Second
National Climate Report
of the Austrian Federal Government

Second National Communication
in Compliance with the Obligations under the
Framework Convention on Climate Change
(Federal Law Gazette No. 414/1994)

About this document

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Vienna, 1998

Second National Climate Report
of the Austrian Federal Government

Austria's Second National Communication
in Compliance with the Obligations under the
Framework Convention on Climate Change
(Federal Law Gazette No. 414/1994)

Federal Ministry for the Environment
Youth and Family Affairs

Vienna, 1997

Cover: A climatic change can cause severe impacts on Austrian glaciers and water resources. (Zillertaler Alps: Schwarzsee in front of Turnerkamp with Hornkees and Großer Möseler with Waxeckkees, photograph by A. Schindlmayr)

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Preface

Only a few months are left before the Third Conference of the Parties to the United Nations Framework Convention on Climate Change will take place in Kyoto (Japan). On the occasion of this conference a Climate Protocol will be signed, which is to set clear standards for the reduction of greenhouse gas emissions and the implementation of strategies for the protection of the climate system in industrialised nations. Within the framework of the EU, Austria will promote a highly rigid and efficient, and above all binding set of instruments for fighting global climate change.

The international community has to show a clear commitment to the precautionary principle followed by concrete measures in order to take corrective action against misguided developments which have taken place in the course of time as we were led to believe that resources were unlimited and natural cycles could withstand anything. Today we know that these corrections are inevitable for a number of reasons, however, above all due to the responsibility we have to future generations.

We still have a chance to reverse the trend, and we must seize this opportunity for ensuring that the foundations of life will be preserved for a long time to come. Due to its economic structure, Austria has a good chance of emerging from this process strengthened. Integrating sustainable thinking and sustainable economic activity into our business strategies opens excellent market opportunities to Austria as a business centre.

The present Second National Communication, which was written with the cooperation of the ministries concerned, the Austrian system of industrial relations and experts in the field of science, whom I would like to thank for their commitment and support, represents the sign-post showing the way for an Austrian policy for the protection of the climate system. This Communication serves as a basis for concrete future action.

In Austria we have accomplished many achievements with regard to environmental matters. As an industrialised country with a high standard of living, we also have to face the ethical responsibility for future global development. In Austria we have embarked on the right path of precautionary environmental protection. In future, however, the implementation of measures for the protection of the climate system does not only have to be intensified in Austria, but above all at an international level, in order to actually fulfill the mission of keeping this globe well worth living.

Dr. Martin Bartenstein
Federal Minister for the Environment, Youth and Family Affairs

Vienna, September 1997

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Executive Summary

1.1 Introduction

Within the scope of the United Nations Conference on Environment and Development (UNCED) held in Rio de Janeiro in June 1992, 158 countries, including Austria, signed the Framework Convention on Climate Change. The objective of this Convention is to achieve stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Parties to the Convention shall provide periodically, inter alia, national emission inventories of greenhouse gases and national programs containing measures aiming at their reduction, and promote the exchange of information and transfer of technology. An additional obligation exists for industrialized countries as to report on policies and measures, which will reduce greenhouse gas emissions to 1990 levels by the end of the present decade. There is, however, no concrete obligation with regard to the realization of this reduction. In addition, industrialized countries shall promote and finance the transfer of technology and provide financial assistance to the developing countries, thereby helping them to comply with their obligations under the Convention.

Austria, as the 58th country Party, ratified the *United Nations Framework Convention on Climate Change (UN FCCC)* on 28 February 1994. The Convention entered into force globally on 21 March 1994, and for Austria on 29 May 1994.

Bearing in mind the precautionary principle, the Austrian federal government has committed itself, in its Energy Reports since 1990 and other relevant documents, to a national target of a 20% reduction of carbon dioxide (CO_2) emissions by 2005, based on the emissions of 1988. This implies a reduction from 57.0 to 45.6 million metric tons CO_2 in 2005 considering pyrogenic and process-related CO_2 emissions. Compared to Austria's First National Communication the current reduction target (45.6 million metric tons) is higher by 1.5 million metric tons due to a most recent update of the emissions estimates for the base year 1988. The necessity of pursuing this so-called *Toronto target* on a precautionary basis receives distinct support, inter alia, from the comprehensive Second Assessment Report of the Intergovernmental Panel on Climate Change (IPCC). Therefore, Austria continues its efforts, at both the federal and the provincial level, to accelerate the adoption and implementation of measures for achieving the Toronto target.

This document is Austria's *Second National Communication*, by which Austria is complying with the obligation of communicating information to the Secretariat of the UN Framework Convention on Climate Change, as specified under Art. 12 of the Convention.

1.2 The Essential Aspects of Austria's Policy

In the early 1990s two committees were set up at the Austrian Federal Ministry of Environment, Youth and Family Affairs in order to develop effective strategies for protecting the climate system. These were: the *Austrian CO_2 Commission (ACC)* that has been succeeded by the *Austrian Council on Climate Change (ACCC)* by the beginning of 1996; and the *Interministerial Committee to Coordinate Measures to Protect Global Climate (IMC Climate)*.

The tasks of the Austrian Council on Climate Change include: to determine scientific and technological potentials, to recommend measures and strategies, and to analyze instruments at expert level for achieving the Toronto target. In addition, the ACCC is identifying opportunities to reduce emissions of other greenhouse gases and to advise the Austrian federal government in all matters related to protecting the climate system.

The scientific and technological expertise of the Austrian Council on Climate Change establishes the basis for activities of the IMC Climate, the mandate of which is administrative. Represented in this committee are the ministries concerned and the social partners. The IMC Climate elaborates detailed programs for pursuing a comprehensive climate change abatement strategy, including implementing the measures listed for the first time in the 1993 Energy Report of the Austrian federal government, which contains largely CO_2 reduction measures. The IMC Climate reports to the Council of Ministers at regular intervals.

The 1996 Energy Report supports essentially the same principles, objectives and strategies of the Austrian energy policy as were already defined in the conceptual part of the 1993 Energy Report. Austria regards the preservation of basic principles of life within an environment subjected to various influences as one of the major challenges at the end of this century. In this context, an energy sector committed to environmentally sound measures is of essential importance. Environmental compatibility next to security of supply, efficiency and social acceptability is one of the key objectives of the Austrian energy policy. From this commitment the following strategies have been developed: further improvement in efficiency of both energy supply and energy use, promotion of switching to renewable energy sources, and increased use of highly efficient, emission-reducing technologies.

The federation ("Bund") and the federal provinces ("Länder") aim at further exhausting the existing energy savings potentials through measures affecting all aspects of the energy system, in particular the area of energy demand. The use of environmentally sound energy sources puts Austria among the top in Europe: approximately one-quarter of the total Austrian energy consumption is covered by renewable resources.

Austria increasingly pursues an incentive-oriented approach to energy policy while at the same time reducing public intervention to the maximum extent possible.

Of note is that the international dimension of energy policy is becoming increasingly important, particularly within the framework of the European integration and in regard to the economies in transition in Central and Eastern Europe. The Austrian federal government is committed to EU intentions aiming at increasing the competitiveness of energy markets. Therefore, Austria is actively participating in and supporting incentive efforts to restructure energy markets and to make them compatible with general environmental including national climatic targets.

1.3 Where does Austria Stand Today - What has been Achieved and What Remains to be Done?

The Austrian Government is actively engaged in developing and pursuing an efficient policy to reduce its national CO_2 emissions and also the emissions of other greenhouse gases including methane (CH_4) and nitrous oxide (N_2O). It should be noted here that the plans for reduction of halocarbon emissions, which on a global scale contribute about 17% to the radiative forcing, are being presented in Austria's commitment to the *Montreal Protocol on Substances that Deplete the Ozone Layer*.

With regard to the possibilities of Austria to reach the target of a 20% reduction on the basis of its 1988 CO_2 emissions by 2005, it can be stated:

- The Interministerial Committee to Coordinate Measures to Protect Global Climate has elaborated a detailed and comprehensive catalogue of measures for reducing greenhouse gas emissions in order to support the Austrian federal government in its efforts. This catalogue of measures, included in this Communication (cf. Chapter 5), is an update of the catalogue presented in the First National Communication. An attempt has been made to re-examine and complete the measures under consideration in terms of their emissions reduction potentials and, to the extent possible, their costs.
- On the basis of all measures, it is being anticipated that the reduction measures already under realization could stabilize Austria's CO_2 emissions at the 1990 level by 2000. This expectation relies on a scenario that, while disregarding any measures in addition to current ones (*current-measures scenario*), projects a slight decrease in CO_2 emissions until 2000 and a very moderate increase afterwards (cf. Figure 1.1).
- In Austria, there is no general competence for environmental matters for the Federation. A general clause gives the nine federal provinces governmental responsibility for all matters not

explicitly mentioned in the Constitution. If a coordinated approach is required and the Federation does not have the competence to impose measures to the Provinces, the Federation and the Provinces may sign a Treaty of State ("Staatsvertrag"), in which they agree to undertake certain actions (jointly or individually). A treaty that specifies the responsibilities of the Governmental Bodies in their common aim of reaching a 20% CO_2 emissions reduction nationally, on the basis of an agreed set of voluntary and mandatory measures, has been drafted; negotiations on this draft are very well advanced. Both the Austrian federal government and the provincial governments are fully aware that they have to increase their efforts to ensure a speedy and efficient implementation of these measures.

- The effect of various levels of implementation of the additional measures aimed at reducing CO_2 emissions is illustrated in Figure 1.1

  The potentials of the additional measures have been judged to be sufficient to reduce the level of emissions well below the stabilization target, with a fair chance to reach the Toronto target nationally.

  Given the assumption that the *current-measures scenario* is realistic, the expectation of reaching the Toronto target relies on an immediate implementation of the additional measures (*additional-measures scenario*).

  It is recognized that any attempt to reduce greenhouse gas emissions requires a long lead time before it produces a significant effect. Thus, even if all the necessary decisions have been taken by the Governmental Partners prior to 2005, it is realized it may take several years before it will be possible to reach the Toronto target.

In addition, Austria recognizes that even if all nations comply with the Toronto target, this would imply only a very modest slow-down of the rate of increase of the atmospheric CO_2 concentration. To achieve a stabilization of the CO_2 concentration at today's level would require an immediate emissions reduction of over 60 per cent. Clearly it is not realistic to believe it is possible to achieve such a reduction of the CO_2 emissions. Therefore, Austria feels that world-wide efforts ought to be devoted to ensure that the CO_2 concentration at least will not be increasing beyond 450 ppmv.

1.4 Inventory of Anthropogenic Greenhouse Gas Emissions and Removals

Austria's annual emission inventories encompass the following greenhouse gases: carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O). The emissions of air pollutants like nitrogen oxides (NO_x), non-methane volatile organic compounds (NMVOC) and carbon monoxide (CO) are reported as well because they contribute, inter alia, to the formation of tropospheric ozone, which is also a greenhouse gas. The emissions of these gases are grouped into sectors as follows: energy, industrial processes, solvent and other product use, agriculture, land use change and forestry, waste and other (cf. Table 1.1 on the facing page). According to the *IPCC Guidelines for National Greenhouse Gas Inventories*, CO_2 emissions from biomass used as fuels are excluded from the total CO_2 emissions value. Fuel combustion emissions are also broken down into fuel categories. For HFCs, PFCs and SF_6 potential emissions instead of actual emissions have been estimated so far.

As in its First National Communication, Austria presents a time series of its CO_2 emissions for the years 1955 to 1995 (cf. Chapter 4). In addition, CO_2 emissions as well as emissions for CH_4, N_2O, NO_x, NMVOC and CO are provided according to the IPCC Guidelines for the years 1990 to 1995. The CO_2 emission factors for these years are based on chemical analyses of representative fuel samples. The exact proportion of international air traffic to total air traffic has been calculated only for the year 1994 and it is assumed that this proportion remained constant for the years 1990 to 1995. The trend data on emissions have been based on regression analysis. CO_2 emissions corrected for fluctuations in temperature and economic activity *(temperature-* and *production-corrected CO_2 emissions)* are presented for 1988 to 1995.

GHG source and sink categories	CO_2 [Tg]	CH_4 [Gg]	N_2O [Gg]	NO_x [Gg]	CO [Gg]	NMVOC [Gg]
National total	62.02	580.19	12.78	175.90	1.145.62	406.06
1 All Energy (Fuel Combustion + Fugitive)	50.30	24.62	5.51	152.45	819.91	125.99
A Fuel Combustion	47.95	19.44	5.51	149.06	819.36	116.27
1 Energy and Transformation Industries	11.05	0.13	0.13	7.17	0.98	0.22
2 Industry (ISIC)	7.39	0.49	0.11	13.97	6.93	1.22
3 Transport	15.88	3.61	4.34	101.42	344.84	67.98
4 Commercial. . . , Residential,. . .	13.58	15.20	0.92	26.04	466.05	46.74
5 Other Combustion Activities	0.04	0.01	0.02	0.47	0.56	0.11
B Fugitive Emissions from Fuels	2.35	5.19	0.00	3.38	0.55	9.71
1 Solid Fuels	0.00	0.01	0.00	0.00	0.00	0.00
2 Oil and Natural Gas Fuels	2.35	5.18	0.00	3.38	0.55	9.71
2 Industrial Processes	11.30	0.11	0.55	16.25	319.76	21.65
3 Solvent and Other Product Use	0.41	0.00	0.75	0.00	0.00	131.83
4 Agriculture	0.00	208.92	3.33	6.19	1.50	2.38
A Enteric Fermentation	0.00	145.84	0.00	0.00	0.00	0.00
B Manure Management	0.00	27.32	0.00	0.00	0.00	0.00
C Rice Cultivation	0.00	0.00	0.00	0.00	0.00	0.00
D Agricultural Soils	0.00	35.71	3.33	6.19	0.00	2.22
E Prescribed Burning of Savannas	0.00	0.00	0.00	0.00	0.00	0.00
F Field Burning of Agricultural Residues	0.00	0.05	0.00	0.01	1.50	0.16
G Other Agriculture Activities	0.00	0.00	0.00	0.00	0.00	0.00
5 Land Use Change & Forestry	−13.58	126.84	2.63	0.82	0.00	123.54
A Wood & Woody Biomass Stock Change	−13.39	0.00	0.00	0.00	0.00	0.00
B Forest and Grassland Conversion	0.00	0.00	0.00	0.00	0.00	0.00
C Abandonment of Managed Lands	−0.19	0.00	0.00	0.00	0.00	0.00
D Other Land Use Change Activities	0.00	126.84	2.63	0.82	0.00	123.54
6 Waste	0.01	219.69	0.01	0.20	4.45	0.67
A Solid Waste Disposal on Land	0.00	185.25	0.00	0.00	0.00	0.00
B Wastewater Treatment	0.00	14.22	0.00	0.00	0.00	0.00
C Waste Incineration	0.01	0.22	0.01	0.20	4.45	0.67
D Other Waste	0.00	20.00	0.00	0.00	0.00	0.00
7 Other	0.00	0.00	0.00	0.00	0.00	0.00
International Aviation and Marine*	1.21	0.00	0.01	6.41	2.08	0.82

* not included in national totals

Table 1.1: IPCC Table 7a – Summary report for national greenhouse gas inventories 1995. Estimation from CORINAIR national annual data, allocated to IPCC source and sink categories. (Note: Minus values of CO_2 relate to carbon uptake and **are not** included in national totals.)

Emissions of	1990	1995
CO_2	61.9	62.0
CH_4	587.4	580.2
N_2O	11.6	12.8
NO_x	196.7	175.9
NMVOC	490.7	406.1
CO	1333.0	1145.6

Table 1.2: Austria's greenhouse gas and air pollutant emissions for 1990 and 1995 (in Gg = 1,000 metric tons; CO_2 emissions in Tg = million metric tons) in accordance with the IPCC Guidelines.

Year	1990	1995
Removal	-13.3	-13.6

Table 1.3: Removal of CO_2 by Austria's forests for 1990 and 1995 (in Tg = million metric tons) in accordance with the IPCC Guidelines

Table 1.2 lists Austria's 1990 and 1995 emissions of CO_2, CH_4, N_2O, NO_x, NMVOC and CO in accordance with the IPCC Guidelines. Potential emissions of HFCs, PFCs and SF_6 are given for various years between 1991 and 1996 in Table 1.4 on the facing page.

Research on the role of Austria's biosphere, particularly in regard to the removal of CO_2, has been taken up on a broader basis. Table 1.3 lists the removal of CO_2 by Austrian forests in 1990 and 1995, taking into account past land-use/cover change.

Table 1.2 shows that – in comparison with CH_4 and N_2O – CO_2 was by far the most important greenhouse gas in 1995 with 62.0 million metric tons. The CO_2 emissions for the year 1995 are only 0.1 million metric tons above the value for the year 1990 (61.9 million metric tons). These values show that Austria was able to stabilize its CO_2 emissions in the period 1990 to 1995.

The largest contribution to the total greenhouse gas emissions according to the IPCC source split is given by the following sectors (sub-sectors) in 1995:

- **1A3:** Transport (22.1%)
- **1A4:** Commercial/Institutional, Residential etc. (18.1%)
- **2:** Industrial Processes (14.7%)
- **1A1:** Energy and Transformation Industries (14.2%)
- **1A2:** Industry (9.5%)
- **4:** Agriculture (6.9%)
- **6:** Waste (5.9%).

The comparison of the emission values of the other greenhouse gases for the years 1990 and 1995 shows that CH_4 emissions slightly decreased, whereas N_2O emissions increased at a rate of 1.8% per year. The sub-sector with the strongest increase in CO_2 emissions is international aviation and marine (5.2% per year), followed by transport (1.9% per year). The precursors of tropospheric ozone (NO_x, NMVOC and CO) decreased by 2.8% to 3.7% per year.

The (potential) emissions of PFCs and HFCs (see Table 1.4 on the facing page show a very strong increase. However, SF_6 is more important as a greenhouse gas due to its high global warming potential.

1.5 Policies and Measures

The Interministerial Committee to Coordinate Measures to Protect Global Climate has elaborated a detailed and comprehensive catalogue of measures for reducing greenhouse gas emissions. This catalogue of measures, included in this Communication (see Chapter 5), is an update of the catalogue presented in the First National Communication. It contains four groups of measures:

1. voluntary measures and subsidies under implementation;
2. (mandatory) measures under implementation;
3. planned measures; and
4. measures that are in a conceptual stage and will require more time to be realized and to become effective.

The groups of measures 1 to 3 are summarized in Table 5.1 in Chapter 5. Most of them aim at reducing CO_2 emissions, although some of them refer also to other greenhouse gases. The emissions reduction measures for CO_2 are grouped according to: energy supply and transformation, traffic, industry, small consumers, agriculture, forestry

	1991	1992	1993	1994	1995	1996
HFCs						
Pentafluoroethane (R125)	−0.1	5.7	0.1	0.0		
1,1,1,2 Tetrafluoroethane (R134)	0.3	4.1	144.7	198.6		
other Tetrafluoroethanes	0.8	3.1	6.6	21.1		
Difluoroethane (R152)	0.3	0.0	15.8	0.0		
other Difluoroethanes	37.4	44.4	9.7	10.2		
other HFCs	8.8	0.9	8.4	6.8		
mixtures of R125, R134, R152	9.4	2.1	14.0	15.3		
total HFCs	56.9	60.3	199.3	252.0		
PFCs						
Perfluorobutane				0.0	1.1	10.4
SF_6				55		

Table 1.4: Potential emissions (in accordance with the IPCC Guidelines) of PFCs, HFCs and SF_6 in Austria for various years between 1991 and 1996 (in Mg = metric tons).

Umweltbundesamt
Federal Environment Agency - Austria

and land-use, and cross-sectorial measures. Priority is paid to measures relating to: tightening of energy-relevant regulations for buildings (introduction of characteristic energy indices, more rigorous criteria for buildings subsidies); promotion of combined heat and power plants (regulations for electric energy supply); promotion of renewable energies (biomass, sun, heat pumps, wind, geothermal energy, subsidies); and subsidy instruments in general.

An attempt has been made to briefly describe each measure under consideration in terms of: type of instrument, objective, status of implementation, reduction potential until 2005 and 2010, and intermediate indicator of progress. In particular, the emissions reduction potentials have been carefully assessed; they are realistic potentials and are considered to be conservative estimates.

To evaluate the total (maximal) reduction potential of the measures for the years 2000 and 2005, their reduction potentials are combined with the *current-measures scenario* of the Austrian Institute of Economic Research (see Chapter 1.6). This scenario projects a slight decrease in CO_2 emissions between 1995 and 2000 and a very moderate increase afterwards (see Figure 1.1). The projected CO_2 emissions in 2005 amount to 57.5 million metric tons, which is lower than Austria's CO_2 emissions in 1990 (61.9) by 4.4 million metric tons; that is, the stabilization target is considered to be achievable per se.

For the groups of measures 1 to 3 the reduction potentials in 2005 and, if possible, in 2010 have been estimated:

- For the groups of measures under implementation, that is group 1 (voluntary measures and subsidies) and group 2 (mandatory measures) the total (not compounded) reduction potential in 2005 amounts to about 9.8 million metric tons CO_2. It should be noted that this evaluation of the CO_2 reduction does not take into account the fixation of carbon by Austria's forests (cf. measure 5.3.6.3). Thus, these measures can imply a reduction of Austria's projected CO_2 emissions in 2005 from 57.5 to 47.7 million metric tons.
- Considering also the group 3 measures in Table 5.1, which are planned and the total (not compounded) reduction potential of which is about 4.9 million metric tons in addition, it seems to be possible for Austria to reduce its CO_2 emissions to 42.8 million metric tons, that is well below the Toronto target (45.6 million metric tons).

The group of measures 1 to 3 also contain measures that have not yet been quantified. Nevertheless, there is no doubt that they can contribute to reduce Austria's CO_2 emissions.

With regard to the total effect of all the identified measures it has to be recognized that many of them are difficult to quantify, and therefore the projected reduction of the CO_2 emissions is bound to exhibit a wide range of uncertainty. Consequently, it cannot be excluded that this may imply a certain delay in reaching the Toronto target.

Given the fact that most emissions reduction measures require a considerable time before they have reached a widespread implementation, as a next step a timetable should be established in order to ensure a speedy implementation of the identified measures. This is in agreement with the recommendations put forward by the Austrian Council on Climate Change.

1.6 Projections and Effects of Policies and Measures

Monitoring current trends of energy use and exploring policy options for greenhouse gas emissions reductions is an integral part of ongoing cooperative research efforts between various institutions in Austria, as the federal ministries represented in the Interministerial Committee to Coordinate Measures to Protect Global Climate, the Federal Environment Agency of Austria, the Austrian Institute of Economic Research, the Austrian Council on Climate Change, the Austrian Research Centre Seibersdorf, and various universities.

Four scenarios of the Austrian CO_2 emissions until 2010 have been developed. They reflect different underlying assumptions with respect to policy actions:

1. A *without-measures scenario*, which extrapolates CO_2 emissions trends as observed over the past years, without accounting for actions aiming at emissions reductions.
2. A *current-measures scenario*, which assumes that no additional measures will be taken in the future, but currently implemented measures will continue to be effective (none of the additional measures described in Chapter 5 are assumed to be implemented).
3. An *additional-measures scenario*, which investigates the potential of immediate policy actions needed to meet the Toronto target by 2005.
4. An *additional-measures-delayed scenario*, which assumes that the Toronto target will not be reached before 2010 because of a delayed start (2000 instead of 1997) of the actions program.

These scenarios are closely linked with Austria's policy goals of reducing greenhouse gas emissions, above all the commitment to stabilize CO_2 emissions in the European Union by the year 2000 at 1990 levels; and to reduce, according to the Toronto target, these emissions by 20% in 2005, based on the emissions of 1988.

The scenarios are the results of various modeling efforts (ACCC, 1996; FEA, 1996c; Kratena et al., 1996, 1997; Schleicher, 1996). The *without-measures scenario* is based on an econometric extrapolation of the time series for CO_2 emissions. The *current-measures scenario* stems from the latest forecast of the Austrian energy sector, as provided by the Austrian Institute of Economic Research. The *additional-measures* and the *additional-measures-delayed scenario* are model runs of a detailed energy model (ACCC/NEP model), originally developed for the Austrian National Environmental Plan and now taken over and extended by the Austrian Council on Climate Change. The reduction potentials they employ are provided by the Federal Environment Agency of Austria (FEA, 1996c).

Figure 1.1 and Table 1.5 on the facing page allow to compare the various scenarios under discussion. According to the *without-measures scenario*, it seems not to be likely that Austria's CO_2 emissions will exceed the 1991 peak value (66.5 million metric tons) until 2010. Given the assumption that the *current-measures scenario* is realistic, existing policy measures may enable Austria to meet the 2000 stabilization target of the European Union per se. However, decisive and immediate additional measures are required to meet the Toronto target

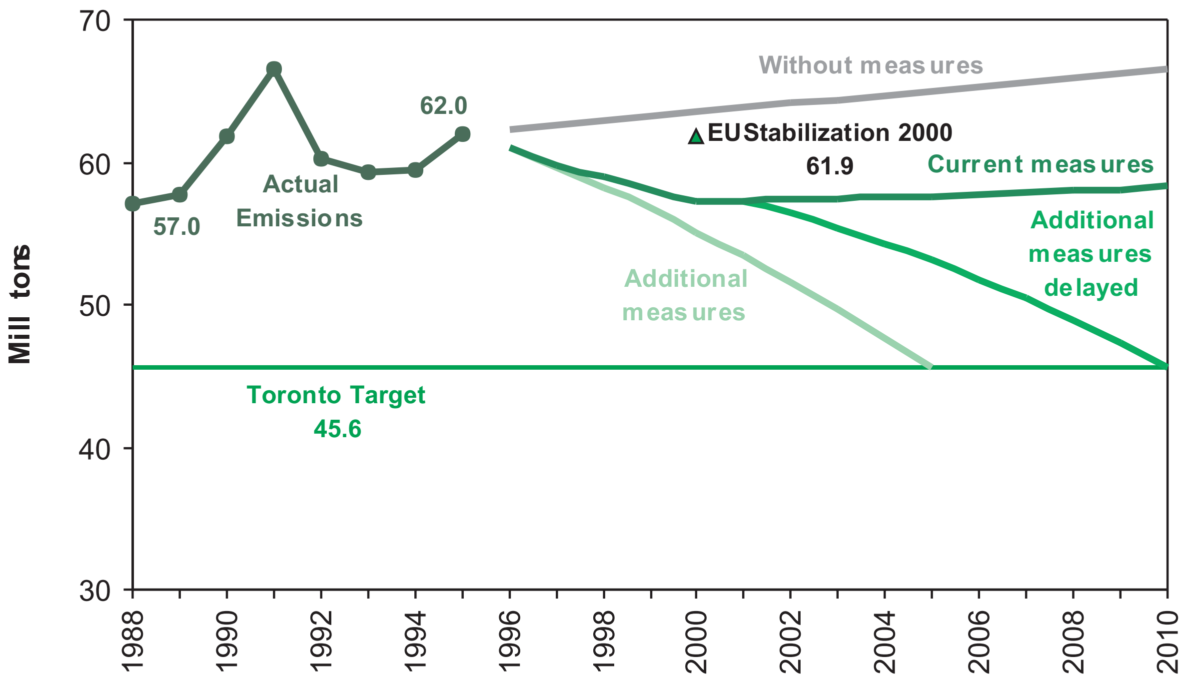


Figure 1.1: Austria's CO_2 emissions 1988 - 2010: Past trend (until 1995) and projections until 2010. (Sources: Austrian Council on Climate Change, Austrian Institute of Economic Research, Federal Environment Agency of Austria)

by the year 2005 or, even in case of a delayed action program, by 2010.

In Figure 1.2 on the next page scenario uncertainties are indicated. They reflect both the historically observed impact of fluctuations caused by temperature and economic activities and a (not quantified) additional uncertainty caused by extending the time horizon of the projections.

It should also be pointed out that a special study has been carried out (Kratena et al., 1997). It shows that a plan for accomplishing the required

Scenario	2000	2005	2010
Without	63.5	65.0	66.5
Current	57.3	57.5	58.3
Additional	55.1	45.6	
Add. delayed	57.3	53.1	45.6

Table 1.5: Projected CO_2 emissions (in million metric tons) for Austria in 2000, 2005 and 2010 for different scenarios.

CO_2 emissions reductions can be designed, which is cost efficient both from the perspective of individual households and firms and from an overall economic perspective. A key design element of such a plan is the principle of private-public partnerships and provision of incentives for market-driven technical progress.

Using the computer model GEMIS (FEA, 1997), recently completed simulations of CO_2 reduction potentials with regard to supply of electricity, district heating and space heating in Austria have shown that the reduction measures in the energy sector (see Chapter 5) are in fact very effective and could lead to results clearly exceeding the 20 % reduction target. It should be emphasized, however, that only a rapid realization of the substitution process and of efficiency improvements – assumptions these simulations were based on – will ensure the calculated CO_2 reduction results.

In regard to emissions projections of non-CO_2 greenhouse gases, the following observations can be made:

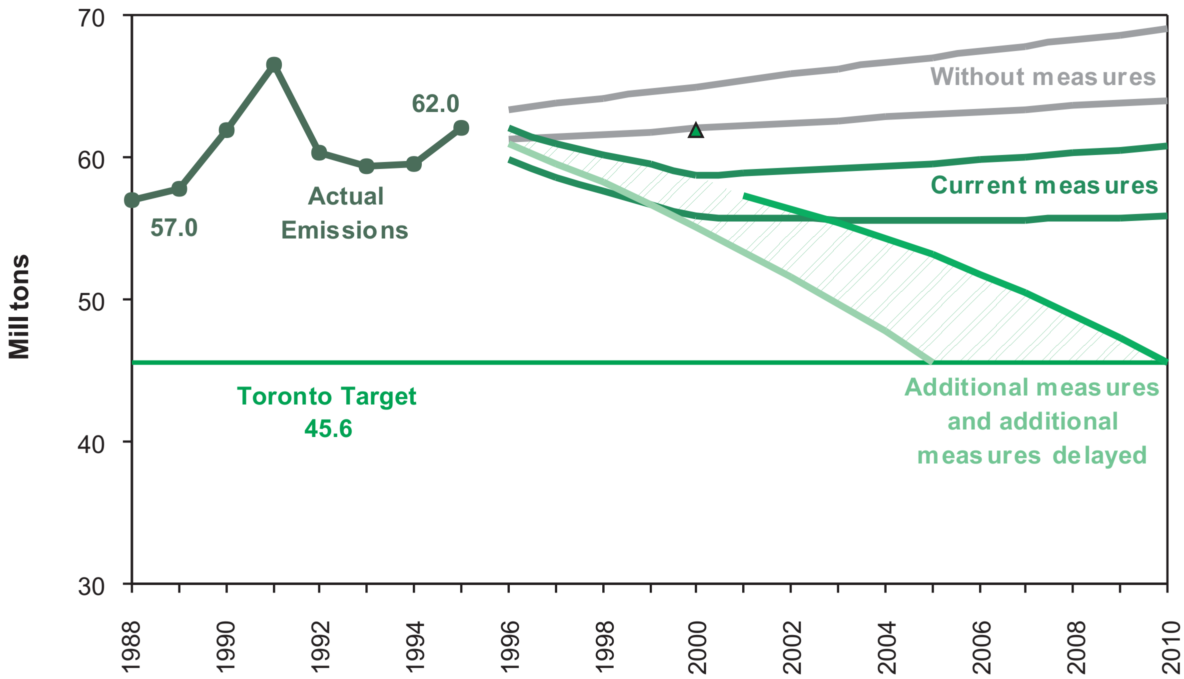


Figure 1.2: Austria's CO_2 emissions 1988 - 2010: Indication of scenario uncertainties. (Sources: Austrian Council on Climate Change, Austrian Institute of Economic Research, Federal Environment Agency of Austria)

- The existing emissions projections for CH_4 (Orthofer and Hackl, 1993; Steinlechner et al., 1994; cf. also FMEYF, 1994) are still in agreement with the emissions reported for 1990 and 1995, that is about 587,000 and 580,000 metric tons, respectively (cf. Chapter 1.5). In 2000 about 600,000 metric tons are expected, which seems to indicate a stabilization trend for Austria (cf. also FMEYF, 1994). Although no quantitative assessment of the reduction potential of the new ordinance on landfills has been made, a certain reduction beyond 2000 due to this ordinance can be expected.

- Because of revised emission factors, the existing emissions projections for N_2O (Orthofer et al., 1995; cf. also FMEYF, 1994) do not agree any more with the emissions reported for 1990 and 1995, that is about 11,600 and 12,800 metric tons, respectively (cf. Chapter 1.4). Therefore, reliable projections for 2000 and beyond cannot be presented.

- With regard to the ozone precursors NO_x and NMVOC, reference is made to Austria's First National Climate Report (FMEYF, 1994). Austria has passed an ozone law (Federal Law Gazette 210/1992), which establishes a stepwise reduction in emissions of 40% by the end of the year 1996, of 60% by the end of 2001, and of 70% by the end of 2006 – based on 1985 and 1988 emissions for NO_x and NMVOC, respectively. To reach this target, two resolutions containing measures catalogues were adopted by the First Chamber of Parliament ("Nationalrat") in 1992 and 1996. It calls on the competent authorities to implement concrete measures in their respective areas of competence.

Emissions reductions for NO_x and NMVOC are 11% and 17%, respectively, between 1990 and 1995 (cf. Chapter 1.5). It is noted that the emissions of these gases prior to 1990 are presently being recalculated and also being standardized according to the CORINAIR '94 methodology. Therefore, the presently achieved emissions reductions with reference to the respective base years (NO_x: 1985; NMVOC: 1988) cannot yet be presented.

- No projections are available for CO, which decreased by 14% between 1990 and 1995; and for HFCs, PFCs and SF_6, which are of major importance because of their high global warming potentials and, in some cases, of their large rates of increase.

1.7 Expected Impacts of Climate Change and Vulnerability Assessment

Austria can be expected to be very vulnerable to a climatic change in view of the fact that ecosystems in mountainous regions are highly sensitive. 70% of Austria's surface area are 500 m above the sea level, and 40% above 1,000 m.

The intricate topography of mountain environments complicates weather patterns by perturbing atmospheric dynamic and thermal characteristics, thus making it difficult to project changes in climate in these regions. Scenarios of these changes are highly uncertain; they are poorly resolved even in the highest-resolution general circulation models (GCMs). Assessing climate-induced impacts as well as establishing mitigation and adaptation strategies to counteract possible consequences of climate change, however, require climatological information at a spatial and temporal resolution that cannot yet be reached by current climate models. With these facts in mind, the effects of climate change on Austria's mountains can be summarized as follows:

If climate changes as projected in climate scenarios and with the help of downscaling techniques, it must be assumed that the length of time that snow packs remain will be reduced due to changed precipitation regimes, altering the timing and amplitude of runoff from snow, increasing evaporation, and decreasing soil moisture and groundwater recharge. As a consequence, flat areas as in the east of Austria, will experience hydrological conditions that are more distinct and severe than those in the mountains. Preliminary results imply that a rise of the European mean temperature by 1°C may reduce the length of the winter snow cover period by up to three weeks, depending on elevation. Already today, many Austrian glaciers are reported to be considerably reduced in size according to changes in glacier characteristics since the middle of last century. Changes in extreme events could affect the frequency of natural hazards such as avalanches and mudslides. Already today, the protective potential of Austria's high-altitude protection forest is not sufficient to cope with these events. Downstream consequences of altered mountain hydrology are likely to be highly significant.

Mountains support a relatively broad distribution of climates and a high diversity of habitats within a small physical area. Projections of responses of mountain vegetation to changes in temperature and precipitation, e.g., vegetational shifts, are complicated by uncertainties in species-specific responses to increased CO_2 as well as uncertainties in projections of the regional climatological characteristics themselves. These factors influence the competitive interactions between species while they are migrating upslope in response to warming. Results of ongoing Austrian field studies allow to deduce moving rates for a number of typical nival plant species over the last 70-90 years that are generally below 1.5 m per decade, but can be as great as 4 m per decade. These results suggest that global warming is already having a measurable effect on alpine plant ecology.

In the Alps where people do not depend on mountain environments for subsistence, mountain lands are primarily used for cash crops, timber harvest, and recreational activities. While not critical to human survival, mountain areas are of increasing local and regional economic significance. Recent results providing expertise on Austria's winter tourism at the level of districts indicate that future climate conditions will have important consequences for the winter tourism industry, which accounts for 4% of Austria's GDP. Since the length of the skiing season is sensitive to quite small climatic changes, considerable socio-economic disruption in communities that have invested heavily in the skiing industry, can be expected. Competition between alternative mountain land uses is likely to increase in the future.

1.8 Adaptation Measures

The Austrian federal government puts priority on the mitigation of greenhouse gas emissions, rather than on the adaptation to the adverse effects of a climatic change. It should be pointed out, however, that Austria continues to implement a set of adaptation measures that in the first hand serve the purpose of reduction of other environmental risks, but which are also beneficial for adapting to a climatic change. These measures range from the emission reduction of air pollutants over nature-conforming forestry to avalanche, erosion and torrent control.

Forest research and avalanche, erosion and torrent control, in particular, have a long history in Austria and are considered to be of vital importance to the country. About 46% of Austria is covered with forest and 70% of its surface area are 500 m and higher above the sea level. Climate change is likely to alter the natural range of many forest tree species, the genetic diversity of which is one of the most important prerequisites for adaptation. The genetic diversity of Austria's tree populations is mainly due to the size and number of refugial populations during glacial periods, to the number of pathways and interplay during re-colonisation, and to man-made influence of past deforestation and present-day forestry. Austria undertakes considerable scientific long-term efforts to evaluate macro- and microspatial genetic patterns, the impact of global change, and the impact of silviculture on the genetics of its domestic forest tree species.

Forests on steep slopes and in watershed areas of torrents and rivers constitute a protective measure against avalanches, mud flows, floods and erosion. At present, large areas of the potential sub-alpine protection forest zone (e.g., above the actual timberline, which in many regions is somewhat lower than the natural timberline) are deforested, or existing forests do not have sufficient protective capability. Research in Austria is aiming at providing basic knowledge about high-altitude afforestation and protection forest management. New and additional prevention measures are accompanying such protection measures. Complex field investigations and techniques allow to delineate and to reproduce hazard areas and thus to provide a fundamental basis for regional planning, which has a legal basis in Austria since 1975.

1.9 Financial Assistance and Technology Transfer

In 1994 Austria's *Official Development Assistance (ODA)* reached about 740 million US $, that is a proportion of 0.33% of its *gross domestic product (GDP)* (OECD average: 0.30%). 61% of budgetary and ERP (European Recovery Program) funds for bilateral technical assistance were allocated to priority regions and countries.

Austria's contributions to the *European Development Fund (EDF)*, which will start in 1998, will amount to about 400 million US $ over a 5-year period.

It is the declared policy of the Austrian authorities that all ODA-supported projects should be environmentally sustainable. In 1994 bilateral environment-specific and environment-integrated projects totaled 29 million US $.

Within the scope of the *East-Ecofund*, Austria's Federal Ministry of Environment, Youth and Family Affairs is practicing bilateral assistance in the field of environmental protection in its neighboring countries Czech Republic, Hungary, Slovak Republic and Slovenia. By the end of 1996, 105 projects have been approved for funding. The total commitment amounts to about 71 million US $.

During the pilot phase of the *Global Environment Facility (GEF)*, Austria has contributed about 35 million US $ (about 2.7%) to the *Global Environment Trust Fund (GET)* in order to underscore its interest in international measures for the protection of the environment. For the first replenishment of the GET, Austria contributed 20 million US $ or 1%.

In addition, there are a number of other, bilateral and multi-lateral, financial contributions for the support of the UN Framework Convention on Climate Change. Austria's new and additional bilateral contributions related to the implementation of the Convention amounted to about 16.9, 10.6 and 9.3 million US $ in 1994, 1995 and 1996, respectively. Austria's multi-lateral contributions related to the operating entity or entities of the financial mechanism, regional and other multilateral institutions and programs amounted to about 15.2, 14.9 and 13.7 million US $ in 1994, 1995 and 1996, respectively; some of them are new and additional contributions.

1.10 Research and Systematic Observation

Austria is actively engaged in promoting research and systematic observation related to the climate system by supporting numerous research projects and programs, at both the national and the international level.

In 1996 the *Austrian Network for Environmental Research (Österreichisches Netzwerk Umweltforschung)* was founded, in particular to coordinate the Austrian climate and environmental research. The network is intended to assist as a supporting tool in the growing internationalization of the Austrian environmental research. It consists of nine interdisciplinary nodes and its main objective is to cover various research fields in the environmental sector. For the time being the node for *Climate, Impacts of Climate Change and Atmospheric Environmental Research* concentrates on the recording and documentation of Austrian research activities in a wide range of scientific areas. The long term objective consists of the preparation of (i) a concept for a *Coordination and information center for Research on Climate and Climate Changes (Koordinations- und Informationszentrum für Klima- und Klimawirkungsforschung)* in Austria and (ii) a research concept in the area of climate and effects of climate change.

The *Austrian Council on Climate Change* works as a link between science and politics. It consists of representatives from various academic disciplines and provides consultation and support to the Austrian climate policy in view of the challenges of a global climate change. In interdisciplinary cooperation scientists from a wide range of research fields participate in the design of international research programs on climate change. They interpret the meaning of these research results for Austria and explore the possibilities of an environmentally sound economy in discussions with consumers, managers and politicians.

1.11 Education, Training and Public Awareness

The Austrian federal government does not only rely on the effectiveness of regulatory instruments. In order to ensure the lasting success of environment and (in particular) climate protection, defined goals must find social acceptance and the population must show the willingness to actively contribute to their realization. According to a comprehensive study, a superior majority of the Austrian population shows this acceptance and willingness. People understand the need to contribute politically and personally as well as to accept limitations of their own life styles. However, further information on this topic would be appreciated and is also very necessary. In some areas the lack of information still prohibits good energy saving measures from becoming fully effective.

Information and public relations instruments are systematically built up for this purpose. The Federal Ministries for the Environment, Youth and Family Affairs as well as for Education and Culture have already initiated a series of important and far-reaching projects. Currently, as projects of exemplary importance, there are a state-wide campaign for climate protection organized for autumn 1997 and the introduction of a focus program “Building Ecology Awareness in Schools”, tentatively limited to 22 state-wide selected schools. From these and other projects the federal government expects, for good reasons, a positive impact on the Austrian contribution to the global climate protection policy in addition to legislative measures.

Chapter 2

Introduction

2.1 International Background Information

Austria signed the United Nations Framework Convention on Climate Change at the United Nations Conference on Environment and Development (UNCED) held in Rio de Janeiro in June 1992.

Preparations had been under way for many years on a global agreement to regulate measures for controlling the anthropogenic greenhouse effect and its adverse impacts. The objective of these efforts was to adopt an international convention under which the required measures could be regulated at a global level and to ensure the dynamic development of such a convention through appropriate protocols.

The work toward a climate convention began at the First World Climate Conference in Geneva in February 1979.

The international efforts to protect the earth's atmosphere took on an even more concrete form at the conferences in Villach in 1985 and in Villach and Bellagio in 1987.

At the Toronto Conference in 1988, an action plan was recommended which, inter alia, calls for the 1988 CO2 emission levels to be reduced by 20% and energy efficiency world-wide to be increased by 10% by the year 2005. The Conference also recommended that a comprehensive framework convention be drawn up on the protection of the Earth's atmosphere.

An Austrian intervention issued during the Second World Climate Conference in 1990 underscored the role of the precautionary principle as an essential basis for environmental action.

In late 1990 the UN General Assembly set up an organizational framework for developing and negotiating a climate convention as a legally binding instrument to control the anthropogenic greenhouse effect. After several years of consultations in an international scale, the United Nations Framework Convention on Climate Change was signed in June 1992 at the UNCED by 158 States, Austria among them.

The Convention entered into force world-wide on 21 March 1994 (90 days after the date of deposit of the fiftieth instrument of ratification), it entered into force for Austria on 29 May 1994.

The objective of this Convention is the "… stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Such a level should be achieved within a time frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner" (Art. 2).

The commitments under the Convention pertain to the greenhouse gases not controlled by the Montreal Protocol on Substances that Deplete the Ozone Layer.

As a developed country, Austria has – among others – the following obligations under the Convention (Art. 4.2 and 12):

- ▹ To draw up national inventories of anthropogenic emissions by sources and removals by sinks of greenhouse gases not controlled by the Montreal Protocol;
- ▹ To develop and implement national and, where required, regional programs to mitigate climate change;
- ▹ To adopt national strategies and take corresponding measures to mitigate climate change;
- ▹ To communicate detailed information about these strategies and measures and about the anthropogenic emissions of the corresponding greenhouse gases expected to result from them.

In regard to measures designed to achieve this target and implement the agreement, the parties to the contract should be guided by a number of principles. Apart from the precautionary principle stipulated in Article 3, Paragraph 3, another important premise is the Principle of Common, Yet Different Responsibilities laid down in Article 3, Paragraph 1. Due to the global character of climate change, all nations have been called upon to take action. However, since it is a fact that the greater part of CO_2 emissions has been caused by industrialized nations, they will assume a leading role in fighting climate change.

The agreement's supreme body is the Conference of the Parties (COP). The other bodies are one secretariat and two permanent subsidiary bodies, viz. SBSTA – Subsidiary Body for Scientific and Technological Advice and SBI – Subsidiary for Implementation. The SBSTA is in charge of providing information and expert opinions on scientific and technological issues. The COP SBI is supposed to offer support in putting the convention into practice and in monitoring the implementation procedure.

The first Conference of the Parties was held in Berlin from 28 March to 7 April 1995. The decision to strengthen the contents of the Climate Convention may be described as the most important outcome. The so-called Berlin Mandate contains the instruction to negotiate a protocol or another legal instrument for reducing greenhouse gas emissions that defines concrete goals and time-frames, strategies and measures. Negotiations on this matter by the newly established Ad-hoc-Group on the Berlin Mandate have to be completed by the third Conference of the Parties, to be held in Kyoto in December 1997, at the latest. The Ad-hoc-Group on Article 13 was set up as yet another body which is to introduce a consultative process for resolving issues on the implementation of the agreement.

The most significant political signal of the second Conference of the Parties, which took place in Geneva between 8 July and 19 July 1996, was the Ministerial Declaration. It is a political declaration of intent sending out a highly positive signal for an accelerated continuation of the negotiating process for a protocol. Among other things this declaration, based on the scientific results of the second IPCC Report, calls for determining binding reduction goals for industrialized countries in the FCCC Protocol. The Ministerial Declaration explicitly recognizes and underscores the results of the IPCC Report. The Ministerial Declaration was supported by most delegations within the COP.

