustainability was extended to all forest functions. Funds were made available for subsidies according to the new principles.
2005: Revision of Forest Act is in progress.

Indicator(s) of success or estimate of impact:

Increase in forested area between 1890 and 1990: 369,000 hectares. (1890: 825,000 hectares; 1990: 1,194,000 hectares.)
Increase in growing stock (volume of live trees): about 235 million m^3. (1890: about 130 million m^3; 1990: about 365 million m^3). Between the two national forest inventories of 1985 and 1995, the area increased by 47,600 hectares (4.0%). Over the same period, the growing stock increased from 387 million to 404 million m^3.

Documentation available from SAEFL, CH-3003 Berne:

- Sustainable development of Switzerland's forests. Swiss Agency for the Environment, Forests and Landscape. Berne 1995
- Criteria and Indicators for Sustainable Forest Management in Switzerland. Swiss Agency for the Environment, Forests and Landscape. Berne 1997
- Forest and Hunting Legislation in Switzerland as of 1 August 1996
- Mahrer, F. et al.: Inventaire forestier national suisse. Résultat du premier inventaire 1982-1986. Institut fédéral de recherches forestières, Birmensdorf 1990
- Brassel, P. and U.-B. Brändli (ed.): Inventaire forestier national suisse. Résultat du deuxième inventaire 1993-1995. Berne 1999
- Swiss National Forest Programme (Swiss NFP); http://www.environment-switzerland.ch > Forest > New forest policy

10	**Greenhouse gases in agriculture**	Sector: **Agriculture** GHGs mainly affected: **CH_4, N_2O**

Relevant federal authority:
Swiss Federal Office for Agriculture
CH-3003 Berne
Tel.: +41-31-322 25 11; contact person: Mr H. Haenni
e-mail: heinz.haenni@blw.admin.ch
www.blw.admin.ch/e/index.htm

Level of implementation: national

Brief description of measure or policy:

The agriculture policy reform is based on measures on three different levels:
- Research, Education, Consulting
- Incentives
- Regulatory means

Over the last ten years, the focus has been on the creation of economic incentives (direct payments) that serve ecological ends. These are supported by conventional regulatory means.

Objective(s):

Promote ecological practices on farms to reach set agri-environmental aims. For example: Reduction of nutrient losses by limiting animal numbers to the land available for manuring (appropriate soil nutrient balance) with effects on emissions of methane and nitrous oxide, also water protection and soil management.

Schedule and status of implementation:

Implementation started in 1993. Since 1999, every farm that wishes to receive direct payments of any kind has to prove that it satisfies the ecological criteria required by the law.

Indicator(s) of success or estimate of impact:

Reduced nitrogen and methane fluxes in agriculture;
Reduced phosphorus load/reserves in agricultural soils in the catchment basins of Swiss lakes (prevention).
In 2001, over 90% of all farms met the requirements to receive direct payments.

Documentation available from the Swiss Federal Office for Agriculture, Staff Position Ecology, CH-3003 Berne:

- Report on "Methane Emissions in Swiss Agriculture" (Methanemissionen der schweizerischen Landwirtschaft, including English summary)
- Report on "N_2O Emissions in Swiss Agriculture" (Lachgasemissionen der Schweizer Landwirtschaft: including English summary)

11	**Regulation of the use of synthetic GHGs**	Sector: **Industry** GHGs mainly affected: **HFCs, PFCs, SF_6**

Relevant federal authorities:

Swiss Agency for the Environment,
Forests and Landscape
CH-3003 Berne
Tel.: +41-31-322 93 11; contact person: Mr B. Horisberger
email: blaise.horisberger@buwal.admin.ch
http://www.umwelt-schweiz.ch > Chemikalien > Themen > Schutz der Atmosphäre; then select language

Level of implementation: national

Brief description of measure or policy:

Amendment of the Ordinance about Environmentally Hazardous Substances.
Limitation of the uses and emissions of synthetic GHGs in all main sectors of use (refrigeration, air conditionning (fixed and mobile), foams, solvents, spray cans, fire protection, high-voltage electricity, metal industry, semi conductors, etc.)

Objective(s):

Stabilization of synthetic GHGs' emissions at a level below 1000 Gg CO2 eq.

Schedule and status of implementation:

Adopted on 1 April 2003
Implemented on 1 July 2004

Indicator(s) of success or estimate of impact:

Stabilization of synthetic GHG emissions at a level below 1000 Gg CO2 eq.

Documentation available from SAEFL, CH-3003 Berne:

- Ordinance about environmentally hazardous substances (annexes 3.5; 4.9; 4.11; 4.14; 4.15; 4.16)

Annex 3: Stakeholder review

The following institutions have furnished comments on an early draft of this report.