The IPCC, the expert committee of the United Nations, submitted its second comprehensive report shortly before the second Conference of the Parties. After careful evaluation of all circumstantial evidence, the gist of the report was that human influence on the global climate system was discernible. The AGBM was instructed to intensify its efforts to create a protocol/legal instrument. It should be particularly noted that this legal instrument to be adopted has to contain legally binding targets regarding emission ceilings and the reduction of emissions within a stipulated time-frame.

2.2 National Background Information

Austria has committed itself to the "Toronto Target" which calls for CO_2 emission levels from 1988 to be reduced by 20% by the year 2005. This target is laid down in writing in the Energy Reports of the Austrian government (1990, 1993 and 1996) and in resolutions of the Nationalrat (First Chamber of Parliament).

A First National Climate Report was conveyed to the Climate Secretariat in September 1994. It has already been subjected to a thorough examination by the Climate Secretariat and commented on in a UN document (FCCC/IDR.1/AUT). At this point the Second National Climate Report is to be submitted to the UN Climate Secretariat.

The guidelines on the basic structure and individual items contained in the National Communication were decided by the Conference of the Parties at its second session (FCCC/CP/1996/15/Add.1). The National Communication in Austria was elaborated in accordance with these guidelines by the IMC Climate (Interministerial Committee for the Coordination of Measures on the Protection of Global Climate).

The climate report was put together by the lead authors Dr. Matthias JONAS (ÖFZS) and Univ.-Prof. Dr. Stefan SCHLEICHER (ACCC and University of Graz, Institute of Economics). The Federal Environment Agency of Austria has elaborated the emission inventory (Chapter 4) and the reduction potential estimates in Chapter 5. Reviewers were Professor Bo DÖÖS (GEM - Global Environmental Management) and Dr. Krzysztof OLENDRZYNSKI (NMI - Norwegian Meteorological Institute). The Federal Ministry of the Environment, Youth and Family Affairs, Unit I/4 (Dr. Helmut HOJESKY, Dr. Barbara KRONBERGER-KIESSWETTER, Birgit KAISERREINER), coordinated the production of the National Climate Report, submitted its own contributions to it, and took on the editing tasks of revising and compiling the report.

The following sources were particularly involved in writing this text:

- ▷ Federal Ministry of Economic Affairs
- ▷ Federal Ministry of Agriculture and Forestry
- ▷ Federal Ministry of Science and Transport
- ▷ Federal Ministry of Finance
- ▷ Federal Ministry of Education and Cultural Affairs
- ▷ Federal Ministry of the Environment, Youth and Family Affairs (units I/5 and II/1)
- ▷ Federal Environment Agency of Austria
- ▷ Austrian Research Centre Seibersdorf (S. Schidler)
- ▷ Austrian Institute of Economic Research (K. Kratena)
- ▷ University of Agricultural Sciences, Vienna (H. Aulitzky, J. Boxberger, H. Hasenauer, H. Kromp-Kolb, H.P. Nachtnebel, S. Seidl)
- ▷ University of Innsbruck (M. Kuhn)
- ▷ University of Vienna (M. Gottfried, G. Grabherr, M. Hantel, H. Hauck, H. Pauli)
- ▷ University of Graz (M. Narodoslawsky)
- ▷ Federal Forest Research Institute (T. Geburek, F. Müller, H. Schaffhauer)
- ▷ Gerling Global (W. Jakobi)
- ▷ Hydrographic Central Bureau (F. Nobilis)
- ▷ Münchener-Rückversicherungsgesellschaft (G. Berz)
- ▷ Swedish University of Agricultural Sciences (M. Breiling)
- ▷ Austrian Association of Power Utilities (O. Pirker)
- ▷ Central Institute for Meteorology and Geodynamics(I. Auer, R. Böhm)
- ▷ Federal Institute and Research Centre for Agriculture (O.H. Danneberg)
- ▷ Federal Chamber of Labour (Bundesarbeitskammer) (Ch. Streissler)

Other references are listed in the bibliographies.

The Austrian Council of Ministers took official notice of this report on 1 July 1997.

Chapter 3

National Circumstances

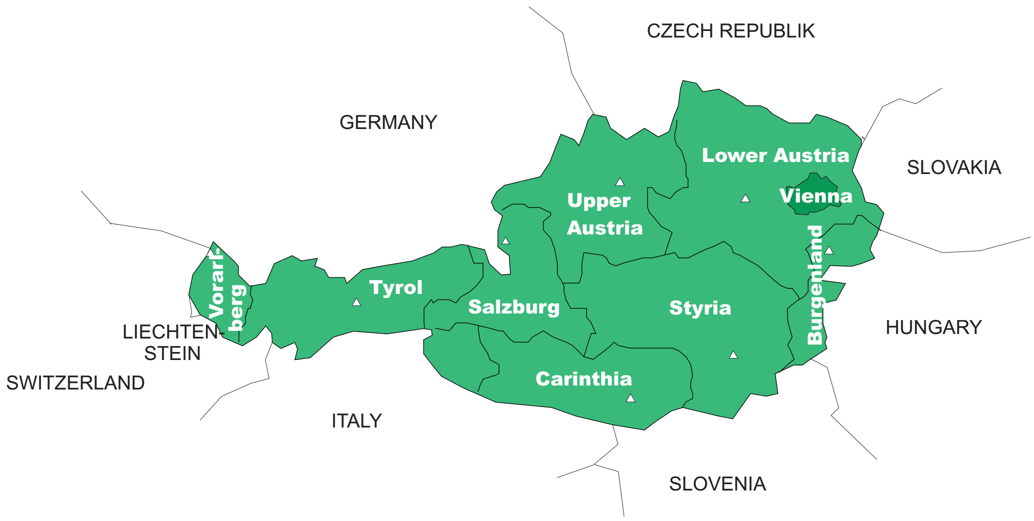


Figure 3.1: Austria and its neighbour countries

This chapter provides background information about Austria with respect to geography, climate, population, economic performance, energy use and social indicators. We complement this information with an overview of government related climate policy activities.

3.1 Geographical Profile

Austria's location in the center of Europe implies that it is highly exposed to all activities of its neighbor countries, ranging from economic performance and transit traffic to cross-border pollution (see Figure 3.1).

Austria's total surface area of 83,855 km^2 features five main types of landscapes: the dominating eastern Alps (63 per cent of total area), the Alpine and Carpathian foothills (11 per cent), the eastern foreland which is part of the low-lying Pannonic plains (11 per cent), the Vienna basin (4 per cent) and the granite and gneiss highland north of the Danube which is part of the Bohemian massif (10 per cent).

3.2 Climate Profile

Austria is experiencing three different types of climate. The continental climate in the eastern part is characterized by average summer temperatures of around 19°C and annual rainfalls and 700 mm. The Alpine climate in the mountain areas is shaped by high rainfall, short summers and long winters. The remaining parts of the country face a transition climate that is determined by the predominant westerly and north-westerly winds from the Atlantic and precipitation of between 700 and 2500

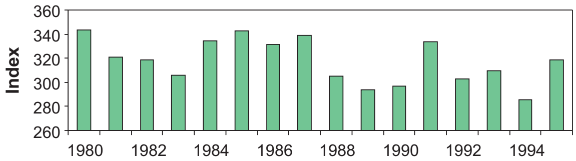


Figure 3.2: Heating Degree Days (Source: IER)

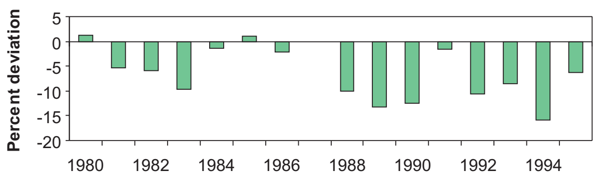


Figure 3.3: Heating Degree Day deviations from normal year (Source: IER)

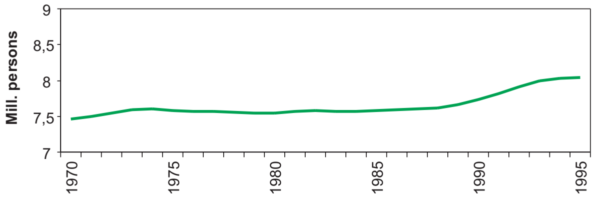


Figure 3.4: Population

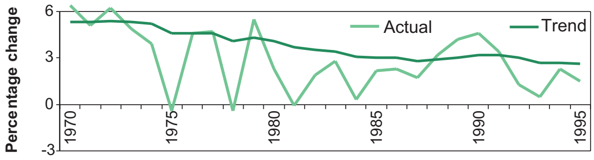


Figure 3.6: Gross domestic product at constant prices (Source: IER)

mm, depending of altitude.

Also in Austria an increase of about one degree in average temperatures has been measured over the last 100 years. Exceptional warm years could be observed during the last fifteen years. An important indicator for this phenomenon is the decrease in the annual number of Heating Degree Days (HDD), which has a strong impact on the energy demand for space heating. Figures 3.2 and 3.3 on the facing page present the HDD values and their percentage deviations from their normal year values. Obviously Austria has experienced a sequence of remarkable warm years since 1988.

Other useful indicators for long term tendencies in average temperatures stem from measurements of the Alpine glaciers. Historical measurements reveal a steady decline of the volume of glaciers since the past century. This tendency has increased since the early eighties of this century. Additional information about Austria's climate is provided in Chapter 7.

3.3 Population Profile

Austria's total permanent population has reached 8.05 million inhabitants in 1995. After declines in the late seventies and stagnation in the early eighties the political events in neighboring eastern countries have lead to increased immigration in the early nineties. The population density is about 105 inhabitants per square meter. Figures 3.4 and 3.5 indicate the changing dynamics of Austrian population trends.

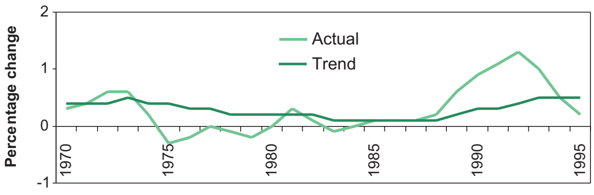


Figure 3.5: Population trends

Infant mortality is now at 5.4 per 1,000 live births, down from 27 in the late sixties. Over the same period the number of births per woman was cut by half and is currently at 1.40. Life expectancy at birth is 73.5 years for male and 80.1 years for female persons. Future trends of Austrian population will be mainly determined by immigration policies.

3.4 Economic Profile

Austria is a typical small open economy that is closely linked to its main trading partner Germany. In 1995 current GDP was ATS 2,326 billions, resulting in a per capita GDP of ATS 289,090. With a GDP per capita of USD 28,670 Austria belongs to the most prosperous economies of the world. Since January 1995 Austria is a member of the European Union.

Austrian GDP growth has been stronger than total or European OECD average. The history of Austria's business cycle fluctuations and the trend values of GDP growth is presented in Figure 3.6. Currently a long term GDP growth of about 2.7% is expected.

Two specific structural features of the Austrian economy are of special relevance to climate issues. Compared to most other industrialized countries Austria is still overexposed in basic materials industries, a historical burden of the Second World War that explains the high energy intensity of Austrian industry. Tourism, on the other hand, contributes about 15% to GDP and is heavily vulnerable both

	GDP at 1983 prices		GDP price index		GDP at curr. prices		Popul.	GDP per head	
	Bill ATS	%-Chg.	Index	%-Chg.	Bill ATS	Bill USD	Mill	1,000 ATS	1,000 USD
1980	1182.3	2.3	85.9	5	1016.1	78.53	7.549	134.61	10.4
1981	1181.1	−0.1	91.6	6.6	1081.7	67.93	7.569	142.92	8.97
1982	1203.6	1.9	96.5	5.3	1161.2	68.07	7.576	153.27	8.98
1983	1237.4	2.8	100	3.7	1237.4	68.88	7.567	163.52	9.1
1984	1241.5	0.3	104.6	4.6	1299	64.92	7.57	171.6	8.58
1985	1269.3	2.2	107.9	3.1	1369.1	66.18	7.578	180.67	8.73
1986	1299.1	2.3	110.8	2.7	1439	94.26	7.588	189.65	12.42
1987	1320.9	1.7	113.1	2.1	1494.1	118.19	7.598	196.65	15.56
1988	1362.7	3.2	114.9	1.6	1565.8	126.8	7.615	205.62	16.65
1989	1420.3	4.2	118	2.7	1676.7	126.73	7.659	218.92	16.55
1990	1485	4.6	122.1	3.4	1813.5	159.5	7.729	234.63	20.64
1991	1535.9	3.4	126.7	3.7	1945.8	166.65	7.813	249.05	21.33
1992	1556.5	1.3	132.2	4.3	2057.3	187.21	7.914	259.95	23.66
1993	1564.2	0.5	135.9	2.8	2125.2	182.7	7.991	265.95	22.86
1994	1600.6	2.3	140.1	3.1	2242.5	196.34	8.03	279.27	24.45
1995	1623.8	1.5	143.3	2.3	2326.3	230.74	8.047	289.09	28.67

Table 3.1: Economic indicators (Source: IER)

	Production Sectors			Domestic Demand				Foreign Sector	
	Prim.	Sec.	Tert.	Private Cons.	Public Cons.	Fixed Invest.	Inven-tories	Export	Import
1980	3.7	37.6	58.6	55.9	18.7	24.1	3.6	34	36.2
1981	3.6	37.1	59.3	56.4	19	23.9	0.9	35.7	36
1982	4	35.7	60.3	56.7	19.2	21.7	0.3	35.6	33.7
1983	3.7	36	60.3	57.9	19	21.2	0.5	35.9	34.6
1984	3.9	35.4	60.7	57	19.1	21.2	2.6	38.1	38
1985	3.6	36.1	60.3	56.8	18.9	22.1	1.7	39.9	39.4
1986	3.6	36.3	60.2	56.7	18.9	22.2	1.6	38	37.4
1987	3.5	35.7	60.8	57.4	18.6	22.8	1.5	38.6	38.8
1988	3.6	35.6	60.9	57.5	18.2	23.6	1	41.2	41.5
1989	3.4	35.6	61	57.2	17.7	24	0.2	44	43.1
1990	3.4	35.6	61.1	56.7	17.2	24.5	0.5	45.4	44.3
1991	3	35.7	61.2	56.4	17	25.2	0.5	46.5	45.6
1992	2.9	35.2	61.9	57.3	17.1	24.9	−0.1	46.7	45.8
1993	2.9	34.5	62.6	57.4	17.5	24.2	0.3	45.8	45.3
1994	3	35.1	62	57.4	17.5	25.4	0.3	47.3	47.9
1995	2.8	34.6	62.6	57.8	17.2	25.8	0.3	49.7	50.8

Table 3.2: Structure of supply and demand as percentage of GDP (Source: IER)

in winter and in summer with respect to weather conditions and thus potential climate changes.

Table 3.1 on the facing page summarizes key information about Austria's GDP at constant and current prices and the corresponding numbers per capita. The dynamics of the supply and demand structure is outlined in Table 3.2 on the facing page. Primary production contributes now less than 3 percent to total GDP. With declines in the secondary sector the most dynamic sector is obviously the tertiary sector. A similar analysis for domestic demand reveals with respect to GDP constant shares for private consumption, declining shares for public consumption but increasing shares for fixed investment. A look at the corresponding shares for exports and imports stresses the increasing international links of the Austrian economy which were even accelerated after the opening of the Eastern borders in 1989 and EU membership in 1995.

3.5 Energy Profile

Since the oil price shocks Austria was fairly successful in decoupling energy demand from GDP growth. Currently one percent GDP growth requires only a half percent increase in energy requirements. Another feature of the Austrian energy profile is the outstanding high share of renewable energy. Hydropower and biomass account now for a quarter of energy inputs. Almost two thirds of energy, however, stem from imports.

A first look at the supply and demand structure of the energy sector is contained in Table 3.3 on the next page which also reveals a fairly stable share of transformation and distribution losses in the Austrian energy system. Energy demand shares by sectors show a strong expansion of energy in the transport sector which is almost completely matched by the declines in industry. The demand share of the remaining sectors (residential and other) remains almost stable.

Electricity generation deserves special attention since around 70 percent of electricity is generated by hydro power. In a referendum in 1978 the use of nuclear power for electricity generation was voted down.

Information about the energy intensity of the Austrian economy may be gathered from Table 3.4 on the next page. The energy requirements per capita which fluctuate around 140 MJ belong to the lowest among industrialized countries. On the other hand energy input per unit GDP could be halved over the past 15 years.

The supply structure of the Austrian energy system is still heavily dependent on oil with a share of around 40 percent as can be seen from Table 3.4 on the next page. Coal declined to 11 percent whereas gas increased to more than 22 percent. Altogether the supply share of fossil fuels declined from almost 80 percent in 1980 to 74 percent in 1995. Hydropower now accounts for almost 15 percent and contributes with a 9 percent share of biomass and about 2 percent waste to more than one quarter of renewable energy in the supply mix.

Changes in the structure of energy demand are indicated in Table 3.5 on page 25. The demand fuel mix is again dominated by a constant 30 percent share of oil products. Direct use of coal fell to 5 percent whereas gas has expanded to 13 percent. The increased transformation of energy to electricity shows up in a contribution of 14 percent. Direct use of biomass in energy consumption fluctuates around 9 percent. Remarkable is the low 3 percent share of heat which could be raised by increasing cogeneration capacities.

3.6 Social and Political Profile

Austria is a federal state with government responsibilities shared by three levels of territorial authority, the federation ("Bund"); the nine federal provinces ("Länder") and the local authorities.

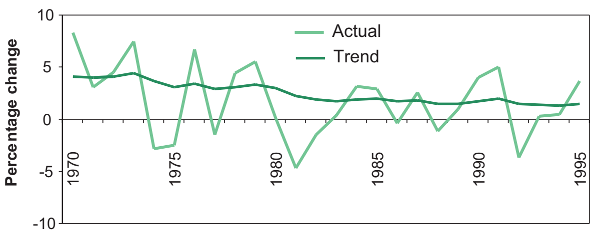


Figure 3.7: Energy consumption (Source: IER)

	Energy Consumption			Supply %-Shares		Demand %-Shares			
	Petajoule	Actual %-Chg.	Trend %-Chg.	Imports	Domestic	Transport	Industry	Other Sectors	Losses
1980	1046.1	0	3	65.2	34.8	17.7	24	34.5	23.7
1981	996.8	−4.7	2.2	65.6	34.4	18.3	23.9	34	23.8
1982	981.2	−1.6	1.8	58.4	41.6	18.5	23.6	35.3	22.5
1983	985.3	0.4	1.7	55	45	18.6	22.9	34.8	23.8
1984	1016	3.1	1.8	63.9	36.1	17.8	23.2	34.4	24.6
1985	1044.8	2.8	1.9	62.5	37.5	17.7	22.7	35.7	23.9
1986	1040	−0.5	1.7	64.5	35.5	18.3	21.8	36	23.9
1987	1070.8	3	1.8	62.3	37.7	17.9	21.2	36.1	24.7
1988	1059	−1.1	1.5	60	40	19.3	22	34.5	24.2
1989	1072.8	1.3	1.5	60.4	39.6	19.7	22.2	33.5	24.6
1990	1116.4	4.1	1.8	64.8	35.2	19.4	21.7	33.5	25.5
1991	1172.1	5	2.1	63.7	36.3	20.4	20.5	34.1	24.9
1992	1130.2	−3.6	1.5	64.9	35.1	21.2	20	34.3	24.5
1993	1134.1	0.3	1.4	63	37	21	19.4	35.6	23.9
1994	1140.8	0.6	1.3	61.7	38.3	21.5	19.5	34.3	24.7
1995	1183.3	3.7	1.6	63.2	36.8	21.4	19.4	34.1	25.2

Table 3.3: Energy indicators (Source: IER)

	Total	Energy Supply by Fuel %-Shares						Intensity	
	Petajoule	Coal	Oil	Gas	Biomass	Waste	Hydro	MJ per capita	GJ per GDP*
1980	1046.1	14.7	48.3	16.8	7.5	1.5	12.5	138.6	1029.5
1981	996.8	15.9	45.3	16.5	8.3	1.8	13.9	131.7	921.5
1982	981.2	15.4	44.4	16.2	9.3	2.2	14.2	129.5	845
1983	985.3	16.3	42.9	16.3	9.5	2.3	14	130.2	796.3
1984	1016	18.1	39.9	17.7	9.2	2.6	13.1	134.2	782.2
1985	1044.8	17.4	39.4	18.4	8.9	2.9	13.6	137.9	763.1
1986	1040	15.5	41.2	18	8.9	3.2	13.7	137.1	722.7
1987	1070.8	15.5	41.2	18.2	8.6	3	15.4	140.9	716.7
1988	1059	14.6	40.7	17.5	8.7	3.9	15.5	139.1	676.3
1989	1072.8	14.4	40	18.6	10.2	2.1	15.2	140.1	639.9
1990	1116.4	15.4	39.6	19.6	9.9	2.1	13.1	144.4	615.6
1991	1172.1	15.4	40.7	19.8	8.8	2.1	12.6	150	602.4
1992	1130.2	12.3	41.2	20.1	9	2.3	14.4	142.8	549.4
1993	1134.1	10.8	41.2	21.2	9.2	2.3	15.1	141.9	533.7
1994	1140.8	11	40.9	21.6	9.1	2.5	14.6	142.1	508.7
1995	1183.3	11.6	39.8	22.6	9.1	2.4	14.6	147.1	508.7

* GJ per mill. ATS GDP at 1983 prices

Table 3.4: Structure of energy supply and energy intensity (Source IER)

	Total	Energy Demand by Fuel %-Shares							Losses
	Petajoule	Coal	Oil	Gas	Electricity	Biomass	Waste	Heat	%-Shares
1980	1046.1	8.9	34.9	11.2	11.4	7.5	1	1.3	23.7
1981	996.8	9.2	33.2	10.7	12	8.3	1.3	1.4	23.8
1982	981.2	8.9	32.9	10.6	12.3	9.3	1.6	1.7	22.5
1983	985.3	9	31.6	10.2	12.4	9.5	1.7	1.7	23.8
1984	1016	9.9	29.2	10.8	12.6	9.2	1.9	1.7	24.6
1985	1044.8	9.5	29.7	11.3	12.8	8.9	2	1.9	23.9
1986	1040	8.3	30.7	11.1	12.9	8.9	2.2	2	23.9
1987	1070.8	7.9	30.3	11.2	13	8.6	2.1	2.1	24.7
1988	1059	7.4	30.2	11.1	13.7	8.7	2.7	2.1	24.2
1989	1072.8	7	29.7	11.2	13.8	9.9	1.4	2.5	24.6
1990	1116.4	6.4	29.1	11.6	13.8	9.7	1.4	2.6	25.5
1991	1172.1	6.5	30.2	11.8	13.7	8.6	1.3	2.8	24.9
1992	1130.2	5.6	30.4	12.3	14.1	8.7	1.3	2.9	24.5
1993	1134.1	5.1	30.6	12.9	14.1	8.9	1.3	3.2	23.9
1994	1140.8	5.1	30.2	12.5	14.2	8.8	1.3	3.1	24.7
1995	1183.3	4.9	29.5	13.1	14.1	8.8	1.2	3.3	25.2

Table 3.5: Structure of energy demand (Source: IER)

The social organization shows strong corporalist influences with its compulsory memberships in chambers of commerce or chambers of workers and employees. Traditionally these chambers and the labor unions are involved in political decision making.

The distribution of government responsibility between the federation an the provinces is the main reason why energy and environmental matters to a large extent are in the competence of the provinces. Whenever a national approach is required but the federal government does not have the authority of policy making the parties involved may conclude a treaty of state ("Staatsvertrag") in which they agree to undertake certain actions, jointly or separately. Such a state treaty is currently in preparation for the coordination of climate policy.

3.7 Indicators for Mitigation Performance

Figure 3.8 with Austria's CO_2 emissions reveals a number of causalities that shaped energy use and related emissions over the past decades. The oil price shocks of 1974/75 and 1979/80 led to a significant decline of energy flows. With the decline of oil prices in the late eighties energy intensities increased again. The 1991 spike is mainly due to comparatively low winter temperatures in that year. Figure 3.9 on the next page depicts the actual percentage changes and their trend value which is currently approximately 0.4 percent per year.

A first indicator about emission mitigation are per capita emissions. Except for variations due to temperature and production fluctuations, per capita CO_2 emissions have been remarkable stable over the past decades as visible in Figure 3.10 on the next page.

Another indicator about emission mitigation relates emissions to GDP. Together with an index that also relates primary energy to GDP we obtain in Figure 3.11 on the next page revealing insights about the restructuring of the Austrian energy sec-

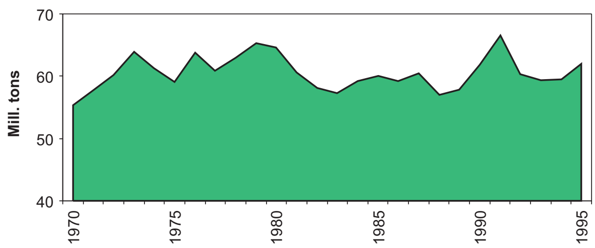


Figure 3.8: CO_2 emissions (Source: IER)

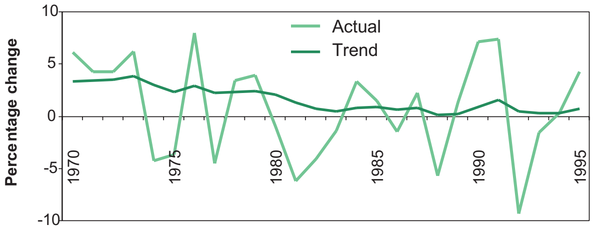


Figure 3.9: CO_2 emissions — Percentage changes (Source: IER)

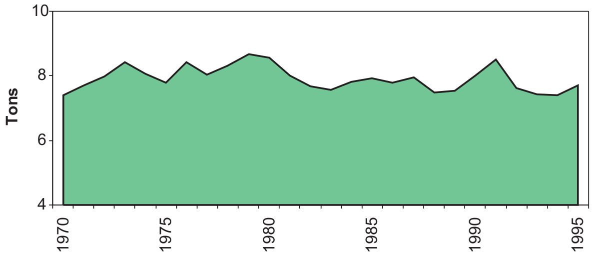


Figure 3.10: CO_2 emissions per capita in tons (Source: IER)

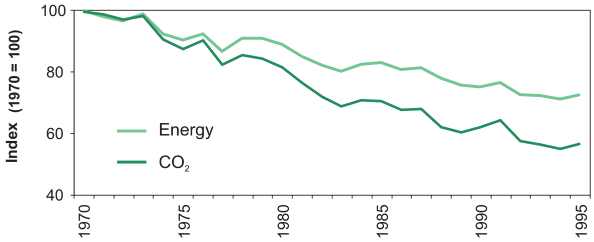


Figure 3.11: CO_2 emissions per unit GDP Index (1970 = 100)

tor. Obviously the CO_2 emission intensity of production declined faster than the energy intensity of production. This means that besides a general increase of energy efficiency a significant fuel switching effect became effective.

3.8 Land-Use/Cover Characteristics

As common to all Alpine areas that underwent changes due to developments in industry and tourism during recent decades, Austria also experienced extensions of human settlement areas beyond limits that were observed in the past or are known from experience (Aulitzky, 1974, 1996). Figure 3.12 on the facing page shows the areal development typical for villages in small valleys and along big rivers, here for various villages in the Inn valley between 1740 and 1963. Their areal extension is linked with the disappearance of flood-plain forests and the loss of flood-retention areas.

Interesting to note is that tourist nights in mountain valleys increase with altitude and, therefore, with risk potential (Amt der Tiroler Landesregierung, 1970; Aulitzky, 1974). Due to alterations of mountainous landscapes brought about by the building of roadway dams, sealing of soils, adverse agricultural practices, etc., the risk potential of natural disasters is greater than in the past (cf. Figure 3.13 on page 28). Another important reason for the increase in risk potential is the lack of high-altitude forests at the expense of pastures for agricultural needs (FMAF, 1972; Greif, 1980). This, in turn, lead to an increased landscape sensibility with consequences for mountain populations and existing socio-economic structures (Günschl, 1970; Schönegger, 1996; Aulitzky, 1996a, b; see also Chapter 7).

The overall land-use/cover change of Austria since 1960 and the development of Austria's forested area and growing stock in particular are shown in Figures 3.14 on page 28 and 3.15 on page 29. Between the inventory periods 1961/70 and 1986/90 the total area of Austria's forest increased from about 3,691 to 3,878 kha, mainly at the expense of grassland and cropland. Average rates of annual area increase were 16 kha/y during 1960 - 1970 and 9 kha/y during 1970 - 1990. The area of Austria's productive forest makes up most of the total forest area: In 1961/70 its area fraction was about 88% and in 1986/90 about 86%. The standing stock of the productive forest (similar numbers of the total forest are not available) also increased, from about 757 (1961/70) to 972 mill. m^3 o.b. (1986/90). This explains the considerable sink strength of Austria's forest in regard to CO_2; the CO_2 removal rates for 1990 and 1995, taking into account past land-use/ cover change since 1960, are estimated to be 13.3 and 13.6 million metric tons, respectively (cf. Chapter 4).

About 70% of Austria's surface area are 500 m

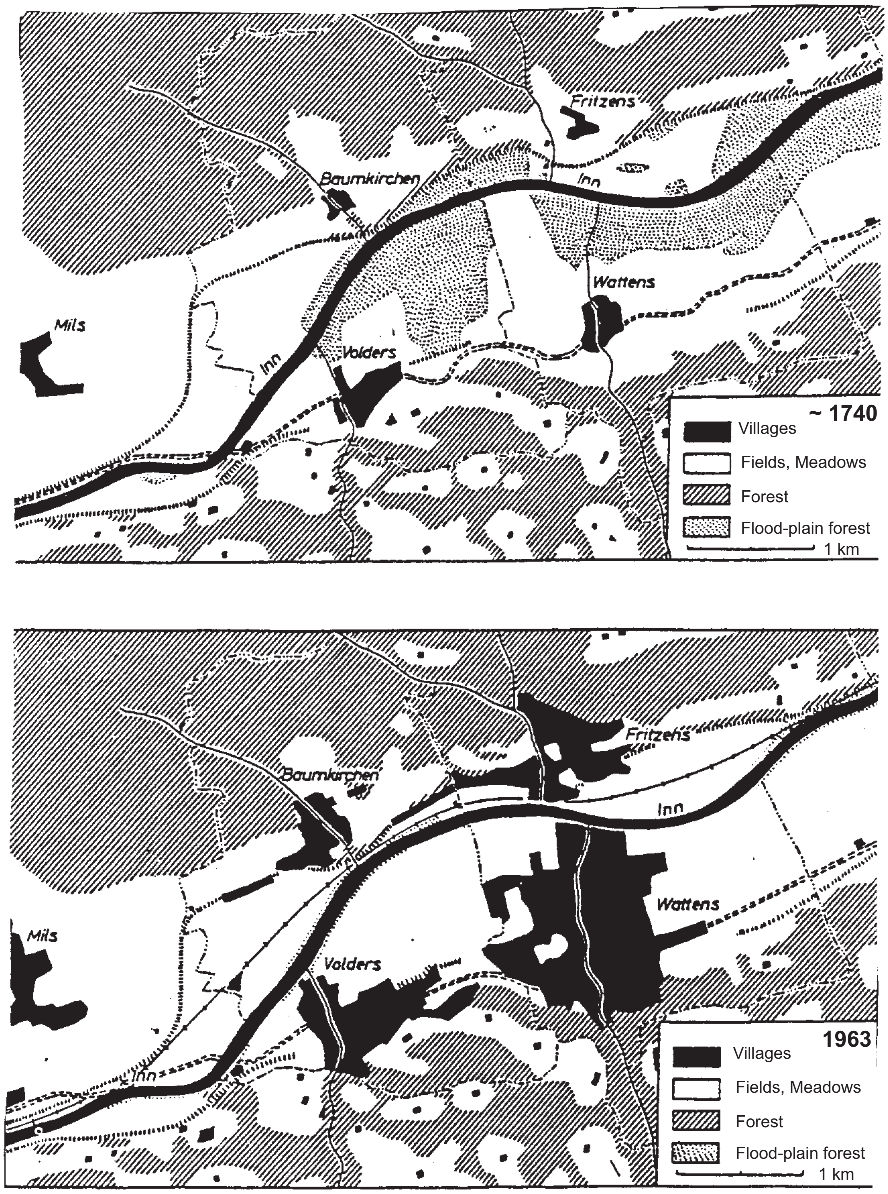


Figure 3.12: Extension of settlement areas and disappearance of flood-plain forests and flood-retention areas in the Inn valley between 1740 and 1963 (the area affected in total by this development increased by 828 %). (Source: Fliri 1964)

above the sea level, and 40% above 1,000 m. Given this information and the fact that ecosystems in mountainous regions are highly sensitive, it must be feared that Austria is particularly vulnerable to a climatic change (see 7.1). Figure 3.16 on page 29 shows Austria's land use/cover in 1991 by altitude.

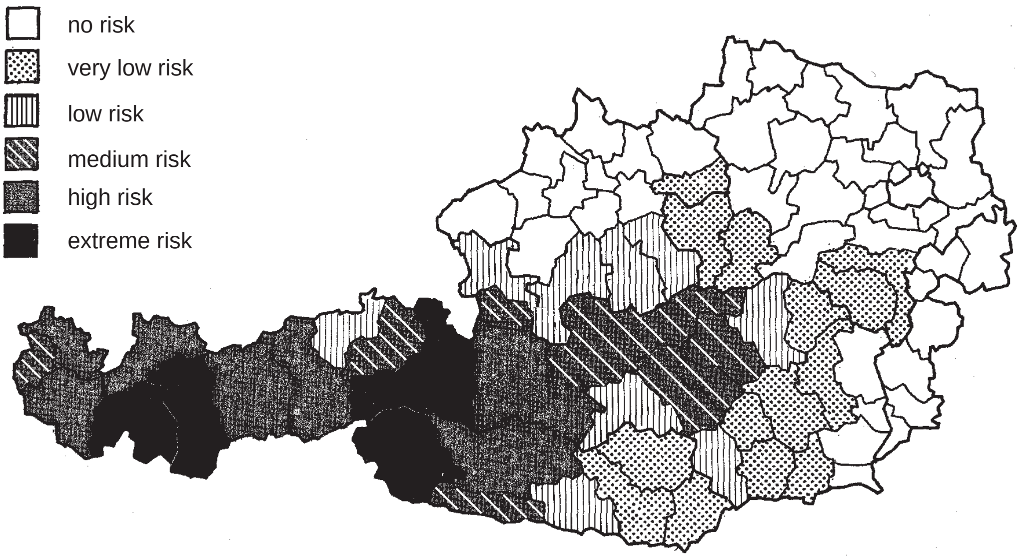


Figure 3.13: Austrian districts with high risk of natural disasters, amongst others due to the lack of high altitude forests. (Source: Kreisl 1982, Fischer-Kowalski et al. 1988, FMAF 1972)

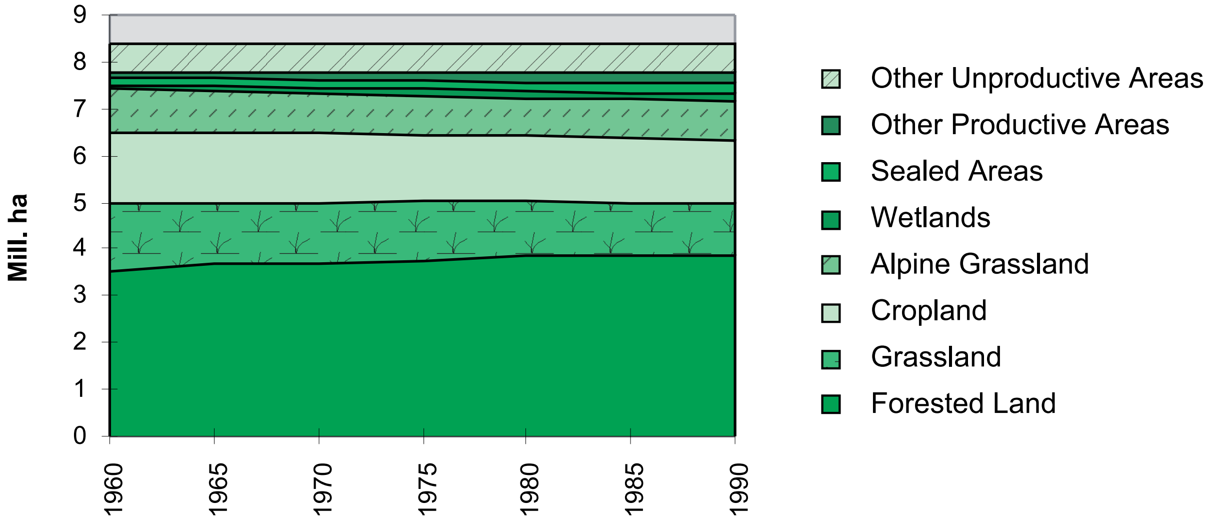


Figure 3.14: Land-use/cover change of Austria from 1960 to 1990 (Source: Jonas and Schidler 1996)

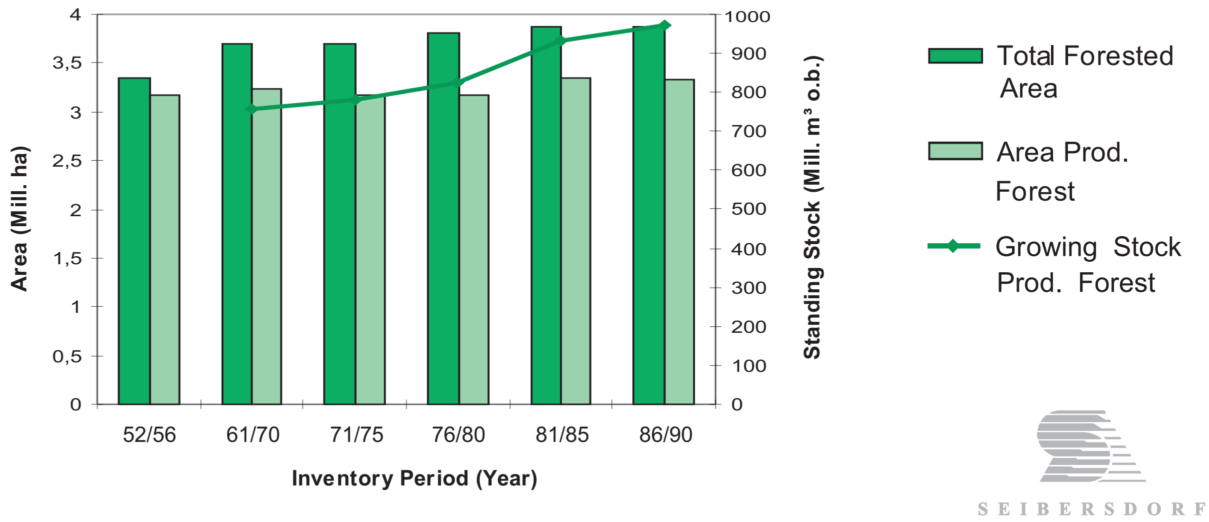


Figure 3.15: Development of Austria's forest (area and standing stock) between the inventory periods 1952/56 to 1986/90 (Source: Jonas and Schidler 1996)

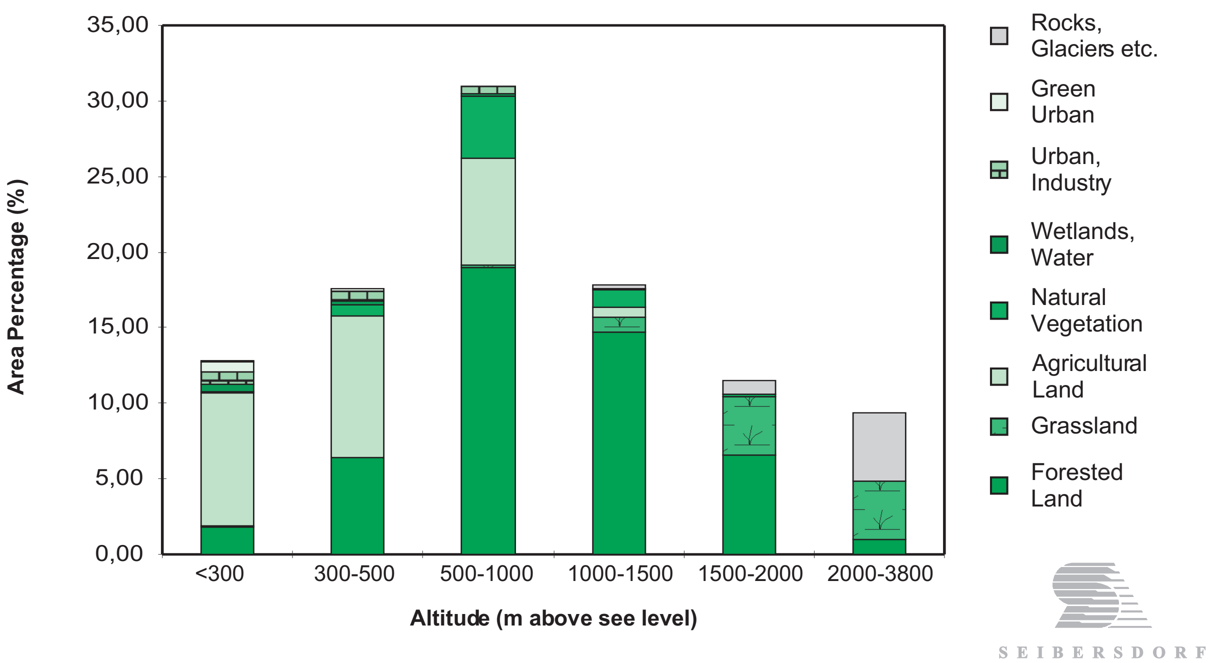


Figure 3.16: Austria's land use/cover in 1991 vs. altitude (Source: Austrian Research Centre Seibersdorf)

Chapter 4

Inventories of Anthropogenic Greenhouse Gas Emissions and Removals

4.1 Introduction

In this chapter the Austrian emission inventory focused on the years 1990 and 1995 will be presented. The following greenhouse gases are covered: CO_2, CH_4, N_2O, NMVOC, NO_x, CO, PFCs, HFCs and SF_6 (FEA 1996d, 1996e, 1997b). For CO_2 the historical emission development will be explained. In addition temperature- and production-corrected CO_2 emission figures are given. The corresponding tables with detailed data can be found in Appendix A.

All emissions are presented in the IPCC format based on the IPCC Guidelines for National Greenhouse Gas Emission Inventories (IPCC 1995b). Please be aware of the fact that the figures may differ considerably for other formats like the UN-ECE format (with the exception of CO_2 as the same format has been defined for this GHG). The data have been estimated according to the CORINAIR methodology. The CORINAIR data for 1990 and 1995 will be published in reports of the Austrian Federal Environment Agency.

In the Inventory according to IPCC there have not been applied any corrections (neither for temperature nor for electricity production share from hydropower). Bunker fuels have not been included in the national totals, but tabled separately. No CO_2 emissions have been attributed to feed stocks.

4.2 Emissions in 1995

4.2.1 CO_2

In the year 1995 the CO_2 emissions of Austria have been 62.02 Tg according to the IPCC format. The sector "Fuel Combustion" (1A) accounted for 47.95 Tg or 81% with the subsector "Transport" (1A3) showing the largest contribution to sector 1A with 15.88 Tg or 25.6%. The next largest subsectors have been "Commercial/Institutional, Residential etc." (1A4) with 13.58 Tg (21.9%) and "Energy and Transformation Industries" (1A1) with 11.05 Tg (17.8%). The sector with the next largest contribution has been "Industrial Processes" with 11.3 Tg or 18.2%, this contribution being significantly larger compared to subsector "Industry" (1A4) with 7.39 Tg (11.9%).

Sector "Land Use Change & Forestry" (5) has been a sink in 1995 which amounted to minus 13.58 Tg CO_2. This amount is due to the increase in Biomass Stock Change which by far has not been compensated by the use of biomass. See also Table A.1 on page 140.

4.2.2 CH_4

In the year 1995 the CH_4 emissions of Austria have been 580.19 Gg according to the IPCC format. The sector "Waste" (6) shows the largest contribution with 219.7 Gg (37.9%) and Subsector "Solid Waste Disposal on Land" (6A) is the largest subsector with 185.25 Gg (31.9%). The sector "Agriculture" (4) accounted for 208.9 Gg or 36.0% with the subsector "Enteric Fermentation" (4A) showing a contribution of 145.8 Gg (25.1%) which is larger compared to subsector "Other Land Use Change Activities" (5D) with 126.84 Gg (21.9%). It should be mentioned, however, that this ranking as well as the absolute figures are quite uncertain (in comparison to GHG like CO_2) because of a lack of investigations about national emission factors for methane. See also Table A.2 on page 142.

4.2.3 N_2O

In the year 1995 the N_2O emissions of Austria have been 12,78 Gg. The subsectors "Transport" (1A3), "Agricultural Soils" (4D) and "Other Land Use Change Activities" (5D) showed the largest N_2O emissions with 4.34 Gg (34.0%), 3.33 Gg (26.1%) and 2.63 Gg (20.6%). The next largest subsector was "Commercial/Institutional, Residential etc." (1A4) with 0.92 Gg or 7.2%. The uncertainty of the figures for N_2O are large compared to CO_2. See also Table A.3 on page 144.

4.2.4 NMVOC

The main contributions to the total of 406.06 Gg of NMVOC emissions in Austria originated from the following sectors (subsectors) according to the IPCC format :

- ▷ Solvent and Other Product Use (32.5%)
- ▷ Other Land Use Change Activities (30.4%)
- ▷ Transport (16.7%)
- ▷ Commercial/Institutional, Residential etc. (11.5%)

See also Table A.4 on page 146.

4.2.5 NO_x

The main contributions to the total of 175.90 Gg of NO_x emissions in Austria originated from the following sectors (subsectors) according to the IPCC format:

- ▷ Transport (57.7%)
- ▷ Commercial/Institutional, Residential etc. (14.8%)
- ▷ Industrial Processes (9.2%)
- ▷ Industry (7.9%)

See also Table A.5 on page 147.

4.2.6 CO

The main contributions to the total of 1 145.62 Gg of CO emissions in Austria originated from the following sectors (subsectors) according to the IPCC format:

- ▷ Commercial/Institutional, Residential etc. (40.7%)
- ▷ Transport (30.1%)
- ▷ Industrial Processes (27.9%)

See also Table A.6 on page 148.

4.2.7 PFCs, HFCs, SF_6

The potential emissions of various HFCs, PFCs and SF_6 have been estimated. The emissions are dominated by tetrafluorethane (R134) and other tetrafluorethanes as well as mixtures of this substance with pentafluorethane and difluoroethane. In 1996 perfluorobutane has become an important GHG as well. Although the data basis is not very complete the figures show that there is a rapid increase in the potential emissions for HFCs (the emissions in 1994 are more than four times larger compared to those of the year 1991!) and PFCs the emissions of perfluorobutane of the year 1996 being even 10times larger compared to the emission of 1995! However in the year 1994 the PFCs, HFCs and SF_6 still contributed less to the GWP than the CFCs. In comparing the emissions of PFCs, HFCs and SF_6 for the year 1994 the most important contribution was from SF_6 According to information from gas suppliers this substance is mainly used as GHG in windows with a very low k-value and to fill tires of fast passenger cars. See also Table 1.2.

4.2.8 Total GHGs

The emissions of the GHGs CO_2, N_2O and CH_4 (as CO_2 equivalents based on the global warming potential GWP evaluated for a reference period of 100 years; factors according IPCC Second Assessment Report) amounted to 78.2 Tg in the year 1995. The ranking of the subsectors (sectors) according to their relative contribution is as follows:

- ▷ Transport (22.1%)
- ▷ Commercial/Institutional, Residential etc. (18.1%)
- ▷ Industrial Processes (14.7%)
- ▷ Energy and Transformation Industry (14.2%)
- ▷ Industry (9.5%)
- ▷ Agriculture (6.9%)
- ▷ Waste (5.9%)

If the emissions of subsector “Fuel Combustion in Industry” (1A2) and sector “Industrial Processes” (2) were summed up as one industrial sector, this one would be even larger than the transport sector (24.2% versus 22.1%).

The emissions of CO_2 clearly dominate the GHG emissions in Austria with 62 Tg or 79.3% compared to 15.6% for CH_4 and 5.1% for N_2O. See also Table A.7 on page 149.

4.3 Trend of Emissions from 1990 to 1995

A comparison is made between the emission figures for the years 1990 and 1995. The figures for the year 1990, which were included in the First National Communication, have been recalculated to obtain consistent numbers.

4.3.1 CO_2

The total emissions of CO_2 have been practically constant showing a difference between the two years of only 0.2%. Fuel Combustion showed an increase of about 1.5 Tg CO_2 which is due to the strong increase in the Transport sector (1.9 Tg CO_2). Also Industry and Commercial/Institutional, Residential etc. showed an increase whereas Energy and Transformation Industries showed an decrease as did also the sector Industrial Processes (1.4 Tg).

A significant increase (the largest relative increase of almost 36% in 5 years!) was also estimated for International Aviation and Marine (0.3 Tg). However this increase does not contribute to the national total according to the current IPCC guidelines. See also Table A.1 on page 140.

The difference in the total CO_2 emissions between the values given in Table 3.13 of the First Austrian National Communication is mainly due to a more detailed calculation of the emissions of the iron and steel industry and a more comprehensive estimation for industrial processes. It has also to be noted that another 0.54 Tg have been added in accordance with the IPCC guidelines for the sector Solvent and other Product Use. The large differences between the figures for the two sectors one and two are due to a reallocation of emissions of industry. There has been made a decision to characterise industrial emissions mainly as process emissions.

4.3.2 CH_4

There was a slight decrease in CH_4 emissions from the year 1990 to 1995 (minus 7.2 Gg or 1.2%). This decrease is due to a decrease in the amount of waste deposited in solid waste disposals on land (minus 8.0 Gg). The emissions of the other sectors/subsectors did not show large variations. Better knowledge about emissions factors as well as activity rates might have resulted in larger differences for the emission figures of the two years. See also Table A.2 on page 142.

The difference in the total CH_4 emissions between the values given in table 3.13 of the First Austrian National Communication are due to a recalculation of the emissions for all sectors using updated emission factors. The emission factors for sector "All Energy" (sector 1) are based on a study of Joanneum Research (Stanzl et al., 1995), for "Agriculture" (sector 4) a more detailed survey of the manure management system has been used (Jonas et al., 1996). Emissions of subsector "Other Land Use Change Activities" (5D) have not been defined as anthropogenic emissions in the First National Communication.

4.3.3 N_2O

The N_2O emissions showed an increase of 10% (or 1.17 Gg) from 1990 to 1995. This increase is mainly due to the increase in the Transport sector (1.2 Gg). The emissions of the other sectors (subsectors) remained practically constant. See also Table A.3 on page 144.

The strong increase in N_2O emissions in comparison to the values given in Table 3.13 of the First Austrian National Communication is mainly due to the use of updated emission factors for fuel combustion. They are now based on a study of Joanneum Research (Stanzl et al., 1995). Furthermore additional sources have been included (sectors 3 and 5).

4.3.4 NMVOC

The NMVOC emissions showed a decrease of more than 17% (or 84.62 Gg) from 1990 to 1995. The sectors/subsectors "Transport" (39 Gg), "Solvent and other Product Use" (42 Gg) and "Commercial/Institutional, Residential etc." (5 Gg) contributed to this decrease. Fugitive Emissions from Fuels (0.94 Gg), Industrial Processes (0.98 Gg) and Waste (0.11 Gg) showed a significant increase of

NMVOC emissions (as well as International Aviation and Marine). See also Table A.4 on page 146.

4.3.5 NO_x

The NO_x emissions showed a decrease of almost 11% (or 20.76 Gg) from 1990 to 1995. The sectors/subsectors "Energy and Transformation Industries" (7.61 Gg), "Industry" (5.46), "Transport" (3.95 Gg), "Industrial Processes" (1.63 Gg) and "Commercial/Institutional, Residential etc." (1.17 Gg) contributed among others to this decrease. No sectors/subsectors with the exception of "International Aviation and Marine" showed a significant increase of NO_x emissions (1.68 Gg or 35.5%). See also Table A.5 on page 147.

4.3.6 CO

As the other two precursors of tropospheric ozone also CO showed decreasing emissions (14% or 187 Gg). The sectors "Transport" (130 Gg), "Commercial/Institutional, Residential etc." (45 Gg) and "Industrial Processes" (9.6 Gg) contributed among others to this decrease. As in the case of NO_x no sectors/subsectors with the exception of "International Aviation and Marine" showed a significant increase of emissions. See also Table A.6 on page 148.

The difference in total emissions can be attributed to an update of emission figures (sectors 1A2, 1A3 and 1A4). Furthermore the industrial emissions have been estimated in a special study (Windsperger 1997) and the split between sectors 1 and 2 has been changed (see also comment for CO_2). In the sector "Agriculture" new information concerning the activity open burning of biomass became available in 1996.

4.3.7 Total GHGs

The emissions of total GHGs showed an increase of 0.5% (0.36 Tg CO_2eq) from 1990 to 1995 because of an increase in the sector "Fuel Combustion" (1.80 Tg CO_2eq) which could not be compensated by the decrease in other sectors like Industrial Processes (1.42 Tg CO_2eq). See also Table A.7 on page 149.

4.4 Fuel Split of CO_2 Emissions

The contribution of solid, liquid and gaseous fuels to the CO_2 emissions of sector "Fuel Combustion" (1A) are presented.

4.4.1 Split in 1995

In the year 1995 sector "Fuel Combustion" (1A) accounted for 47.95 Tg emissions of CO_2. Oil contributed 55.1% or 26.42 Tg, natural gas 29 % or 14.08 Tg and coal 14.6% or 7.01 Tg. Petrol and diesel oil together accounted for 34.6% or 16.58 Tg.

For reasons of comparison in addition to the emission figures the activity data are also provided. In the year 1995 the fuels combusted were equivalent to 777.7 PJ. Oil contributed 357.51 PJ or 46%, natural gas 205.39 PJ or 26.4% and coal 77.00 PJ or 10%. Waste, fuel wood and biomass contributed 131.02 PJ or 16.8% to fuel combustion. See also Table A.8 on page 150.

4.4.2 Trend of Split from 1990 to 1995

A comparison of the figures given in Tables A.8 on page 150 and A.9 on page 152 shows that from 1990 to 1995 the CO_2 emissions of the sector "Fuel Combustion" increased by 3.1% or 1.5 Tg whereas the activity increased by 5.9% or 43.2 PJ. To the increase in CO_2 emissions oil contributed 0.93 Tg. However, the trend for the individual oil products was different with diesel oil, gasoil-extra light and kerosene showing a significant increase and with petrol, gasoil and gasoil light and medium with a significant decrease. The CO_2 emissions for natural gas were increasing by 3.03 Tg or 27.4% whereas those of coal showed a decrease of 2.52 Tg or 26.5%. The amount of waste, fuel wood and biomass remained almost constant (decrease of 0.5 PJ or 0.4%).

4.5 Time Series of CO_2 Emissions

The trend of the CO_2 emissions is presented for the period from 1980 to 1995 and for the period from 1955 to 1979, which are each consistent. The separate presentation of these two periods has been chosen because the emissions have been calculated according to two different methodologies. Therefore figures according to the IPCC sector split are only available for the period 1980 to 1995.

4.5.1 Time Series from 1980 to 1995

Consistent data for CO_2 emissions based on CORINAIR94 methodology and an output according to the IPCC format are available for the time period from 1980 to 1995. See also Figures 4.3 on page 38 and 4.4 on page 38 and Table A.1 on page 140. The CO_2 emissions showed a fluctuation between 66.49 Tg (1991) and 57.02 Tg (1988). The record shows decreasing emissions for the years 1981, 1982, 1983, 1986, 1988, 1992 and 1993 and increasing emissions for the other years of the period under investigation. The change between years with increasing and decreasing CO_2 emissions results in a curve with several minima and several maxima. The largest decrease of emissions between a year and the following year was minus 9.3% (from 1991 to 1992) and the largest increase 4.61 Tg (from 1990 to 1991). A mathematical analysis of the time series shows that the total CO_2 emissions neither show a significant increasing nor a significant decreasing trend but fluctuate around a value of 60.3 Tg.

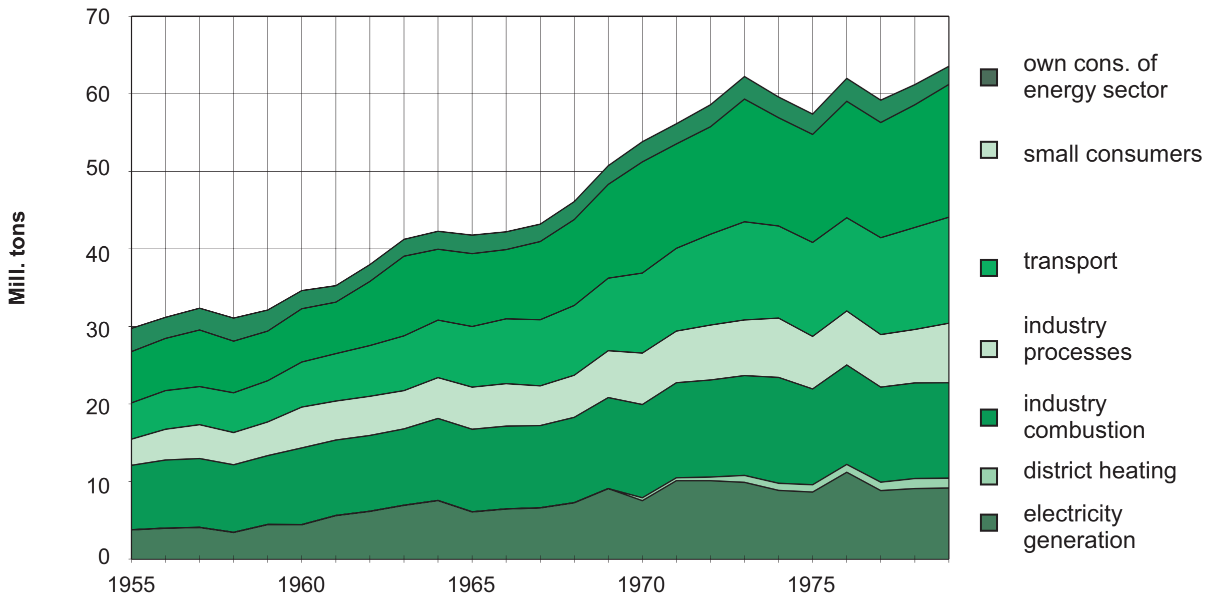
It is not surprising that the sector "Fuel combustion" (1A) shows a very similar trend compared to the total CO_2 emissions. However, the different subsectors show different trends. Subsector "Energy and Transformation Industries" (1A1) shows a lot of fluctuation (lowest emissions in 1981, 1988 and 1982 and highest emissions in 1991, 1990 and 1995), subsector "Industry" (1A2) decreasing emissions (decrease from 1980 to 1995 by almost 38% or 3.7% per year), subsector "Transport" (1A3) an increasing trend (increase from 1980 to 1995 almost by 36% or 2.6% per year) and subsector "Commercial/Institutional, Residential etc." (1A4) also fluctuating emissions like 1A1 (lowest emissions in 1990, 1982 and 1983 and highest emissions in 1991, 1989 and 1987). Like subsector 1A2 also Sector "Industrial Processes" shows a decrease from 1980 to 1995 (by 17.2% or 1.2% per year).

4.5.2 Time series from 1955 to 1979

Historical data for the years before 1980 presented in this report have been estimated according to a method more aggregated than CORINAIR. Both methods delivered practically identical values for 1994 and 1995. However, there are larger differences in the years before. These differences may be due to a less detailed estimation of process emissions, some differences in emission factors and in activity data. Some corrections to the original data set according to the First National Climate Report have been made. The data presented allow to give a reliable trend as they are consistent.

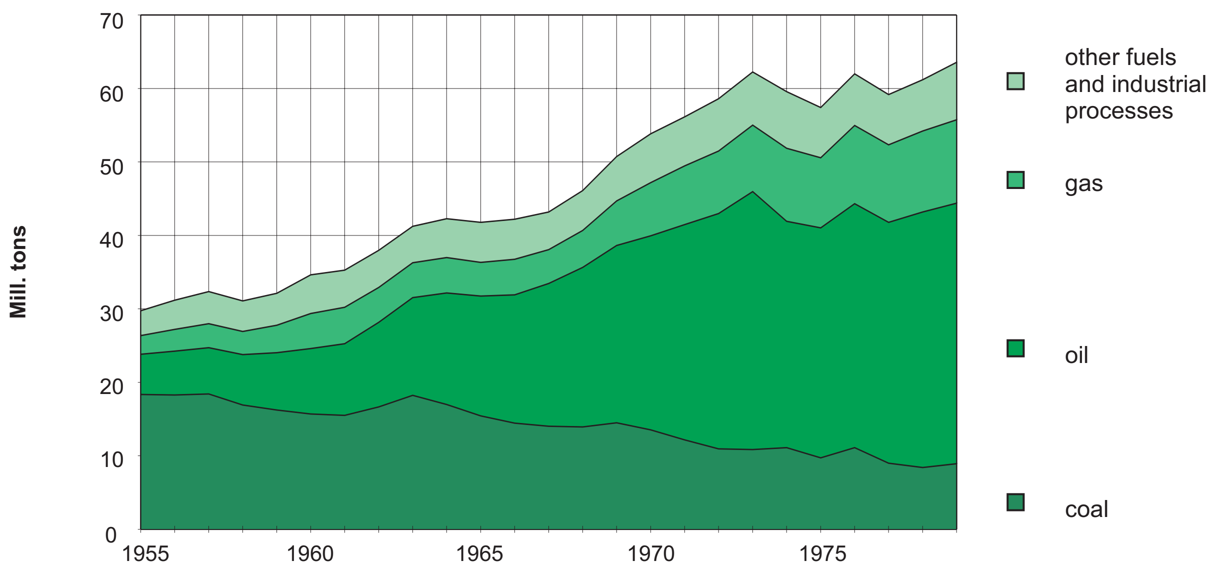
The CO_2 emissions increased from 29.75 Tg CO_2 in 1955 to 63.56 Tg CO_2 in 1979. See also Figures 4.1 and 4.2 on the facing page and Table A.10 on page 154. In the year 1968 the emissions corresponded to the emissions according to the Toronto target. During the period from 1955 to 1979 the trend is determined by the economic growth that has driven increasing energy demand and which resulted in increasing CO_2 emissions.

The development during 1955 - 1979 shows a distinct differentiation into two segments: until 1975 the trend of CO_2 emissions runs parallel to the economic development. After 1975, however, a decoupling phenomenon between GDP and CO_2 emissions is observable. The CO_2 emissions remain more or less constant despite still rising GNP values. Such a decoupling has apparently been triggered by the events around the oil price crises that have exerted a considerable impact onto the western economies and that has consequently lowered the energy intensity (= E/GNP) of the Austrian economy. It is worth noting that only a continuous and intense effort is able to result in such CO_2 growth rates near to zero, but certainly not a single event of measures during a limited period. In the moment when efforts are loosening, the initially observed increase rates for CO_2 emissions would enter into force again. Consequently, if in a given future period the efforts to implement reduction



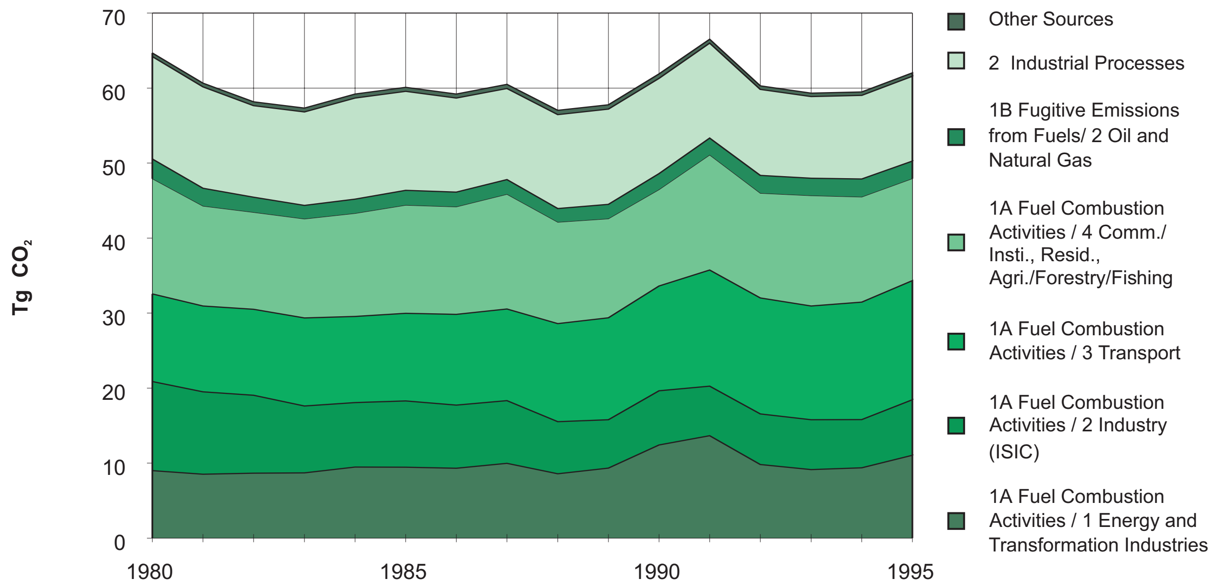
Umweltbundesamt Federal Environment Agency - Austria

Figure 4.1: CO_2 emissions in Austria by sectors 1955 – 1979



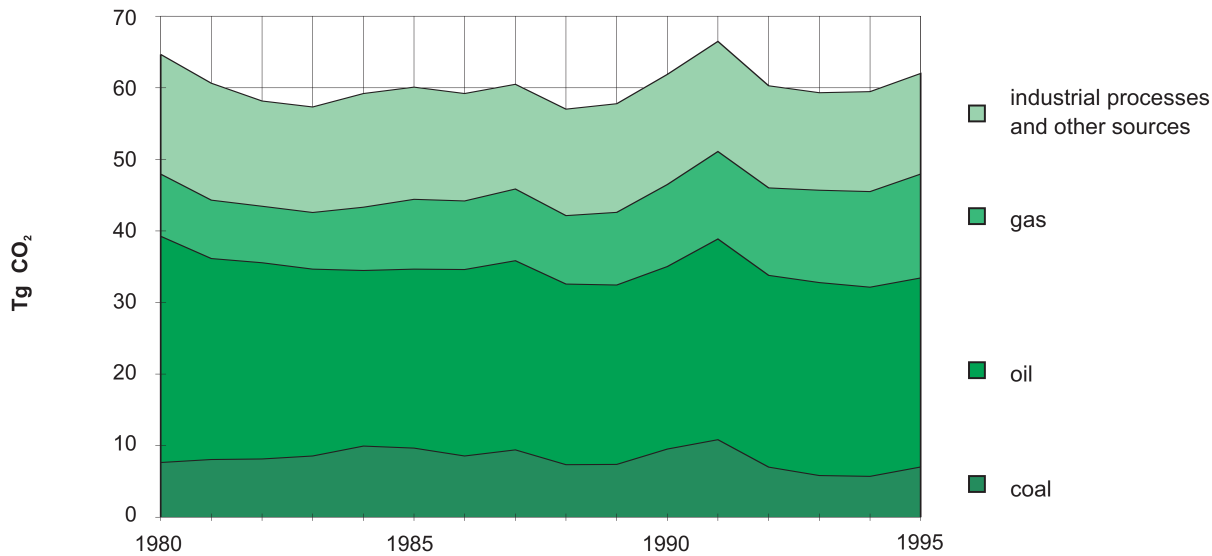
Umweltbundesamt Federal Environment Agency - Austria

Figure 4.2: CO_2 emissions in Austria by fuels 1955 – 1979



Umweltbundesamt
Federal Environment Agency - Austria

Figure 4.3: CO_2 emissions in Austria by IPCC source sectors 1980 – 1995



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Federal Environment Agency - Austria

Figure 4.4: CO_2 emissions in Austria by fuels 1980 – 1995

measures were weakened, the assumption of a continuation of the present trend into the future would be not more applicable. This fact has to be considered when evaluating the potentials for emission reduction and the emission scenarios linked up with them.

The differentiation during this statistical period is according to the energy balances provided by the Austrian Institute for Economic Research and therefore differs from the one presented in the above paragraph. The relative shares of traffic emissions and emissions from combustion in industry are roughly equal around 1970 as the following figure shows (10 Tg CO_2 and 11.5 Tg CO_2 respectively). The striking difference between the two, however, is their development during time: the sector traffic shows a steady increase whereas the sector industry begins to level off during the seventies. Two other components of the Austrian total related to industry show an analogous trend: processes and electricity generation in industry. In the 1960's they grew on an average by 3-5% annually, in the late 1970's, when they exhibited a value of 7 Tg CO_2 and 2.5 Tg CO_2respectively, their growth rate declined to -2% to -4%. The emissions from small consumers (households and commerce) have sharply grown from 1955 to 1975 to around 16 Tg CO_2 but then reached a maximum. Public electricity generation grew markedly (around 7%/year) during the early sixties but its increase rate fell continuously until the late seventies, if seen on an average. Austrian CO_2 emissions from electricity generation are substantially marked among others by the water-carriage of rivers and thus the availability of hydropower which necessitates strongly fluctuating input of fossil fuels. On a relative scale, the sector of district heating shows the highest rates of increase: up to 10% per year in the decade until 1980.

The emission shares differentiated by fuels have changed along the period envisaged according to the international trend: whereas in 1955 the largest share has been occupied by coal, it can be seen that towards the seventies oil products have taken over the lead. High rates of increase, however, can be observed for gas throughout the period 1955 to 1979. See also Figure 4.2 on page 37 and Table A.11 on page 155.

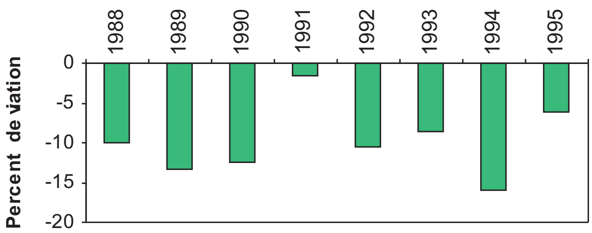


Figure 4.5: Heating degree day deviations

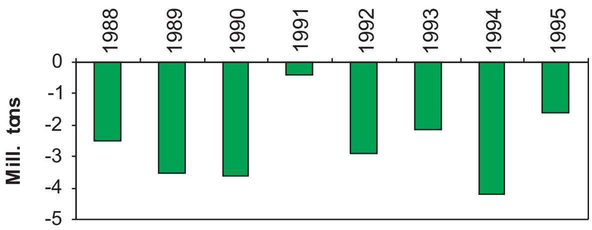


Figure 4.6: Temperature impact on CO_2 emissions

4.6 Temperature- and Production-corrected CO_2 Emissions

Energy consumption reflects besides the amount of energy services and choice of technologies also the impact of fluctuations in temperature and economic activity. In order to interpret the tendencies in CO_2 emissions the influence of temperature and production on energy demand was investigated.

4.6.1 Impact of Temperature Fluctuations

A relevant indicator of temperature fluctuations is the number of actual Heating Degree Days (HDD) and their deviations from a long-term mean. Figure 4.5 indicates that since 1988 Austria has experienced HDD values up to 15% below the long-term average. As a consequence the corresponding CO_2 emissions were lower up to almost 7% as can be seen in Figure 4.6. These deviations have to be subtracted from the actual emissions in order to obtain the temperature-compensated CO_2 emissions.

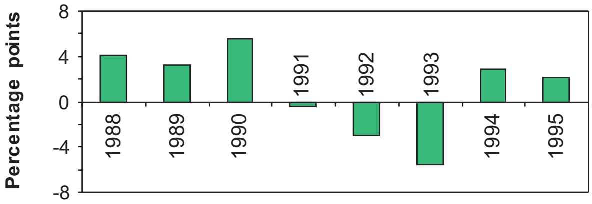


Figure 4.7: Production deviations from trend

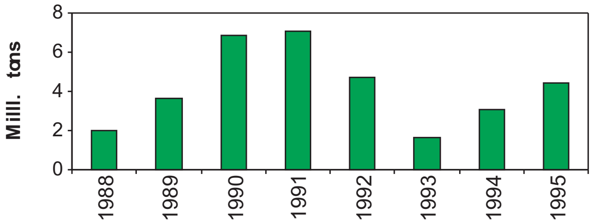


Figure 4.8: Production impact on CO_2 emissions

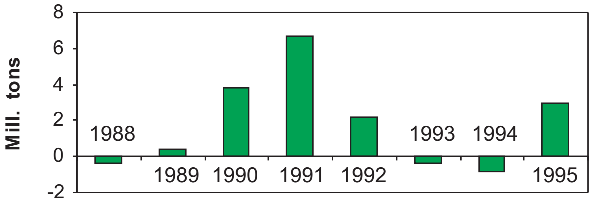


Figure 4.9: Temperature and production impact on CO_2 emissions

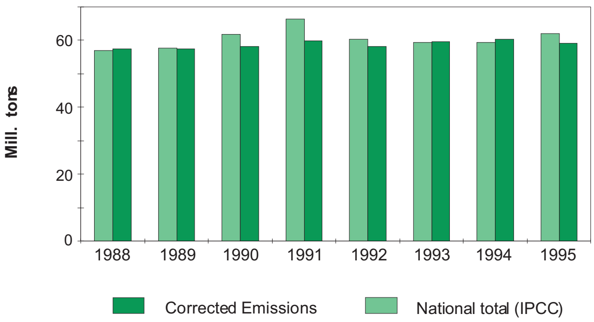


Figure 4.10: Comparison of IPCC- and temperature and production corrected CO_2 emissions

4.6.2 Impact of Production Fluctuations

Figure 4.7 demonstrates the business cycle of production activity as measured by the index of industrial production. The corresponding impact on CO_2 emissions is visible in Figure 4.8 and reveals the remarkable result that fluctuations in production account for up to more than 10% of actual CO_2 emissions. As almost three quarters of energy for production are used by the basic materials sector, it is also the sectoral composition of production that has a significant impact. Production-compensated emission values are obtained by substracting these deviations from the actual observed emission data.

4.6.3 Total Impact of Temperature and Production Fluctuations

Adding up both the impact of temperature and production fluctuations we obtain the results presented in Figure 4.9. Two conclusions can be drawn. First, at least between 1988 and 1995 the impact of temperature and production on CO_2 emissions showed offsetting effects, thus reducing the overall impact of these two factors. Secondly, we still should expect CO_2 emissions to vary because of these important fluctuations in the range of about two million tons of CO_2 per year.

Chapter 5

Policies and Measures

5.1 Outline of the National Strategy for Combating a Possible Anthropogenic Climate Change

5.1.1 National target

In its 1990, 1993 and 1996 Energy Reports the Austrian federal government set the target of achieving a 20% reduction in CO_2 emissions — relative to 1988 – by the year 2005 in accordance with the recommendations of the 1988 Toronto Conference. The so-called Toronto Target is thus specified as the national target.

To assist in the development of effective strategies for the protection of the climate system two committees were set up at the beginning of the nineties: the National CO_2-Commission, now reorganized as the Austrian Council on Climate Change (ACCC) (*Österreichischer Klimabeirat*), and the Interministerial Committee to Coordinate Measures to Protect Global Climate (IMC Climate).

5.1.2 Austrian Council on Climate Change

The tasks of the ACCC include, inter alia, the following:

- Expert support for the implementation of national climate change strategies as well as the definition of well-founded reduction targets for greenhouse gases
- Discussion of the question of adapting to a climatic change in Austria, presentation of feasible solution approaches in various sectors
- Identification of research requirements, dialogue with university-based and other research institutions on national and international level
- Preparation of reports and information based on the results of current research and consultation activities
- Organization of climate protection conferences for defined target groups.

The members of the Commission are scientists of all relevant research branches of Austrian universities.

The work by the ACCC forms an essential expert base for activities in the IMC Climate.

5.1.3 IMC Climate

The Interministerial Committee to Coordinate Measures to Protect Global Climate was founded in January 1991 and is established at the Federal Ministry of Environment, Youth and Family Affairs. Members of the IMC are the representatives of all the ministries concerned by the subject matter and representatives of the Austrian system of industrial relations. The IMC develops detailed programs for a comprehensive national strategy for reducing greenhouse gas emissions and formulates regulative and economic instruments for their implementation.

The Committee reports to the Council of Ministers at regular intervals.

To date five interim reports by the IMC Climate have been brought to the attention of the federal government in the form of Council of Ministers papers.

The last interim report was adopted as the 1995 Austrian Climate Protection Report, prepared in accordance with the resolution of the "Nationalrat" (First Chamber of Parliament) dated January 1994.

The structure presented above for the development of a national program to prevent global climate change – a scientific and an administrative committee, both cooperating closely with representatives of the economic sectors concerned – forms a sound basis for the gradual, flexible implementation of measures for achieving the national target of a reduction in CO_2 emissions and all other trace gases of relevance to the climate, which are not regulated by the Montreal Protocol.

5.2 Comments Regarding the Assessment and Evaluation of CO_2 Reduction Potentials Resulting from the Measures as Initiated in the Second National Communication

1. The reduction potentials stated therein refer to the emission reduction expected additionally beyond the base line scenario (IER reference scenario).

2. Reduction potentials (binding potentials) have only been quantified for measures, which have an immediate emission reduction or CO_2-binding effect (e.g. improvement of thermal insulation). Reduction potentials have not been quantified for supporting measures (such as economic instruments), which in fact are of essential importance to the realization of directly effective measures and, thus, are indispensable.

3. The potentials indicate the level of CO_2 reduction to be expected until the stated year resulting from the measures discussed, based upon conservative estimates and provided that certain assumptions apply. The figures do not represent all theoretically possible potentials. The potential actually feasible is limited by a range of factors, among others the availability of funds. The potentials stated herein are intended to permit an evaluation of how likely the achievement of defined reduction targets is.

4. The potentials refer to the effectiveness of each individual measure, thereby neglecting a frequently occuring synergy effect with other measures. Thus, simply adding all potentials will yield only insufficient results.

5. In so far as measures are identical or very similar to those of the resolution E 46 to the Ozone Act dated April 2, 1992, the CO_2 reduction potential was adapted to the NO_x (VOC)-reduction potential according to the Ozone Report of the federal government. In so far as measures are identical or very similar to those stated in the draft of an agreement between the federation and the federal provinces (according to Article 15a of the Austrian Federal Constitution Act) "on achieving the CO_2 reduction target (Toronto target) and the emission reduction of other climate relevant gases", the potentials discussed in a panel of experts between the federation ("Bund") and the federal provinces ("Länder") have been used.

6. Details on the potentials in the traffic sector have not been reported, since this is the subject of a separate study to be completed in the course of 1997.

7. In regard to the substitution (saving) of electricity it has been assumed that this electricity was supplied by fossil fuel fired power stations. This assumption only applies under special conditions. Further, an emission factor of 207 t CO_2/TJ or 745 t CO_2/GWH, respectively, has been assumed for electricity supplied by fossil fuel fired power stations. This factor is based on calculations by the Joanneum Research Society (Stanzl et al., 1995 - Table 19). It has to be noted that the abovementioned emission factor may change until 2010. A change is very likely if measures to reduce CO_2 emissions are adopted.

Competent authority:

The expression "competent authority" used in the following text does not only refer to "competent authority" as defined by national laws but also includes the meaning of responsibility (at a private enterprise level) for initiatives, research programs and subsidies or specific public relations projects.

5.3 Measures for the Protection of the Climate System – Carbon Dioxide

5.3.1 Energy Supply and Transformation

Voluntary measures/subsidies under implementation:

5.3.1.1 Promotion of the Use of District Heating and Block Heating

Assessment: District heating covers 3.4% of final energy and accounts for 10% of the room heating and hot water supply. District heating is of crucial importance for economic, energy and environmental policies since it ideally combines environmental protection with efficient energy use and offers stimuli for the domestic economy. Efficient and effective energy use is achieved above all by the use of combined heat and power production and industrial waste heat.

Furthermore, district heating offers the possibility to use a wide range of energy sources with low energy content and can take advantage of industrial waste heat not directly usable (e.g. from steel industry, ceramic industry, cement and pulp and paper industry). In addition, the renewable energy sources, here in particular biomass, can be used mainly in smaller-scale decentralized district heating systems. However, considering current energy prices, a further development of district heating does not always prove to be profitable. For this reason, adequate measures for funding would be required. The granting of residential construction subsidies should increasingly depend on the fulfillment of ecological criteria. Priority should be given to: connection to district and regional block heating systems and environmentally sound heating and hot water supply systems using renewable energy sources.

Reduction potential: By promoting district and regional block heating one half of the expected reduction potential (1.25 mill. t CO_2/a) can be reached by 2005 (biomass potential not included) and by 2010 a total reduction of 2.5 mill. t CO_2/a will be attained.

Competent authority: Federation, federal provinces

Current situation: The use of biomass (e.g. chipping) in regional block and district heating networks (whenever possible with combined heat and power) has already gained considerable status in terms of energy policy. Currently funds for the realization of biomass district heating projects are available partly due to EU Regional Aid. In this respect the levies on natural gas (ATS 0.60/m^3) and electricity (ATS 0.10/kWh) which entered into force as of 1 June 1996 should be mentioned. By means of financial adjustment 11.835% of the yield will be appropriated to the federal provinces for additional funding of environmentally sound and energy saving measures – such as the promotion of district heating. In addition, as part of the tariffing for electrical energy, infeed from combined heat and power plants on a biomass basis are assisted with special tariff incentives (see 5.3.1.3).

In the energy sector, as part of the agricultural investment subsidies, subsidies are also provided for biomass heating plants for individual operations, biogas plants, small-scale biomass district heating generation and conduction plants as well as district heating distribution plants, and plants for producing fuels from renewable raw materials used mainly for the purpose of the self-sufficiency of agricultural and forestry operations.

In 1995 about 2000 projects of this kind were subsidized by approx. ATS 250 mill. by the federation and federal provinces under the Investment Assistance Program. In addition, measures for switching to renewable energy sources (solar and wind energy, biomass), the connection to district heating, the installation of modern biomass boilers and the construction of combined power and heating systems are being subsidized within the framework of environmental promotion in accordance with the Environmental Support Act (*Umweltförderungsgesetz, UFG*). In the period from 1994 to 1996 such projects with a total investment volume of approx. ATS 440 mill. were financially supported by investment subsidies of approx. ATS 130 mill. in accordance with the Environmental Support Act (biomass heating plants for individual operations, biomass district heating and combined heat and power plants based on biomass).

5.3.1.2 Utilization of Renewable Sources of Energy

An orientation of the Austrian energy supply towards sustainability based on renewable energy sources would be possible through substantial modifications and adaptation of the energy supply system. None of the renewable energy supply technologies can meet the complex requirements of a sustainable energy supply system by itself. Therefore, various technologies have to be used in an inter-connected system consisting of centralized and decentralized plants to meet the different customers' demands. A ranking of individual energy supply systems based on a qualitative evaluation regarding sustainability, state of the art, overall economic reasonableness and practical experience in Austria produced, inter alia, the following results:

- ▷ further development of hydropower and use of firewood and chipping are well advanced in Austria and
- ▷ solar collectors, straw, biogas, sewage gas, methane gas recovery from landfills, methyl esters from plant-based oils, heat pumps and wind energy as energy sources as well as solar architecture are already now of importance.

Evaluation criteria are required for the selection of energy technologies; current prices are primarily subject to short term decisions and, thus, are not a sufficient means of evaluation. Generally speaking, the complete life cycle of biomassßrelated products has to be considered in all economic evaluations.

Reduction potential: See section 5.3.7 and in particular sections 5.3.7.1 (wood) and 5.3.5.3 (Straw).

Competent authority: Federation

Current situation: In 1994 hydropower and other renewable energy sources accounted for 302 PJ or 26.4% of total energy use. Refer to section 5.3.7. Subsidies were granted in accordance with the Environmental Support Act, see also section 5.3.1.1.

5.3.1.3 Supply of Electricity into the Public Grid

Assessment: The supply of electricity from biomass and biogas plants and from wind power and photovoltaic stations is to be promoted on the basis of the considerable potentials that exist in this area; most efficient technologies should be used. In principle suppliers should be granted tariffs in the amount of the "avoided costs" which must reflect the costs avoided in the long term as a result of the supply. Given the characteristics particular to Austria with regard to winning methods and requirements (hydro-thermal interconnected system), promotion is to be given in particular to combined heat and power, which ideally complements hydraulic power.

Reduction potential: Given an electricity supply of about 1.5 TWh/a supplied by small scale hydropower stations a CO_2 reduction of 1.1 mill. t CO_2/a can be expected by 2010. By 2005 a potential of 0.5 mill. t CO_2/a should have been reached. The reduction potentials of other renewable resources have been discussed in sections 5.3.7 and 5.3.1.8.

Competent authority: Federation, federal provinces

Current situation: In the course of the continually promoted tariff reform, a tariff incentive for the application of combined heat and power has al-

ready been established through the restructuring of the inter-connected tariff and the federal supply order.

In 1994 a general agreement limited until 1996 between the Republic of Austria, represented by the Federal Minister of Economic Affairs, and the Austrian Association of Electricity Utilities (VEÖ), was concluded. In order to substantially improve compensation for electricity supplied by photovoltaic and wind power stations as well as by generation plants operating on the basis of biomass or landfill gas or sewage gas, the agreement provides for subsidies in the amount of 100% and 20% respectively for the corresponding delivery prices applicable in each case for the utility company drawing the electricity. The compensation paid for supplies from photovoltaic and wind power stations will therefore be raised up to ATS 1.75 per kWh (in the winter peak tariff), and up to ATS 1.05 per kWh (100 ATS is approx. 9 US$) for supplies from biomass installations as well as landfill and clarification gas installations. By December 1995 a major part of the provincial companies and provincial capital utility companies as well as a number of small and medium-sized power supply companies had acceded to the agreement.

For the promotion of these technologies a subsidy program based on competitiveness is currently under preparation. In addition, by resolution E 36-NR/XX.GP, dated December 12, 1996 of the Nationalrat the Federal Minister for economic Affairs was requested to advocate the rapid realization of a suitable follow-up regulation to the General Agreement.

Measures under implementation:

5.3.1.4 Mineral Oil Tax for Fuels

As of 1 May 1995 the existing mineral oil tax rates were increased by between 50% and 150% and a tax on liquid gas for heating purposes, prior to this date not subject to taxation, was introduced. Fuels subject to mineral oil tax do not fall under the ceiling of the Energy Levy Reimbursement Act (*Energieabgabevergütungsgesetz*). Contrary to other Member States with high tax rates on energy, there will be no reduced tax rates for fuels used in the industrial sector.

According to the goals of the Austrian energy policy the preferred use of renewable sources of energy is pursued. The Austrian mineral oil tax rates are relatively high compared to international standards, therefore, the competitiveness of domestic businesses must be considered in setting taxation policies. This is of crucial importance, especially since the EU regulations only provide for low minimum tax rates for fuels – compared to Austrian tax rates – and, thus, are already causing big differences in taxation among the Member States.

Competent authority: Federation

5.3.1.5 Energy/CO_2 Tax

The Energy/CO_2 tax has to be considered an essential part of an effective set of measures for reaching the CO_2 reduction target. For the further development of the Austrian energy taxation the results of the debate within the European Union are of vital importance – particularly for securing the competitiveness of the Austrian economy.

Consensus could not be reached at the EU level: neither on the original proposal for a Council directive in 1992 with the objective of introducing a general energy and CO_2 tax nor on the 1995 revised directive proposal. This 1995 revised proposal offered Member States the preliminary freedom – within a strictly limited period of transition – to tax (individual) energy sources with an individual tax rate in the framework of a harmonized tariff structure. As a medium term objective the proposal provided for the introduction of mandatory minimum tax rates for all Member States.

The European Commission prepared a new directive proposal based on the relevant Council decision dated March 1996 in order to introduce a community wide taxation through a combination of existing mineral oil taxation and the inclusion of additional sources of energy. Austria supports this EU proposal to introduce a community wide energy taxation using existing tax structures because this measure will also strongly influence the scope for action on a national level for adopting a comprehensive energy taxation.

Assessment: For environmental policy considerations in particular, a medium to long term objective according to the polluter-pays principle should be to take the external costs of the impact on the environment caused by the use of energy adequately into consideration in consumer cost accounting.

The taxation of energy sources causes an increase of their relative prices and, thus, gives incentives to improve the efficiency of energy systems. In addition, the energy levy helps to internalize the external costs resulting from energy use and consequently leads to fairer prices in the framework of the economy. The effects on a macro-economic level depend largely on the tax structure (amount of tax rate, taxable units, tax exempts, etc.), the implementation in an overall concept within the European Union as well as on the allocation of the tax revenues.

Reduction potential: As a result of the accelerated realization of measures for emission reduction an additional reduction of 0.9 mill. tons CO_2/a by 2005 can be expected.

Competent authority: Federation

Current situation: As of 1 May 1995 the mineral oil tax rates for energy sources already subject to taxation were increased and at the same time the list of taxable energy sources was extended.

As of 1 June 1996 levies on natural gas (ATS 0.60/ m^3) and electricity (ATS 0.10/kWh) entered into force (Natural Gas and Electricity Levies Act, Energy Levy Reimbursement Act) and by means of financial compensation 11.835% of the tax yield will be appropriated to the federal provinces for additional funding of environmentally sound and energy saving measures. In order to avoid double taxation heating oils and natural gas used in the production of electric energy are exempt from mineral oil tax and energy levies, respectively. For businesses with a focus on the production of physical assets these energy levies are limited to 0.35% of the net production value. For 1997 a tax yield from energy levies in the amount of ATS 7 billions has been budgeted.

Planned implementation:

5.3.1.6 Tightening of the Energy-relevant Building Code, Regional Planning and Land Development Regulations

Implementation of Item 18 of the resolution dated 2 April 1994 adopted by the Nationalrat (First Chamber of Parliament): tightening of energy saving measures, in particular of the energy-relevant building code, regional planning and land development regulations, e. g. introduction of energy certificates and energy indicator values.

Assessment: Easily implementable measure, implementation by agreement as per Art. 15a B-VG (Federal Constitution Act). Despite the difficulty in quantifying them, measures aimed at lowering room energy requirements are to be implemented in only due to the population increase and the resulting demand for residential buildings.

The introduction of energy indicator values is a prerequisite for intelligent, energy efficient planning and the overall evaluation of the energy-related quality of buildings, since measures like the application of passive solar energy or a sensible thermal zoning of buildings cannot be stimulated by k-values. Nevertheless, it is still necessary to regularly adjust current k-values to the state of the art. The instruments residential construction subsidies and renovation of old buildings subsidy have to be devoted to the objective of energy saving by granting subsidies progressively depending on the total energy demand of the building and the use of renewable energy sources.

Reduction potential: A decline in heating requirements in new building to 50 kWh/m^2·a and in old buildings to 75 kWh/m^2·a has been assumed. In the case of new buildings energy savings of 3.6 TWh/a (corresponding to 0.5 mill. t/a reduction in CO_2-emissions) and regarding old renovated buildings energy savings of 21.3 TWh/a (corresponding to an annual reduction of 3.2 mill. in CO_2 emissions) can be expected by 2010. By 2005, a CO_2-reduction of 0.23 mill. t CO_2/a for new buildings and of 1.5 mill. t CO_2/a for old buildings can be expected.

Costs: difficult to quantify, minimum added costs in the case of new housing and old building rehabilitation, efficient monitoring of subsidies necessary in the case of residential construction promotion and old building rehabilitation promotion.

Competent authority: Federation, federal provinces. Art. 15a B-GV Agreement: Federation and federal provinces; building code: Federal provinces only; room heating allocation between sources of energy - building code: Municipalities and federal provinces; district heating promotion: Federation, federal provinces; residential construction subsidy: Federal provinces.

Current situation: The Article 15a B-VG Agreement on energy savings entered into force as of 15 June, 1995 includes the use of energy indicator values in the evaluation of the thermal quality of buildings in addition to k-values. These indicators form the basis for state-wide energy certificates for buildings. Nevertheless, a further adjustment of k-values to the state of the art is still desirable. According to the objectives stated in the 1993 Energy Report the following measures were adopted in the Agreement:

- Harmonization of federal provinces regulations for the realization of the Agreement's objectives
- Increased consideration of objectives relating to environmental policies
- Basic regulations regarding the energy consumption of appliances
- Specific regulations regarding heating systems and building structures

Pilot projects, especially in the area of residential construction and combined heat and power technologies, indicate that switching to more efficient energy technologies – even at current prices – can already result in cost advantages for both consumers and investors. In many cases obstacles such as the lack of energy indicator values in building codes hamper the use of these innovative energy technologies. Discussions between the federal government and the federal provinces for the further improvement of the issues contained in the Art. 15a B-VG Agreement are currently in progress.