- Alliance for a responsible climate policy (representing 48 Swiss environmental, religious, consumer, union and development aid organizations from civil society)
- Centre for Energy Policy and Economics (CEPE) at the Swiss Federal Institute of Technology, Zurich
- National Centre of Competence in Research on Climate (NCCR Climate), Berne
- oeku Church and environment, Berne
- Swiss Advisory Body on Climate Change (OcCC), Berne
- Swiss Association for Environmentally Conscious Management (öbu), Zurich
- Swiss Association of Gas Industry (VSG), Zurich
- Swiss Business Federation (economiesuisse), Zurich
- Swiss Farmers' Union (SBV), Brugg
- Swiss Oil Association (EV), Zurich.

Abbreviations

BSRN	Baseline Surface Radiation Network
CFCs	chlorofluorocarbons
CHARM	Swiss Atmospheric Radiation Network
CH_4	methane
CHF	Swiss francs
CIS	Commonwealth of Independent States
CO	carbon monoxide
CO_2	carbon dioxide
COP	Conference of the Parties
CORE	Federal Energy Research Commission
COST	European Cooperation in the Area of Scientific and Technical Research
DETEC	Federal Department of Environment, Transport, Energy and Communications
eae	Energy Agency for Electrical Appliances
EAEc	Energy Agency for the Economy
ECAC	European Civil Aviation Conference
EMPA	Swiss Federal Laboratories for Materials Testing and Research
EnDC	Conference of Cantonal Energy Directors
ETH/ETHZ	Swiss Federal Institute of Technology Zurich
EURATOM	European Atomic Energy Community
EUREKA	European Research Coordination Agency
FAL	Swiss Federal Research Station for Agroecology and Agriculture
FOAG	Swiss Federal Office for Agriculture
FOSD	Swiss Federal Office for Spatial Development
FOT	Swiss Federal Office of Transport
FOWG	Swiss Federal Office for Water and Geology
GATT	General Agreement on Tariffs and Trade
GAW	Global Atmosphere Watch
GAW-WCC	GAW-World Calibration Centre
GAW-WORCC	GAW-World Optical depth Research and Calibration Centre
GCOS	Global Climate Observing System
GDP	gross domestic product
GEF	Global Environment Facility

GEP	Global Environmental Programme (of SDC)
Gg	gigagram (1,000 tonnes)
GHG	greenhouse gas
GNP	Gross National Product
GOOS	Global Ocean Observing System
GSN	GCOS Surface Network
GTN-G	Global Terrestrial Network - Glaciers
GTN-P	Global Terrestrial Network - Permafrost
GTOS	Global Terrestrial Observing System
GUAN	GCOS Upper Air Network
GWP	Global Warming Potential
HFCs	hydrofluorocarbons
HGV	heavy goods vehicle
HVF	Heavy Vehicle Fee
IEA	International Energy Agency
ICAO	International Civil Aviation Organization
IPCC	Intergovernmental Panel on Climate Change
JPOI	Johannesburg Plan of Implementation
MDGs	UN Millennium Development Goals
MeteoSwiss	Federal Office of Meteorology and Climatology
Mt	million tonnes
NC3	Switzerland's third National Communication
NC4	Switzerland's fourth National Communication
NCCR	National Competence Centre of Research
NDSC	Network for the Detection of Stratospheric Change
NGO	non-governmental organization
NMVOC	non-methane volatile organic compound
NO_X	oxides of nitrogen
N_2O	nitrous oxide
OcCC	Swiss Advisory Body on Climate Change
OECD	Organization for Economic Cooperation and Development
p.a.	per annum
PACE	Permafrost and Climate in Europe
PFCs	perfluorocarbons
PJ	Petajoule (1 PJ = 277.8 Gigawatt-hours)
PLANAT	National Platform for Natural Hazards
PMOD/WRC	Physikalisch-meteorolog. Observatorium Davos / World Radiation Centre
ProClim-	Swiss Forum for Climate and Global Change
PSI	Paul Scherrer Institute
SAEFL	Swiss Agency for the Environment, Forests and Landscape
SDC	Swiss Agency for Development and Cooperation

seco	State Secretariat for Economic Affairs
SF_6	sulphur hexafluoride
SFOE	Swiss Federal Office of Energy
SFOS	Swiss Federal Office of Statistics
SFOPH	Swiss Federal Office of Public Health
SFRA	Swiss Federal Roads Authority
SIA	Swiss Society of Engineers and Architects
SINGADS	Synthesis of Integrated Global Aerosol Data Sets
SLF	Swiss Federal Institute for Snow and Avalanche Research
SMEs	small and medium enterprises
TCS	Swiss Motorists' Association
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
WDCA	World Data Centre for Aerosol (GAW, Italy)
WDCGG	World Data Centre for Greenhouse Gases (GAW, Japan)
WGMS	World Glacier Montoring Service (GTN-G)
WMO	World Meteorological Organisation
WSL	Swiss Federal Institute for Forests, Snow and Landscape Research