5.3.1.7 Conclusion of an Art. 15a B-VG (Federal Constitution Act) Agreement on Achieving the CO_2 Emission Reduction Target and on Emission Reduction of Other Gases of Relevance to the Climate Between Federation and Federal ProvInces

Specification of the Toronto Target (20% reduction in CO_2 emissions by 2005 relative to 1988) and of the regulations to be taken at federation and federal provinces level for this purpose.

Assessment: Fundamental measure to be rated as extremely important.

Competent authority: Federation, federal provinces

Current situation: The negotiations are well advanced.

5.3.1.8 Promotion of Combined Heat and Power in Industry and in Room Heating Supply

Promotion of combined heat and power with electricity supply into the national grid – optimum process concept for the cascaded utilization of temperature levels (see also 5.3.1.3). With regard to promoting the expansion of CHP, the subjects of supply tariffing, maintenance of reserves and tariff structure will have to be discussed further.

Assessment: Highly effective measure. The provision of such comprehensive packages as, for example, the use of combined heat and power in the area of process heat guarantees a marked improvement in efficiency due to a focused and economic use of fuel, as a result of which considerable energy savings effects and therefore CO_2 reductions can be achieved especially in the trade and industry sector.

Reduction potential: No additional reduction potential compared to the IER-scenario can be assumed, as the measure is already included in this scenario.

Competent authority: Federation, federal provinces. District heating promotion: Federation and federal provinces; allocation of room heating market between sources of energy, building code: Local communities and federal provinces.

Supply of "derived current" into public supply networks, appropriate legal foundation; the subject of crossborder electricity supply into public supply networks is to be legally regulated by the federal supply order effective as of 1 August 1995.

Current situation: In 1994 and 1995 several large scale, industrial combined heat and power plants, subsidized by funds as per Environmental Support Act, were put into operation, mostly in the pulp and paper and sugar industry. Since this involved a shift to natural gas, the CO_2-emission in these industry sectors could be reduced.

5.3.1.9 Continuation of the Electricity Tariff Reform

The basic principles of the overall Austrian tariff model ("federal savings tariff") and the further tariff policy principles obtained through the continuation of the tariff reform as per the 1993 Energy Report form the basis for the tariff changes. The model of a reform tariff is based on the guiding principle of cost orientation, i.e. the polluter-pays principle, and is aimed at contributing towards a more efficient energy application. By departing from non-electricity related reference variables in particular, the customer is to be given an appropriate additional incentive for a more efficient application of electricity since a change in consumption habits leads to a change in the (basic) demand rate.

In principle this new tariff model sets out a direction along which the Austrian reform tariff systems should develop in the long term. In its essence it is designed as a "broad umbrella" under which all existing reform tariffs can essentially be accomodated. This "federal savings tariff" is compatible with EC principles (two-part tariff, demand determination).

The current reforms of the tariff systems in the electricity sector are to be continued in accordance with the principles of the 1993 Energy Report, in particular with regard to the cost-orientated and causality-compatible shaping of the tariff systems. As part of the accompanying measures the accelerated market introduction of active-power meters in particular is to be boosted.

Competent authority: Federation

Current situation: Presently, new reform tariff systems have basically been adopted state-wide – with the exception of a single utility company in one of the capitals.

Concepts/Projects:

5.3.1.10 Preparation and Coordination of Energy Concepts at the Municipal and Provincial Level – Provision of Regional Energy Concepts and Energy Statements

Assessment: With the compilation of the "CO_2/ energy scenarios" as the basis for the 1993 Energy Concept and its catalogue of measures the federation has taken a first step towards the coordination of the energy concepts of the federation and the federal provinces. The methodology and implementation principles are being continually refined and improved. Regionalized models are to be incorporated in the energy and energy saving concepts. In this way a foundation essential in a cooperative federal state is to be created in order to

- achieve a reorganization of the law of conducted energies on the basis of new delimitations between the federation and the federal provinces in terms of jurisdiction, in particular with regard to the winning, distribution and levy structures of conducted energy;
- obtain, on the utilization side, the optimum coordination in terms of energy policy between federation and federal provinces instruments (especially those of building law and dwelling law) and, in this context, to make use also of

the instrument of the agreement between federation and federal provinces as per Art. 15a of the Federal Constitution.

Competent authority: Federal provinces

Current situation: Since the publication of the 1993 energy report and energy plan there have been a number of contacts and negotiations between the federation and the federal provinces , in particular on the areas of

- ▷ cooperation between the federation and the federal provinces in the area of energy research,
- ▷ promotion of regional and local energy concepts,
- ▷ Summary of energy-related subsidies as basis for the harmonization of energy subsidies by the federation and the federal provinces .

Concrete research on cost/benefit relations has been carried out or is in the planning stage in the course of work already in progress on energy and CO_2 reduction scenarios . Since the publication of the 1993 Energy Report, 57 energy concepts received subsidies in the amount of ATS 8.7 million from the Federal Ministry for Economic Affairs and subsidy summaries have been updated on a regular basis. The Austrian Central Statistical Office (ÖSTAT) prepared the federal provinces energy balance statements in 1993 including the reorganization balance sheets and calculation of useful energy based on the 1988 analysis of useful energy. The data is available for users in the form of an EDP file. The federal provinces energy balance statements for 1994 were prepared by ÖSTAT in October 1995. At the request of the Federal Ministry of the Environment, Youth and Family Affairs the "Guidelines for climate protection at municipal level" were published in 1995 and 1996 and a seminar concept for the protection of the climate system at the local level was also completed in this period.

5.3.1.11 Planning and Conceptual Considerations on the Realization of a Sustainable Power Industry as Part of the Energy Concepts to Be Drawn up by the Federal Government

Assessment: The energy concepts of the federal government are to form the operational basis for the energy policy of the next few years and are therefore of considerable significance. The integration of the environmental aspect in the energy policy represents the main challenge on the way to a sustainable power industry. Valid long-term guidelines in this sector are to be drawn up in order to reveal energy policy objectives and means of achieving those objectives within that context and secure the foundations for the energy policy of the future in terms of the principle of sustainability. (The energy concept work of the federal government is to bear in mind the considerations made in the course of drawing up the National Environmental Plan.)

Competent authority: Federation

Current situation: In the 1993 Energy Report and Energy Concept various models were evaluated resulting in the verbal and numerical description of the CO_2-reduction scenario (CO_2 emissions in 2005 less 20% relating to 1988 levels) and the CO_2-stabilisation scenario (Stabilization of CO_2 emissions in 2005 relating to the 1990 levels). It was agreed to further improve the evaluation procedures by joining together all authorities and institutions involved in the model evaluation. Since more accurate information is available on the actual contribution of biomass to renewable sources, the 1993 Energy Report prognosis was adjusted to the new levels by the Austrian Institute of Economic Research (IER).

Preparatory discussions have been conducted regarding the organization of a working group "Energy models". It is planned to include, inter alia, IER, the Ecology Institute and the working group "Energy industry" of the National Environmental Plan. Further, a new comprehensive energy prognosis covering the period up to 2010 was presented by the IER for the 1996 Energy Report under the inclusion of the energy model of the National Environmental Plan. By including this model it is now possible to compare the results of the NEP prognosis with those of the IER prognosis thereby pointing out the implications of each individual scenario.

5.3.1.12 Utilization of Waste Heat in Industrial Processes and Electricity Production

- ▷ Supply of waste heat into heat supply networks to cover the room heating demand,
- ▷ examination of the expedience of a waste heat utilization requirement,
- ▷ creation of regulatory outline conditions to promote the supply of waste heat to suitable district heating networks,
- ▷ Promotion of combined heat and power among others through appropriate supply conditions,
- ▷ use of existing instruments for the promotion of trade and industry to promote the utilization of waste heat (see also 5.3.1.3).

Assessment: Regional and sector-specific studies necessary. Problem of the availability of waste heat depending on the corresponding industrial process. With regard to promoting the expansion of waste heat utilization and power cogeneration, the issues of supply tariffing, maintenance of reserves and tariff structure will have to be discussed further.

Reduction potential: The reduction potential of this measure has already been captured in the potential according to section 5.3.1.1.

Competent authority: Federation, federal provinces

Current situation: With regard to waste heat utilization from power plants, research into the case studies on combined power and heat is to be extended initially to the sector of utility companies.

5.3.1.13 Setting-up of Energy Supply Areas Coordinated in Terms of Regional Development – Improved Harmonization of Conducted Fuels (Gas and District Heating), Particularly of Renewable Fuels for Room Heating Provision (Primarily Biomass)

This can be achieved through regional development, in particular zoning plans.

Assessment: These planning documents are to contain recommendations for the coordination of

conducted energies, taking into account or incorporating building codes as well as regional development and zoning plans. The sensible coordination of federation and federal provinces competences in legislation and execution should be aimed ultimately at obtaining optimum energy supply structures, resulting in the best possible coordination of the supply with conducted energy while making use of local energy resources and local waste heat potentials and integrating renewable fuels and new technologies. This approach should harmonize with the prevailing circumstances in settlement and production structures and their anticipated development as well as the requirements of environmental protection.

Reduction potential: Not quantifiable, since coordinating measure, yet of great significance for the construction of district heating systems based on combined heat and power and/or biomass and the use of waste heat from waste incineration plants.

Costs: Planning expenditure, subsidy requirements (connection charges and line construction) in the case of marked price differences in comparison to rival sources of energy.

Assessment: The choice of energy source and energy technology, especially in the room heating sector, is a medium to long term commitment for investment decisions. Given the current price competition between fossil, renewable and conducted sources of energy (gas for district heating) in municipal and rural areas, long-term, ecologically favorable energy source priorities are to be made using “regional development measures in energy matters". In this connection regional energy concepts are designed to play an important role especially in view of the emphasis on the use of biomass, based essentially on local circumstances, as a starting point for sensible delimitations, for example of district heating supply compared with the use of natural gas.

Competent authority: Federation, federal provinces

Current situation: In consultation with lobbies and experts, the main parameters for a reform of the law on conducted energies are currently being reviewed.

Main stages:

- ▷ Authorization of studies together with the federal provinces
  Competent authority: Cooperation between the federation and the federal provinces
- ▷ Agreements between suppliers of sources of energy
  Competent authority: Federal provinces, local communities, utility companies
- ▷ Examination of an arrangement for delimiting heating supply areas
  Competent authority: Federation
- ▷ Reorganization of the law of conducted fuels (1993 and 1996 Energy Reports)
  Competent authority: Federation

5.3.1.14 Introduction of Least Cost Planning (LCP) as Part of the Reorganization in the Law Regulating Prices in the Electricity Sector

The aim is to increase the efficiency of electricity services. Least cost planning is to give an incentive to power supply companies in particular to assume an active role in initiating and implementing measures on the consumption side aimed at improving efficiency.

In the opinion of the federal government, least cost planning is an instrument that can be used to remedy existing shortcomings in the market as well as regulation deficits when the marginal costs of the additional provision of electric energy are higher than the costs for an increase in efficiency in ultimate consumption. In such cases program costs for efficiency-enhancing investments are to be recognized (Measure 87 of the 1993 Energy Report).

Since the concept of LCP can be applied to other energy sources, similar actions have to be taken in this area.

Assessment: Priority is given to the preparation of a concept regarding the introduction of LCP.

Competent authority: Federation, federal provinces

Current situation: The research project "Least Cost Planning in Austria" initiated by the federal government studied feasible ranges of application and possible ecological effects of LCP. The identified possibilities of LCP are currently being analyzed.

5.3.1.15 Examination of Energy-relevant Issues in Connection with

5.3.1.15.1 Third Party Financing (TPF)

As part of the reorganization of utility companies into energy service companies, aspects of third party financing are to be taken into consideration accordingly. Under examination is the application of the principles of TPF beyond the scope of the electricity supply industry, for example through the use of an energy savings financing company (at federal provinces level). These activities would be implemented in close coordination with the activities of the energy advisory offices (1993 Energy Report).

5.3.1.15.2 The Problem Area of Landlord and Tenant

In the course of amending the dwelling law, one objective is the inclusion of energy-related rehabilitation measures in the rent (as a cost-neutral charge for the tenant): the tenant should be entitled under certain circumstances to arrange for the implementation of energy-relevant improvements and/or to reclaim the costs of such improvements from the landlord.

Competent authority: Federation

5.3.2 Transport

Measures under implementation:

5.3.2.1 Fuel Consumption Levy and Reform of the Tax on Motor Vehicles

As of 1 January 1992 the fuel consumption level and as of 1 May 1993 the engine related insurance tax were introduced. The fuel consumption levy (in addition to a VAT of 20%) replaced the luxury VAT (32%). The introduction of the Structural Adjustment Act (*Strukturanpassungsgesetz*) in 1996 caused an increase in the fuel consumption tax rate of about 1% by changing the measuring of fuel consumption from ECE- to MVEG-consumption. At the same time the maximum tax rate was raised from 14% to 16%.

Assessment: Since the fuel consumption levy increases the tax burden depending on the vehicle's relative fuel consumption, this measure offers incentives to buy energy efficient vehicles and thereby reduces the relative CO_2 emissions per km. By raising the maximum fuel consumption tax rate to 16% the current indirect tax burden for new vehicles (fuel consumption levy and VAT) increases by up to 7.2%. Revenues from the fuel consumption levy have increased by 23.7% to ATS 5.7 billion between 1994 and 1997.

Reduction potential: 0.35 mill. tons CO_2/a by 2005

Competent authority: Federation

Current situation: A strong trend towards diesel powered vehicles reduces the average fuel consumption and thereby reduces the relevant CO_2 emissions. In 1996 diesel powered vehicles accounted for 50% of all new registrations compared to 22% before the introduction of the fuel consumption levy; Diesel vehicles currently hold a share of more than 25% of the total passenger vehicle fleet compared to 5% in the mid-eighties.

5.3.2.2 Mineral Oil Taxation

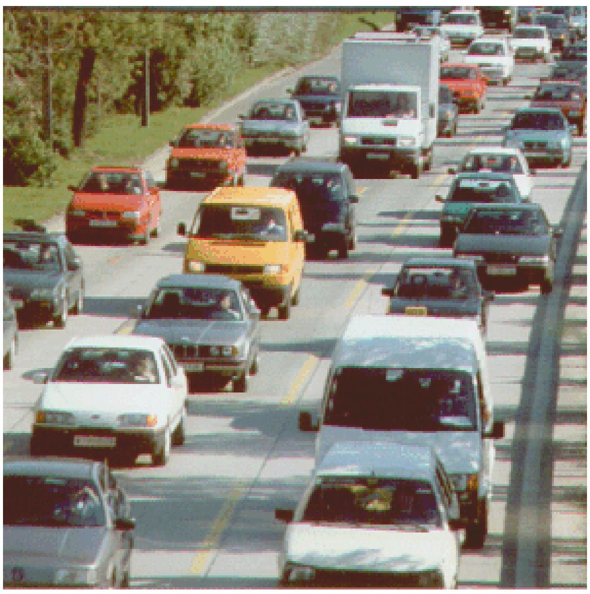
Assessment: The mineral oil taxation has positive effects on CO_2 emissions in two ways. Firstly, the tax represents a direct and variable cost per kilometer driven and thus, offers incentives to reduce and minimize the increase of mileage. Secondly, it offers stimuli to accelerate the realization of technological possibilities to reduce fuel consumption.

The autonomous tax policy of a small state has its limits though. Differences in mineral oil tax rates – mirrored by price differences – among neighboring third countries lead to undesired "fuel tourism" and, besides negative economic effects, also cause counter productive effects from an ecological point of view. Like in the past, mineral oil taxation has to be adjusted to the price level of, in particular western, neighboring countries.

Reduction potential: 0.1 mill. tons CO_2/a by 2005

Competent authority: Federation

Current situation: See also section 5.3.1.5. Mineral oil tax rates have generally experienced a real increase since the beginning of the nineties. The most recent increases amounted to about ATS 0.50 per liter of gasoline on 1 January 1994, about ATS 1.00 per liter of gasoline (considering the elimination of the special levy for mineral oil) and about ATS 0.60 per liter of diesel by 1 May 1995. In 1997 a total of about ATS 1.93 mill. from mineral oil tax and energy levies revenues can be earmarked to finance extensions of local railway lines.



5.3.2.3 Night Driving Ban for HGVs

General HGV night driving ban for non-low noise HGVs and 60 km/h speed limit for low-noise HGVs at night, which support the use of new vehicles with better emission standards and lower fuel consumption.

Reduction potential: 0.02 mill. tons CO_2/a by 2005.

Competent authority: Federation

Current situation: These provisions were adopted in the 19th amendment to the Road Traffic Regulations and came into force on 1 January 1995.

5.3.2.4 Electronic Speed Limitation for Trucks and Buses

This technical measure prevents HGVs and omnibuses from exceeding specific maximum speeds. Thereby consumption and emission reductions are to be expected, in particular from motorway traffic.

Reduction potential: 0.12 mill. t CO_2/a by 2005

Competent authority: Federation

Current situation: The provisions concerning electronic speed limitation devices for HGVs as of 12 tons (max. 85 km/h) and for omnibuses over 10 tons (max. 100 km/h) came into force on 1 January 1995.

5.3.2.5 Monitoring the Compliance with Existing Speed Limits (According to Item 3 of the Resolution by the Nationalrat dated 2 April 1992)

Assessment: Positive assessment, because better monitoring enhances safety in traffic. Meeting the legal speed limits on highways is connected with large reductions in fuel consumption (1 to 1.5 liters per 100 km). Advantage of a quick effect of the measure. Out of 15% of all speeding incidents where the legal maximum speed limit of 130 km/h was considerably exceeded, a potential of 1% of total passenger vehicle fuel consumption could be achieved. Need for more speed monitoring.

Costs: A certain percentage of the fine is used to cover the costs of monitoring.

Reduction potential: 0.18 mill. t CO_2/a by 2005

Competent authority: Federal provinces, federation

Current situation: The Road Traffic Regulation (*Straßenverkehrsordnung, StVO*) permits the financing of large scale monitoring measures. (19th amendment to the Road Traffic Regulations, has entered into force on 1 October 1994).

5.3.2.6 Restrictive Quota Regulations for HGVs and Omnibuses with all Eastern Neighboring States

5.3.2.6.1 Agreement on Freight Transport

Quotas have been stipulated in these agreements to promote, above all, the use of vehicles with technologically advanced environmental and safety standards (according to the respective CEMT resolutions "Conference Europeenne des Ministres de Transport"). Further, "reward quotas" have been agreed upon and are provided for, granted for transport via combined traffic ("Rolling highways" (RoLa – Rollende Landstraße) and "Roll on-Roll off" (RoRo)).

Assessment: Measure for shifting road traffic to environmentally sound and more energy efficient means of transportation (rail, water).

Reduction potential: Not estimated

Competent authority: Federation

Current situation: In the meantime Austria has concluded modern and transportation means-integrating agreements on road traffic with almost all Central and Eastern European countries.

5.3.2.6.2 Agreement on passenger transport

Busses, not meeting the standards defined in the corresponding agreement, are subject to authorization based upon a bilaterally agreed quota. By restrictive use of this quota bus companies should be enticed to invest in technologically well-advanced vehicles (high safety and emission standards). A

CMET resolution on traffic on demand for passengers was adopted in June 1995 in Vienna, which provides for the compliance with certain safety and emission standards of high technological quality on a multilateral level.

Assessment: Accelerates the use of vehicles low in emission and consumption.

Reduction potential: Not estimated

Competent authority: Federation

Current situation: Up to this date Austria has concluded bilateral agreements with Slovenia, Croatia, and Bosnia Herzegovina, Lithuania, Moldavia and Belarus. Agreements with Latvia, Estonia and Macedonia are ready for signature. Negotiations with Poland, the Czech Republic, Slovakia and Hungary are under way.

5.3.2.7 Continued Implementation of the Guidelines in the 1991 Master Transportation Concept

The 1991 Master Transportation Concept adopted the goal of reducing CO_2 by 20% by the year 2005 (from 1988 levels) and formulated appropriate programs (e.g. 5-step program for CO_2 reduction) and measures to bring about this reduction (see especially item 5.3.2.1 and 5.3.2.4). These measures are based on the following principles:

- ▷ Avoid unnecessary traffic
- ▷ Shift traffic to more energy efficient and environmentally compatible means of transport
- ▷ Undertake technical innovations in motor vehicles to optimize energy
- ▷ Use of real costs

Competent authority: Federation, federal provinces, local communities

Current situation: Measures are continually implemented (see below).

5.3.2.7.1 Expansion and Improvements of Rail Infrastructure and in Modal Split

(It should be emphasized that nearly 93% of the energy demand for the railways is covered by hydroelectric power.)

- Based on the Rail Infrastructure Financing Act (*Schieneninfrastruktur-Finanzierungsgesetz*) adopted in 1996 ATS 60 billion in federal funds will be allocated in the coming years for planning and realizing important rail infrastructure development projects. Thus, the rail infrastructure agency will be able to make total investments in the amount of ATS 90 to 100 billion, depending on the financing of the first two years. If required, this amount can be increased at the request of the Federal Minister for Science and Traffic. According to the Federal Railways Act (*Bundesbahngesetz*) 1992 and Promotion of Private Railways Act (*Privatbahnenunterstützungsgesetz*) a total amount of ATS 8.8 billion has been budgeted for non-profit services (such as tariff reductions) provided by Austrian railways and private railways.
- Investments are made on the one hand for the improvement of quality and quantity of rail infrastructure and on the other hand to promote the improvement of railway stations, freight terminals, new rolling material, promotion of park & ride facilities, further development of the underground system and of high quality local transportation networks as well as the extension of services by interlinked public transport systems. ATS 658 mill. were budgeted in 1996 and 1997 by the federation for the coordination of public passenger transport in the framework of the interlinked public transport systems (optimizing services offered, flat rates and tariff reductions).
- Promotion of development of combined transport: The Austrian EU Accession Treaty maintains the essential elements of the Transit Agreement. The positive effects of the transit regulation on fuel consumption reduction result from the regulations concerning the extension of rail infrastructure and the introduction of the eco-point system leading to a rapid fleet replacement.
- Supporting measures regarding combined traffic:
  - Program for the promotion of combined freight transport road-rail-water (1992-1996) with a focus on the construction/

remodeling of terminals for combined transport, ramp facilities, containers, interchangeable structures, logistics, etc.

- Special program (1995-1999) supporting the extension/modernization of branch lines, since more than two thirds of goods distribution takes place on branch lines.
- Exceptions from the general night driving ban for low noise HGVs were standardized as per 19th amendment to the Road Traffic Regulations (*Straßenverkehrsordnung, STVO*), dated 1 January 1995, allowing transports to and from loading stations at night on major access roads. Transports by combined transport are exempt from the weekend driving ban within 65 km to and from loading stations defined in the Road Traffic Regulations.

Reduction potential: 0.50 mill. tons CO_2/a by 2005; higher savings potentials can be expected in the long term.

5.3.2.7.2 Development of Inland Navigation

The establishment of the "Wasserkombi" in 1994 has to be regarded as an important traffic related initiative for the transport by waterways. Since then, line traffic has gradually increased (1994: 1,800 containers, 1995: 12,000 containers).

- Legal provisions applying to both Rhine and Danube traffic can only be expected in the medium term. In 1996, a multilateral inland navigation agreement was signed by the EU and the Czech Republic, Poland, and Slovakia.
- Special ad-hoc measures relating to hydraulic engineering to establish the navigable water depth of 2.5 m at regulation low water level have been completed according to the Inland Navigation Act (*Binnenschiffahrtsmemorandum*) of 1997. A framework plan aimed at retaining this navigable waterlevel is currently in preparation.
- In the course of studies regarding the national park Donauauen consensus was reached on regulation measures to improve the navigability up to a draught of 2.7 m at regulation low water level are not subject to the national park acts. A general project based on the basic elements of the "River Engineering Overall Concept" with a navigable water level up to 3 m at regulation low water level could be immediately initiated.
- Establishment of a program to promote investment in the port infrastructure in the course of 1997; planned duration until 1999.

Assessment: The Rhine-Main-Danube Canal was well received by the Austrian economy. Westbound transports increased by more than 1 mill. t in 1995 compared to 1992 (opening of canal) and transit traffic increased by 1.6 mill. t. From an environmental point of view the results are even more favorable, as the canal helped to avoid dead freight transports and considerably increased transport distances. The above-mentioned regulation measures in the Upper Danube area would offer an even greater potential for CO_2 reduction than the opening of the Rhine-Main-Danube Canal. However, using this potential requires the extension of other Danube areas (e.g. Bavaria, Hungary). The states on the Upper Danube are currently trying to solve this problem.

Reduction potential: Not estimated

5.3.2.7.3 Stepped-up Efforts in Research and Development

Key technology transport engineering in ITF

Objective: Initiatives for the creation of environmentally compatible and efficient transport system by promoting the development of environmentally friendly technologies, system solutions and pilot installations for transport, logistics and mobility.

Contents: Main efforts in progress or planned include: "Logistics-Supervisory System", "Intermodality" and "Innovative mobility forms and technologies" (development of alternative fuels and drive technologies, car pooling, car sharing, telematic, demand-oriented public traffic). One of the projects to be realized is a pilot project to reduce traffic in tourist resorts by using these technologies.

Current situation: Continued realization by means of research, technology, development and pilot projects; adopting implementation of technology related concepts of the federal government.

5.3.2.7.4 Further Measures from the Master Transportation Concept

The following measures are partly comprised in item 15 of the resolution by the Nationalrat (First Chamber of Parliament) dated 2 April 1992 regarding the reduction of ozone precursors:

A. Launch urban planning measures to reduce traffic movement, provide for shorter transportation distances, and create or maintain decentralized local shopping systems.

B. Make the regional zoning of land for construction contingent on providing access to public mass transit

C. Vary support for residential construction according to its location and whether access to public mass transit is provided for in the project

D. Give preferential treatment to the acquisition of construction sites near public mass transit stops/stations – include this aspect in the building code

E. Create integrated bike path concepts not confined to tourism and recreation, include a financing concept (Competent authority: Local communities)

F. Limit individual traffic, especially in downtown areas – limit entry to city centers by such measures as pedestrian zones (Competent authority: Local communities)

G. Manage parking space (Competent authority: Local communities)

Assessment: Chief measures to reduce individual traffic and energy consumption

Reduction potential: 0.20 mill. tons CO_2/a by 2005; higher savings potentials can be expected in the long term.

Competent authority: Federation, federal provinces, local communities

5.3.2.8 Federal Traffic Route Plan

As basis for the Federal Traffic Route Plan, alternative sets of measures relating to finance and traffic policies and their effects on traffic density, choice of transportation means, traffic output, energy consumption and emissions are determined in the form of scenarios. The results of these simulations combined with the principles contained in the National Environmental Plan form the basis for political decisions. Measures are to be implemented to decrease the use of non-renewable energy sources for transport thereby reducing pollutants and CO_2 emissions.

Another criterion for the assessment of individual traffic infrastructure projects is its effects on energy consumption. Energy consumed during construction and operation of traffic routes (energy consumption of vehicles, illumination and ventilation of traffic routes) as well as increased energy consumption by new traffic, shift of traffic and higher speeds.

Assessment: Instrument to harmonize regional and traffic planning with the goal to contribute to climate protection.

Reduction potential: Not estimated

Competent authority: Federation

Current situation: In preparation, instruments for the Federal Traffic Route Plan and first assessment results for railway and road projects should be available in the course of 1997.

Planned implementation:

5.3.2.9 Consumption Limitation in Aviation

5.3.2.9.1 Technical standards

Assessment: Development of advanced airplane drives has made good progress over the past years. Fuel consumption was reduced by between 30% to 40% due to technological developments. A further decrease in energy consumption is still necessary especially since the expected dynamic development of air traffic contributes considerably to the climate problem. Since the research and development activities in the aviation sector are of large scale, Austria can hardly contribute directly: Austria will exercise influence by establishing international standards and regulations.

5.3.2.9.2 Kerosene taxation

Assessment: There are differences in the taxation of fuels since aviation fuels (kerosene) used in commercial aviation are mandatory tax exempt as per EU-legislation (92/81/EEC). Currently air traffic is responsible for about 2-3% of anthropogenic CO_2 emissions. Taxation would be appreciated for environmental reasons; however, it would only be financially justifiable and ecologically successful through harmonized action at the EU-level and the inclusion of (in particular neighboring) third countries.

Further activities aimed at traffic/energy optimizing overall systems:

- ▷ environmentally compatible handling of traffic to/from/on airports
- ▷ more offers combining rail and air
- ▷ Increase appeal of railway as an incentive to substitute short distance flights by train

Reduction potential: Not estimated

Competent authority: Federation

Current situation: In the resolution E 19/GP XX dated July 12, 1996 the Nationalrat requested the federal government to support EU efforts to apply the concept of real costs in the aviation sector. In order to achieve a "world-wide" taxation on kerosene a change of conduct not only among EU member states but also among ICAO states is necessary. Austria supports, as a first step in this direction, a shift from mandatory tax exemption to facultative taxation at the EU level.

5.3.2.10 Reduction in Fuel Consumption of Motor Vehicles

Improving the energy efficiency of motor vehicles (→ 3 liter car).

Reduction potential: 0.6 mill. metric tons of CO_2 per year by 2005 (based on 5-liter consumption Otto engine and 4.5-liter consumption diesel engine)

Competent authority: Federation

Current situation: The discussion conducted with automobile manufacturers over the last three years has borne fruit in that it now appears possible to have vehicles with standard fuel efficiency rates of 3 l/100 km on the road by the year 2000. Standard fuel efficiency rates of 5 l/100 km are already common today, especially for diesel powered vehicles and the car industry has announced further savings potential.

On the occasion of the CEMT (Conference of European Ministers of Transport), held in June 1995 in Vienna, a joint declaration of objectives and concrete measures for the reduction of CO_2 emissions caused by passenger vehicles has been adopted. The federal government has to provide the respective political framework committing the car industry to developing and producing fuel efficient vehicles.

At present a voluntary mobility agreement with the Austrian car importers is in preparation with the goal to reduce fleet consumption. Fuel consumption is an important assessment criterion in the selection process (share of 25%) for federal motor vehicles.

5.3.2.11 Use of Biogenic Fuels in Ecologically Sensitive Areas

The use of biogenic fuels is to be made mandatory in environmentally sensitive areas such as on protected waterways, in nature preserves, in inland navigation, and on alpine ski slopes.

Reduction potential: 0.1 mill. t CO_2/a.

Competent authority: Federal provinces, federation

Current situation: Recommendations have been issued by the Federal Ministry for Agricultural and Forestry to the Federal Hydraulic Engineering Administration and the water law authorities to require or to use biogenic fuels; part of these recommendations have already been implemented. (Refer also to 5.3.5.2) The working group "Biogenic raw materials" in the FMEYF studies this topic.

5.3.2.12 Road-Pricing

According to the Austrian EU Accession Treaty Austria was entitled to impose road toll on heavy lorry transport (vehicles from 12 t and higher) exceeding the maximum tax rate set by community law. The draft for a new road-pricing directive provides for the allocation of road freight traffic related costs according to the polluter-pays principle. Thereby, costs for damages to infrastructure as well as environmental costs will be taken into consideration.

Assessment: Because of the current low maximum rates for road traffic, according to the road pricing directive (93/89/EEC), a striking discrepancy between infrastructure costs caused by road users as well as external costs and the price to be paid for road use has emerged. The proposal of the European Community with regard to an increased consideration of external costs, in particular of extra charges for road use in ecologically sensitive areas, is supported.

At a price of ATS 0.50/km for passenger vehicles and of ATS 2.00 for heavy transport depending on total volume and under the condition of a comprehensive introduction, energy consumption and CO_2 emissions could be reduced by 14%. Conventional pollutants could be reduced by between 6% and 12% depending on pollutants. An introduction limited to motorways and expressways would yield a considerably lower reduction (CO_2 only up to about 3%).

Objective: A measure to regulate traffic by the introduction of a comprehensive, ecologically designed electronic toll system depending on mileage and in conformance with EU regulations. This represents an important step towards establishing the concept of real costs in the transport sector.

Reduction potential: 0.5 mill. t CO_2/a by 2005

Competent authority: Federation

Current situation: The Federal Motorways Financing Act (*Bundesstraßenfinanzierungsgesetz*) of 1996 provides for 1997 the introduction of a vignette (validity limited by time) for motorways and expressways. In addition, the introduction of a toll depending on mileage for motor vehicles exceeding 3.5 t is planned for 1998 and for all vehicles for 2001. The price of the annual vignette (validity limited by time) amounts to ATS 550 (passenger vehicles) and ATS 12,000 (HGV up to 12 t). Revenues in the amount of ATS 1.2 billion have been budgeted for 1997.

5.3.2.13 Plan by Stages for the Reduction of Emissions in the Transport Sector

Reduction potential: Not estimated

Competent authority: Federation

Current situation: A plan by stages for a speedy emission reduction and the marketability of vehicles low in consumption in the areas of "Environmental technology for vehicles", "Increase appeal of environmentally friendly transport means", "Achieving real costs in the traffic sector", "Mobility management, Mobility behavior" is in preparation.

5.3.2.14 Environmentally sound conduct in traffic

Reduction potential: Not estimated

Current situation: Initiation of various pilot projects and action programs.

5.3.2.14.1 Model Project "Individualized Marketing Illustrated by Public Passenger Traffic"

This regional action program tries to improve acceptance and to increase use of public transportation means by motivation and information among the part of the population participating mostly in individual motorized traffic.

Assessment: Increase in road safety and reduction of environmental pollution from traffic.

Competent authority: Federation

5.3.2.14.2 Model project "Mobility Management by Companies"

In the course of the last 10 years the share of cars in the work-related commuting traffic has dramatically increased. Every second work-related commuter uses a car to get to work, while the share in public means of transportation has further decreased.

Assessment: Initiative for an environmentally compatible administration of mobility to reduce the environmental burden.

Competent authority: Federation

Current situation: Following the example of the USA and the Netherlands, Austria is to promote the use of "Travel Demand Management" instruments.

Concepts/Projects:

5.3.2.15 Stricter Speed Limits

Assessment: Lowering the speed limit from 130 km/h to 100 km/h results in a reduction in fuel consumption (in the range of 0.5-0.75 l/100 km). The priority here is to enforce existing speed limits more strictly and to earmark part of the fines for enforcement measures.

Competent authority: Federation, federal provinces

5.3.3 Industry – Combustion and Processes

Following an international trend combustion-related CO_2 emissions in the industry sector have been declining over the past 20 years. Responsible for this decline are the improvement of energy efficiency and a structural shift within the sector from energy intensive to less energy intensive branches of industry.

The energy consumption was lowered by almost 5% between 1973 and 1992 for an increase in production of more than 65%, and at the same time oil consumption was reduced by 68% over the same period. Between 1975 and 1995 total CO_2 emissions of the industrial sector (combustion emissions, process induced emissions, emissions from generation of current) decreased by approx. one third. In spite of this success there is still more potential for savings in industrial processes, in particular in the sector of process heat.

There are a number of options for achieving the energy saving potential in this area, in particular combined heat and power, cascade utilization of temperature levels, energy utilization of residual material, optimization of furnace technology, reduction of standby and heat distribution losses, and in particular improved measuring and control technology.

Voluntary measures/subsidies under implementation:

5.3.3.1 Combined Heat and Power Installations

Reduction potential: No additional reduction potential compared to the IER-scenario can be assumed, as the measure is already included in this scenario.

Competent authority: Federation

Current situation: In particular, combustion technology with a high cascaded energy utilization is to be promoted in the future, also. By using new gas turbine technologies and due to lower gas prices it was possible to install larger facilities, partly as replacements for heavy oil boilers, mainly in the paper and sugar industries. These projects were subsidized under the Environmental Support Act (see section 5.3.1.1). CHP plants are subsidized according to the Environmental Support Act.

5.3.3.2 Optimization of Mechanical Systems

Assessment: In the corporate sector there are possibilities for savings in mechanical drive systems, especially as a result of the following improvements:

- ▷ Optimum drive type
- ▷ Recuperative braking
- ▷ Load-dependent motor control
- ▷ Low-friction bearing mounting (tribological measures)

These are mainly technical measures, and their realization is the responsibility of the companies themselves, the institutions advising them as well as the civil engineers concerned by planning and project planning.

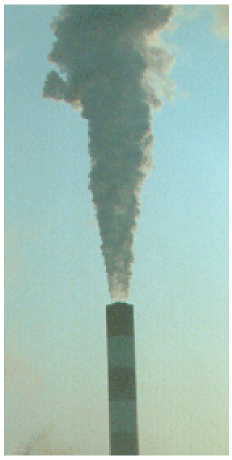
Reduction potential: A savings potential of about 4 PJ/a (corresponding to a reduction of 0.8 mill. t CO_2/a by 2005) can be achieved based on a rough estimate that 80% of electric energy used in Industry is related to mechanical work and could be reduced by 10% within the scope of optimization.

Competent authority: Federation

Current situation: A study about energy efficiency improvements for electric drives was completed in autumn of 1996 pursuing the objectives of the PACE-decision dated 6 June 1989 (action program for the increase of efficiency of electricity use) in connection with the EU-SAVE program.

5.3.3.3 Fuel Switch

Reduction potential: A study about energy efficiency improvements for electric drives was completed in the autumn of 1996. CO_2 emissions could be reduced by 1.2 mill. t/a by doubling the current share of biomass and combustible waste and substituting them for fossil energy sources. But the use of firewood in industry currently only accounts for less than 1% of total combustible waste used. According to IPCC Guidelines for National Greenhouse Gas Inventories combustible waste has to be included in the CO_2 balance sheet as far as industrial waste or household waste are concerned, for biomass (including spent liquor, biogenic waste) this is not the case. In order to provide more accurate information on reduction potentials a detailed specification of combustible waste is required for estimating the CO_2 reduction according to IPCC guidelines. A reduction potential of 0.3 mill. CO_2 t/a by 2005 was assumed.



Competent authority: Federation (subsidies)

Current situation: Although the number of plants powered by biomass and combustible waste continued to slightly increase during 1994, large potentials still remain. The share of these energy sources in the industrial sector could be increased from currently 11% to between 15% up to 20%. Despite unfavorable conditions (comparatively low prices for fossil fuels) the results are satisfactory.

5.3.3.4 Improving Information about the Energy Flow in Businesses

Reduction potential: The reduction of 1.25 PJ corresponds to a reduction of 0.3 mill. t CO_2/a. It is assumed that this potential can be realized by 2005.

Competent authority: Federation

Current situation: Since the beginning of the eighties a consulting institute has been in charge of offering free consultation services on energy related problems to companies in the industrial sector. Since its foundation approx. 400 companies have been inspected and consulted on site. One key aspect of all consultations was the introduction of an energy accounting and balance system to document the internal energy flow in a most accurate way. Other areas of interest include investments for more efficient energy use and the recommendation of profitable substitutes.

The success of this campaign is evident from the fact that the total costs of ATS 5 mill. (100 ATS equal approx. 9 US$) incurred by these consulatations have yielded potential cost savings for the companies of some ATS 120 million a year, with the proposed energy savings estimated at some 1.25 PJ a year.

Early in 1994 the lower limit of annual consumption for the energy consumers to be included in the study was set at 20 TJ so that smaller industrial companies and larger trade businesses could also take advantage of this campaign. The next step is to analyze the available statistical material and to compile it in an anonymous form so it can be used for informational purposes.

5.3.4 Small Consumers

Measures under implementation:

5.3.4.1 Consumption-related Heating Costs Accounting

As per Art. 15a B-VG Agreement concerning the reduction of energy, the Heating Cost Accounting Act (*Heizkostenabrechnungsgesetz, Federal Law Gazette 827/1992*) now regulates the accounting of heating costs based on actual consumption instead of usable floor space provided that suitable heat measuring instruments are put in place.

Assessment: The development of more precise and cheaper heat measuring instruments (relatively cheap measure) and rehabilitation in terms of heating technology of buildings and heat supply installation (relatively expensive measure) could prevent the trend towards accounting as a percentage of usable floor space and the 10-20% higher energy consumption observed in this connection.

Reduction potential: Since this measure does not have an immediate effect on CO_2 reduction, no reduction potential has been quantified. It promotes, inter alia, the measures stated in 5.3.4.3 and 5.3.1.5.

Competent authority: Federation

Current situation: Consumption-related heating costs accounting has been stipulated in the Heating Costs Accounting Act, corresponding ordinances were issued. With regard to the large energy and CO_2 reduction potential, this current legal basis should continuously be improved and adapted to the state of the art.

Planned implementation:

5.3.4.2 Consumption Reduction for Electrical Appliances and Motors as well as Lighting and Electronic Systems

The determination of maximum consumption standards in conjunction with a complete product coding (energy consumption) is sensible. Preparation and enactment of orders as per Section 8 Electrical Engineering Act.

Assessment: The reduction potential is based on an investigation of the trends which can be observed at the moment with regard to efficiency improvement, appliance replacement, number of electrical appliances utilized and number of households. In each case the old appliances are replaced by the best available appliance on the market. As was estimated, by using the most efficient electrical appliances, especially in the household appliance sector, the consumption of electric energy for this appliance group could be reduced by approx. 30%. Therefore, the full utilization of the electricity saving potential in small consumption through the accelerated market introduction of the most efficient appliances is a priority target in energy policy.

Reduction potential: 1.25 mill. tons of CO_2/year could be achieved in the long term. 0.6 mill. tons of CO_2/year could be achieved by 2005, 0.8 mill. tons of CO_2/year by 2010.

Competent authority: Federation

Current situation: The agreement on efficient energy use mentioned in section 5.3.1.6 between federation and federal provinces contains the following:

- Labeling and description of specific energy consumption of household appliances

- Legal requirement to provide information for comparison of household appliances
- Ceilings regarding maximum consumption of household appliances

EU directives have been implemented as follows: directive 92/75/EEC and 94/2/EC regarding labeling of energy consumption of household appliances and refrigerators in 1994; directives 95/12/EC (household washers) and 95/13/EC (laundry dryers) in 1996 as per Electrical Engineering Act (*Elektrotechnikgesetz, ETG*). A working group has been studying possible procedures in connection with the regulations as per ETG. The implementation of directive 96/75/EC with regard to energy efficiency requirements of household cooling and freezing appliances and combinations thereof is in preparation. Based on cost/benefit analyses of intermediate units for fluorescent lamps and on estimates of stand-by losses of household appliances, measures such as mandatory standards, limits, quality labeling, consumer information, etc. should be established at the EU level.

In addition, it is planned to consider the requirements of advanced international "energy-labels" in the framework of the public procurement system. In the framework of the energy research cooperation a study on energy savings potentials of electrical household appliances was promoted.

5.3.4.3 Improving the Thermal Quality of Old and New Structures – Substantially Higher Standards for Thermal Protection of Buildings

Raising the standards in building codes to reflect the advancements in technology for increased thermal insulation using environmentally compatible materials and monitoring compliance with these standards.

- Provision for an energy certificate for buildings (see proposal for an EC Directive from the Council dated 26 June 1992)
- Setting of characteristic energy figures instead of k-values (characteristic energy figures should be implemented within the framework of an Art. 15a B-VG agreement and be made gradually stricter according to a designated schedule)

Assessment: Measures are urgently needed.

Reduction potential: The potential for energy savings in room heating and water heating is very high. Some 40% of the total end energy is used for room heating and water heating. More than 80% of it is related to the use of energy for heating. The savings potential is substantial.

Competent authority: Federation, federal provinces

Current situation: The agreement on efficient use of energy mentioned in section 5.3.1.6 between federation and federal provinces according to Art. 15a B-VG contains the following measures:

- Higher minimum requirements for building components (k-values)
- Possibility to replace measures for thermal insulation by other measures relating to efficient energy policies to attain defined energy standards, proof of equivalence of such measures has to be effected by use of energy value indicators.

5.3.4.4 Improvement of the Thermal Quality of Heating Systems

Two agreements in conformity with Art. 15a B-VG support the improvement of the thermal quality of heating systems.

The Agreement on the efficient use of energy mentioned in section 5.3.1.6 between the federation and the federal provinces according to Art. 15a B-VG contains:

- Definition of a minimum impact for small-scale furnace plants
- Providing subsidies within the framework of residential construction promotion and rehabilitation of buildings for the objective of this agreement

An agreement according to Art. 15a B-VG on safety measures regarding small furnaces (type verification and test) entered into force as of June 17, 1995. It contains:

- ▷ Basic separation of water heating from room heating
- ▷ Stepped up promotion of modern combustion technologies
- ▷ Integrated coordination of all system components (e.g. burner-boiler-trap)
- ▷ Improved maintenance, servicing and inspection of heating systems
- ▷ Improvement in control and instrumentation technology for heating systems

Assessment: Substantial measure also for reducing the emissions of other air pollutants.

Reduction potential: 4 mill. t CO_2 (EVA 1994) by improving the quality of heating systems (boiler replacement, switching from single heating installations to central heating, insulation of heating tubes, etc.). By using modern control engineering systems the total potential amounts to about 5–6 mill. t CO_2/a. These measures, however, have already been considered in the calculations of the IER reference scenario. The results of an increased promotion of this measure are very difficult to quantify: it is assumed that a reduction potential of additional 1.4 mill. CO_2/a can be achieved by 2005.

Competent authority: Federation, federal provinces

Current situation: A furnace ordinance (for commercial plants) is currently in preparation. The agreement on type verification and test has already been implemented by some federal provinces.

Concepts/Projects:

5.3.4.5 Energy Accounting in Public Buildings and in Trade and Industry

For public buildings: The Austrian Federal Test and Research Institute Arsenal has been instructed by the Federal Ministry for Economic Affairs to keep energy accounts.

Assessment: recommended measure – the government is to set an example.

Competent authority: Federation

5.3.4.6 Easing Restrictions on the Use of Wood as a Building Material in Compliance with Thermal Insulation Standards

Harmonization of the separate building codes and their adaptation to the possible use of wood under current technical conditions

Assessment: Promising measure

Reduction potential: See 5.3.6.4

Competent authority: Federal provinces, federation

5.3.4.7 Subsidy for the Rehabilitation of Old Buildings

As part of promoting residential construction – funds for the rehabilitation of houses in the federal provinces should be made contingent on the submission of an energy rehabilitation plan and on compliance with thermal insulating standards (see 4.2.1.3).

Costs: Depend on the grants involved.

Competent authority: Federal provinces

5.3.4.8 Adopting Energy-based Parameters in Subsidizing Residential Housing

Government support of residential housing promotion was to be allocated according to energy quality standards. Characteristic energy index numbers were to be applied to represent the standard consumption of energy in an apartment. Since the expense for constructing or rehabilitating a building or apartment might be increased if low energy index figures are applied, the grants should be ranked accordingly.

Assessment: Essential control measure

Competent authority: Federal provinces

Current situation: With regard to government promotion policy, the compilation "Energy-related government promotion in the sector of residential construction subsidies/residential housing rehabilitation in the federal provinces" was updated by the

Federal Ministry for Economic Affairs. The promotion activities of the federal provinces are increasingly harmonized. The agreement as per Art. 15a B-VG on the efficient use of energy also supports developments in this direction.

In the federal provinces Vorarlberg, Salzburg, Tyrol, Upper Austria and Styria residential housing construction subsidies are granted depending on fulfillment of energetic criteria exceeding standard requirements.

5.3.4.9 Reducing Government Support in the Promotion of New Residential Housing Construction where Electric Resistance Heating Is to Be Installed

If electric resistance heating is to be installed, the funds to be approved for government housing promotion should be reduced accordingly.

Competent authority: Federal provinces

5.3.5 Agriculture

Voluntary measures/measures under implementation:

5.3.5.1 Extension of Organic Farming and Integrated Husbandry, Further Reduction in Fertilizer Utilization through the Targeted Fertilizer Management in Accordance with Requirements

Assessment: Important measure given its double effect (reduction in N_2O emissions and savings of energy for fertilizer production).

Reduction potential: The decreased usage of fertilizer results in a reduction of 0.1 mill. tons CO_2/a in 2005.

Competent authority: Federation, federal provinces

Current situation: In the agricultural sector mineral fertilizer (nitrogen, phosphate, potassium) sales continue to decrease due to measures (such as intensive consulting activities, recommendations of the Committee for Soil Fertility) administered by the Austrian Program for Environmentally Compatible Agriculture (*Österreichisches Programm für umweltgerechte Landwirtschaft, ÖPUL*) and because of changes in the general economic framework. Table 5.1 shows the progress over the past few years.

acc. year	N	P_2O_5	K_2O	total
1987/88	145,5	79,8	107,4	332,8
1988/89	140,9	78,3	103,0	322,2
1989/90	136,8	74,9	98,5	310,2
1990/91	140,0	75,4	94,5	309,9
1991/92	134,8	70,8	86,4	292,0
1992/93	125,6	65,2	78,5	269,2
1993/94	126,7	62,3	76,5	265,5
1994/95	116,0	53,7	61,3	231,0

Table 5.1: Mineral fertilizer sales in Austria (in 1000 tons pure nutrient)

Following from the above the consumption of mineral fertilizers per hectare of arable land (2,476,763 ha according to the cultivation survey 1990) amounts on average to 46 kg nitrogen, 22 kg phosphate and 25 kg potash, in total 93 kg. Organic farming as the most consistent form of renouncing the use of mineral fertilizers and chemical crop pesticides has shown a rapid upwards trend since 1988. Table 5.2 on the next page shows the development since 1978.

In 1996 there were about 20,000 organic farms in Austria representing about 10% of all farms with farm land. In 1996 subsidies of ATS 17 mill. for eco-associations and of ATS 788 mill. for organic farming were granted. Various measures for integrated agriculture were promoted in the framework of ÖPUL.

5.3.5.2 Cultivation of Oil-seed Crops (In Conjunction Substitution of Fossil Fuels with Biogenic Fuels) – Provision of Biogenic Fuels and Lubricants for Environmentally Sensitive Areas of Use

Assessment: Multiple benefits for the environment, many of the necessary structures already in place; if financial incentives were provided - quickly implementable

	1978	1980	1982	1984	1986	1988	1989	1990	1991	1992	1993	1994	1995	1996
Farms	100	200	320	420	600	880	1190	1540	1970	6000	9710	13320	18790	19900

Table 5.2: Development of organic farming in Austria. Number of farms (cumulative) since 1978

Reduction potential: 0.3 mill. tons CO_2/a

Competent authority: Federation (eco-label), federal provinces

Current situation: Rape acreage was 31,000 ha in 1988 and 63,000 ha in 1996. Agricultural subsidies are available for rape cultivation. With the lubricant regulation an initial step has been taken with regard to the use of biogenic lubricants. Consideration of the criterion "regenerative resources basis" in the guidelines for the Austrian eco-label.

5.3.5.3 Utilizing the Energy of Surplus Straw

Due to a number of measures straw burning on open fields has been declining since 1988. With the law banning the outdoor burning of biogenic material the burning of straw on open fields has been restricted to a very large extent. Energetic use of surplus straw becomes increasingly more important.

Assessment: The necessary structures have partly been created; technical modifications to firing installations required in part.

Reduction potential: included in section 5.3.1.2 with a reduction of 0.6 mill. t/a.

Costs: Retrofit measures on firing installations.

Competent authority: Room heating distribution among energy carriers – regional planning: local communities and federal provinces; government promotion of district heating: federation, federal provinces ; government promotion of residential construction: federal provinces, for combined heat and power schemes (CHP): feed regulations; waste management: Federation.

Current situation: No dynamic trend is currently in sight. There is some government promotion of agriculture in this regard and of some other sectors of the economy.

5.3.5.4 Determination of Biogas Potential for Economically Feasible Uses and the Substitution of Fossil Fuels with Biogas (Refer also to Section 5.4.2)

Assessment: An effective measure in light of the double effect on the climate (reduction of methane emissions and the substitution of fossil fuels).

Reduction potential: 0.1 mill. tons CO_2/a through substitution of fossil fuels. The energetic potential of this measure is about 1 PJ. It is assumed, that half of the potential can be realized by 2005 and the whole potential by 2020; by 2010 at the most 0.07 mill. tons CO_2/a.

Costs: Development of the necessary infrastructure.

Competent authority: Feed regulations (federation and federal provinces), government promotion of district heat: federal provinces or federation; distribution of room heating market according to energy carriers - regional planning: local communities and federal provinces; government promotion of residential housing: federal provinces; waste management: federation.

Current situation: No dynamic trend currently in sight. There is some government support for the erection of biogas plants in agriculture as well as other sectors of the economy. It has to be noted, that without favorable feeding conditions and promotion of investments the wide use of biogas technology might be jeopardized.

5.3.6 Forestry and Land Use

Measures under implementation/ planned implementation:

5.3.6.1 Maintenance of a Vital Forest as CO_2 Sink

- Provision of appropriately stringent legal regulations (emissions, ambient air quality) to protect forests against air pollutants detrimental to forests (e.g. with the planned ordinance according to the Ambient Air Quality Act, with the 3rd ordinance against air pollutants detrimental to forests) with special reference to reducing tropospheric ozone through the implementation of the resolution of the Nationalrat of 2 April 1992, Item 5 (stipulation of emission limits according to the state of the art on old and new installations in individual industrial sectors).

  Efforts to adapt ambient air quality regulations to the scientific state of the art are still under way.

  Assessment: Important for the regeneration and preservation of damaged forests, since air pollutants affect forest ecosystems and cause long-lasting and partly irreversible damages through N-concentration, erosion of plant nutrients as well as increases in soil acidity.

  Competent authority: Federation

  Current situation: As of now, consensus on the Third Ordinance to the Forest Act against Forest-damaging Air Pollutants could not be reached with all ministries involved. The Ambient Air Quality Act (*Immissionsschutzgesetz-Luft*) was adopted; it provides for the authorization to issue an ordinance to set standards for ambient air quality, inter alia, for the protection of forests.

- Reduction in deer and grazing damage to an ecologically sustainable level, inter alia, through the implementation of the appropriate provisions of game legislation, forestry-related measures for the improvement of living space for game assisted by comprehensive wildlife ecological regional planning as well as reduction of grazing damages by the segregation of forest and grazing areas.

  Assessment: important measure for achieving the regeneration of near-natural forest regions.

  Competent authorities: Federal provinces, federation

  Current situation: Game damages affect the forest's ecological and economic functions to a considerable degree. Mutual efforts of the forestry and hunting sectors have resulted in improvements at the local level: most provinces have modern hunting laws and make stricter use of the legal instruments. Game damages are still a problem, a considerable reduction in damages has yet to be observed.

- Measures for the preservation and natural development of biological diversity, inter alia, by establishing a state-wide net of forest preserves (already under way).

  Assessment: important measure to ensure the conservation of the Austrian forest and the fulfillment of its manifold functions.

  Competent authorities: Federal provinces, federation

  Current situation: in 1996 the first preserves could be secured by contracts.

- Forestry measures for a lasting management of Austrian yield forests, Prevention of single cropping, promotion of forest rejuvenation, restoration of protection forests

  Assessment: Important measure, to increase the stability and vitality of forests and to make them more resistant against extreme weather conditions and the effect of pests as well as to improve their adaptation potential in view of possible climate changes.

  Reduction potential: In the long run the C-budget of each forest is balanced, i.e. an additional accumulation of carbon for longer periods is not possible, so that securing the present forests as C-sink forests becomes increasingly more important.

  Competent authority: Federal Ministry of Agriculture and Forestry

Current situation: Financial promotion in the following areas is possible: complete valuable forest rejuvenation, change forest stands presently consisting of tree species unsuitable for the respective site conditions and provide biodiversity in deciduous tree and mixed forests. Projects are currently realized in the framework of the Protection Forest Improvement Concept of federation and federal provinces (relating to 161,000 ha protection forest with ban effect). Timber stock (diameter of 5 cm at breast height) of yield forest increased by approx. 33 mill. cubic meter of solid timber stock between the inventory periods of 1981/85 and 1986/90 resulting in a medium-term binding of approx. 37 mill. t CO_2.

5.3.6.2 Extension of the Forest Area

Assessment: Through afforestation in regions lacking enough forests and areas previously used for agriculture as well as through natural reforestation (extension of the CO_2 sinks) a certain strengthening of the "depot effect" (C-fixing) can be achieved.

In this way success in CO_2 reduction could be obtained in the short to medium term. However, there are limitations imposed on intensive afforestation by the available surface area. 46% of the national territory of Austria is already covered with forests.

Potential of the sink: 0.255 mill. tons of CO_2/a assuming a constant increase in forest area of 2,000 ha/a.

Competent authority: Federation, federal provinces

Current situation: Contrary to the assumptions in the 1994 Climate Report, the extension of forest areas has experienced a considerable decrease. According to the inventory period 1986-1990 it presently amounts to 2,000 ha/a. In the framework of forestry-related regional planning a project was started in cooperation with the Forest Service of Lower Austria. The project's objective is to provide for new afforestation and improvement of protection forests in the pannonic lowland and hills, an area experiencing extreme lack of forests.

5.3.6.3 Increase in Biomass

An increase in stock is possible through the intensification of forest-engineering measures, better use of existing forest soil as well as higher planting density and measures such as segregation of forest and grazing areas. Through natural forms of forest management the humus stock can be also increased resulting in the binding of C.

Sink potential: 13.6 mill. t CO_2/a assuming a continued increase in growth (and stock) at the same rate until 2005 as well as an improvement of the humus stock.

Competent authority: Federation

Current situation: Objectives for forestry policy include above all:

- ▷ Improvement of ecological stability
- ▷ Quality improvement
- ▷ Extension of product line and services

Although the increase in surface productivity and the extension of forests ceased to be prioritized, a considerable growth can still be observed. According to the forest inventory period of 1980/91 the growth increased by 38% compared to the period of 1971/80. The increase in area combined with the growth rate in connection with a stable rate of use of about 60% of continuing growth results in an considerable increase in CO_2 binding by forest.

Among the reasons for this growth rate and stock increase are the intensification of forest-engineering measures, a favorable mixture of tree species (increase of mixed and deciduous trees), thinning potential as well as the surplus of growth-intensive age groups, and also the nitrogen deposition and the increase of CO_2 concentration in the air. Whether the predicted increase in growth will continue at the same rate until 2005 will be verified by the results of the Austrian forest inventory 1992-1996.

5.3.6.4 Doubling the Use of Long-lived Wood Products

Assessment: Relatively large amounts of CO_2 could be bound from the atmosphere over the medium term through the increased use of long-lived wood products (enlargement of the CO_2 reservoir). This would be a sensible industry-wide policy for the Austrian woodworking and wood-processing industry.

Reduction potential: Up to now approx. 0.15 mill. t CO_2/a were bound, by 2005 0.3 mill. t/a (100% increase) and an additional binding of 0.15 mill. t/a is expected.

Costs: very slight

Competent authority (for building code): federal provinces

Current situation: In the period from 1988 to 1993 approx. 700,000 m^3 of sawnwood was sold as building material, furniture, etc. in Austria, which results in the binding of approx. 771,000 metric tons of CO_2 over the medium to long term.

5.3.7 Cross-sectoral Measures

Promotion of renewable fuels

For many years already, the federal government's energy policy has put special emphasis on the intensified use of renewable energies. Besides the maximum possible utilization of all existing energy saving potentials, the best possible opportunities for achieving the CO_2 emission reduction target are seen in the greatest possible tapping of renewable sources of energy, in particular in the stronger market penetration of biomass.

Over the last few years the use of hydropower and the more intensified tapping of other renewable sources of energy, in particular biomass, have covered more than two thirds of the energy generated in Austria (1995: 73.5%) and, thus, account for one quarter of the total Austrian energy supply (domestic production of gross energy plus imports).

At present the utilization of hydropower provides approx. 165 PJ (approx. 14% of total energy consumption) while other renewable fuels provide approx. 143 PJ (12% of total energy consumption).

Compared with other European countries, Austria rates in the top section; around one quarter of the entire energy supply comes from renewable sources.

The shares of renewable sources of energy excluding hydropower are as of 1995 as follows:

Firewood	60.3%
Combustible waste and spent liquor including waste and sludges of the paper industry	20.0%
Saw by-products, hogged wood, bark, chipping, straw, sewage gas and landfill gas	13.8%
environmental energy (heat pumps)	3.7%
active solar energy	1.0%
Biogas	0.8%
RME	0.3%
Geothermal energy	0.1%

(Source: preliminary results of a study conducted by ÖSTAT, Technical University Vienna and the Institute for Interdisciplinary Research and Continuing Education of the Universities of Innsbruck, Klagenfurt and Vienna)

The already high share of renewable fuels in energy supply can be extended considerably further still. Expert estimates have shown an additional technical potential of renewable fuels still available of 80 - 100 PJ, excluding hydropower.

The instruments and measures listed below are aimed at the additional tapping of 30 to 40 PJ above the existing yield.

- ▷ Research programs for renewable energy
- ▷ Reduction of information deficits when utilizing renewable energy
- ▷ Tightening of the subsidy system
- ▷ Fair outline conditions for all fuels.

Utilizing the energy value of biomass is of significance in terms not only of the national economy but also of the regional economy as it enables decentralized energy generation, with favorable repercussions on local economic development. For people, decentralized systems are more easily manageable and therefore entail greater social acceptance. There are also advantages to a decentralized energy supply in the light of supply safety. Finally, an increased utilization of biomass would create additional job opportunities not only in agriculture, but in machine and plant construction and in the building trades.

The primary goal with respect to biomass utilization is to create evaluation criteria for determining what form of utilization would be most expedient in all regards. There are several energy-specific promotion programs at the federal level with special emphasis on renewable fuels. As part of the priority area "Energy Technology" set up by the Innovation and Technology Fund (ITF) in 1992, 23 projects received a total of ATS 105 mill. (100 ATS is approx. 9 US$) in government support by 1 July 1994. These projects, too, were developed against the backdrop of pressing needs to reduce energy emissions. As part of the ITF priority area "Environmental Technology", far more than 100 projects have received a total financial assistance of ATS 335 mill. since 1988.

Voluntary measures/subsidies under implementation:

5.3.7.1 Use of Biomass as a Fuel and Raw Material

5.3.7.1.1 Use of Wood in Furnaces (To Replace Fossil Fuels)

Assessment: Very effective and relatively cost-effective measure. However, it is important to ensure that the combustion takes place in systems which reflect the current state of the art. The use of wood in furnace installations can be advanced by increasing the price of fossil energy sources, by further identifying priority areas for the use of renewable energy sources for room heating purposes as well as by providing information and public relations services.

Reduction potential: by decentralized use of biomass 1.45 mill. t CO_2/a by 2005 and approx. 2.9 mill. t CO_2/a by 2010. See also Section 5.3.5.3.

Costs: Possible costs for the conversion of existing furnaces

Competent authority: Division of the room heating market between energy carriers – regional planning: local communities and federal provinces; government promotion of housing construction: federal provinces; in conjunction with combined heat and power schemes (CHP): Federation.

Current situation: Total capacity of hogged wood and bark furnaces amounted to 1.787 MW at the end of 1995, this translates into a growth of about 124 MW compared to last year. Small-scale plants up to 100 kW experienced an increase of about 1,600, i.e. there are now approx. 15,600 heating plants in operation. The increase of medium-scale plants (100 - 1,000 kW) amounts to 126. At the end of 1995 2,130 such plants were in operation in Austria. A slight increase in large plants (more than 1 MW) was registered in 1995. Together with the 11 major plants which started operation in 1995, their number increased to about 250.

Modern split billet furnaces have also come on the scene and sales figures for them have already surpassed those for chip furnaces. These modern wood-burning furnaces help to improve the situation regarding emissions by utilizing wood energy more efficiently and by replacing fossil energy or at least not creating extra demand for it. Agricultural subsidies currently exist in this area (see also 5.3.1.1).

- In the sector of modern chip and bark furnaces, the period from 1988 and 1995 saw the installation of 10,500 small plants (less than 100 kW output), 1,200 medium-sized plants (from 100 to 1000 kW) and 140 large-sized plants (more than 1 MW).
- While small plants usually replace older wood furnaces, large plants generally replace fossil energy.
- If an old wood furnace is replaced, the improved combustion technologies reduce emissions and increase the degree of efficiency.

5.3.7.1.2 Use of Biodiesel

Current situation: In a series of research and experimental programs including fleet tests, the technical groundwork was laid for the production and use of biogenic fuels and lubricants. Two industrial plants and five small plants on farms were built for the production of rape methyl ester (RME) with an annual capacity of approx. 36,000 metric tons of RME (corresponds to a rapeseed cultivation area of approx. 36,000 ha). There are agricultural subsidies for the construction of RME plants and for the cultivation of rapeseed. The quality requirements for biodiesel were standardized. (Refer also to section 5.3.5).

5.3.7.1.3 Energy Utilization of Excess Straw

See Section 5.3.5.

5.3.7.1.4 Energy Utilization of Biogas, Landfill Gas and Sewage Gas

See Sections 5.3.5.4 and 5.4.1.1, 5.4.1.2.

5.3.7.2 Utilization of Solar Energy, Especially for Water Heating, and Partial Solar Room Heating – Use of Solar Collectors – Passive Solar Energy Utilization

Assessment: Relatively high reduction potential in connection with quick implementation; high acceptance can be expected.

Reduction potential: approx. 1.2 mill. metric tons CO_2 /a by 2005

Competent authority: Promotion: federal provinces and local communities; building code: federal provinces; promotion of residential housing: federal provinces.

Current situation: A dynamic trend is evident in the thermal utilization of solar energy. The construction of solar systems is currently being promoted in all federal provinces, in many local communities, by the Environmental Fund and by agricultural development institutions. Austria is one of the best equipped countries in the world in terms of solar collectors. At the end of 1995 solar collectors covering a total area of 1.24 mill. m^2 were installed. The gain in useful energy amounted to 415 GWh.

Considering a total investment expenditure of approx. ATS 357 mill., an amount of ATS 33 mill. was granted in subsidies in the period from 1994 to 1996 in the framework of environmental subsidies. A summary of solar funding at the level of federal provinces has been established by the FMEA and is continuously updated to improve transparency of the manifold federal provinces promotions. In addition, it also serves as a basis for negotiations on the harmonization and coordination of promotion activities.

5.3.7.3 Photovoltaic Utilization of Solar Energy

At the federal level, commercial plants are promoted according to the Environmental Support Act. At the provincial level, support is currently available in Burgenland, Lower Austria, Upper Austria and Vienna. Refer to section 5.3.1.3. on General Agreement.

A solar energy program was launched by the Federal Ministry for Economic Affairs. It consists of the subprograms:

- ▷ Broad-based test for photovoltaic systems
- ▷ Broad-based test for electric cars
- ▷ Measures for a rapid market launch of these technologies
- ▷ Scientific program to accompany these tests and measures

Broad-based test for photovoltaic systems: In the framework of this broad-based test, mains coupled PV systems with a peak preformance of 1 to a maximum of 3.6 kW (in exceptional cases from a lower limit of 0.3 kW to a ceiling of 10 kW) were promoted by ATS 80,000 per kW. Total investments of ATS 680,000 were subsidized by approx. ATS 200,000 within the scope of environment promotion between 1994 and 1996.

Broad-based test for electric cars: Regarding the broad-based test for electric cars, grant commitments exhausted the total framework of 200 vehicles by autumn 1994 and the bonus payments for keeping a driver's log book were made.

Both broad-based tests are accompanied by scientific research programs.

Reduction potential: by 2005 a CO_2 reduction potential of about 0.04 mill. t CO_2/a; by 2010 of about 0.08 mill. t CO_2/a assuming a generation of current of about 50 or 100 GWh respectively and a CO_2 reduction of 207 t/TJ or 745 t/GWh, respectively. This reduction potential could be increased to a large extent, in particular assuming a combination of photovoltaic technologies and storage power stations (Federal Environment Agency report BE 004 dated 1992). However, the intensive use of photovoltaic technologies is – at least for the time being — hampered by its high costs.

Current situation: Total framework of broad-based test for photovoltaic systems of 200 kW was exhausted. Thus, investment allowances amounting to ATS 16 million were granted by the federation and, in particular, by the electricity sector. In addition, the federal provinces contributed between ATS 4 and 5 million.

For the time being 91 plants with a capacity of about 187 kW have been completed and accounted for. Situation in Austria as of 1995: 3,450 PV-plants with a capacity of 1,360 kW or a generation of electricity of 1,029,635 kWh.

Austria actively participates in respective projects in the framework of IEA.

5.3.7.4 Utilization of Environmental Energy by Means of Heat Pumps

Assessment: Judging from the number of systems being installed each year, heat pumps appear to be penetrating the market successfully. It should be kept in mind that part of the power needed to operate the electric-driven heat pumps is produced in CHP plants and the emissions produced in generating this power must be taken into account in accordance with supra-regional criteria. According to analyses of this aspect and the CO_2 issue, heat pumps still maintain their advantage over conventional heating plants in terms of energy policy.

Based on these premises and after having weighed the advantages of using heat pumps against any negative impacts they may have on the environment, it has been decided to continue promoting the increased use of heat pumps. The corresponding promotional measures are being continued, especially in the area of room heating and water heating. At the same time, great efforts are being made to find substitute coolants which are not considered to have a harmful effect on the climate. Austria is participating in pertinent international research projects on this topic (especially the IEA).

Reduction potential: The increased use of heat pumps could offer a potential of 750 GWh by 2005. This translates in a CO_2 reduction of 0.75 mill. t/a by 2005 and by 2010 a reduction potential of 1.1 mill. t/a would be feasible.

Current situation: As of the end of 1995 129,000 plants with a heating capacity of 593 MW were in operation.

5.3.7.5 Utilization of Wind Energy

Assessment: Austria has a range of areas and regions suitable for the utilization of wind energy. Wind power represents an ideal supplement for hydropower, since two thirds of wind energy supply are generated during the cold season and can serve as a substitute for energy by fossil fuels. At typical sites the costs of generation amount to approx. ATS 1.6 per kW.

Reduction potential: Considering an annual installation of plants with a total capacity of 15 MW, electricity supply could be increased by about 27 GWh every year. Based on this, an annual growth of CO_2 reduction by 20,000 t can be achieved. This results in a CO_2 reduction of 0.006 mill. t CO_2/a by 2000, 0.16 mill. t CO_2/a by 2005 and 0.26 mill. t CO_2/a by 2010.

Cost situation: Cost of investment for 50 MW amounts to ATS 750 mill. Assuming an investment promotion of 30% total funds required amount to ATS 225 mill.

Current situation: By the end of 1996 11.8 MW mains-coupled wind power stations with a total electricity supply of 18 GWh had been installed. The results of a recently completed study "Wind power for Austria" conducted by the Austrian Environmental Consulting Service will be analyzed. This study project was initiated within the scope of the EU-program ALTENER by the federal government as well as a number of federal provinces. In the framework of environmental promotion programs total investments of approx. ATS 485 mill. were subsidized by funds of approx. ATS 145 mill. in the period from 1994 to 1996.

5.3.7.6 Utilization of Geothermal Energy

Reduction potential: By 2005 the completion of the installation of facilities with a total capacity of 50 MW is to be expected. Assuming an energy generation of 400 GWh from these facilities this results in a CO_2 reduction of 0.06 mill. t CO_2/a by 2005 and 0.09 mill. t CO_2/a by 2010.

Current situation: For the time being there are 6 plants with a geothermal capacity of 21 MW or a heat production of 153 TJ, respectively. According to the Environment Promotion Act a total investment of ATS 97 mill. was subsidized by ATS 31 mill. in the period from 1994 to 1996. There was already an opportunity to promote geothermal projects in conjunction with the promotion of district heating. The government will continue to promote the creation of regional/local energy concepts as well as geothermal studies that sometimes accompany them.

The possibilities of incorporating promising geothermal areas in the regional heat plans were explored in talks with the federal provinces. Assuming further specific studies will be carried out, the federal provinces have been called upon to specify in their regional heat plans the priority district heating areas for the use of geothermal energy and

ensure ist implementation, employing the pertinent promotional instruments of local governments in the process.

5.3.7.7 Continuation of the Analysis of the Austrian System of Government Promotion from the Standpoint of its Possible Effects on the Emission of Greenhouse Gases

Competent authority: Federation, federal provinces

Current situation: The agreement mentioned in Section 5.3.1.6 between the federation and the federal provinces as per Art. 15a B-VG on the efficient use of energy determines the harmonization of all subsidies to fully exhaust the energy savings potential in the commercial and industrial sector.

5.4 Measures for the Protection of the Climate System – Methane

A study commissioned by the Federal Ministry of Environment, Youth and Family Affairs dealt with the possibilities of reducing CH_4 emissions of in agriculture, landfills and sewage treatment plants (Joanneum Research Society 1994).

5.4.1 Waste and Waste Water Treatment

Planned implementation:

5.4.1.1 Energy Utilization of Landfill Gas

Assessment: A very effective measure in terms of the climate due to the double effect (energy conservation and the reduction of CH_4 emissions)

Reduction potential: Provided that landfill gas will be used in CHP plants: 100,000 t CO_2 by 2005 (substitute for fossil energy sources), approx. 2,000 t CH_4/a by 2005.

Costs: development of necessary infrastructure

Competent authority: Federal provinces, federation

Current situation: Landfill ordinance was issued. For further information please refer to Section 5.3.1.3.

5.4.1.2 Energy Utilization of Sewage Gas

Assessment: should be utilized to avoid methane emissions

Reduction potential: By supervised decomposition of sewage sludge with use of biogas: max. 5,800 t CH_4/a (FGJ, 1994)

Competent authority: Study of mandatory utilization of sewage gas: Federation; feed regulations: federal provinces, federation; waste management: Federation.

Current situation: Please see section 5.3.1.3.

5.4.1.3 Energy Utilization of Cooking Waste in Pulp and Paper Industry

Assessment: Could result in the substitution of fossil energy sources and a reduction of methane emissions. Measures to facilitate the energy utilization of cooking waste (rest of wood not usable for production, currently still being dumped on landfills) in the pulp and paper industry should be pursued with the objective to replace fossil energy sources and to reduce methane emissions. Currently hardly used.

Competent authority: Federation

5.4.1.4 Energetic Utilization of Waste

Assessment: The to some extent high energetic potential of waste should be used, especially since the appropriate treatment of waste, in particular by using thermal and mechanic-biological procedures, could result in an considerable reduction potential for climate-relevant pollution (substitution of fossil energy sources, reduction of methane emissions).

Reduction potential: A study is currently in preparation.

Cost situation: Extension of necessary infrastructure.

Competent authority: Federation, federal provinces

Current situation: The landfill ordinance was issued. An amendment to the Water Act is currently being negotiated (Dumping ban for waste of more than 5% w/w TOC by 2004).

5.4.2 Agriculture

Concepts/Projects:

5.4.2.1 Study on the Use of Corresponding Systems with Catalytic Combustion or with Biofilters at Farmyard Manure Storage Sites above a Certain Size

Assessment: Considerable need for research activities which should include international developments.

Competent authority: Federal provinces, federation

5.4.2.2 Determination of Biogas Potential for Economically Feasible Use and Replacement of Fossil Fuels by Biogas

Refer also to Section 5.3.5.4.

Assessment: A very effective measure due to the double effect on the climate (reduction of CH_4 emissions and substitution of fossil fuels).

Reduction potential: Approx. 5,000 tons CH_4/a by 2005.

Costs: Development of the necessary infrastructure – promotion of projects according to the Environmental Support Act is possible

Competent authority: Feed regulations: federal provinces, federation; district heat promotion: federation or federal provinces; distribution of regional heating market according to energy carriers – regional planning: local communities and federal provinces; promotion of residential housing: federal provinces.

Current situation: See section 5.3.5.4 It has to be noted, that without favorable feeding conditions and investment promotions wide-spread use of biogas technology could be jeopardized. In the period from 1994 to 1996 total investments of approx. ATS 22 mill. were subsidized by funds of approx. ATS 6 mill. in the framework of environmental promotion.

5.4.3 Line losses

Concepts/Projects:

5.4.3.1 Reduction in Losses from Natural Gas Supply Networks

At present methane emissions from line losses within Austria amount to approx. 5,200 t/a.

Up until 1993 Austria obtained its natural gas almost exclusively from the former Soviet Union. In many instances the conveyance facilities were critisized for having considerable leakages and, as a result, of releasing a CO_2 equivalent of unburned natural gas (methane) imputable to the recipient country, thereby canceling out completely the relative cost-effective CO_2 record of natural gas. In the meantime these allegations have on the one hand been refuted by the investigations of the CO_2 Commission; on the other, Austria is making efforts in general to diversify its natural gas purchases and in particular to obtain it from modern production plants through modern line systems.

Since autumn 1993 natural gas is being supplied to Austria from Norway. A planning syndicate led by OMV is currently looking at the technical and economic feasibility of landing liquified natural gas from the Mediterranean region and of building a pipeline from the northern Adriatic to Central Europe. Trade policy issues are continually being introduced into bilateral discussions (e.g. in “mixed commissions”).

To be able to use natural gas as non-polluting and energy efficient as possible, the appropriate research and development activities are necessary. The fuel cell in particular represents a plant type which could be used to supply consumers who have consistent electricity and heating requirements throughout the year. The use of natural gas as an engine fuel is also currently undergoing tests.

Competent authority: Federation

5.5 Measures for the Protection of the Climate System – Nitrous Oxide

5.5.1 Industry – Combustion and Processes

Concepts/Projects:

5.5.1.1 Replacement of Urea by Ammonia in the Non-selective Catalytic Reduction of Nitrogen Oxides

Review of instruments: Federation

Competent authority: Federation

5.5.1.2 Optimization of the Combustion Temperature in Fluid Bed Technology

Review of instruments: Federation

Competent authority: Federation

5.5.1.3 Feasibility Study on Setting N_2O Emission Standards

Objective: Reduction of N_2O emissions from industrial processes (= production of nitric acid).

Assessment: Emissions from the production of nitric acid amount to 550 t/a and account for 4.3% of total Austrian N_2O emissions. Nitric acid is produced partly by pressure free and partly by medium pressure combustion, the latter producing N_2O emissions three times the amount of the first procedure.

Instruments: Establishment of mandatory emission limit values (ordinance to article 82 Trade Regulations (*Gewerbeordnung*) or adoption by decision) as well as promotions could accelerate change in procedure.

Reduction potential: A change in combustion methods to exclusively pressure-free combustion would result in a decrease of N_2O emissions from nitric acid production to about 250 t/a (i.e. less than half of current levels).

Costs: low to medium

Competent authority: Federation

5.5.2 Agriculture

Concepts/Projects:

5.5.2.1 Expansion of Integrated Land Management, Decrease in the Use of Fertilizers by Using Fertilizers in a Targeted Manner Tailored to Actual Needs.

Assessment: Appears to be an important measure due to its double effect (energy conservation and reduction of N_2O emissions)

Competent authority: Federation, federal provinces (refer also to section 5.3.5)

5.5.2.2 Development of Strategies to Avoid N_2O

Commissioning of relevant research projects

Competent authority: Federation, federal provinces

Current situation: Refer to Section 5.4.2

5.5.3 Transport sector

Concepts/Projects:

5.5.3.1 Setting N_2O Emission Standards (→ Motor Vehicle Implementation Order)

Setting N_2O emission standards requires further scientific studies and an international consensus.

Refer also to the measures described in section 5.3.2 for reducing fuel consumption and traffic volume

Objective: reduction of N_2O emissions resulting from road traffic

Assessment: Road traffic accounts by far for the largest share of N_2O emissions within the transport sector, and here HGVs and cars with catalytic converters are the main sources. According to a study conducted by TU Graz (1997), road traffic emitted approx. 3,970 t N_2O/a (31% of Austrian N_2O emissions) in 1995. HGVs account for 50% and passenger cars for 43% of the N_2O emissions from road transport.

Instruments: An emission reduction could be achieved by setting N_2O standards (amendment to Motor Vehicle Implementation Order (*Kraftfahrzeuggesetz-Durchführungsverordnung, KDV*)), under the condition that concentration of other pollutants must not increase.

Reduction potential: By use of

- ▷ lean motors
- ▷ technical measures to decrease exhaust N_2O
- ▷ Change of ignition timing to lower levels

N_2O emissions resulting from road traffic could be reduced by up to 75%.

Costs: low

Competent authority: Federation

Table 5.3: Policies and Measures — Summary Table. (Reduction potentials until 2005/2010, in mill. t CO_2/a or in t CH_4/a resp.)

Policy or Measure	Instrument Type	Objective	Status	Reduction Potential	Intermediate Progress Indicators
5.3.1 CO_2: Energy Supply and Transformation					
Voluntary measures and subsidies under implementation					
5.3.1.1 Promotion of district and block heating	District heat and biomass subsidies, tariff measures, agricultural subsidies, environmental subsidies for enterprises	Stimulating their utilization	Subsidies for enterprises to switch to district heating and renewable energy sources	1.25 / 2.50	Support of numerous projects
5.3.1.2 Utilization of renewable energy sources	Environmental subsidies	Stimulating their utilization	Renewables (hydro, biomass etc.) contributed ≈ 26% to the total energy consumption in 1994	see no. 5.3.7	Support of several projects
5.3.1.3 Supply of electricity into the public grid	Federal ordinance on supplying electricity into the public grid; general agreement	Stimulating the application of as efficient and environmentally as compatible technologies for generating electric energy as possible	Ordinance on supplying electricity into the public grid has been revised on 1. Aug. 1995 based on the principles of energy- and tariff-policy	0.5 / 1.1	Temporary agreement signed between Fed. Gov. and Ass. of Austrian Power Plants in Feb. 1994 to further increase tariffs for supply of electricity from renewable energy sources into the public grid (in force until 1996)

Table 5.3: (continued)

Policy or Measure	Instrument Type	Objective	Status	Reduction Potential	Intermediate Progress Indicators
Measures under implementation					
5.3.1.4 Mineral-oil-tax for heating fuels	Increase in taxation	Stimulating more efficient use of fuels	Raising mineral oil taxation and broadening the taxable energy sources by 1. May 1995	not estimated	–
5.3.1.5 Energy/CO_2 taxation	Support of a comprehensive taxation of energy products on EU level; further development of the national possibilities in energy taxation	Stimulating more efficient use of energy; internalizing external costs	Taxation on natural gas and electricity by 1. June 1996	0.90 / –	–
Planned Measures					
5.3.1.6 Tightening of the energy-relevant regulations for buildings, regional and land use planning	Treaty between Federation and Fed. Provinces, certificates for buildings, characteristic energy indices, stronger criteria for buildings subsidies	Reduction of energy consumption in space heating	Partly realized	New buildings: 0.23 / 0.50 Existing buildings: 1.5 / 3.2	–
5.3.1.7 Treaty between Federation and Fed. Provinces on achieving the CO_2 emission reduction target	Treaty between federation and federal provinces	Achieving the Toronto target, emission reduction of other greenhouse gases	Negotiations on the draft are well advanced	–	–

Table 5.3: (continued)

Policy or Measure	Instrument Type	Objective	Status	Reduction Potential	Intermediate Progress Indicators
5.3.1.8 Promotion of combined heat and power (industry, space heating)	Subsidies (i.a. for district heating), regulations concerning supply of electric energy	Optimizing the employment of temperature in a cascading fashion	Realization envisaged, partly realized	–	Co-generation concept employed by various industrial plants and municipal enterprises
5.3.1.9 Continuation of electricity tariff reform	Overall model of tariff structure for Austria ("federal savings tariff")	Reduction of use of electricity, adaptation to the supply	Mainly realized	–	Continuation of the current tariff reforms
5.3.2 CO_2: Traffic					
Measures under implementation					
5.3.2.1 Tax on standard fuel consumption and reform of the tax on motor vehicles	Imposing a progressive tax on motor vehicles depending on a standardized fuel consumption of the car	Reduction of fuel consumption	Measure being realized	0.35 / –	Highly increasing trend towards diesel-fuelled vehicles
5.3.2.2 Mineral oil taxation	Increasing the mineral oil tax	Lower increase in total amount of kilometers driven; providing financial means for rail-bound local traffic; reduction of fuel consumption per km driven (incentives for technical improvements)	Increase of mineral oil tax (0.50 ATS per liter) by 1. Jan. 1994 and by 1. May 1995 (e.g. gasoline by 1.10 ATS, diesel by 0.60 ATS per liter)	0.10 / –	–

Table 5.3: (continued)

Policy or Measure	Instrument Type	Objective	Status	Reduction Potential	Intermediate Progress Indicators
5.3.2.3 Night driving ban for HGVs	Legal regulation	Night noise abatement, because of speed limit and the more rapid exchange of the transport park reduction of fuel consumption as well	Amendment to Road Traffic Regulation entered into force on 1. Jan. 1995	0.02 / –	–
5.3.2.4 Electronic speed limitation for trucks and buses	Legal regulation	Increasing safety in traffic, decreasing fuel consumption	Amendment to Road Traffic Regulation entered into force on 1. Jan. 1995	0.12 / –	–
5.3.2.5 Forced monitoring of the adherence to existing speed limits	Providing the relevant infrastructure	Decreasing fuel consumption; increasing safety in traffic	Amendment to Road Traffic Regulation entered into force on 1 Oct. 1994	0.18 / –	–
5.3.2.6 Restrictive quota regulations for HGVs and buses with all eastern neighboring states	Bilateral agreements, i.a. on technical minimum standards and incentives for rail transport ("rolling highway")	Increasing transboundary HGV transport on trains	Measure being realized	not estimated	Relevant agreements already existing with most of the CEE countries
5.3.2.7 Continued implementation of the guidelines in the 1991 Master Transportation Concept	Legal regulation, regional and land use planning, investments to create relevant infrastructure, R&D	Avoiding unnecessary traffic, promotion of means of traffic, which are more energy-efficient and environmentally more compatible, as well as of non-motorized traffic	Partly realized, partly planned	0.70 / –	Ecologically oriented transit regulations with the EU. Extension of infrastructure for rail traffic. Program for subsidies for combined carriage
5.3.2.8 Federal Traffic Route Plan	Planning instrument	Harmonizing regional planning and traffic planning	Under preparation, instruments ready in the course of 1997	not estimated	–

Table 5.3: (continued)

Policy or Measure	Instrument Type	Objective	Status	Reduction Potential	Intermediate Progress Indicators
Planned implementation					
5.3.2.9 Reduction in fuel consumption of aircrafts	Technical standards, kerosene taxation in the EU	Incentives to improve international technical standards, internalization of external environmental costs	Resolution of the Parliament to support discussion at EU level	not estimated	–
5.3.2.10 Reduction in fuel consumption of motor vehicles	Binding agreements with car producers within the EU; voluntary agreement with car importers	Improvement of energy efficiency of motor vehicles (3 liter passenger car)	Realization envisaged	0.60 / –	Joint resolution within the framework of CEMT on the reduction of CO_2 emissions
5.3.2.11 Use of biogenic fuels in ecologically sensitive areas	Ordinance and recommendations	Protecting (ground)water resources, substitution of fossil fuels	Partly realized, partly realization envisaged	0.10 / –	–
5.3.2.12 Road pricing	Creating necessary infrastructure	Reflecting real (net) costs in traffic	Realization envisaged, Working Group established	0.50 / –	–
5.3.2.13 Stepwise emission reduction in transport	Step-by-step plan with different instruments (legal, R&D, economic)	Reduction of fuel consumption and CO_2 emissions from passenger and combined transport	Realization under way	not estimated	Establishing a technology priority "Energy and Mobility Technologies" within the "Innovation and Technology Fund"
5.3.2.14 Environmentally friendly traffic behavior	Action program	Stimulating innovative demo projects to reduce greenhouse gas emissions	Realization under way	not estimated	–

Table 5.3: (continued)

Policy or Measure	Instrument Type	Objective	Status	Reduction Potential	Intermediate Progress Indicators
5.3.3 CO_2: Industry — Combustion and Processes					
Voluntary measures/subsidies under implementation					
5.3.3.1 Combined heat and power installations	Subsidies and regulations (supply tariffing, maintenance of reserves and tariff structure)	More efficient energy use	CHP-program within the framework of the environmental subsidies for enterprises	–	A doubling of the 900 MW-output of CHP installed in 1990 seems realistic
5.3.3.2 Optimization of mechanical systems	Information, education, consulting	Reduction of frictional loss, energy saving	Measure being realized	0.80 / –	At present electronic speed controls and simple asynchronous machines in use
5.3.3.3 Fuel switch	Encouraging the use of biomass and combustible waste	Substitution of fossil fuels	Voluntary measure in realization, partly with subsidies of the FMEYF	0.30 / –	At present biomass and combustible waste amounting to a share of 10% of the total industrial final energy consumption
5.3.3.4 Improving information about the energy flow in enterprises	Co-financing of consulting	Increase of energy efficiency, saving energy	Measure being realized	0.30 / –	–

Table 5.3: (continued)

Policy or Measure	Instrument Type	Objective	Status	Reduction Potential	Intermediate Progress Indicators
5.3.4 CO_2: Small Consumers					
Measures under implementation					
5.3.4.1 Consumption-related heating costs accounting	Legal regulation laid down in the Heating Costs Accounting Act	Reducing energy consumption for space heating by 15-20%	Measure partly realized	– / –	–
Planned implementation					
5.3.4.2 Consumption reduction for el. equipments and motors as well as lighting and electronic systems	Product declaration, information for consumers, introduction of peak consumption standards possible - ordinance to the Electrical Engineering Act	Reducing energy consumption	Measure partly realized, partly in realization	0.60 / 0.80	–
5.3.4.3 Improving thermal quality of old and new structures	Introduction of energy certificates for buildings and characteristic energy indices	Further reduction of energy use in space heating, combined effect together with measure 1.1.3.	Measure partly realized, partly in realization	included in 5.3.1.5.	–
5.3.4.4 Improvement of thermal quality of heating systems	Obligatory emissions and efficiency test of heating systems (agreement between fed. government and provinces)	Reduction of energy use in space heating	Measure partly realized, partly in realization (agreement on protection measures for small heating systems has entered into force on 17. June 1995)	1.40 / –	–

Table 5.3: (continued)

Policy or Measure	Instrument Type	Objective	Status	Reduction Potential	Intermediate Progress Indicators
5.3.5 CO_2: Agriculture					
Voluntary measures/subsidies under implementation					
5.3.5.1 Extension of biological farming and integrated husbandry	Increase of environmental subsidies in agriculture	Reducing energy for fertilizer production	Partly implemented already, partly in realization	0.10 / –	–
5.3.5.2 Cultivation of oil-seed crops aimed at substituting fossil fuels and fossil raw material	Agricultural subsidies	Substituting fossil fuels and fossil raw material	Partly implemented already	0.30 / –	Ordinance on lubricants (obligatory use of biogenic lubricants, e.g. for chain-saws)
5.3.5.3 Utilizing the energy of surplus straw	Agricult., district heat and buildings subsidies; regulations concerning supply of el. energy into the public grid	Substitution of fossil fuels	Measure partly realized	included in 5.3.7.1	Burning of straw on open fields in principle prohibited
5.3.5.4 Substitution of fossil fuels with biogas	Agriculture and buildings subsidies; regulations concerning supply of el. energy into the public grid	Reduction of CH_4 and CO_2 emissions	Biogas potentials registered, some installations in operation	0.05 / 0.07	–

Table 5.3: (continued)

Policy or Measure	Instrument Type	Objective	Status	Reduction Potential	Intermediate Progress Indicators
5.3.6 CO_2: Forestry and Land Use					
Measures under implementation/Planned implementation					
5.3.6.1 Maintenance of a vital forest as CO_2 sink	Regulations concerning emission, ambient air quality, hunting, woodland pasture; forest management regulations (forestry close to nature); natural forest reserves	Protection of forests against air pollution; reduction of damages caused by game and cattle; use of forest management techniques emulating nature; conservation and enhancement of biodiversity	Partly implemented, partly realization envisaged	0	Forest inventory proves rising wood stock, fixation of ≈ 37 million tons CO_2 in the medium term
5.3.6.2 Extension of the forested area	Afforestation projects, natural restocking	Enhancing the carbon sink	Measure being realized	−0.255 / –	–
5.3.6.3 Increase of biomass	Strategic forest-related targets	Enhancing the carbon sink	Measure being realized	−13.4 / –	–
5.31.6.4 Doubling of the use of long-lived wood-products	Building regulations	Long-term carbon fixation	Measure being realized	0.15 / –	–

Table 5.3: (continued)

Policy or Measure	Instrument Type	Objective	Status	Reduction Potential	Intermediate Progress Indicators
5.3.7 CO_2: Cross-sectoral Measures					
Voluntary measures/subsidies under implementation					
5.3.7.1 Use of biomass as a fuel and raw material	District heat and buildings subsidies; regulations concerning supply of el. energy into the public grid; agricultural subsidies	Substituting fossil fuels and fossil raw materials	Measure under implementation; subsidies in some provinces and in scope of the federal environmental and technological promotion	1.45 / 2.90	Production of fire wood increasing; between 1988 and 1995 ca. 10,000 modern private heating systems (< 100 kW), ca. 1,200 medium systems and 140 large systems (> 1 MW) for split wood and bark were installed
5.3.7.2 Utilization of solar energy especially for water heating; use of solar collectors; passive solar energy utilization	Subsidies, building regulations	Substituting fossil fuels	Subsidies in all provinces and in scope of the federal environmental and technological promotion; subsidies of the Min. for Environment for enterprises	1.00 / –	At the end of 1995 solar collectors installed amounted to 1.24 million m^3
5.3.7.3 Photovoltaic utilization of solar energy	Subsidies in various fields, tariff-related measures	Substituting fossil fuels	Subsidies in some provinces and in scope of the federal environmental and technological promotion	0.04 / 0.08	200 kW program of the federal government and the power supply companies finished. Financial support for buying solar or electric cars for 200 units has been finished

Table 5.3: (continued)

Policy or Measure	Instrument Type	Objective	Status	Reduction Potential	Intermediate Progress Indicators
5.3.7.4 Utilization of environmental energy by means of heat pumps	Subsidies	Substituting fossil fuels	State of implementation differing regionally	0.75 / 1.10	By the end of 1995 ≈ 130,000 heat pumps installed
5.3.7.5 Utilization of wind-energy	Subsidies	Substituting fossil fuels	State of implementation differing regionally	0.16 / 0.26	By the end of 1996 11.8 MW wind plants installed (delivering 18 GWh into the grid)
5.3.7.6. Utilization of geothermal energy	Subsidies	Substituting fossil fuels	Partly implemented, high technical potential	0.06 / 0.08	6 plants installed (= 21 MW capacity)
5.3.7.7 Analysis of the Austrian subsidies	Treaty between federation and federal provinces	Substituting fossil fuels	Measure under realization	0	–

Table 5.3: (continued)

Policy or Measure	Instrument Type	Objective	Status	Reduction Potential	Intermediate Progress Indicators
5.4.1 CH_4: Waste and Waste Water Treatment					
Planned implementation					
5.4.1.1 Energy utilization of landfill gas	Regulations concerning supply of el. energy into the public grid; ordinance on landfills	Substituting fossil fuels, reducing CH_4 emissions	Partly realized, partly realization envisaged	CO_2: 0.10 / – CH_4: 2,000 / –	Regulation on landfills entered into force
5.4.1.2 Energy utilization of sewage gas	Examination in regard to obligatory utilization of sewage gas; regulations concerning supply of el. energy into the public grid	Substituting fossil fuels, reducing CH_4 emissions	Realization envisaged	CH_4: 5,800 / –	–
5.4.1.3 Energy utilization of cooker waste from the pulp and paper industry	Voluntary agreement	Substituting fossil fuels, reducing CH_4 emissions	Realization envisaged	not estimated	–
5.4.1.4 Energy utilization of waste	Project	Substituting fossil fuels, reducing CH_4 emissions	Realization envisaged	not estimated	Regulation on landfills entered into force; improved Water Act has been adopted by Parliament

Chapter 6

Projections and Effects of Policies and Measures

6.1 Introduction

Monitoring the current trends of energy use and exploring policy options for greenhouse gas emissions reductions is an integral part of ongoing cooperative research efforts between various institutions, as the federal ministries represented in the Interministerial Committee to Coordinate Measures to protect Global Climate (*IMC Climate*), the Federal Environment Agency of Austria, the Austrian Institute of Economic Research, the Austrian Council on Climate Change, the Austrian Research Centre Seibersdorf, and various Austrian universities.

For evaluating the future developments of Austrian CO_2 emissions, there are four scenarios available which represent different assumptions with respect to policy actions:

1. The *Without Measures* Scenario just extrapolates emission trends as observed over the past years without taking into account any actions for emission reductions.
2. The *Current Measures* Scenario assumes that no additional measures will be taken in the future but currently implemented measures will continue to be effective. None of the measures described in Chapter 5 are assumed to be implemented.
3. The *Additional Measures* Scenario investigates the immediate policy actions needed to meet the Toronto emission target for CO_2 by 2005.
4. The *Additional Measures Delayed* Scenario assumes that the Toronto target will not be reached before 2010 because of a delayed start of the actions program.

These scenarios are closely linked to Austria's policy goals for greenhouse gas reduction policy, above all the commitment to stabilize CO_2 emissions in the European Union by the year 2000 at 1990 levels and to reduce, according to the Toronto target, these emissions by 20% in 2005 compared to 1988 values.

The scenarios are the results of various modeling efforts. The *Without Measures* Scenario is based on an econometric extrapolation of the time series for CO_2 emissions. The *Current Measures* Scenario stems from the latest forecast for the Austrian energy sector produced by the Austrian Institute of Economic Research. The *Additional Measures* and the *Additional Measures Delayed* Scenario is based on a detailed energy model (ACCC/NEP model) originally developed for the Austrian National Environmental Plan and now continued by the Austrian Council on Climate Change. The estimation of the reduction potentials is taken from FEA, 1996.

6.2 Key Assumptions of the Scenarios

6.2.1 Extrapolating CO_2 Emission Trends: The Without Measures Scenario

As a starting point for an understanding of the assumptions made for the various scenarios serves the *Without Measures* Scenario. It is based on a simple econometric analysis that reveals an exponentially filtered trend value of 0.4 percent for the relative changes of CO_2 emissions over the previous year.

6.2.2 Spreading the Energy Standard of New Buildings: The Current Measures Scenario

The *Current Measures* Scenario is part of the regular energy forecast produced by the Austrian Institute of Economic Research. Although also the underlying model mainly extrapolates current trends of economic activity and energy technologies, it is less mechanistic since it explicitly takes into account recently observed energy efficiency improvements. As an example, technological changes in space heating have a considerable impact on total energy requirements since this sector accounts for almost 40% of useful energy requirements. Current incentives linked to subsidies for new residential buildings are expected to become effective also for existing buildings and should become a major source for reducing total energy requirements and thus also contribute substantially to CO_2 reductions.

Altogether, the *Current Measures* Scenario is based on assumptions for GDP growth over the 1995/2000, the 2001/2005 and the 2006/2010 five year intervals of 2.0%, 1.9% and 1.75%, respectively. The corresponding autonomous increases in energy efficiency per unit of GDP are 1.9%, 1.3% and 1.0% and are in line with historically observed trends. This adds up to a largely stable outlook for CO_2 emissions up to 2010.

6.2.3 A Comprehensive Technology Program for the Austrian Energy Sector: The Additional Measures and Additional Measures Delayed Scenarios

The ACCC/NEP energy model is the main tool for analyzing the impact of technological changes in energy requirements and emissions. In contrast to most conventional energy simulations, this model starts out with assumptions about fundamental energy service indicators and proceeds, depending on the choice of application and transformation technologies, to energy flows. Tables 6.1 to 6.5 present an overview about the technological changes that would lead the Austrian energy system from the current state to a structure that would be compatible with the Toronto emission target.

The *Additional Measures* Scenario proposes the immediate start of a comprehensive restructuring program in 1997, named the Austrian Toronto Technology Program (ATTP). A set of 34 policy measures (compare FEA, 1996) contains the following focal points:

- Improvement of the thermal structure of new and existing building,
- Expansion of cogeneration technologies both in industry and residential use,
- Redesign of the transport sector,
- Further increase of the market share of renewable energy,

Energy service indicators	1995	Toronto target
Population	100	103
Living space /capita	100	107
Person-kilometers	100	113
Ton-kilometers	100	122
Basic products	100	85
Electrochemicals	100	79
Final products	100	122
Other products	100	122

Table 6.1: Scenarios – Index of energy service indicators

	Useful energy	1995	Toronto target
	Petajoule	488.1	449.3
% shares	Space heating	43.4	43.7
	Steam processes	10.2	10.2
	Industrial furnaces	18.2	17.2
	Stationary engines	14.5	14.9
	Vehicle engines	13.4	13.7
	Lightening etc.	0.3	0.3

Table 6.2: Scenarios – Useful energy

- Research and development programs for advanced solar technologies.

The *Additional Measures Delayed* Scenario indicates how a delayed start of this action program in 2000 would enable Austria to meet the Toronto target only by 2010.

The following tables provide information on the underlying assumptions regarding the Austrian energy system in 2005 in order to meet the Toronto CO_2 emissions target. Table 6.1 indicates that very generous assumptions were made with respect to the demand for energy services. Energy productivity determines the corresponding useful energy as listed in Table 6.2. It can be seen that the most important type of useful energy is space heating which accounts for more than 40 percent. Despite the proposed increases in energy services, the assumed gains in energy productivity will lower the demand for useful energy. The application technologies furthermore lead to final consumption energy as described in Table 6.3 on the next page. Compared to 1995, the "Toronto structure" needs about 17% less energy flows for final consumption. Via the choice of transformation technologies gross energy

	Final consumption energy	1995	Toronto target
	Petajoule	885.6	739.0
% shares	Transport	28.5	27.2
	Industry	25.9	25.7
	Other sectors	45.6	47.1

Table 6.3: Scenarios – Final consumption energy

	Gross energy requirements	1995	Toronto target
	Petajoule	1183.4	977.6
% shares	Coal	11.6	12.0
	Oil	39.8	35.5
	Gas	22.6	17.7
	Biomass & waste	11.4	17.7
	Hydro	14.6	16.2
	New solar	0.0	0.9

Table 6.4: Scenarios – Gross energy requirements

requirements are obtained (Table 6.4), which decline by about 17% and exhibit a pronounced shift in the market shares of fossil energy. The corresponding CO_2 emissions can be found in Table 6.5.

6.3 Comparing the Scenarios for CO_2 Emissions

Figure 6.1 on the facing page and Table 6.6present a comparison of the various scenarios. According to the assumptions discussed above, it is unlikely that Austrian CO_2 emissions will exceed by 2010 the historical peak values. Current policy measures should enable Austria to meet the stabilization target of the European Union in the year 2000. Decisive additional measures are required, however, to meet the commitment of the Toronto target both by the year 2005 or even in a delayed action program by 2010.

	CO_2 emissions	1995	Toronto target
	Index 1988 = 100	109	80
% shares	Coal	13.4	22.7
	Oil	49.9	41.1
	Gas	17.4	18.2

Table 6.5: Scenarios – CO_2 emissions

Scenario	2000	2005	2010
Without Measures	63.5	65.0	66.5
Current Measures	57.3	57.5	58.3
Additional Measures	55.1	45.6	
Add. Meas. Delayed	57.3	53.1	45.6

Table 6.6: Scenarios and targets for Austrian CO_2 emissions (in Million tons)

In Figure 6.2 on page 94 ranges of uncertainty by upper and lower bounds for the without measures- and the current measures-scenario as well as the impact of a delay in the proposed action program for reaching the Toronto emission target are indicated. These ranges of uncertainty reflect both the historically observed impact of fluctuations caused by temperature and economic activity and an additional uncertainty caused by extending the forecast horizon.

A special study (Kratena et al., 1997) by the ACCC analyses the possible cost efficiency of such an action program in terms of an individual perspective of households and firms and of an overall economic perspective. A key design element of this program is the principle of private-public partnerships and the provision of incentives for market driven technical progress.

In this technology program the authors gave special attention to the aspect of cost efficiency. First, from a microeconomic perspective households and firms usually require payback periods of less than four years for considering investments in energy efficiency to be cost efficient. Despite the fact that a substantial amount of investment opportunities are available that meet this most stringent cost criterion, information gaps and institutional barriers prevent these investments from becoming effective. Therefore, the study concludes that measures, which provide relevant information on available cost-efficient technologies (such as low energy building designs) and eliminating market barriers for some technologies (such as cogeneration of heat and electricity), should have top priority in the list of policy tasks of the public sector. Second, this microeconomic cost criterion can be extended to investment projects with payback periods up to

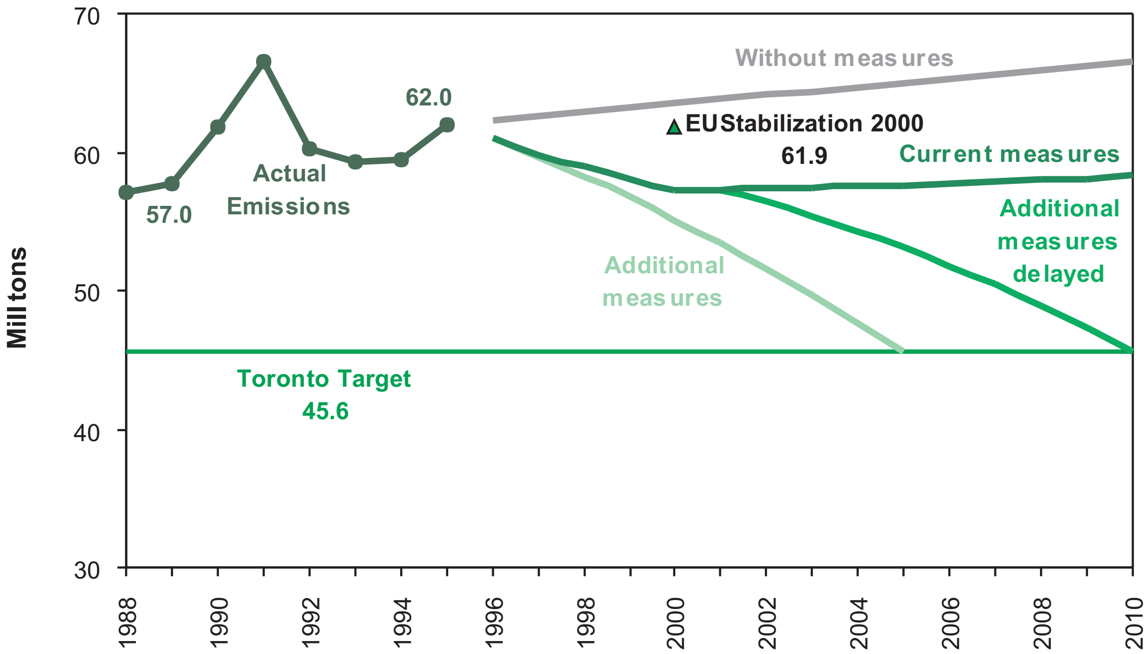


Figure 6.1: Scenarios and targets for Austrian CO_2 emissions

ten years, if the financial sector can be involved by providing the service of risk spreading. Again, the study concludes that the public sector has to focus on institutional barriers, which prevent third party financing and the emergence of energy service companies. Third, the macroeconomic aspect of cost efficiency has to be discovered.

Using the computer model GEMIS (FEA, 1997), recently completed simulations of CO_2 reduction potentials with regard to supply of electricity, district heating and space heating in Austria have shown that the reduction measures in the energy sector (see Chapter 5) are in fact very effective and could lead to results clearly exceeding the 20% reduction target. It should be emphasized, however, that only a rapid realization of the substitution process and of efficiency improvements – assumption these simulations were based on – will ensure the calculated CO_2 reduction results.

6.4 Projections of Non-CO_2 GHG

In regard to emissions projections of non-CO_2 greenhouse gases, the following observations can be made:

- The existing emissions projections for CH_4 (Orthofer and Hackl, 1993; Steinlechner et al., 1994; cf. also FMEYF, 1994) are still in agreement with the emissions reported for 1990 and 1995, that is about 587,000 and 580,000 metric tons, respectively (cf. Chapter 1.5). In 2000 about 600,000 metric tons are expected, which seems to indicate a stabilization trend for Austria (cf. also FMEYF, 1994). Although no quantitative assessment of the reduction potential of the new ordinance on landfills has been made, a certain reduction beyond 2000 due to this ordinance can be expected.

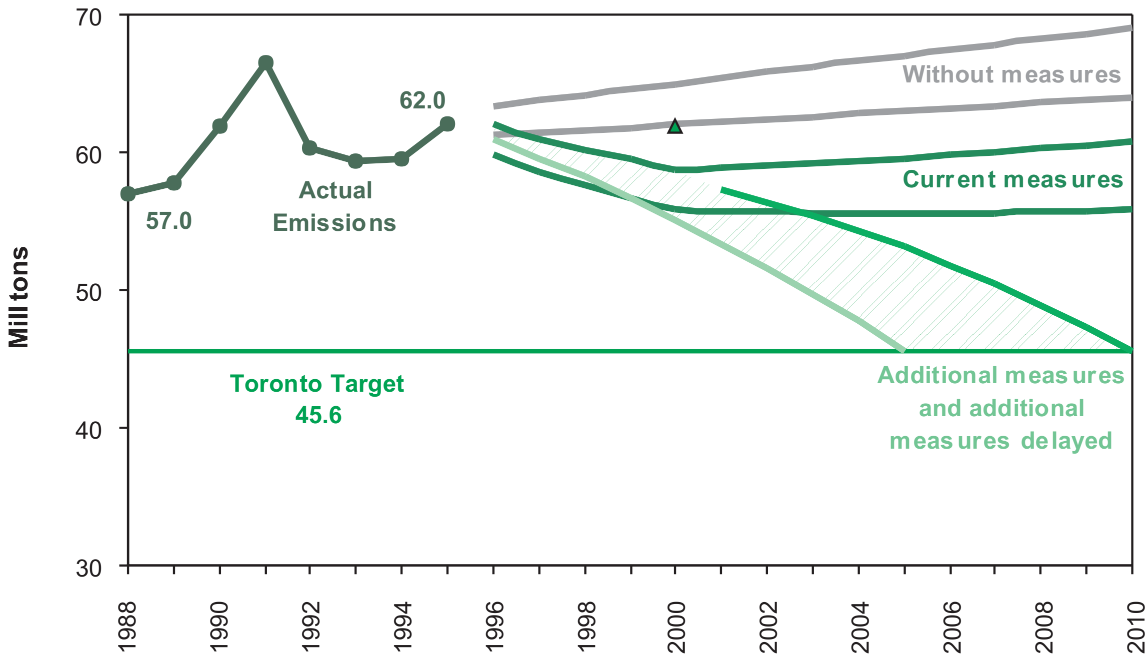


Figure 6.2: Scenarios and targets for Austrian CO_2 emissions: Range of uncertainty

- Because of revised emission factors, the existing emissions projections for N_2O (Orthofer et al., 1995; cf. also FMEYF, 1994) do not agree any more with the emissions reported for 1990 and 1995, that is about 11,600 and 12,800 metric tons, respectively (cf. Chapter 1.5). Therefore, reliable projections for 2000 and beyond cannot be presented.

- With regard to the ozone precursors NO_x and NMVOC, reference is made to Austria's First National Climate Report (FMEYF, 1994). Austria has passed an ozone law (Federal Law Gazette 210/1992), which establishes a stepwise reduction in emissions of 40% by the end of the year 1996, of 60% by the end of 2001, and of 70% by the end of 2006 – based on 1985 and 1988 emissions for NO_x and NMVOC, respectively. To reach this target, two resolutions containing measures catalogues were adopted by the First Chamber of Parliament ("Nationalrat") in 1992 and 1996. It calls on the competent authorities to implement concrete measures in their respective areas of competence. Emissions reductions for NO_x and NMVOC are 11% and 17%, respectively, between 1990 and 1995 (cf. Chapter 1.4). It is noted that the emissions of these greenhouse gases prior to 1990 are presently being recalculated and also being standardized according to the CORINAIR '94 methodology. Therefore, the presently achieved emissions reductions with reference to the respective base years (NO_x: 1985; NMVOC: 1988) cannot yet be presented.

- No projections are available for CO, which decreased by 14% between 1990 and 1995; and for HFCs, PFCs and SF_6, which are of major importance because of their high global warming potentials and, in some cases, of their large rates of increase.

Chapter 7

Expected Impacts of Climate Change and Vulnerability Assessment

7.1 Introduction

Parties are encouraged to make use of the *IPCC Technical Guidelines for Assessing Climate Change Impacts and Adaptations* for preparing Chapter 7. Austria does not follow this suggestion, although it is stressed that this suggestion is greatly acknowledged by and receives broad support of Austria's different scientific communities.

The approach taken in the *First National Communication* (FMEYF, 1994) to present an up-to-date overview of climate-induced impacts on Austria was a dual one:

1. Scientific findings of relevance to Austria were reported based on information from international sources such as the IPCC, the UNEP/WMO Information Unit on Climate Change (IUCC) and others.
2. These findings were complemented by Austrian-specific research results compiled in a summary report by the Austrian Academy of Sciences (ÖAW, 1992, 1993).

A follow-up summary report of this kind has not yet been published. However, attempts are presently being made by Austria's Federal Ministry of Science and Transport to gather the scientific expertise that is available in the area of climate impact research on a national level (cf. also Kromp-Kolb et al., 1995) and to set up an *Austrian Climate Program* including a *Coordination and Information Center for Climate and Climate Impact Research*. Therefore, until the climate program is established and the climate center is in operation, a dual approach similar to the one in 1994 was also selected here: international findings, mainly of the IPCC (1996), with specific relevance to Austria are complemented, to the extent possible, by research results of national experts covering impacts on Austria's mountain physical systems, ecological systems and socio-economic systems. IPCC findings not exclusively relevant to mountain systems are not restated. The present approach is more comprehensive than the earlier approach in that the vulnerability assessment presented in the 1994 National Communication is updated and supplemented by new findings of and insights into the impact characteristics of mountain systems.

Given the information that in Austria 70% of its surface area is 500 m above the sea level and about 40% above 1,000 m (cf. Chapter 3), together with the fact that ecosystems in mountainous regions are highly sensitive, it can be feared that Austria is particularly vulnerable to a climatic change.

Mountains act as physical barriers to the atmospheric circulation. They perturb synoptic patterns and are considered to be one of the trigger mechanisms of cyclogenesis in mid-latitudes. Because of significant altitudinal differences, mountains such as the Himalayas, the Rockies, the Andes, and the Alps exhibit within short horizontal distances climatic regimes similar to those of widely separated latitudinal belts. Mountains are also a key element of the hydrological cycle; they function as the water tower for the plains below them (FMEYF, 1994). With regard to Austria, it can be expected that a climatic change, manifested by changes of the present temperature and precipitation patterns, can cause significant changes of the distribution of vegetation, ice, snow and permafrost zones and thus impact heavily on the unique features of mountain environments. This, in turn, can be expected to lead to significant perturbations to the existing socio-economic structures for populations living within the mountains themselves and indirectly to populations living outside these zones but dependent on them.

So far only few impact assessments have been conducted for mountain regions, despite their potentially high vulnerability to the impacts of global warming. The main reason for this is that scenarios of climate change including mitigation and adaptation strategies to counteract climate-induced impacts require climatological information at high spatial and temporal resolution. Unfortunately, even in the highest-resolution general circulation models (GCMs), mountain regions are poorly resolved, making it difficult to project the consequences of climate change on mountain hydrology, glaciers, and ecosystems (Giorgi and Mearns, 1991; Beniston, 1994). Therefore, other options such as downscaling techniques, limited area modeling, and the use of paleoclimatic and geographical analogues are being applied to help improve the quality of climate data required for impact assessments and economic decision making.

7.2 Impacts on Physical Systems

7.2.1 Hydrology

Climate-driven hydrology in mountain regions is determined to a large extent by orography itself; mountain belts produce concentration of precipitation on upwind slopes and rainshadow effects in the lee of mountains and in deep intermontane valley systems. The spectrum of variability of hydrological regimes ranges from the predominantly rain-forested slopes of Papua-New Guinea to the ice fields of the Patagonian Andes. Climate change will affect the relative importance of these two extremes, as well as the total moisture flux and how the water is delivered temporarily.

Undoubtedly, the projections carried out with presently available climate models are fraught with uncertainties, and this is particularly true with regard to projected changes of precipitation (including snowfall) in mountain regions (Houghton et al., 1990). Nevertheless, they might provide sufficiently realistic estimates of possible changes of the climate to undertake impact assessments at a variety of spatial scales (Rubke and Boer, 1989; Bultot et al., 1992; Martin, 1992).

A climatic change may be characterized by changes in seasonal or annual precipitation, the ratio of solid to liquid precipitation, or the frequencies of extreme events. Whatever the directions and magnitudes of a change may be, mountain communities, and those downstream, need to be prepared to implement flexible water management strategies that do not assume that recent patterns will continue. Events in recent history may provide useful guidelines for developing such strategies (Glantz, 1988).

Austria's average annual rainfall is around 1,170 mm, but it is distributed unevenly: The western part of the country receives as much as 2,500 mm, while in the densely populated east rainfall is only about 500 mm (OECD, 1995). The distribution of the annual mean precipitation reveals a maximum along the Central Alps, while the frequency of precipitation events with, e.g., 200 mm/d is minimal there and maximal at the northern and southern border of the Alps (Aulitzky, 1973). Recent studies have addressed the question of trends in the frequency of dry spells and floods in Austria. Nobilis and Weilguni (1997) conclude from observations (1971-1994) of the Pannonian region in East Austria that there is no general trend in time and space to shorter or longer dry spells (averages and extremes). Evaluation of flood statistics for the whole of Austria is not as clear: While the number of flood events per year and the annual flood maxima reveal positive linear trends in time from 1972 to 1981 and from 1982 to 1991, respectively, this is not the case for the annual daily maxima of precipitation during the period 1952-1991 (Nobilis and Lorenz, 1997).

So far, there is no detailed assessment of possible climate change impacts on hydrology and water resources for the whole of Austria. In a first attempt, Kuhn et al. (1992) discuss possible linkages between climate and hydrology in a general way, thereby taking Austria's specific topography into account (FMEYF, 1994). Presently, efforts are underway to assess several catchments and their possible reactions to a changing climate at the basin scale, employing a range of approaches and hydrological models (Haiden and Schultheis, 1995; Nachtnebel et al., 1996; Bogardi et al., 1996). Instead of using GCM outputs like temperature and rainfall, a downscaling approach (Bardossy and Plate, 1992; Matyasovszky et al., 1994) was applied integrating regional characteristics to obtain higher spatial resolution. In general, input data to the hydrological models are such that the increase in temperature is small during the winter period and more pronounced in late summer and fall. Summer rainfall

is slightly decreased and winter rainfall increased, while the annual amount of rainfall remains rather stable except for the dry and flat basins in southern and eastern Austria, where the annual amount of rainfall is decreased. In general, the daily variability of rainfall is slightly increased.

Preliminary studies indicate that in the Alpine basins the seasonal runoff pattern will change. Low-flow conditions occurring now in early winter will appear during fall because of increased temperatures. The melting period will also start earlier; the occurrence of monthly runoff maxima is basin dependent and will fall into the time period March to June. The number of days with snow cover will decrease as will the frequency and duration of frost periods. The increase in temperature and thus in evaporation is higher than the changes in rainfall and, therefore, there is a tendency towards a decreased runoff which is only counterbalanced by higher runoff during winter. The frequency of low-flow conditions, especially in late summer and fall, increases. Because evaporation increases and soil moisture decreases as will the groundwater recharge, flat areas will experience hydrological conditions that are more distinct and severe than those in the mountains. More research is needed to consolidate and generalize present findings and to study feedbacks that might occur and thereby influence model parameters, e.g., through feedbacks induced by changes in vegetation.

7.2.2 Mountain Cryosphere

The effects of temperature and precipitation changes on glaciers are complex and vary by location. Haeberli (1994) indicates that alpine glacier and permafrost signals of warming trends constitute some of the clearest evidence available concerning past and ongoing changes in the climate system. Glacier fluctuations, in particular, indicate that secular changes in the surface energy balance may well be in accordance with the estimated anthropogenic greenhouse forcing. Furthermore, there is strong evidence that the situation is now evolving at a high and accelerating rate beyond the range of Holocene (natural) variability.

In regard to climate-induced impacts on snow, Föhn (1991) has pointed out that one potential effect of global warming in the European Alps might be a delay in the first snowfall and a reduction in the length of snow cover. Analysis of satellite data from the 1980s and early 1990s shows that lowlands around the Alps experience about 3-4 weeks less snow cover than they did historically (Baumgartner and Apfl, 1994). This tendency can be expected to accelerate in a warmer climate with the consequence that early seasonal runoff will increase and thus lead to drier soil and vegetation in summer. Additionally, snow accumulation and ablation exhibit different temporal patterns than in the past and could be even more irregular in a changed climate. In higher elevations, the total annual snow volume accumulated during the winter has not changed significantly this century, despite the observed global temperature rise.

Inferences in regard to the future of Austrian glaciers are possible from long-term observations, particularly from the past decade. The mass balance of glaciers is determined predominantly by summer temperature, winter precipitation and by changes in surface reflectivity introduced by summer snow falling on dark glacier ice. The mass balance is easiest to visualize by the concept of an equilibrium line that separates regions of net gain above from those of net ice loss below the line. The equilibrium line altitude of Austrian glaciers goes up by 100 m if either accumulation increases by 400 mm of water equivalent or temperature increases by 0.8°C.

These changes can be put into relation to those experienced since the middle of last century when the ice covered area in Austria was nearly twice as large as today's (approximately 500 km^2) and the mean equilibrium line altitude of Austrian glaciers was approximately 100 m lower than today's (approximately 3,000 m above sea level; regionally dependent on the amount of precipitation and the geographical, i.e., north-south exposition). Therefore, Austrian glacier areas most endangered by a continued warming are those in mountain ranges with peak altitudes little above present equilibrium lines, e.g. in Carinthia and Vorarlberg.

During recent years even large areas above the equilibrium line have been affected, at altitudes that had been considered "safe" at first glance. The ice cover on the steeper slopes surrounding the main glacier bodies is thinner than the latter and thus subject to rapid wastage and disappearance. This implies that many Austrian glaciers are reduced in size at both lower and upper ends. Researchers at the University of Innsbruck are involved in a long-term monitoring study to document these changes and to establish a sound basis for future assessments of the Austrian glacier system (Kuhn, 1989a, b, 1996a, b; Kuhn et al., 1987).

The researchers are also applying models to assess the possible reaction of 20 Austrian river basins to changes in temperature and precipitation, thereby taking into account glacier systems. The hydrometeorological model used permits derivation of monthly values of basin precipitation, evaporation, and storage (snow, ice, groundwater) from monthly records of runoff, temperature and precipitation. Transition from rain to snow fall, snow and glacier melt, and the partition in liquid and solid storage are parameterized in terms of temperature and precipitation according to regional hydrometeorological and topographic conditions.

The modeling exercise emphasizes the paramount importance of snow cover and glaciers for the Austrian water cycle (Kuhn 1993, 1994, 1995; Kuhn et al., 1992). The model has been used to determine monthly runoff and storage for a range of scenarios of changes in temperature (warming, cooling) and precipitation (increase, decrease). Due to critical limits in the snow/rain transition, potential melt, and feedbacks of evaporation and liquid water retention with the variable snow cover, the reaction of the 20 Austrian basins to the climate scenarios is not uniform. Only for the scenarios of increased temperatures (+1, +2, +3°C), general qualitative statements can be made (cf. 7.2.1): 1) Winter runoff will increase; and 2) meltwater with significant contributions of glacier melt will peak earlier in spring and will be less pronounced. At intermediate elevations (1,000 - 2,500 m above sea level) there are cases where runoff will peak twice, initially during seasonal snow melt in early summer and for the second time during the subsequent precipitation maximum. This feature is strongest south of the main Alpine divide. In the lowlands total runoff will decrease on account of increasing evaporation.

In the scenario of decreased precipitation (-30%) Alpine and high Alpine basins do not react significantly in winter and may experience an earlier runoff peak. Lowland basins may suffer from droughts. In the scenario of increased precipitation (+30%) runoff peaks are delayed in Alpine basins. Some of the low basins will develop significant snow packs that do not exist under present conditions. Additional precipitation is thus stored until spring and will contribute to melt water peaks.

Austrian researchers at the University of Vienna continue work on establishing a correlation between the seasonal number of days with snow cover at Austrian climate stations and the seasonal mean temperature over Europe (cf. FMEYF, 1994). When the temperature increases, the number of snow days decreases and vice versa. In consecutive winters the temperature varies and so does the snow day number. The snow-temperature curve becomes saturated both for low temperatures (90 snow days/season) and for high temperatures. In the saturated regions the sensitivity of this curve is zero while in the transition region in between it is maximal. Hantel et al. (1993, 1997) determined the sensitivity for individual Austrian climate stations from their snow-cover records for the four seasons by fitting the data with a two-parameter logistic function. The sensitivity becomes extreme for the winter season with a value of -21 ± 6 days/season/K at an altitude of about 500 m above sea level. These results imply that a rise of the European mean temperature by 1°C may reduce the length of the winter snow cover period in the Austrian Alps by about three weeks which is in agreement with similar results of other authors (Koch and Rudel, 1990). Concomitantly with these results, however, is the great scatter in the data so that the change in snow cover at specific locations may be much less than suggested here. The European temperature used for this work is defined from only three climate stations. Therefore, more research is required to corroborate present results.

7.2.3 Extreme Events

It is uncertain whether a warmer global climate will be accompanied by more numerous and severe episodes of extreme events because current GCM capability to simulate extremes and their frequency of occurrence in a changed climate, is extremely limited.

One potential impact typically associated with extreme events is the enhanced occurrence of intense storms accompanied by high precipitation and/or winds with significant repercussions on a number of sensitive environmental and socio-economic systems (e.g., forest systems, rail and road systems).

7.2.4 Geomorphological Processes

The latitude and altitude of different mountain systems determine the relative amount of snow and ice at high elevations and intense rainfall at lower elevations. Climate change could alter the magnitude and/or frequency of a wide range of geomorphologic processes (Eybergen and Imeson, 1989).

Examples are rockfalls and landslide events caused by changes in average and extreme precipitation. Other trigger mechanisms for such events are linked to pressure-release joints following deglaciation (Bjerrum and Jfrstad, 1968), to freeze-thaw processes (Senarclens-Grancy, 1958; Rapp, 1960; Heuberger, 1966), and to the reduced cohesion of the soil through permafrost degradation (Haeberli et al., 1990).

Such events may have a number of economic consequences for mountain communities, where the cost of repair to damaged communications infrastructure and buildings will rise in proportion to the number of landslide events. In many mountainous regions, tourist resorts such as those in the Alps have spread into high-risk areas, and these will be increasingly endangered by slope instability. Additional transport of sediments in the river systems originating in mountain regions is also expected to occur (Aulitzky, 1988, 1989, 1996a).

In Austria 74% of all communities are endangered by torrents and avalanches. In some provinces (Carinthia, Vorarlberg, Salisbury, Tyrol) the area threatened by such events amounts to 80% and more of the total (FMAF, 1996). Most of the torrent events (93.5%) occur from June to August, that is, during only three summer months (Andrecs, 1995), and more than 20% of them are dangerous debris flows. From 1972 and 1992 the total amount of the material eroded is estimated to add up to 16.6 million m^3 with an per-event average of 10,000 m^3 (except for the provinces Lower Austria and Styria) (Andrecs, 1995).

More than 5,800 avalanche catchments threaten permanently settled areas in the Austrian part of the Alps. Historical and present avalanche catastrophes are studied to assess a range of parameters and characteristic extreme values such as date of incidence, runout length and damage in order to provide support in planning future protection measures (hazard zoning, etc.). According to Austrian avalanche reports that are published regularly since 1967/68, 764 persons were killed by avalanches until 1995/96. About 78% of winters' accidents involving death occurred during ski-mountaineering. According to control measurements, the number of avalanches threatening settlements, however, is presently decreasing due to successful reforestation and/or avalanche control measures. One of the most important results since the 1951 and 1954 avalanche disasters killing 271 persons is that almost two thirds of all avalanches start below the potential timberline. At the research station in Obergurgl (2,000 m above sea level) high-altitude afforestation measures are investigated aiming at replacing expensive local control measures. Predictions on how climate change may affect the magnitude and/or frequency of avalanches in the future are difficult. Fliri (1992) expects the danger potential of avalanches in high-altitude valleys to increase with increasing temperature.

7.3 Impacts on Ecological Systems

7.3.1 Ecophysiological Processes

It is known from both common sense and paleoenvironmental research that plant communities respond to a general increase in temperature through a shift towards higher latitudes and altitudes. However, this shift is controlled by ecophysiological processes at the individual plant level, involving direct and indirect effects of temperature and precipitation change (Callaghan and Jonasson, 1994; Bugmann and Fischlin, 1994); photoperiod constraints (Heide, 1985, 1989, 1990; Solhaug, 1991); and competition processes (Bowman et al., 1993; Baron et al., 1994; Körner, 1989, 1994). One of the key climatic factors for the ecophysiological processes of alpine vegetation is the length and depth of snow cover, often correlated with mean temperature and precipitation (Barry and Van Wie, 1974; Aulitzky et al., 1982; Ozenda, 1985; Burrows, 1990; Musselmann, 1994). Snow cover provides frost protection for plants in winter and water supply in spring, when water is also required to commence growth.

7.3.2 Vegetation Migration

The general biogeographical rule (*Hopkins bioclimatic law*) used to derive the potential movement of the climatic ranges of species states that a temperature increase of 3°C corresponds to an upward shift of about 500 m (MacArthur, 1972; Peters and Darling, 1985). Therefore, the expected impacts of climate warming in mountainous nature reserves would include the loss of the coolest climatic zones at the peaks of the mountains and the linear shift of all remaining vegetation belts upslope. Evidence in favor of this rule is provided by ongoing field studies (Grabherr et al., 1994; Harte and Shaw, 1995). Because mountain tops are smaller than bases, the present belts at high elevations would occupy smaller and smaller areas, and the corresponding species would have smaller populations and might thus become more vulnerable to genetic and environmental pressure (Peters and Darling, 1985; Hansen-Bristow et al., 1988; Bortenschlager, 1993). In the Alps, the main climatic space concentration and fragmentation of plant populations would be in the present alpine and nival belts, where rare and endemic species with low dispersal capacities could become extinct. It is important to note that even if vegetation belts would not move up as a whole in response to global climate change, the ecological potential of sites will change in relation to shifts in climatic features (Halpin, 1994).

In addition to the impact of climatic change on the altitudinal vegetational distribution, interferences with latitudinal vegetation changes have to be taken into account. Deep valleys that split mountain systems into isolated "island subsystems" constitute migration barriers. They may prevent species concentrated in specific, high-altitude refugia from re-establishing at higher, adjoining mountains (Grabherr et al., 1995). At lower altitudes, Mediterranean tree species can substitute for submontane belt species. While on the Italian slopes of the Alps, a northward progression of Mediterranean influences is to be expected, a similar (xeric) change is less likely in the southeastern part of the range (Julian and Carnic Alps), where a much more humid climate exists.

Ongoing Austrian field studies in temperature-limited environments such as high mountains seem to provide increasing evidence of an upward shift of vegetation belts. A team of researchers at the University of Vienna collected data on the state of the flora at 30 summits exceeding 3,000 m in the center of the Alps (Western Austria, Eastern Switzerland) and compared the actual records on cover and abundance of vascular plant species with very precise historical records (Gottfried et al., 1994; Grabherr et al., 1994, 1995; Pauli et al., 1996). This comparison indicates that species richness has increased during the past few decades, and is more pronounced at lower altitudes. Calculated upward moving rates for nine typical nival plant species over the last 70-90 years (with a realized warming of approximately 0.7°C) are generally below 1.5 m per decade, but can be as great as 4 m per decade. By way of contrast, potential (i.e., theoretically possible) moving rates in agreement with Austria's historical warming trend are greater by approximately one order of magnitude indicating that alpine biota reacts with a remarkable time lag to changes in climate.

Therefore, the important conclusion drawn from the study is that even a moderate warming induces migration processes. The example from the limits of plant life at high alpine summits is of general importance and suggests that global warming is already having a significant effect on alpine plant ecology. Upward migration may therefore cause disastrous extinctions in these environments.

7.3.3 Ecosystem Responses and Forest Growth

There are a number of ecosystem models currently available that can be used to test the sensitivity of a particular system to processes such as nutrient cycling (e.g., CENTURY, TEM), to investigate species composition under changed environmental conditions (e.g., BIOME, DOLY, MAPSS), or to assess forest health (e.g., FORET).

However, it should be emphasized that there are considerable limitations in present-day simulation techniques for assessing ecosystem responses to climatic change, in particular the temporal changes of these responses. In general, increases in atmospheric temperature will affect the structure and function of vegetation, as well as species composition where time may not be sufficient to allow species to migrate to suitable habitats (Kienast, 1991; Bugmann, 1994; Klötzli, 1994).

A number of modeling studies employing forest gap models have been conducted to assess the impacts of climatic change on forest biomass and species composition in mountainous regions (e.g., Kienast, 1991; Kräuchi and Kienast, 1993; Bugmann, 1994; Bugmann and Fischlin, 1994; Kräuchi, 1994). Although several different models and climate scenarios are used in these studies, they yield quite similar conclusions regarding the sensitivity of forests in the European Alps. Modeled forest changes at a subalpine site (e.g. using the FORSUM model; Kräuchi, 1994) indicate for no change in climate and for the IPCC IS92A scenario that the species composition is different under the two climates while the overall forest biomass may remain the same. The competitive dominance of *Picea abies* reduces and the proportion of broadleaves increases under the IS92A scenario.

Since 1961 basic data on structure and development of the Austrian forests are compiled within the Austrian Forest Inventory program. Results show a continuous increase in forest area, growing stock and annual increment as well as in the damage of forest stands in protected forests (FMAF, 1995a; Schieler and Schadauer, 1993; Sterba, 1996; cf. also Chapter 3). Based on more than 20,000 sample plots from the Austrian Forest Inventory, Schadauer (1996) evaluated different increment parameters such as basal area and volume increment per hectare as well as individual tree height and diameter increment rates. The results indicate an annual volume increment increase per hectare of about 24% since 1961 and most of the increment increase occurred within the last inventory period between 1981 to 1990. Similarly, core data reveal a long-term trend in radial increment for the last 100 years. Causes like climatic change, increasing nitrogen supply, and CO_2 are discussed, but no clear cause-effect relationships can be presented.

There are a number of forest-growth models that have been employed in studies aiming at accounting the carbon budget of Austria's forest (Halbwachs et al., 1994, 1995; Jonas and Schidler, 1996; Ruppert et al., 1996) or of plantation systems, thereby taking account of biomass utilization strategies (Marland et al., 1995, 1996; Schlamadinger et al., 1995, 1996; Schlamadinger and Marland, 1996a, b). So far, the primary focus of model applications, however, has been on the evaluation of different forest management or bioenergy strategies under current climatic conditions and not on the investigation of a CO_2-stimulated growth.

7.3.4 Alpine Protection Forests

In Alpine regions forests play an essential role in reducing significantly risks of erosion and avalanches, and thereby they provide an indispensable prerequisite for habitation in these regions. However, it has to be recognized that forests in mountain regions are highly sensitive to changes of climate conditions, and that this is particularly true in areas close to the timberline. In these areas only small changes of temperature and precipitation are bound to have significant impacts on the extent of the forests. Thus, it can be expected that in the

European Alps a warming of 1°C would imply a rise of the timberline by about 150 m.

In estimating the impact on Alpine protection forests, account needs to be taken to that an increased atmospheric concentration of carbon dioxide can increase the net photosynthesis and thereby enhance the growth of trees. At the same time it cannot be excluded that a climatic change can disturb the photosynthetic potential of mature trees.

It can be stated with some confidence that the limits of life of the most important tree species in the Austrian mountain regions are known (*Forschungsstelle für Lawinenvorbeugung*, 1961, 1963; Aulitzky, 1963; Tranquillini, 1979; Aulitzky et al., 1982) as well as the influence of temperature on their growing conditions in the Inner Alps (Ozenda, 1988). The documentation of a vegetation map of Tyrol has been finalized (Schiechtl, 1971, 1973; Schiechtl and Stern, 1983; Schiechtl et al., 1967-1987; Ozenda, 1988) and the investigation of other trees and regions of relevance is recommended (Aulitzky, 1971, 1972a, 1990), with the goal to initiate highland reforestation and thus to accelerate the shift of forests upward to today's timberline. However, at the time of the upward shift the composition and structure of forest communities will also change (cf. Chapter 8.3; Mayer, 1992). Spruce with approximately 61% the most abundant and important tree of Austria would be reduced in all communities and at all altitudes in about 50 to 100 years from now, in favor of oak and other deciduous trees in lower regions, larch in higher regions, and pine in southern regions under Mediterranean influence or in regions turning increasingly dry. According to Austrian experiences of the last dry period between 1980 and 1985, an intensified forest dieback would take place due to air pollution on the one hand and changing forest community structures with more summer-green trees on the other hand. However, the protective function of forests, first of all with respect to avalanches, would reduce especially during the disintegration phases and in the case of exposed forests disappearing on steep slopes (Heumader, 1987; Mayer, 1992). Only the upward shift of the larch-pine forest (the Subalpine spruce-larch-pine forest is ranging today from approximately 1,400 to 2,000 m above sea level) would slowly improve the forests' protective function and, at the same time, decrease the water discharge of catchments locally.

In estimating the future extent of the Alpine protection forests account needs also to be taken of the increasing air pollution. During the last few decades different air pollutants have lead to significant damage to the mountain protection forests. Thus, the Northern Alps reveal the highest percentage of damaged trees (54%) due to the loss of needles and leaves. In Tyrol 42% are damaged on the average, while Tyrolian production forests reveal a damage rate of only 30%. The average damage rate for the entire Austrian forest amounts to 33% with approximately 7% of the trees damaged more seriously (FMAF, 1996).

Among different air pollutants, ozone reaches exceptionally high (day and night) peak values, especially at the altitude of the timberline and above, the region of the formerly deforested *combat zone* (FEA, 1996a; FMAF, 1996; Loibl, 1995, 1996; Loibl and Smidt, 1996; Schneider et al., 1996). Vegetation reacts adversely to high ozone concentrations through disturbed photosynthetic activity. At the altitude of the timberline, the critical ozone level can exceed eightfold. This bioclimatic situation which is primarily affected by traffic exhaust gases, reveals an alarming development in regard to the state of mountainous forests. Transport processes across or convective processes in the Alps affect the deposition of particles, and together with increased short-wave radiation at higher altitudes contribute to the production of ozone thus implying serious long-term consequences (Türk, 1996; Mayer, 1992).

Depending on the site quality of mountainous highlands, reforestation of a damaged forest may require 300 – 1,000 years (Mayer, 1992). Deforestation of forest stands at steep slopes is more likely nowadays than their reforestation (Heumader, 1987), and it gives rise to an increasing avalanche potential. In case of Tyrol, Heumader (1987) expects, for only half of the 12,000 ha of inclined forested area, technical control measures (like snow bridges) worth some 20 billion ATS (1.75 billion USD), and a reforestation time of about 200 years. Given these circumstances, it is intelligible that measurement profiles are established at the borders and within the Alps, to investigate the distribution and impact of ozone and other air pollutants (FMAF, 1987; Herman and Smidt, 1996).

In the case of higher temperatures due to a climatic change, the impact of ozone on sensitive mountainous forests is expected to increase with irreparable long-term consequences for many Alpine regions (Heumader, 1987) which would imply serious problems for Austria's forests, the protection forest of which amounts to approximately 31% (FMAF, 1995b).

7.4 Impacts on Socio-economic Systems

7.4.1 Mountain Agriculture

Mountains contribute a not insignificant proportion of the world's agricultural production in terms of economic value, and this is also the case in Austria. Upland regions are characterized by altitudinal climatic gradients that can lead to rapid changes in agricultural potential over comparatively short distances. Yield variability often increases at higher elevation implying that climate change may cause a greater risk of yield shortfall, rather than a change in mean yield (Carter and Parry, 1994).

Several authors have predicted that currently viable areas of crop production will change as a result of climate change (Alps: Baltenau et al., 1987). However, given the wide range of microclimates already existing in mountain areas that have been exploited through cultivation of diverse crops, direct negative effects of climate change on crop yields may not be too great. While crop yields may rise if moisture is not limited, increases in the number of extreme events may offset potential benefits. Compounded with these effects are those related to augmented duration and/or intensity of precipitation, which would enhance soil degradation (erosion, leaching, etc.) and lead to loss of agricultural productivity.

No surveys have been carried out yet on the effects of climate change on the Austrian agricultural sector. Moreover, the agroclimatic impact of climate change might overlap with other factors disadvantageous to mountain agriculture such as socio-economic conditions for farms operating under more difficult topographic and climatic circumstances (Rest, 1996). There can be no doubt, however, that climate change will cause an alteration in the balance of the agricultural ecosystems (change in radiation intensity, temperature, precipitation, wind). It is not only feared that climate change will affect plant growth, but will also modify the soil which might lead to a reduced contents in organic matter and consequently reduced carbon absorption and an increase in gaseous emissions.

According to the Institute for Climate Research Relevant for the Agricultural Sector in Müncheberg, Germany, the following effects may be expected (Obenauf und Rogasik, 1996):

- reduced growth periods with fewer yields due to increased temperatures, reduced vegetation density, diminished soil carbon input and increased danger of erosion. An increase in temperature of 1°C causes a loss in yield of about 5% and a reduction in carbon input of app. 3%.
- rising temperatures and sufficient soil moisture, a situation that is valid for many parts of Austria, result in intensified conversion processes causing a loss in carbon and heightened danger of erosion.
- Austria's arid areas are characterized by a combination of increasing temperatures and water deficiency (decreasing precipitation). This leads to a marked decline in yields in places, where no artificial irrigation measures may be taken, accompanied by the danger of wind erosion and decreased carbon input or increased carbon output. In artificially irrigated areas, the energy demand for irrigation increases while the groundwater level decreases.

The above-mentioned augmented soil erosion due to water and wind lowers food production and jeopardizes the ecosystem. At the same time degraded soil loses its chance of carbon absorption (CO_2-sink).

The premise that an increase in yield could be achieved by augmenting the CO_2 contents in the atmosphere near the surface (CO_2 fertilization) was confirmed only to a highly limited extent. In case of extensively cultivated agroeconomic systems no increase in yield is to be expected. A small harvest increase may be achieved by means of high cultivation intensity.

With a view to reducing the emission of climate-relevant gases, it is recommended to reduce the cultivation intensity as this will lead to an improvement of the sink capacity of soils for climate-relevant trace gases.

The soil condition surveys conducted over the previous years give an overview of the humus and, therefore, the carbon contents and other information for agriculturally-cultivated soils in Austria. These are all-embracing measuring programs (Blum et al., 1989) designed to provide data on the current condition of agriculturally used soils of a larger area, i.e. of one Austrian province. The results of these soil condition surveys have been submitted or partially submitted for six out of nine provinces (Burgenland, Lower Austria, Upper Austria, Salzburg, Styria and the Tyrol), and will be incorporated in a *Soil Protection Concept for Austria* by Danneberg et al. (1997).

7.4.2 Hydropower

An important socio-economic consequence of global warming on the hydrological cycle is linked to potential changes in runoff extremes. However, current difficulties in implementing water resource development projects will be compounded by uncertainties related to hydrological responses that may be possible under a climatic change. Among these, possible increases in sediment loading would perturb the functioning of power-generating infrastructure.

Sensitivity of mountain hydrology to climate change is a key factor that needs to be considered when planning hydropower infrastructure. Mountain runoff (electricity supply) and electricity consumption (demand) are both susceptible to changes in precipitation and temperature. Long-term changes in future climate will have a significant impact on the seasonal distribution of snow storage, runoff from hydroelectric catchments, and aggregated electricity consumption. So far, only few researchers have attempted to integrate the effects of climate change by considering both electricity supply and electricity consumption (Jäger, 1983).

Austria's electricity supply is based on a combination of *hydro and thermal production*. Depending on the respective water volume, the share of regulated rivers in hydrological power generation may vary between 58% and 75% and on average accounts for 70% (Schiller and Drexler, 1993). Consequently Austria is among Europe's leading hydroelectric power countries. With regard to the percentage share hydroelectric power accounts for in power production, it is surpassed only by Norway (99.6%) and Iceland (approx. 97%). From an absolute point of view, Iceland merely plays a minor role. In contrast to other countries dominated by hydroelectric power generation such as Switzerland or Norway, the Austrian system has another peculiarity, i.e. the extremely high share of production from run-of-river head installations. About 70% of the energy generated by hydroelectric power stations in Austria originate in run-of-river and pondage power stations. The production of run-of-river power stations directly depends on the runoff and hence on the immediate weather situation. Precisely in such a system changes in the natural water balance would have a serious impact.

In case of the *annual balancing reservoir* altered influx conditions, which do not exceed a certain limit, might be balanced by means of a changed strategy regarding reservoir management. If the reservoir management allows for a certain degree of freedom, an adjustment based on demand is possible. Should not only the seasonal distribution of the reservoir influx change, but also the overall water volume, this would naturally have an impact on the annual production capacity. In individual cases even today receding glaciers cause operating problems in storage power plants due to more shifting activity and bigger particle volumes (Wagner et al., 1996).

In *run-of-river power stations* altered runoff conditions directly affect the way power is generated. Even now run-of-river power stations in Austria are characterized by short-term, medium-term and long-term fluctuations in power generation (Schiller, 1979). High water as well as low water may be problematic. In high water conditions a reduction in falling height may bring about instant generation failure. As the production from run-of-river head installations plays such an important role in Austria, the missing energy has to be provided by other means such as storage power stations, thermal power stations or by importing electricity from abroad. Comparatively steady runoff conditions over the year would have a positive effect on the production from run-of-river head installations. Extreme events always create problems for hydropower generation. Should a possible climatic change result in an increase of the currently low winter runoff due to fewer snow reserves, and in a proportional decline in spring runoff, it would prove advantageous to hydropower generation. Whereas more incidents of flooding and dry periods would cause disadvantages. The power plants at the river Drau (southern side of the Alps) have been showing a markedly reduced annual production since the beginning of the 70s. This development may be attributed to dry periods in late fall as well as diminished spring runoff. No significant trend in the annual production figures was determined for the main rivers at the northern side of the Alps.

Constant water supply changes play an important part in Austrian hydropower generation. Currently, there is no telling whether they will have a positive or a negative impact. On the one hand, the production situation of the power plants themselves is affected, on the other hand the many functions of hydropower plants (flood protection, improving the low discharge) gain in importance as the number of extreme runoff situations seems to be rising.

7.4.3 Commercial Timber Activities

Commercial utilization of mountain forests can be affected directly and indirectly by climate change. Direct effects include problems in regeneration and lower seedling survival. Indirect effects relate to losses caused by fire, insects and diseases. The indirect effects depend on the influence of climate on the disturbance agents themselves. Warming in winter, e.g., may allow destructive insects and pathogenic fungi to survive at higher latitudes and altitudes than at present, enabling subtropical or warm-temperate pests and pathogens to invade vegetation from which they are now excluded (Dobson and Carper, 1992).

7.4.4 Tourism

Resources required for tourism are climate-dependent – that is, their availability may be affected in the short and long-term by variability, extremes, and shifts of climate zones. These resources include the landscapes of natural and anthropogenically influenced ecosystems and climatic conditions that are suitable for specific touristic activities (Price, 1994).

The majority of studies focuses on winter tourism. Scenarios derived from GCMs have been used to examine the possible implications of climate change for skiing in several mountain regions including Austria (Breiling and Charamza, 1994). These studies show that, because the length of the skiing season is sensitive to quite small climatic changes, there could be considerable socio-economic disruption in communities that have invested heavily in the skiing industry. To some extent, such impacts might be offset by new opportunities in the summer season and also by investment in new technologies, such as snow-making equipment, as long as climatic conditions remain within appropriate bounds. However, artificial snow-making also raises environmental concerns because of the quantities of energy and water required, the disturbances generated during the operation of the equipment, and the damage to vegetation observed following the melting of the artificial snow cover.

In a recent study Breiling et al. (1997) focus on winter tourism and the climate sensibility of Austria at the level of districts. The authors are certain that:

- Climate conditions will have important consequences for the winter tourism industry, which accounts for 4% of Austria's GNP.

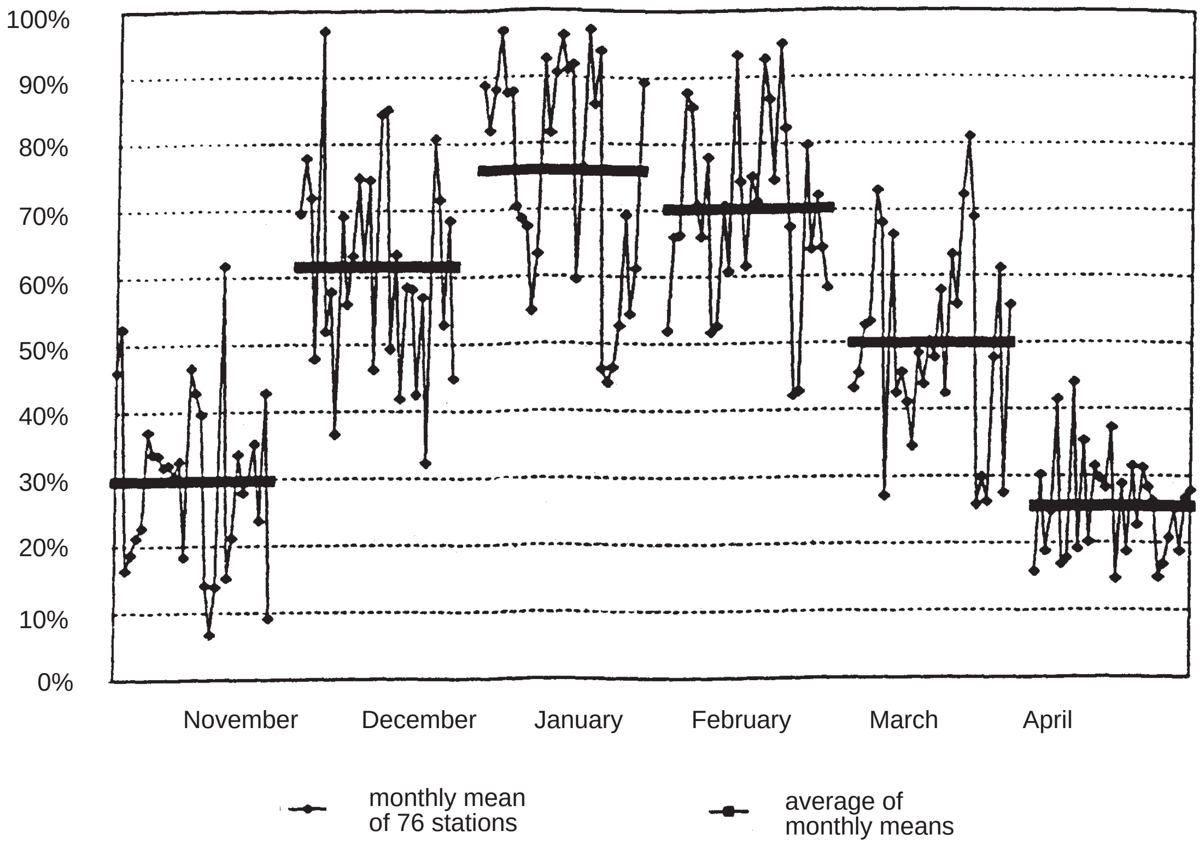


Figure 7.1: Probability of snow cover in Austria. November 1965 to April 1995; 76 representative snow stations between 174 and 2,140 m above sea level. (Source: Breiling et al., 1997)

- With an increase of temperature the number of good seasons will decrease, and a further concentration of winter tourism to midwinter months of January and February may take place.
- The less intensively utilized month of January provides a potential for expansion (cf. Figures 7.1 and 7.2).
- Lower-situated tourist resorts are disfavored relative to those higher up.

The authors are uncertain in regard to the effect of warming at specific locations. For example, due to temperature inversions may snow conditions be better at 900 m altitude than at 1300 m. Other factors for local variations of snow cover are wind exposure and topography.

Breiling et al. (1997) emphasize that the effect of climate conditions on the economy of winter tourism in Austria is not yet fully understood and that further analysis is required. In Austria 56% of the population live in regions below 400 m above sea level where winter tourism is of no importance. The economic potential of these regions is not likely to be influenced much by changes in snow conditions. Regions between 400 m and 800 m above sea level with 38% of the population are likely to experience adverse effects in case of a warmer winter climate. This may cause a loss of industry (up to 1% of GNP for a 2°C increase in average winter temperature) and thus great adversities to the economic balance of these regions. Only 6% of the Austrian population live above 800 m. At these altitudes snow conditions have been relatively stable. Regions at higher altitudes may even experience a

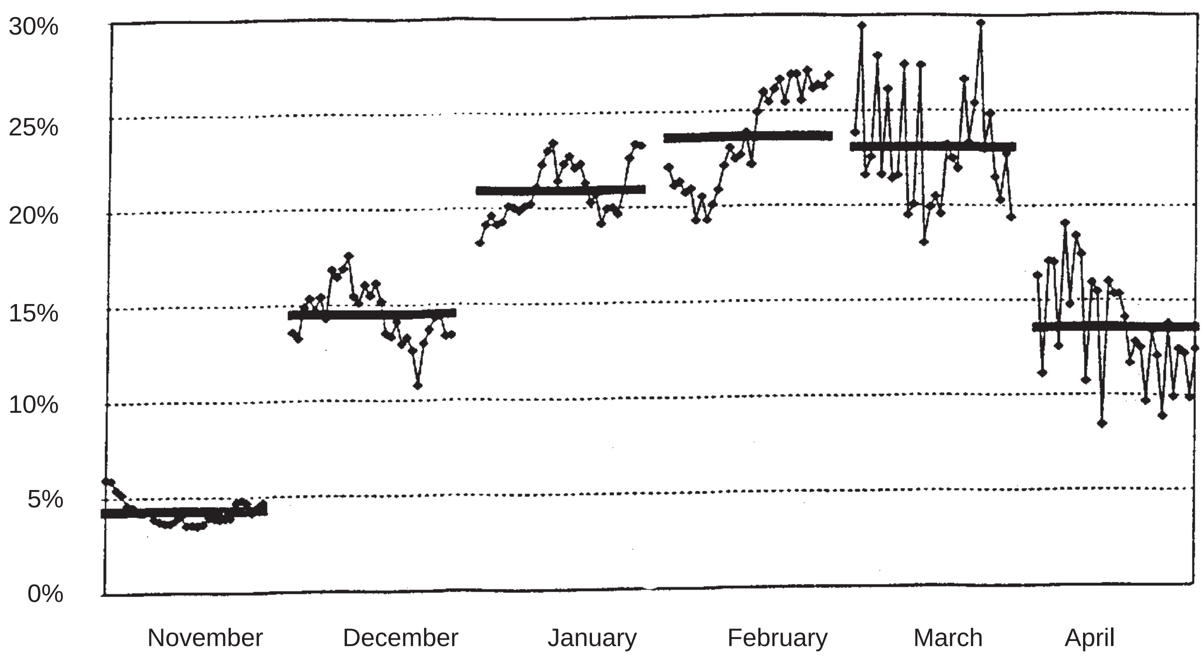


Figure 7.2: Relative importance of month for Austrian winter tourism. November 1965 to April 1995; indicated by tourist nights (Source: Breiling et al., 1997)

comparative advantage.

7.4.5 Property Loss and Insurance

Within financial services, the property insurance industry is most likely to be directly affected by climate change since it is already vulnerable to extreme weather events. The cost of weather-related disasters to insurers, in particular due to damage by windstorms, floods and hail, has risen rapidly since 1960 (Berz, 1996, Jakobi, 1996a). This trend has led to restrictions in coverage or steep price increases. Where insurance is unavailable or too costly, there are consequences for other economic activities, as well as for consumers and governments. New enterprises may not start without insurance. Banks may be exposed to losses where financial transactions are backed by property.

The escalation in the cost of weather-related disasters is multi-causal and it is a common perception that there is a trend toward an increased frequency and severity of extreme climate events. So far, examination of the meteorological data fails to support this perception in the context of a long-term climatic change (IPCC, 1996; Döös, 1997). Yet, the past insurance record of extreme events induces an increasing number of insurance companies to join the environmental declaration originally signed by 17 insurance companies at the UN in Geneva in November 1995 (Jakobi, 1996b; ACCC, 1996). The signatories of this declaration explicitly acknowledge the principle of sustainability and the precautionary principle as integral parts of the overall economy.

In regard to Austria, there is presently little knowledge available what implications climate change will have for its financial services. Currently damage control measures following natural catastrophes and preventive measures are governed by special laws. The Catastrophe Fund Law regulates fundraising for preventing future damage and catastrophe damage control. Funds are raised on the basis of a special ratio system from income and corporation tax. These funds may be used among other things for eliminating and preventing extraordinary damage caused by floods, landslides, mudflow and avalanches.

The Law Promoting Water Buildings executed by the Ministry of Agriculture and Forestry governs among other things the planning and implementation of measures for the protection against and control of devastation by water damage, avalanches, rock-slide, falling rocks, mudslides and slides, and determines adequate financing methods.

7.4.6 Human Health

Presently, climate change-induced impacts on human health are of no great concern for WHO-Europe. Relatively little research has yet been done in Europe to investigate such effects. However, various impacts may also strike central and northern Europe. Due to extensive traveling, vector-borne diseases shifting into wide areas preferred for vacations may increase the risk of incidence in the home country as well. Model predictions even indicate seasonal malaria occurrence in areas like Austria, if temperatures should continue to increase (Martens et al., 1995; Martin and Lefebvre, 1995).

Thermal adaptation within the usual temperature range in central Europe is generally no problem and can certainly be handled even if temperature extremes should increase. In general, higher temperatures and hyper thermal stress are promoting extended cardiovascular and respiratory complaints, where the very young and the very old as well as the chronically ill are the most susceptible groups. Considering the increasing poverty in many regions, compensation by heating and cooling could become more difficult for these groups.

Health problems caused by indirect effects due to a climatic change, however, might be of greater importance for central European countries. Migration driven by unstable political situations and poor living conditions is already a problem of acceptance by the native populations in these countries. Climate change-induced worsening of food and water supply could aggravate these problems additionally. The possibility of violent conflicts or demographic disruptions that might adversely affect the rest of Europe including Austria, might increase.

Because fossil-fuel combustion produces both carbon dioxide and various primary air pollutants, a climatic change would also be associated with increased levels of air pollution. Higher temperatures, particular in urban environments, enhance both the formation of secondary pollutants (e.g., ozone) and the health impact of certain air pollutants. There would be increases in the frequency of allergic and cardiorespiratory disorders and deaths caused by various pollutants (e.g., ozone and particulates). In Austria, the highest short-term ozone peak levels over 100 ppb can currently be detected in the plumes of Vienna and Linz where photochemical ozone production is high due to high concentrations of ozone precursor substances (FEA, 1996b). Long-term mean values of ozone in Alpine regions have shown an increasing trend until 1990 (and a not unambiguous trend since then) and it is to be expected that the increasing trend will continue due to increasing temperatures and solar radiation (caused by depletion of stratospheric ozone).

Stratospheric ozone is being depleted concurrently with greenhouse gas accumulation in the troposphere. A sustained depletion of stratospheric ozone over several decades would cause increased exposure to UV-B radiation and incidence of skin cancer in fair-skinned populations.

7.5 Long-term Climate Observations

In general, even carefully-measured long observational series are biased by inhomogeneities due to the technological development of instruments, changes in observers and observation regulations, relocations, environmental changes and others (Böhm, 1992; Auer, 1993; Frich et al., 1996). The inhomogeneities can be of the same order of magnitude as the long-term climate signal itself and should, therefore, be eliminated prior to further usage (by, e.g., climate variability researchers, environmental impact modellers or assessors).

For this purpose, a special working group has been established within the Austrian Central Institute for Meteorology and Geodynamics (ZAMG) that makes use of the ZAMG climate network and data base. Their work has resulted in a considerably more reliable climate data base for Austria with regard to the spatial and temporal variability of a range of climate elements (up to 15 are envisaged)

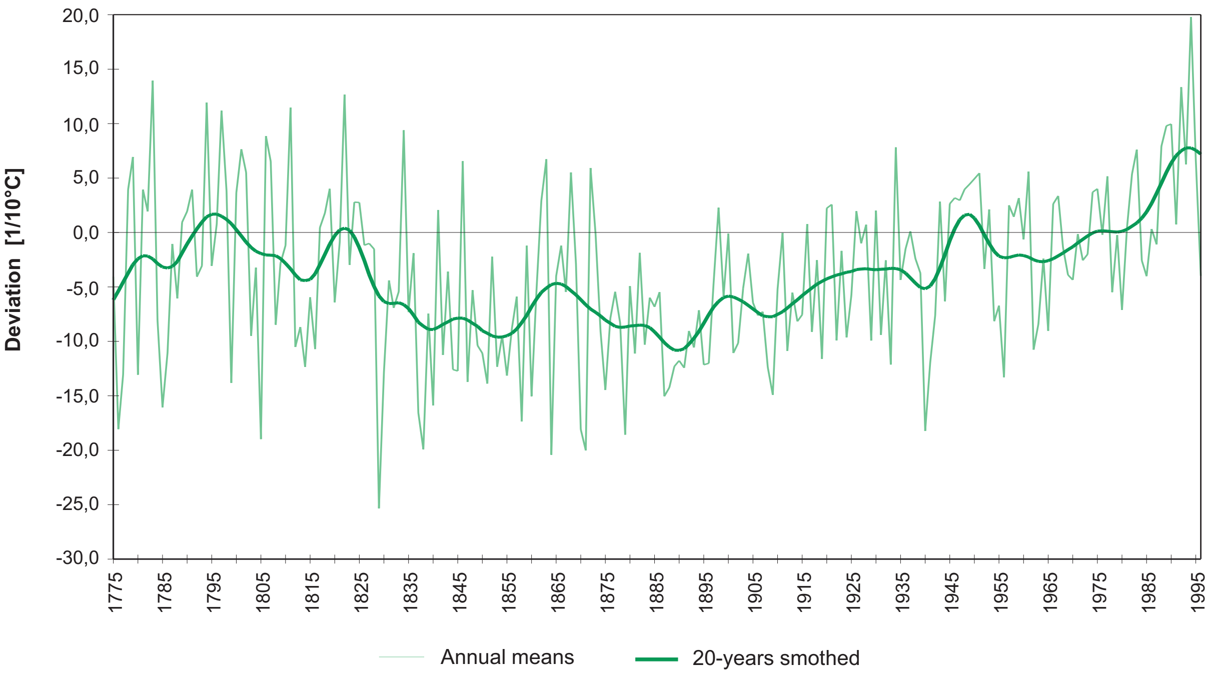


Figure 7.3: Temperature evolution in Austria (annual means and 20-years smoothed). Homogenized mean temperature data back to the 1770ies. No significantly different long-term patterns exist within the country. Therefore, the Austrian mean temperature evolution shown in the figure is representative for each part of Austria (cf. also Böhm, 1992). (Source: Central Institute for Meteorology and Geodynamics (ZAMG), Vienna, Austria)

covering the period from the beginning of instrumental observations. So far, about 60 long-term series of climate data (e.g., temperature, precipitation, snow cover duration and snowfall totals) for the different regions of Austria have been digitized, tested for homogeneity and, if necessary, adjusted; they are available in various formats (Böhm, 1992; Auer, 1993; Auer and Böhm, 1994; Böhm and Auer, 1994; Mohnl, 1994). Examples of the variation with time of temperature and precipitation are given in Figures 7.3 and 7.4 on the facing page. The longest Austrian temperature series begin in the 18th century (Vienna: 1775, Kremsmünster: 1796) and are among the longest carefully measured climate data that exist.

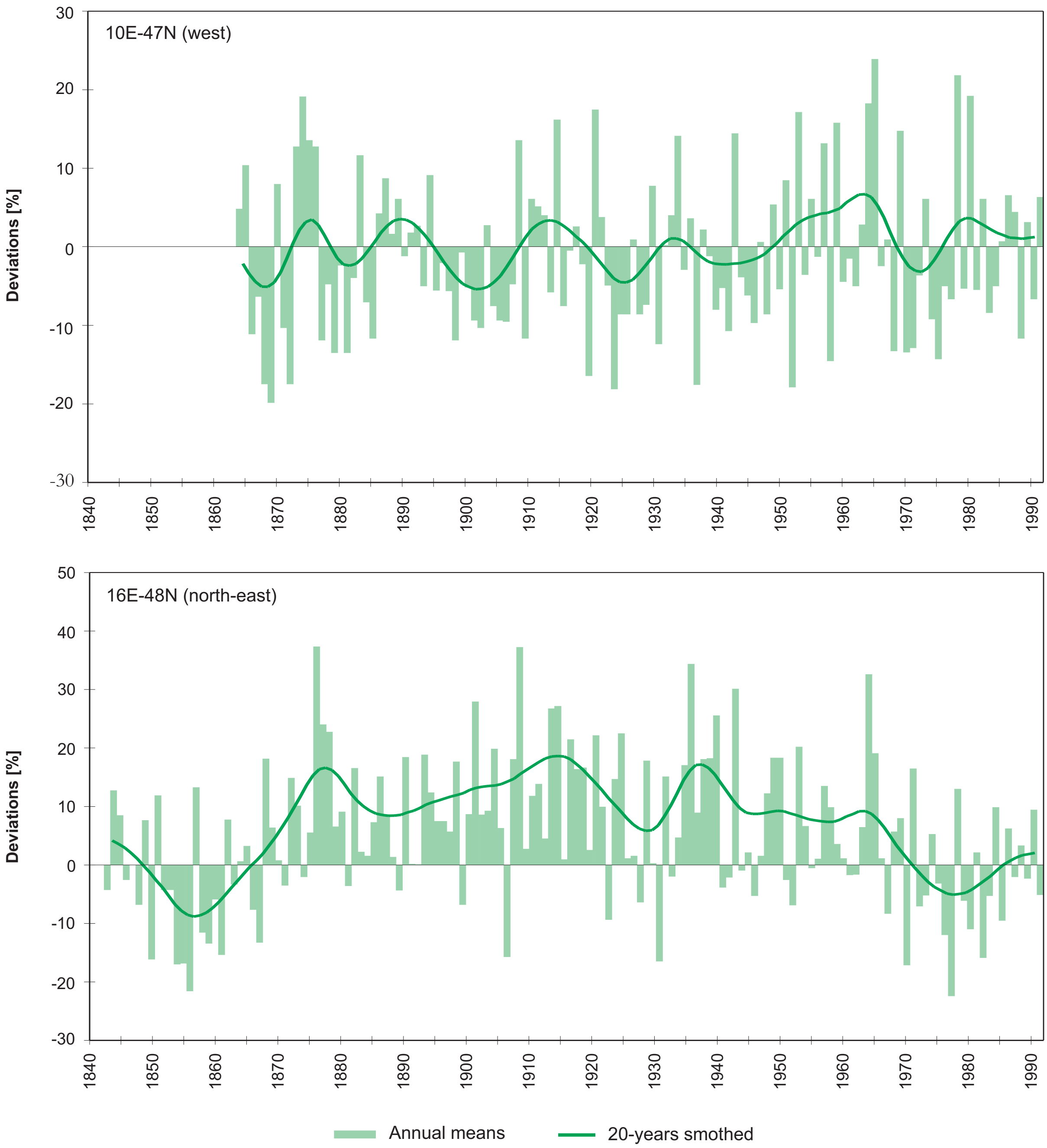


Figure 7.4: Precipitation evolution for two grid-points in Austria (Annual means and 20-years smoothed). Homogenized data back to the 1840s. Strongly different long-term evolution within the country as shown for two annual grid-point series at 10E-47N and 16E-48N. Therefore, no representative Austrian mean evolution; seasonal and monthly evolution are also different. Users, therefore, need to pay attention in employing the appropriate regional and seasonal data for their study area (cf. also Auer, 1993). (Source: Central Institute for Meteorology and Geodynamics (ZAMG), Vienna, Austria)

Chapter 8

Adaptation Measures

8.1 Introduction

According to the *IPCC Technical Guidelines for Assessing Climate Change Impacts and Adaptations* Parties are encouraged to report on the planning and implementation aimed at adaptation to a climatic change, i.e., the development of responses to both adverse and positive effects of a climatic change. These Technical Guidelines contain also a broad framework for the evaluation of such adaptation strategies. It consists of the following basic steps:

- ▷ Define the objectives.
- ▷ Specify the climatic impacts of importance.
- ▷ Identify the adaptation options.
- ▷ Examine the constraints.
- ▷ Quantify measures and formulate alternative strategies.
- ▷ Weight objectives and evaluate trade-offs.
- ▷ Recommend adaptation measures.

The methodologies outlined in each step embrace assessments conducted across a wide range of environments, economies, and societies subject to climate change (Carter, 1996; Carter et al., 1994, 1996).

Austria does not follow the suggestion of using the IPCC Technical Guidelines. The Austrian federal government puts priority on the mitigation of greenhouse gas emissions, rather than on the adaptation to the adverse effects of a climatic change. It should be pointed out, however, that Austria continues to implement a set of adaptation measures that in the first hand serve the purpose of reduction of other environmental risks, but which are also beneficial for adapting to a climatic change.

8.2 Assumptions, Principles and Potential of Adaptation

In the development of realistic and efficient strategies for adaptation to climatic change it is crucial to take into account altered biological, technical, economic, institutional, and regulatory conditions. Socio-economic as well as ecological or technological issues arise in judging the potential for adaptation with respect to different natural systems. In discussing attempts to better understand adaptation potential and to expand its scope internationally, six basic issues emerge:

1. ecological and socio-economic impacts are as important as changes in atmospheric chemistry;
2. beneficial climate change policies include opportunities for reducing risks from future climate change;
3. adaptation is a key complement to reducing greenhouse gas accumulations;
4. adaptation potential varies significantly across natural and human systems and depends crucially on both financial capacity and social infrastructure;
5. a number of adaptation options can be pursued at relatively low costs, especially those that involve correcting existing economic inefficiencies; and
6. governments have an important role in promoting effective research and development of available adaptation options, for example by reducing domestic barriers for cost-effective adaptive measures and by promoting international cooperation with regard to the global consequences of climate change (Toman and Bierbaum, 1996).

The flexibility and robustness of natural systems are critical components in assessing the ultimate socio-economic consequences of climate change. In regard to these systems, Toman and Bierbaum (1996) list three basic principles that underlie current knowledge about the potential for adaptation:

- ▷ Highly managed systems (such as agriculture), given sufficient resources, are likely to be more adaptable (and at lower cost) than less-managed ecosystems.
- ▷ Capacity for adaptation to a particular stress in any system greatly depends on
    1. the level of understanding of ecosystem processes and options for preserving the flows of services provided by them;

2. the degree to which this knowledge is diffused among the many decision makers who are ultimately responsible for the functioning of natural systems and for the capacity of these systems to provide human benefits; and
3. the level of financial and human resources available to support adaptive actions and research to increase options.

▷ Adaptive potential is likely to be greater in countries where levels of capital, stores of human knowledge, and social institutions permit greater attention to adaptive efforts. Economic development that is sensitive to the performance of natural systems is a powerful tool for promoting adaptation to climate change.

Table 8.1 elaborates these points and summarizes the adaptation potential of several systems including natural systems, especially in developed countries. For reasons given above and due to the fact that Austrian-specific expertise on adaptation, to the extent available, has not yet been compiled, e.g., in form of a summary report, it is proposed that this table may also serve as a basis for Austria.

Object of Concern	Low Sensitivity	Adaptation Possible at Some Cost	Limited Adaptation Potential
Agriculture		√	
Water resources		√	
Coastal settlements		√	
Managed forests and grasslands		√	
Natural landscapes			√
Marine ecosystems			√
Industry	√		
Health	√		
Recreation		√	
Migration		√	

Table 8.1: Sensitivity and adaptability of natural systems and human activities/values. Note: See Toman and Bierbaum (1996) for discussion of caveats. (Source: Toman and Bierbaum, 1996)

8.3 Adaptability of Forest Ecosystems

Climate change is expected to severely affect ecosystems at all latitudes (Dobson et al., 1989). Alterations of atmospheric carbon dioxide concentrations, rainfall quantity and distribution, temperature, seasonality, extreme events, etc. will force changes in ecosystem structure and function and subsequently lead to changes in the distribution of flora and fauna (Markham and Malcolm, 1996).

Strategies for adapting to climate change must be developed in the absence of precise information about either climate change or ecological responses. The aim of adaptive strategies should be reducing vulnerability to climate change, which is likely to yield additional benefits by simultaneously reducing the vulnerability of ecosystems to other environmental and anthropogenic stresses. Current scientific knowledge about the reactions of ecosystems and species to rapid change is not yet advanced enough to allow reliable projections. Nevertheless, several general rules have been developed in the climate impacts literature (Markham and Malcolm, 1996; Markham et al., 1993; Peters and Darling, 1985; Peters and Lovejoy, 1992; Rose and Hurst, 1991; World Wildlife Fund, 1994), which can be used to guide adaptation planning:

▷ Ecosystems do not move in response to climate change - species do. Therefore, climate change will disrupt or eliminate existing communities and species assemblages but will allow new ones to form.

▷ Species and ecosystems already under stress from environmental degradation and human pressure are likely to be the most vulnerable to the added stress of climate change.

▷ The faster the rate of climate change, the greater will be the risk, and the harder it will be for ecosystems to adapt.

- ▷ Some species will respond more favorably to climate change than others. Invasive species, generalists, widely distributed species, rapid producers, and efficient dispersers are likely to gain competitive advantages.
- ▷ Species most likely to be negatively affected by climate change will be those at the edges of their geographic ranges or within restricted ranges. Species that occupy narrow and highly specialized niches, are rare, or have genetically impoverished populations, may also be expected to be at risk.

Austria's diverse forest-ecological structure causes a broad range of different risk potentials. In the climatic zone of broad-leaved and mixed mountain forests it is more probable that projected climatic changes will remain within the site tolerance of the existing tree species than it is in Austria's warm east with its characteristics of the Pannonian climate. In areas with sufficient forest cover along pronounced climate gradients, in particular along altitudinal gradients, the conditions for adaptation by exchange of genuses and species are more favorable than they are in isolated forests with poorly structured ecological conditions.

Both natural conditions and anthropogenic interference influence the adaptive capacity of forests.

Genetic diversity. Intra-specific adaptability is a consequence of genetic diversity. Simplistically, it means that the more genetic variants a tree population harbors, the better its genetic adaptability to environmental stress. Unfortunately, genetic diversity can be assessed only indirectly. Today's genetic inventories are based on modern biochemical methods and provide important information on the genetic composition. However, a meticulous overall assessment as to whether Austrian tree populations are genetically adaptable or not remains impossible. Nevertheless, some plausible conclusions can be drawn. The genetic diversity of Austria's tree populations is mainly due to the size and number of refugial populations during glacial periods, to the number of pathways and interplay during recolonization and, finally, to man-made influence of past deforestation and present-day forestry. As these factors have or have been varied for different tree species, genetic adaptability to environmental changes must be different among populations. For instance, based on the current state of knowledge Norway spruce is genetically less variable in the Alpine area than it is in the more eastern regions.

As a possible means, broadening the genetic diversity is apt. This can be achieved by enhancing natural regeneration in more or less natural forest plant communities and by mixing appropriate seed lots where artificial reforestation is necessary. Also, artificial establishment of satellite tree populations is a conceivable measure. Such populations have genetic compositions which make them poorly adapted to current site conditions, but well adapted to environmental conditions in future decades.

Species composition. The ecophysiological amplitude and the ability to respond to environmental stress depend on the natural or man-made species composition. Only after the extent of environmental changes has exceeded the genetic adaptability of the individual species does the situation call for the adaptive capacity of the ecosystem.

Measures to speed up forest dynamics. In that we tolerate or advance natural dynamics, we make use of the ability of self-regulation or self-stabilization of forest ecosystems and thereby contribute to the reduction of the risk potential. As interferences form part of the overall dynamic process, they can be used to improve and enrich the structure of forests for the purpose of a high biodiversity. The measures classified under the term of *nature-conforming forestry* are equally oriented to the natural dynamics of forest ecosystems. Typical examples are the integration of natural succession in the regeneration of forests or the use of self-differentiation in forest tending.

Forests in harmony with nature. Forest ecosystems which correspond to nature as regards their species composition and dynamic processes, will have a higher adaptive potential than substitute communities, the stability of which is already endangered under today's climatic conditions. The study of hemerobia (Koch et al., 1997; Grabherr, 1997) indicates that, in general, the degree of naturalness of Austria's forests is comparably high and that the diversity of Austrian forest communities corresponds to the typical proportions in that field. Two thirds of the forest-covered areas clearly show elements of the natural forest community. And

25 % of Austria's forests are natural or nature-conforming, which is a European peak value.

Research requirements. Earlier reactions of forest communities to interferences allow conclusions regarding their response to environmental changes. Processes of adaptation and succession depend on the diversity of species, on their ecological amplitude, the colonizing strategies of the existing and additional species, the reproductive capacity, and several other parameters, the assessment of which will require considerable scientific efforts.

8.4 Avalanche, Erosion and Torrent Control Measures

Under present climatic conditions, the natural timberline in the Austrian Alps lies between 1,800 (external Alpine rim) and 2,200 m (internal Alpine areas) above sea level. Interdisciplinary research and basic ecological concepts aiming at conserving and extending high altitude and protection forests in the subalpine zone are elaborated. Results of this research are important for the management of mountain forests, avalanche and torrent control, and for the conservation of natural resources. Structure analysis of subalpine forests are made to keep track of long-term trends for supporting the management of protection forests.

For a country like Austria with various and complex geological conditions (cf. Chapter 3), influenced by widely different climates (Atlantic, Mediterranean, Pannonian), it is essential to successfully develop and apply measures aiming at avoiding torrent disasters. Therefore, it was quite natural that erosion control research was first initiated in Austria approximately two hundred years ago (Aulitzky, 1994).

In the meantime, a number of countries (China, Taiwan, Japan, Switzerland, Greece, Venezuela, etc.) have organized their torrent control systems by adopting Austria's experiences. Since its foundation, the *International Research Society Interpraevent* with affiliated societies in various European and Asian countries, has its seat in Austria, where it serves as a center for the distribution of new protection and prevention measures (Interpraevent, 1996).

In particular, the remarkably increasing level of damage due to erosion disasters during the second half of this century (Fliri, 1986, 1989; Aulitzky, 1996c; Schönegger, 1996) shows the necessity of searching for additional and new protection and prevention methods. Hampel (1977, 1981, 1982), e.g., developed a new debris theory to control debris and sediment discharge economically, as well as the effectiveness of technical control measures (like chains of control dams) and storage capacities. The combined application of the debris theory and new types of open dams (slit dams, debris-sorting dams, flow-dosing dams, etc.) improves the effectiveness of all technical countermeasures in use today (Kettl, 1984). These new dam types for debris management receive increasing acceptance especially in countries with a great erosion potential like Japan (Takei, 1990).

In order to avoid increased damage by avalanches, debris flows and floods it would be necessary to quickly afforest the region from the today's timberline to the new potential one, by making use of the best available temperature projections, and to also improve the structure of the protection forest (Prenner, 1986; Aulitzky, 1996c; FMAF, 1996). By so doing and taking advantage of the fact that transpiration is increasing after afforestation, the discharge of water could be reduced considerably and disastrous impacts due to uncontrolled water flows would be reduced or avoided (Richard, 1963; Prenner, 1986; Aulitzky, 1969, 1996c). This is because transpiring trees are able to exhaust the water saturation of soils over a wide range down to a minimum available soil-water content, and thus to increase their water holding capacity. In this way it would be possible to account for a settlement situation that became typical for Austria and other parts of the Alps during recent decades. Tourist resorts and urban areas have transformed into high-risk areas increasingly endangered by slope instability (cf. Chapter 3). It must be feared that extreme precipitation and discharge intensities for Austria, which are already among the greatest in the world, will increase even further and reach unprecedented levels should preventive measures be disregarded (Aulitzky, 1968a, 1974).

Investigations taken up after the greatest Austrian torrent disasters of this century in 1965 and 1966, show that two thirds of all damages were caused by anthropogenic activities that did not consider and respect local and regional natural conditions (Aulitzky, 1968b). Especially the sudden expansion of settlements into areas that are known to be potentially endangered as debris cones and flood plains, requires that protection measures are accompanied by prevention measures (e.g., hazard-zone mapping). Complex field investigations and techniques, like the derivation of a torrent-cone index (Aulitzky, 1972b) and a new torrent classification scheme adapted for protection as well as for prevention purposes (Aulitzky, 1984), allow to delineate and to reproduce hazard areas and thus to provide a fundamental basis for regional planning (Huna, 1984; Aulitzky, 1984, 1989). By the beginning of 1996, 652 hazard-zone maps were completed for the most endangered communities of Austria, 1,144 of which are located in the Alpine areas of the country (FMAF, 1996). Expert judgments on the impacts of avalanches, landslides and floods are also included in the hazard-zone maps. Hazard-zoning has a legal basis in Austria since 1975.

Chapter 9

Financial Assistance and Technology Transfer

9.1 Official Development Assistance

Since the 1970s the industrialized countries, including Austria, have been committed under the United Nations to increase, as and when possible, their national development aid percentages to 0.7% of Gross Domestic Product (GDP). While Austria repeatedly stated (in line with other countries) that it intended to achieve this goal by the year 1991, it had to point out in 1985, that it would take longer to achieve the 0.7% target. Since that time the interim objective has been set at the OECD average (FMfA, 1995; OECD, 1996). The Austrian Parliament (in two resolutions in 1988 and 1994) and the Government (in a decision of 1990) have formally decided to enhance both the quality and quantity of Austria's development aid efforts and to bring them gradually in line with the international standard.

In 1991, Austria´s official development assitance (ODA) for the first time reached the OECD average (0.33% of GDP). In 1993 Austria again reached the OECD average of 0.30% of GDP. In 1994 Austria reported a proportion of 0.33%, more than the 0.30% OECD average. In 1994 Austria's ODA amounted to ca. 740 million US $, that is about 110 million US $ more than in 1993.

Bilateral credits, and in particular concessional export credits accounted for 90% of this increase. Bilateral loans in 1994 amounted to 200 million US $, roughly 28% of total ODA, as compared with 85 million US $ (14%) in 1993. Bilateral grants increased only slightly in 1994, amounting to 400 million US $ (54%) after 380 million US $ (61%) in 1993. Multilateral development cooperation even declined from 150 million US $ (25%) in 1993 to 130 million US $ (18%) in 1994.

Even though Austrian ODA continues to be widely spread geographically, measurable progress has been made in recent years in Austria's endeavors to concentrate its activities on fewer regions and countries. In 1994 61% of budgetary and ERP funds for bilateral technical assistance was allocated to priority regions and countries (59% in 1993, 45% in 1992 and 24% in 1991).

The future aid volume for developing countries will be influenced by EU membership (Austria became a member of the EU on 1 January 1995). Its share in aid financed through the EU budget amounted to 2.7% or about 80 million US $ in 1995. Contributions to the European Development Fund (EDF), which will start in 1998, will amount to about 400 million US $ over a 5-year period (corresponding to 2.6% of EDF-8).

9.2 Assistance for Environmental Purposes

It is the declared policy of the Austrian authorities that all ODA-supported projects should be environmentally sustainable. In 1992 (following UNCED) Austria initiated a three-year Program (1993-95) amounting to 18 million US $ for small projects related to the protection, conservation and rehabilitation of rain forests in 17 developing countries with special emphasis on the preservation of the culture and living space of indigenous populations. In Austria's view the indigenous population is best able to preserve and manage rain forests in a sustainable way. By January 1995 15 million US $ for 30 projects were committed and/or under implementation. According to the statistics bilateral environment-specific and environment-integrated projects totaled 29 million US $ in 1994, some 4% of bilateral commitments in 1994.

Environment considerations play a major role in aid to central and eastern European countries and the countries of the former CIS. Being exposed to long-range transboundary air pollution, Austria pays particular attention to the environmental situation in its neighboring countries. The Austrian Federal Ministry for the Environment is practicing within the scope of the East-Ecofund bilateral assistance in the field of environmental protection in the neighboring countries Czech Republic, Hungary, Slovak Republic and Slovenia. The vital area of the Austrian program are investment-related measures like feasibility studies, consultations, emission measurements, engineering and training. Since January 1997 it is possible to provide funding for investments in the neighboring countries within the framework of international projects. The East-Ecofund projects are mainly focused on

- ▷ biomass heating plants
- ▷ energy saving and energy supply concepts
- ▷ combined heat and power plants
- ▷ desulfurization plants
- ▷ waste water purification plants.

The East-Ecofund was founded in 1991. By the end of 1996 105 projects have been approved for funding. The total commitment amounts to about 772 Mill. ATS (ca. 71 million US $).

Non-governmental organizations occupy a special and important position in the Austrian aid program since they initiate and implement a large share of bilateral technical assistance.

9.3 Climate-Related Expenditures

9.3.1 Global Environmental Facility

The Global Environmental Facility (GEF) was set up in 1991 as a three-year experiment (pilot phase) and, after restructuring in 1994, continued for an indefinite period. Its objective is to help developing countries and countries with economies in transition (Central and Eastern Europe and former CIS) to cope with four major environmental problems of basic and world-wide importance:

- ▷ Global warming
- ▷ Water pollution
- ▷ Biodiversity
- ▷ Stratospheric ozone depletion

GEF is an administrative umbrella which receives financial resource from a variety of funds (approximately 1.3 billion US $ during the pilot phase). The main source is the Global Environment Trust Fund (GET), also referred to as the "Core Fund". Donors provided during the pilot phase roughly 800 million US $ and during the first replenishment period 2 billion US $ for the GET.

During the pilot phase Austria has contributed a comparatively large share to GET (about 35 million US $ or about 2.7%) in order to underscore its interest in international measures for the protection of the environment. For the first replenishment of the GET Austria contributed 20 million US $ or 1%, based on a fair burden sharing. In addition, Austria committed up to 4.5 million SDR (special drawing rights) for a bilateral GEF-Consultant Trust Fund.

The restructuring of GEF involved, among other things, the establishment of a Council as the Facility's new decision-making body. The Council is composed of 32 members and/or constituencies. Austria forms a constituency with Belgium, Czech Republic, Hungary, Luxembourg, Slovak Republic, Slovenia, and Turkey and provided the Council member from 1994 until mid 1997.

9.3.2 Financial Contributions Related to the Implementation of the UN-FCCC

This section sums up the Austrian financial contributions from 1994 to 1996, which are provided bilaterally (listing the individual countries) and multilaterally. Most of these contributions are new and additional and mainly targeted towards measures

Recipient country	Mitigation	
	Transport	Forest
Brazil		3.2
Columbia		0.9
Panama		0.8
Guatemala		0.6
Costa Rica		1.0
Nicaragua		0.8
Kenya		0.4
Senegal		0.6
Burkina Faso		0.7
Cameroon		0.5
Philippines		0.3
Indonesia		0.1
Global		0.6
SADC Region	0.1	0.1
Tanzania	6.0	
Africa	0.2	

Table 9.1: Austrian new and additional bilateral financial contributions related to the implementation of the Convention in 1994 (millions of US $)

to protect forests (the remaining part is for transportation measures).

9.3.2.1 Bilateral financial contributions

The Austrian bilateral financial contributions are shown in Tables 9.1, 9.2 and 9.3.

Recipient country	Mitigation Transport	Mitigation Forest
Brazil		1.3
Columbia		0.2
Panama		0.2
Kenya		0.4
Tanzania	6.0	0.4
Senegal		0.5
Burkina Faso		0.5
Cameroon		0.2
Papua New Guinea		0.3
Global		0.2
SADC Region	0.2	
East Africa	0.2	

Table 9.2: Austrian new and additional bilateral financial contributions related to the implementation of the Convention in 1995 (millions of US $)

Recipient country	Mitigation Transport	Mitigation Forest
Brazil		0.6
Columbia		0.2
Panama		0.4
Senegal		0.1
Burkina Faso		0.4
Cameroon		0.3
Laos		0.4
Philippines		0.1
Indonesia		0.3
Papua New Guinea		0.1
SADC Region		0.2
Tanzania	6.0	
East Africa	0.2	

Table 9.3: Austrian new and additional bilateral financial contributions related to the implementation of the Convention in 1996 (millions of US $)

9.3.2.2 Multilateral financial contributions

The Austrian multilateral financial contributions are shown in Tables 9.4 and 9.5.

	1994	1995	1996
Multilateral institutions:			
UN-FCCC Trust Fund			0.064
UNDP	13.4	13.0	12.4
Multilateral technology programs:			
Cleaner Production*	0.7	0.9	0.2

* UNIDO - Cleaner Production Centers and workshops

Table 9.4: Financial contributions to the operating entity or entities of the financial mechanism, regional and other multilateral institutions and programs (millions of US $)

	1994	1995	1996
Multilateral institutions:			
UN-FCCC Volunt. Fund	0.025		0.025
IPCC Spec. Volunt. Fund	0.025		
Other:			
Capacity 21 (UNDP)	1.0	1.0	1.0

Table 9.5: New and additional financial contributions to the operating entity or entities of the financial mechanism, regional and other multilateral institutions and programs (millions of US $)

Chapter 10

Research and Systematic Observation

10.1 General Information

Annex I Parties are requested to communicate information on their recent, ongoing and planned actions relating to research and systematic observation. This chapter contains representative information with relevance to Austria on

- ▷ Data collection, monitoring and systematic observation, including data banks
- ▷ Climate process and climate system studies
- ▷ Modeling and prediction, including global circulation models
- ▷ Research on the impacts of climate change
- ▷ Socio-economic analysis, including both of the impacts of climate change and of response options
- ▷ Technology research and development.

Research on these issues is carried out, inter alia, by the following institutions:

- ▷ Association of Electric Supply Companies of Austria (Verband der Elektrizitätsversorgungsunternehmen Österreichs, VEU)
- ▷ Austrian Council on Climate Change (Österreichischer Klimabeirat, ACCC) formerly Austrian CO_2 Commission (Österreichische CO_2-Kommission, ACC)
- ▷ Austrian Institute of Economic Research (Österreichisches Institut für Wirtschaftsforschung, WIFO)
- ▷ Austrian Research Centre Seibersdorf (Österreichisches Forschungszentrum Seibersdorf, ÖFZS)
- ▷ Central Institute for Meteorology and Geodynamics (Zentralanstalt für Meteorologie und Geodynamik, ZAMG)
- ▷ Commission for Air Pollution Control of the Austrian Academy of Sciences (Kommission für die Reinhaltung der Luft der Österreichischen Akademie der Wissenschaften)
- ▷ Energieinstitut Vorarlberg (EIV)
- ▷ Federal Chamber of Labour (Bundesarbeitskammer, BAK)
- ▷ Federal Economic Chamber of Austria (Wirtschaftskammer Österreich, WKÖ)
- ▷ Federal Environment Agency of Austria (Umweltbundesamt, UBA)
- ▷ Federal Forest Research Institute (Forstliche Bundesversuchsanstalt, FBVA)
- ▷ Federal Institute of Agricultural Engineering (Bundesanstalt für Landtechnik, BLT)
- ▷ Federal Office and Research Centre of Agriculture (Bundesanstalt und Forschungszentrum für Landwirtschaft, BFL)
- ▷ International Institute for Applied Systems Analysis (IIASA)
- ▷ Joanneum Research Graz
- ▷ Swedish University of Agricultural Sciences (Sveriges Lantbruksuniversitet, SLU)
- ▷ Technical University of Graz (TU Graz)
- ▷ Vienna University of Technology (TU Wien)
- ▷ The Austrian Ecology Institute for Applied Environmental Research (Österreichisches Ökologieinstitut für Angewandte Umweltforschung)
- ▷ The Austrian Energy Agency (Energieverwertungsagentur, EVA)
- ▷ University of Agricultural Sciences, Vienna (Universität für Bodenkultur, BOKU, Wien)
- ▷ University of Linz (Uni Linz)
- ▷ University of Innsbruck (Uni Innsbruck)
- ▷ University of Vienna (Uni Wien).

Research activities are commissioned by the competent federal ministries, provincial governments, special interest associations, industry, the Laxenburg Academy for Environment and Energy, and others. Research foci of the federal ministries, in particular, are as follows:

- For the Federal Ministry for the Environment, Youth and Family Affairs the successful implementation and propagation of innovative strategies and concepts is closely linked with interdisciplinary approaches and cooperative management due to the complex nature of problems regarding the protection of the climate system.

- Surveys on existing institutional obstacles and the development of solution strategies play a vital part in the successful implementation of measures for the protection of the climate system. Hence, initiatives by the Federal Ministry for the Environment, Youth and Family Affairs in this field of research focus primarily on taking steps to propagate and transfer. Consequently, research projects awarded by the Federal Ministry for the Environment, Youth and Family Affairs are primarily oriented towards application and implementation.

- The Federal Ministry of Science and Transport preferably grants projects focusing on stimulating networking (see *Austrian Network Environmental Research*) and international cooperation (emphasis on the 4th EU Framework Programme for FTD) as well as innovation, constantly considering the concept of sustainability where applicable. A focal point is the promotion of Austrian contributions to international global change programs such as IGBP, WCRP and IHDP by the Austrian *Global Change Committee* (established by the Austrian Academy of Science, formerly IGBP Committee).

- The Federal Ministry of Agriculture and Forestry participates in research projects focusing on greenhouse gas emissions in the field of agriculture and forestry. In planning its research activities the Ministry takes policy goals and requirements resulting thereof into consideration. These steps are taken in accordance with international activities (e.g. Alpine Protection Convention, Ministerial Conference on the Protection of Forests in Europe). For instance, the Federal Forest Research Institute is responsible for the international coordination of the implementation of the Helsinki Resolution H4 *Strategies for a Process of Long-Term Adaption of Forests to Climate Change*. Based on the complexity of this phenomenon the Federal Ministry of Agriculture and Forestry within its own research institutions and in the field of commissioned research puts particular emphasis on research projects concerned with network systems in research and implementation.

- The Federal Ministry of Economic Affairs awards research commissions in the field of technical experimentation. The focal point of the promoted research projects are economic and technical issues (stimulation and critical monitoring of technical developments), concerns with regard to the orientation and implementation of the technology policy, and all areas which might be of importance for possible solutions in regard to future developments. Another major aspect in awarding commissions is to promote the introduction of new technologies on the market.

Presently, Austria´s research on climate and climate impact presents itself as a colorful mosaic of mostly basic research with hardly any networking. In regard to possible future applications, research is only partially practice-orientated. The Ministry of Science and Transport considers the establishment of an *Information and Coordination Centre for Climate and Climate Impact Research* at the Institute of Meteorology and Physics at the University of Agricultural Sciences, Vienna a contribution to improving this situation. This Centre is to

- ▷ ensure an improved and more efficient flow of information between researchers, researchers and users, and the ministries within Austria;
- ▷ lead to an internationalization of Austria's climate research and strengthen it's presence in global programs and programs at the EU level; and
- ▷ elaborate a research plan in the field of climate and climate impact research together with the Austrian research community. It is anticipated that the emphasis will be placed on the regionalization of global change and risk assessment, particularly in the Alpine region, two topics which are of particular importance for Austria.

The Information Centre is one of ten nodes of the *Austrian Network Environmental Research*, also initiated by the Ministry of Science and Transport. The network as a whole has similar tasks as the Information Centre and is supposed to serve as a supporting body for the broader field of Austrian environmental research.

The following nine nodes form part of the above-mentioned network:

1. Biodiversity
2. Ecological integrity of running water ecosystems
3. Research on climate, climate change and the atmospheric environment
4. Research on land cultivated by man
5. Sustainable use of water resources
6. Process-orientated research on the plant-environment system
7. Socio-economic environmental research
8. Tropical forest research (within the framework of the *Austrian National Node of the European Tropical Forest Research Network, ANN-EFTRN*)
9. Environmental Monitoring – Ecosystem Research

All nodes currently put together catalogues on the current research activities in Austria in the field they cover. The first three catalogues have already been published, further ones are currently being printed.

The Austrian Council on Climate Change (*Österreichischer Klimabeirat*) works as a link between science and politics. It consists of representatives from various academic disciplines and provides consultation and support to the Austrian climate policy in view of the challenges of a global climate change. In interdisciplinary cooperation scientists from a wide range of research fields participate in the design of international research programs on climate change. They interpret the meaning of these research results for Austria and explore the possibilities of an environmentally sound economy in discussions with consumers, managers and politicians.

10.2 Data Collection, Monitoring and Systematic Observation, Including Data Banks

It is important to note that monitoring climate in the Alps, where the general model-based findings on climate change have limited applicability because of the complex topography, is a particular responsibility that Austria is undertaking, in cooperation with its neighbors. Austria also provides locations for monitoring where there is little influence by human activities, which is rare in Europe. With regard to climate observations, it can be stated that the longest of Austria's instrumental time series go back as far as to the 18th century and are among the longest that exist.

For examples of research projects and activities in which Austria has been particularly active, see Table 10.1.

10.3 Climate Process and Climate System Studies

Climate process and climate system studies in Austria relate to a wide spectrum of topics, but a certain emphasis appears to be on processes influenced by topography, especially the Alps. Precipitation and chemical climatology have attracted a number of research groups. This basic research is of course not only of interest for climate studies, but has other meteorological and also interdisciplinary aspects.

For examples of research projects and activities in which Austria has been particularly active, see Table 10.2.

10.4 Modeling and Prediction, Including Global Circulation Models

In view of the limited resources available to a small country, the Austrian climatological research community has refrained from entering into global circulation model (GCM) research as such. There are, however, modeling activities in special areas, e.g., diagnostic analyses of subsynoptic flows, in which Austrian researchers are particularly active and, if conditional for a research project, GCM outputs are obtained from appropriate international groups. This is, e.g., true for prediction activities based on statistical analyses linking regions or scenarios.

10.5 Research on the Impacts of Climate Change

In regard to the impacts of a climatic change, Austrian research focuses on topics that are of vital interest to the country: forests, water, glaciers, etc. Most of these studies look into the effects of a climatic change on the Alpine region, since its climate is very specific due to the elevated and complex topography and also very sensitive to minor shifts in the general circulation including the paths of cyclones. This is one of the reasons why regionalization is discussed intensively in Austria as a priority in climate research.

For examples of research projects and activities in which Austria has been particularly active, see Table 10.3.

10.6 Socio-economic Analysis, Including both of the Impacts of Climate Change and of Response Options

Austrian research in this field is mainly directed towards two major topics, that is, the estimation of costs and economical as well as social benefits of increased renewable energy supply technologies, and the development of regional response options aiming at reducing greenhouse gas emissions from energy generation.

With respect to cost-benefit analyses accounting for a medium to long-term change in the Austrian energy supply pattern, a thorough study is part of the *Austrian National Environmental Plan*. This is an example of socio-economic research related to climate change that has an important impact on Austrian policy. It is noteworthy that, given the great share of energy supplied by renewable resources (hydro-power, biomass heating), a supply scenario for Austria based exclusively on solar energy is subject of serious scientific discussions.

Regional response options particularly aiming at reducing greenhouse gas emissions are currently integral part of most regional and local development plans. There is a definite demand-side pressure for research in this field, as more than 150 municipalities in Austria have joined the *Klimabündnis* dedicating themselves to halve their CO_2 emissions until 2010.

Apart from research on regional response strategies, Austria's research is also investigating socio-economic impacts related to the introduction of renewable energy systems (mainly solar energy and biomass district heating). Within this context, social as well as economical factors for innovation and adoption of these technologies in Austria have been identified.

For examples of research projects and activities in which Austria has been particularly active, see Table 10.4.

10.7 Technology Research and Development

Austria has a long research tradition concerning energy technologies based on renewable sources and holds competitive positions in the fields of biomass utilization and solar energy technologies. In the first field research is mainly directed towards biomass utilization in small and medium (up to 50 MW) heating facilities. Within this field, a whole range of problems like furnace optimization, effluent gas cleaning, nitrogen oxide reduction and ash management are currently under investigation. Strong emphasis is put on cogeneration technologies in small and medium size plants using gasification as well as sterling engines.

In the field of solar energy technologies there exists a certain peculiarity in the Austrian research landscape. This field is actually driven by active grass-roots organizations with the research establishment reacting to their particular needs. As a result, research directed to solar energy systems, solar architecture and transparent insulation systems has been intensified considerably. Due to the demand-side pressure of grass-roots organizations, this research is close to the market and strongly concentrated on practical solutions.

For examples of research projects and activities in which Austria has been particularly active, see Table 10.5.

Table 10.1: Data collection, monitoring and systematic observation, including data banks

Examples of Research Projects and Activities	Objectives
International data exchange as part of the WWW (World Weather Watch) of the WMO	To make available observational data and other products to meet the needs of the WWW Program of the WMO.
Participation in the Global Atmospheric Watch (GAW) Program of the WMO	A GAW station is being established based on four mountain observatories, one being the Hoher Sonnblick (3,105 m) in Austria. For this purpose, a *Sonnblick Task Force* has been set up consisting of representatives from various governmental agencies and university institutions. Part of the necessary measurements are already being carried out; cooperation with Switzerland and Germany has been initiated ("GAW Station: The Alps").
Glacier mass balance, long-term modeling of glacier-climate relations and chemical analyses of winter snow cover on the Wurtenkees in the Sonnblick region since 1983 as part of the EUROTRAC subproject ALPTRAC	Winter snow cover studies involving chemical analyses of snow have been conducted on the Wurtenkees in the Sonnblick region since 1983 as part of the EUROTRAC subproject ALPTRAC. Together with mass balance measurements, profiles of various anions, cations, OH and pH values as well as conductivity profiles are measured each year in May (at the maximum of winter accumulation). The EUROTRAC studies were continued on the basis of a *FWF grant (Fond zur Förderung der wissenschaftlichen Forschung)*, and are now carried on as far as possible without external funding. A summary of the past 11 years of measurements has been published.
Stratospheric ozone monitoring	The total ozone column is continuously monitored using a Brewer Spectrometer at the Hoher Sonnblick (3,105 m), Austria, and profiles are made whenever the weather allows. The values are markedly below the 30-years average as measured in Arosa, Switzerland. Interdiurnal variability and larger deviations from monthly averages are subject of meteorological analyses.
UV measurements	A UV broadband sensor (Bentham) is established at the Hoher Sonnblick (3,105 m), Austria, a second one is being set up near Vienna, both operating in a continuous mode. Beside monitoring aspects important for man and vegetation, the data collected serve also as a basis for scientific research. Solar UV-A and UV-B irradiance and total irradiance have been measured annually since 1981 in 1-2 measuring periods of eight weeks each at the high mountain research station Jungfraujoch (3,575 m above sea level; Switzerland) to examine the influence of various atmospheric parameters including the total ozone content. For comparison, measurements were carried out at Innsbruck and Hafelekar (577 and 2,300 m above sea level, respectively), both stations being within a horizontal distance of 5.8 km. In addition, a network of the simpler Robertsen-Berger instruments is being set up for day-to-day warnings during summer.
Austrian Long-term Climate (ALOCLIM)	The *Climate Fluctuations Task Force* at the Austrian Central Institute for Meteorology and Geodynamics is conducting time series analyses of Austria's climate stations. Thus far, approximately 50 homogeneous series each have been elaborated and analyzed for temperature, precipitation and snow. Present efforts focus on expanding these studies to other climate elements and on establishing cooperation with other European countries.

Table 10.2: Climate process and climate system studies

Examples of Research Projects and Activities	Objectives
Mesoscale Alpine Program (MAP)	Mountains and in particular Alpine-type orography instigate or influence a wide range of mesoscale phenomena. These phenomena and their associated processes are intricate in character, interact with larger and smaller-scale flow, and are responsible for much of the day-to-day mountain weather and for many extreme weather events. Moreover, their composite effect contributes significantly to determining climatic features of mountain regions. The program's coupled overall goals is to further the basic understanding and forecasting capabilities of the physical and dynamical processes that ▷ govern precipitation over major complex topography; and ▷ determine three-dimensional circulation patterns in the vicinity of large mountain ranges, thereby focusing on key orographic-related mesoscale effects in the Alps.
Subsynoptic scale fluxes of moisture and heat (Contributing project to BALTEX)	The project aims at quantifying the influence of convection on the energy and humidity balance of the atmosphere.
Heavy Precipitation in Alpine Regions (HERA)	Systematic evaluation of mesoscale precipitation systems (1992-1996) using different data sources, statistical and climatological evaluation of the cases and classification into archetypes of mesoscale precipitation systems.
Diagnostic test of the weather generator (Contributing project to the IGBP core project *Biospheric Aspects of the Hydrological Cycle*)	One of the objectives of the *Global Water and Energy Cycle Experiment* (*GEWEX*) to be performed in cooperation with the IGBP core project *Biospheric Aspects of the Hydrological Cycle* is to develop soil-vegetation-atmosphere transfer models from patch over large river basin up to continental scales. This program has been condensed into the concept of the climate simulator or weather generator. Its goal is to relate low resolution surface quantities relevant for local hydrology.
Reconstruction and modeling of the paleoclimate of Tyrol from glacier extents (Contributing project to the IGBP)	This project seeks to understand the role of climate during past glacier advances and retreats, in particular the anomalies of temperature and precipitation during the last four centuries.
Climatic development and geologic dynamics during the last glacial cycle and the Holocene in the Central Alps (Contributing project to the IGBP)	To determine as precisely as possible the development of climate and its sudden changes from the Eemian through Würm to Holocene and its influence on and interaction with geological processes; and to get a better insight into the natural processes during interglacial climatic conditions, apart from an anthropogenic influence. This will allow to define a basis for the recognition of human impacts from the mid Holocene until present times.

Table 10.3: Research on the impacts of climate change

Examples of Research Projects and Activities	Objectives
Vegetation and climate changes within the central area of the Alps (Contributing project to the IGBP)	The geographical abundance or disappearance of plant species are studied and associated with climate and climate change.
Impacts of Climate Change on River Basin Hydrology under Different Climatic Conditions (CCHYDRO)	Global pressure distributions are used to derive local precipitation and temperature profiles through statistical downscaling in catchment areas.
Climatic and anthropogenic impacts on Längsee, Carinthia (Contributing project to the IGBP project *Paleolimnology of East Alpine Lakes*)	The aim of this study is to reconstruct the influence of past climatic conditions and anthropogenic impacts on the aquatic ecosystem Längsee, Carinthia, by a multidisciplinary approach, thereby making use of biological and geochemical indicators.
Computer-aided simulation of forest development, modification and parameterization of a succession model designed for Austrian conditions.	The project is concerned with the consequences of a possible climate change for forest succession.
(1) Growth of newly-planted deciduous trees in secondary stands of coniferous trees (2) Close-to-nature forest management and its impact on the forest ecosystem: An ecological, growth-related and socio-economic analysis	Both projects are significant for C-balance in close-to-nature forest ecosystems with regard to improving the stability of forest ecosystems and increasing humus supply.
Climatological characterization of Austrian growth districts	Identifying climatic differences between the growth areas; climatological solidification of the limits and elevation zones of growth areas, developing plant-related specific climatic identification codes.
Forest soil as a buffer for greenhouse gases	Determining formation rates and disintegration rates of methane, ethylene, carbon dioxide and carbon monoxide.
Glacier research	A dynamic glacier model to simulate the climate variations during the little ice age, the mechanisms of glacier advances, glacier dynamics in Antarctica, a profile of energy balances over an Iceland glacier, and the impact of climate change on Austrian glaciers are just a few of the topics studied in ongoing research projects.

Table 10.4: Socio-economic analysis, including both of the impacts of climate change and of response options

Examples of Research Projects and Activities	Objectives
Environmentally Compatible Energy Strategies (ECS)	The objective of the project is to examine the global links between energy, development and climate change. The project focuses on the issue of how global society can provide adequate levels of energy services, and indeed increase them to support development worldwide, while minimizing emissions of carbon and sulfur dioxide and other energy-related sources of greenhouse gases and aerosols.
Climate sensitivity of Austrian areas placing particular emphasis on winter tourism	Localizing the negative impacts of climate change according to Austrian districts; categorization of districts in groups based on different degrees of climate dependence, identifying economic and ecological impacts on various winter sports areas; elaborating a catalogue of measures according to district group and evaluation criteria for major climate-dependent projects.
Systems Analysis of Austria's Carbon Balance	The project aims at quantifying sources and sinks of carbon compounds (CO_2, CH_4, CO, NMVOC) of relevance to Austria. The approach is holistic and systems-analytically based, and is supported by a dynamic computer simulation model. The results are expected to scientifically support decision making in that they allow to perceive emission reduction measures of greenhouse gases containing carbon in a broad context and to assess potential measures by taking all major sources and sinks into consideration.
Complete Emission Model of Integrated Systems (GEMIS) — Adaptation to fulfill Austrian requirements	Computer model including data base for environmental and cost analyses of processes facilitating the provision of energy, transport and material; identifying overall emissions based on a process chain analysis.
National Account Matrix including Environmental Accounts (NAMEA) for Austria	To facilitate synopsis of environmental and economic indicators on a quantitative basis for the economic sectors according to the NACE system.
Energy saving potential and its utilization cost	Analysis of cost and investment requirements necessary for benefiting from the energy saving potential in Austria.
Evaluation of the potential and the costs of national CO_2 reduction measures	Quantifying the potential of energy conservation, the reduction of CO_2 emissions and related costs in different economic sectors and necessary subsidies for a set of 38 emission reduction measures.
Analysis of the cost effectiveness of measures for the reduction of CO_2 emissions of traffic in Austria	Assessment of the reduction potential of CO_2 emissions and air pollutants to be achieved by the measures stipulated in the transport sector (each by itself and combined), evaluation of measures based on: management costs, economic impact, effect of purchase power, economic consequences etc., disclosing external costs of pollutant emissions; costs avoidable by measures; additional benefits of measures going beyond emission reduction.
Energy and the environment	Research documentation: energy research and energy supply; energy efficiency and protection of the climate system; biomass, solar and wind energy, strategies and measures for the protection of the climate system.

Table 10.4: continued

Examples of Research Projects and Activities	Objectives
Cost-efficient strategies for protecting the climate system in the area of room heating	Warm water : To provide an macro-economic optimization of climate protection strategies for heating and warm water preparation. Cost-benefit relations are calculated for more than 40 CO_2 reduction measures, including energy conservation and energy carrier substitution. Cost calculations include investment and operation costs, and the administrative costs of climate protection measures. Benefits include fuel reductions and external costs.
Electricity-saving potential	Identifying concrete possibilities of saving electricity and putting them into practice in the public sector, trade and industry: developing concepts in cooperation with the parties concerned (e.g. nursery home, kindergarten, hotel).
Energy-efficient universities (Contributing project to the IGBP)	Assessing the economic energy saving potential in universities; creating organization structures with universities facilitating sensible *handling* of energy; elaborating a catalogue of measures and incentives intensifying energy-efficient measures.
Compilation of a data base on Austrian technologies relevant for protecting the climate system	As a rule the use of technologies relevant for protecting the climate system causes substantial costs of investment. In environmental and energy audits an at least approximately realistic estimate is imperative. Consequently incomplete price information, particularly in the context of Central and Eastern European countries, has a hampering effect on considering western technologies for solving local energy and environmental problems. Fulfilling this requirement shall be rendered possible by compiling a data base providing not only general information on the company offering the product, but additional information about the investment cost involved in each technology.
The Austrian Energy Pass for Buildings	The Council of the European Community has prescribed the elaboration and implementation of an energy pass for buildings to its member countries. This energy pass is to provide better transparency of the real-estate market and promote investments in energy saving measures by providing objective information on the energy-related characteristics of buildings. The requirements of an energy pass depend on the type of building, the technical equipment and the planning stage.
Influence of the legislature on passenger car emissions of limited and non-limited emission components	Quantifying the influence of legislation on emissions and fuel composition on hydrocarbon and nitrogen emissions by passenger car traffic.
Optimizing the climate protection strategies of local authorities in Europe	To evaluate the possibilities for climate protection activities in the context of prevailing national framework conditions, to systematize locally applicable instruments and policies for climate protection, to identify and analyze barriers hindering municipalities to implement CO_2 reduction policies in the energy and transport sector, to give recommendations for local authorities as well as for national governments aiming at improving climate protection policies.

Table 10.4: continued

Examples of Research Projects and Activities	Objectives
(1) Guideline on the protection of the climate system at the local level (2) Concrete measures for the protection of the climate system – seminar concept, dissemination and practical implementation of the guideline on the protection of the climate system at the local level	Collection, compilation and dissemination of information on climate protection measures aiming at promoting municipal CO_2 reduction activities.
Ecological development profile and environmental management at the local level	To work out a program of measures to be realized by local authorities aiming at increasing energy efficiency, reducing emissions, and protecting natural resources.
Compatible urban mobility – local action strategies for urban transport ecology	To adapt and apply the concept of *least cost planning* and *demand side management* to fulfill the needs of the population as well as to reduce environmental pressures caused by transportation.
UN-ECE Task Force on Emission Inventories – Nature Expert Panel	To document natural emission sources like forests, volcanoes, swamps, etc. for a chapter in a handbook on emission inventories. This handbook will provide guidelines to national emission experts, which are to be used for reporting to international bodies.

Table 10.5: Technology research and development

Examples of Research Projects and Activities	Objectives
Evaluation of the Austrian CO_2 emissions	Yearly updates of a time series since 1955, according to the IPCC inventory methodology. Disaggregation into sectors and fuel types. Trend analyses of intensity parameters like fuel mix, energy intensity, and per capita energy use.
Model for national emission projections	Tool that allows a detailed evaluation of CO_2 emission reduction measures as it relies on an updated and very detailed data base on energy technologies. It covers potentials, emissions and costs of a broad range of technologies and is based on the IKARUS model developed for Germany.
Emissions and ambient air quality in western industrialized nations	Evaluation of 800 publications on the emission situation of pollutants and greenhouse gases and the ambient air quality particularly considering road traffic.
Database for identifying passenger car emission factors for limited and non-limited emission components	Description and evaluation of a data base of app. 175,000 measured values for 280 emission components in altogether 115 different test cycles.
Potential of the thermal renovation of buildings in Austria	Assessing the potential, methods for adapting the thermal quality of buildings by means of ulterior economic/ecological objectives; consequences, measures.
European Energy-Cultigen Overview (EECO)	Energy plants rape, sunflower, energy grain, short-term growth forest, miscanthus and hamp: actual situation and latest progress in Austria.
Production of timber by means of fast-growing kinds of trees and well-aimed biomass production for energy generation	Comparison of different tree species regarding their capacity and the relevant conditions of cultivation: Evaluation of ecological aspects.
Biomass energy strategy and carbon cycle (as part of the EU project *The Global Carbon Cycle and its Perturbation by Man and Climate II*)	Model-like comparisons of C-balance for various kinds of forest use (clear-cutting, selective single tree cutting), while the harvested biomass may be used for timber products with varying life expectancies or bioenergy timber production.
Reduction potential of climate-relevant trace gases by central biomethanization	Regional determination of the regionally differentiated reduction potential for greenhouse gases by central biomethanization of organic fertilizers and organic residual substances.
Investigations on the humification and mineralization of organic substances contained in biowaste in different temperatures and ventilation conditions	Optimization of composting systems

Chapter 11

Education, Training and Public Awareness

There is a wide range of environmental policy instruments available striving for an environmentally friendly behavior of all agents directly and indirectly responsible for environmental burdens. These environmental policy instruments comprise rules and regulations, environmental impact assessment, space-oriented planning, evaluation of technical effects, economic incentives, commitments, voluntary agreements, advisory and information services as well as environmental awareness activities.

The development of these instruments is characterized by the precautionary principle, the polluter-pays principle and the cooperation principle. The effectiveness of this legal framework is, however, limited. Rules and regulations form no particular incentive to agents causing pollution to keep pollution at the lowest possible level according to scientific findings and technological progress.

Global environmental problems such as the greenhouse effect experience an exponential development barely recognizable at the beginning. As negative effects become apparent and correlations are clearly identified, countermeasures cause enormous costs or are taken too late. For this reason precautionary measures have to be taken and the implementation of measures for the protection of the climate system has to go hand in hand with corresponding public relations activities.

It is essential for a lasting success of environmental policy and the protection of the climate system policy in particular that citizens accept the defined targets and are willing to contribute to achieving them. Along with the legal framework, awareness and initiative have to be raised among the population so that environmental burdens beyond merely legal prerequisites are avoided. Information and public relations instruments pursuing this goal have to be strengthened systematically.

Not only public institutions, but also lobbies representing employees and employers such as economic chambers, agricultural chambers, labor chambers and trade unions play a major part in creating environmental awareness. They organize a whole range of activities and inform their members in what areas they can protect the climate within the framework of their specific situation.

The success of public relations activities depends largely on the way the information is presented. Special emphasis has to be placed on making people feel competent and good about themselves and consequently motivate them to engage in activities to protect the climate system. However, this cannot be achieved merely by means of paper. The written word may only give an impulse, whereas the global level goes beyond the scope of our experience. Describing global and regional consequences on paper cannot replace a personal relationship. A lasting impression will be made by “Climate days” and campaign rallies, where day-to-day behavior patterns are scrutinized for instance by means of using public transport for free, by exhibitions, video presentations, plays and the like. Thus our daily life can be linked to the higher goal of protecting the climate system. Partnership through direct encounters as for example within the framework of the Climate Alliance with members of native South American delegations broaden the experience potential and achieve emotional bonding.

Based on this basic assumption the Federal Ministry for the Environment, Youth and Family Affairs launched a climate information campaign in April 1997. It is designed to promote climate friendly behavior through adequate motivation. This campaign is based on comprehensive empirical surveys, which were conducted between 1994 and 1996 in the general public (1,500 cases) among opinion leaders (about 230 cases) and in companies (app. 600 cases) on behalf of the Federal Ministry for the Environment, Youth and Family Affairs. The results of these surveys, which were partly conducted by interviews, partly by questionnaires, conveyed an idea of the citizens’ knowledge and attitude in regard to the greenhouse effect. This study shows that the topic environment in particular plays an important role for the general public. Almost nine out of ten people interviewed were concerned about the state of the environment. Air pollution and its effects such as forest damage and the greenhouse effect give rise to major concern among the population. Only about one fourth of the population denies that global warming exists. Four out of five persons expect serious climate change if emissions are not reduced drastically. Those Austrians, who believe in global warming, are aware that they have to contribute personally to fighting the greenhouse effect and are willing to make personal sacrifices. From the political angle, the majority expects stricter provisions for the reduction of greenhouse emissions, a general reduction in pollutants and global solution strategies. Further information on this topic is welcome and necessary as some detailed questions indicated. Hence, the current information level does not permit sensible energy saving measures to achieve full impact. It should be noted, for instance, that the share of lighting and cooking in energy consumption is generally overrated, while the share in heating is greatly underrated.

Now that the results of the opinion poll have been submitted, concrete steps may be taken to fight the problems.

The Campaign for the Protection of the Climate System, which is to be conducted by the Federal Ministry for the Environment, Youth and Family Affairs in 1997, will consequently comprise the following focal points:

1. Reduction in energy loss (topics: energy concepts for local communities, energy concepts for industry and trade, ecological building – information for private persons building houses)
2. Saving resources by sustainable economic methods (topics: impact of the greenhouse effect on ecosystems, replacing fossil sources of energy with renewable ones, promoting biological cultivation methods, reducing private transport)
3. Consumer behavior (shopping awareness)

The campaign is designed to encourage people to assume a supporting role in developing an ecologically aware society using initiative and commitment.

A major target group of this campaign are decision makers in local communities.

At the beginning of 1996 the "Guideline on the Protection of the Climate System at the Local Level" (prepared under the leadership of the Austrian Ecology Institute) was presented and distributed to all Austrian local communities. The next step was to commission a concept on seminars for local communities. Currently a documentation on projects of cities and local communities successful in protecting the climate system is being prepared. It also lists concrete contact persons for the purpose of information networking among interested decision makers, citizens' action committees and NGOs. These projects aim at presenting basic facts in regard to the protection of the climate system in a manner which is easy to understand as well as suggesting concrete courses of action for decision makers in local communities. Successful seminars on the protection of the climate system have already been held in a number of local communities. The corresponding seminar concept is at the disposal of interested persons for training and information transfer on the greenhouse effect.

A Mayors' Conference for the Protection of the Climate System will be held in fall 1997 in cooperation between the Climate Alliance Austria and the Upper Austrian Environmental Academy. It is supposed to give further impulse to the implementation of measures for protecting the climate system.

The Climate Alliance was set up on an initiative of NGOs at the international level, and NGOs are mainly responsible for the program. Cities and local communities establish a partnership with the residents of the tropical forests within the framework of the Climate Alliance. The European coordinating body for the alliance is located in Frankfurt/Main. By joining the alliance cities, local communities and provinces commit themselves to reducing CO_2 emissions by 50% by 2010 and to continuing to gradually reduce them at a later stage. The production and use of CFCs is stopped immediately. An active information policy in regard to the causes of forest damage will be pursued and ideal and financial support will be provided to the peoples of Amazonia to preserve their natural environment. As of April 1997 156 Austrian cities and local communities as well as 8 out of 9 provinces have joined the alliance.

Within the framework of the Climate Campaign the Climate Alliance Austria will organize a competition among tourist resorts on the topic of the protection of the climate system and tourism ("holiday climate"). The purpose of this project is to develop and present exemplary projects for the protection of the climate system in tourism and motivate businesses engaging in tourism to cooperate in order to protect the climate system. Prizes will be awarded to particularly climate friendly projects.

The objective of the project "Companies in the Climate Alliance" consists in motivating companies to take precautionary environmental measures. Companies can contribute to the protection of the climate system among other things by efficient energy use, economical use of resources, environmentally friendly transport logistics and waste reduction. Companies which prove successful in this respect will be accepted as partners in the Climate Alliance. The project includes advisory services, provides for inspections and awards prizes to companies, which may use these awards as a market advantage. Above all, companies may appropriate additional funds by lowering their energy costs.

Creating a climate CD-ROM in cooperation with the Austrian Broadcasting Company forms part of intensified public relations activities directed especially at pupils and students. The CD-ROM provides information on the greenhouse effect in general and at the same time offers interactive courses of actions for individual citizens as a contribution towards resolving the problem.

The brochure "25% less power consumption by investing ATS 10,000" documents the results of the pilot project bearing the same name, which had to fulfill this requirement in 10 Austrian testing households.

The Federal Ministry of Education and Cultural Affairs launched a special program called "Building Ecological Awareness in Schools" in the academic year 1996/97. Environmental education training is further promoted by this program. Measures so far taken by the Ministry and decentralized initiatives are linked and work towards a common goal. Among others the OECD/CERI (Centre for Education Research and Innovation) Project "Environmental and School Initiatives", the OECD school construction program and the task force for environmental education (*ARGE Umwelterziehung*) are integrated in this project.

This program is concerned with the creation of infrastructural conditions allowing schools to undergo a sustainable ecological development. 22 schools from all provinces were selected for this purpose to take part in the first two-year pilot stage. It specifically focuses on the school's function as a role model, whose environmental classes will only be credible if a serious attempt is made to run the school in an environmentally friendly and sustainable manner. The actual task of the running project consists in analyzing the current ecological, technical and social state of the respective school by means of a checklist initially, and by defining objectives and concrete measures within the school as a next step.

At the same time environmentally friendly models are set up for saving resources (energy, water, etc.), the reduction of emissions in areas such as waste, transport, and the like and an ecological design of classrooms and schoolrooms. The project incorporates scientific advice and evaluation. The goal of the entire project will be to develop a general model for Austrian schools and thus strive for a sustainable ecological development in the school sector.

Last year a competition was organized among pupils by the Climate Alliance Austria. The task was to present ideas and projects contributing to the protection of the climate system. Participants were pupils aged 8 to 15. Prizes were awarded to the best projects in three age classes.

Appendix A

Greenhouse Gas Emissions and Removals – Tables

Umweltbundesamt
Federal Environment Agency - Austria

Table A.1: **CO_2 emissions in Tg.** IPCC Table 7a — Summary report for national greenhouse gas inventories. Estimation from CORINAIR national annual data, allocated to IPCC source and sink categories. (Note: Minus values of CO_2 relate to carbon uptake and are not included in national totals. * not included in national totals.)

GHG source and sink categories	1980	1981	1982	1983	1984	1985	1986	1987	1988
National total w/o LUWC	64.67	60.64	58.16	57.32	59.19	60.10	59.20	60.49	57.02
1 All Energy (Fuel Combustion + Fugitive)	50.58	46.67	45.49	44.39	45.23	46.40	46.16	47.83	43.98
A Fuel Combustion	47.94	44.30	43.46	42.58	43.32	44.42	44.20	45.87	42.14
1 Energy and Transformation Industries	9.00	8.52	8.65	8.69	9.47	9.45	9.32	9.98	8.59
2 Industry (ISIC)	11.87	10.99	10.38	8.92	8.60	8.85	8.41	8.35	6.94
3 Transport	11.69	11.43	11.46	11.74	11.48	11.67	12.10	12.21	13.07
4 Comm./Inst., Resid., Agri./Forest./Fish.	15.34	13.32	12.93	13.20	13.74	14.41	14.34	15.29	13.49
5 Other Combustion Activities	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
B Fugitive Emissions from Fuels	2.64	2.37	2.03	1.81	1.91	1.98	1.95	1.96	1.84
1 Solid Fuels	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2 Oil and Natural Gas Fuels	2.64	2.37	2.03	1.81	1.91	1.98	1.95	1.96	1.84
2 Industrial Processes	13.64	13.51	12.20	12.45	13.47	13.20	12.53	12.14	12.50
3 Solvent and Other Product Use	0.44	0.45	0.46	0.47	0.48	0.49	0.51	0.52	0.53
4 Agriculture	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
A Enteric Fermentation	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B Manure Management	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C Rice Cultivation	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
D Agricultural Soils	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
E Prescribed Burning of Savannas	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
F Field Burning of Agricultural Residues	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G Other Agriculture Activities	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5 Land Use Change & Forestry	N.E.	N.E.	N.E.	N.E.	N.E.	−8.43	−9.85	−20.66	−11.48
A Wood & Woody Biomass Stock Change						−8.25	−9.67	−20.48	−11.30
B Forest and Grassland Conversion	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C Abandonment of Managed Lands						−0.19	−0.19	−0.19	−0.19
D Other Land Use Change Activities	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6 Waste	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
A Solid Waste Disposal on Land	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B Wastewater Treatment	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C Waste Incineration	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
D Other Waste	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7 Other	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
International Aviation and Marine*	0.39	0.43	0.40	0.47	0.57	0.62	0.62	0.61	0.80

Table A.1 — continued

GHG source and sink categories	1989	1990	1991	1992	1993	1994	1995
National total w/o LUWC	57.77	61.88	66.49	60.29	59.31	59.47	62.02
1 All Energy (Fuel Combustion + Fugitive)	44.53	48.62	53.38	48.39	48.01	47.92	50.30
A Fuel Combustion	42.61	46.49	51.11	46.01	45.69	45.51	47.95
1 Energy and Transformation Industries	9.32	12.41	13.65	9.81	9.14	9.38	11.05
2 Industry (ISIC)	6.46	7.22	6.61	6.73	6.64	6.43	7.39
3 Transport	13.59	13.97	15.47	15.46	15.15	15.66	15.88
4 Comm./Inst., Resid., Agri./Forest./Fish.	13.20	12.85	15.34	13.96	14.72	14.01	13.58
5 Other Combustion Activities	0.04	0.04	0.04	0.04	0.04	0.04	0.04
B Fugitive Emissions from Fuels	1.92	2.14	2.27	2.38	2.32	2.41	2.35
1 Solid Fuels	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2 Oil and Natural Gas Fuels	1.92	2.14	2.27	2.38	2.32	2.41	2.35
2 Industrial Processes	12.70	12.70	12.64	11.47	10.88	11.13	11.30
3 Solvent and Other Product Use	0.54	0.54	0.47	0.43	0.41	0.41	0.41
4 Agriculture	0.00	0.00	0.00	0.00	0.00	0.00	0.00
A Enteric Fermentation	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B Manure Management	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C Rice Cultivation	0.00	0.00	0.00	0.00	0.00	0.00	0.00
D Agricultural Soils	0.00	0.00	0.00	0.00	0.00	0.00	0.00
E Prescribed Burning of Savannas	0.00	0.00	0.00	0.00	0.00	0.00	0.00
F Field Burning of Agricultural Residues	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G Other Agriculture Activities	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5 Land Use Change & Forestry	−11.44	−13.30	−15.30	−17.89	−17.77	−14.73	−13.58
A Wood & Woody Biomass Stock Change	−11.25	−13.11	−15.12	−17.71	−17.59	−14.54	−13.39
B Forest and Grassland Conversion	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C Abandonment of Managed Lands	−0.19	−0.19	−0.19	−0.19	−0.19	−0.19	−0.19
D Other Land Use Change Activities	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6 Waste	0.01	0.01	0.01	0.01	0.01	0.01	0.01
A Solid Waste Disposal on Land	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B Wastewater Treatment	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C Waste Incineration	0.01	0.01	0.01	0.01	0.01	0.01	0.01
D Other Waste	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7 Other	0.00	0.00	0.00	0.00	0.00	0.00	0.00
International Aviation and Marine*	0.97	0.89	1.04	1.11	1.08	1.14	1.21

Table A.2: **CH_4 emissions in Gg.** IPCC Table 7a — Summary report for national greenhouse gas inventories. Estimation from CORINAIR national annual data, allocated to IPCC source and sink categories.

Umweltbundesamt Federal Environment Agency - Austria

GHG source and sink categories	1980	1981	1982	1983	1984	1985	1986	1987	1988
National total	563.97	567.33	571.79	578.39	586.36	589.45	593.16	592.52	594.08
1 All Energy (Fuel Combustion + Fugitive)	21.72	21.54	20.30	19.80	21.90	21.38	23.53	22.80	23.43
A Fuel Combustion	18.40	18.37	17.23	16.68	18.42	17.66	19.91	19.00	19.81
1 Energy and Transformation Industries	0.19	0.21	0.20	0.16	0.17	0.18	0.16	0.19	0.17
2 Industry (ISIC)	0.46	0.45	0.46	0.43	0.46	0.50	0.49	0.47	0.45
3 Transport	4.95	4.79	4.69	4.73	4.57	4.43	4.43	4.42	4.42
4 Comm./Inst., Resid., Agri./Forest./Fish.	12.79	12.91	11.87	11.35	13.21	12.54	14.81	13.91	14.78
5 Other Combustion Activities	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
B Fugitive Emissions from Fuels	3.32	3.17	3.07	3.13	3.48	3.72	3.62	3.80	3.61
1 Solid Fuels	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
2 Oil and Natural Gas Fuels	3.30	3.14	3.04	3.11	3.46	3.70	3.60	3.78	3.60
2 Industrial Processes	0.12	0.11	0.11	0.11	0.11	0.11	0.10	0.11	0.11
3 Solvent and Other Product Use	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4 Agriculture	220.79	220.50	222.40	225.71	227.77	227.56	226.47	223.89	222.14
A Enteric Fermentation	154.96	154.65	156.26	159.39	161.38	161.36	160.69	158.57	157.08
B Manure Management	28.47	28.59	28.97	29.24	29.29	29.08	28.85	28.49	28.32
C Rice Cultivation	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
D Agricultural Soils	36.30	36.20	36.10	36.01	36.03	36.05	35.86	35.77	35.67
E Prescribed Burning of Savannas	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
F Field Burning of Agricultural Residues	1.07	1.07	1.07	1.07	1.07	1.07	1.07	1.07	1.07
G Other Agriculture Activities	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5 Land Use Change & Forestry	126.84	126.84	126.84	126.84	126.84	126.84	126.84	126.84	126.84
A Wood & Woody Biomass Stock Change	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B Forest and Grassland Conversion	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C Abandonment of Managed Lands	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
D Other Land Use Change Activities	126.84	126.84	126.84	126.84	126.84	126.84	126.84	126.84	126.84
6 Waste	194.50	198.33	202.15	205.93	209.74	213.55	216.22	218.88	221.56
A Solid Waste Disposal on Land	171.00	173.80	176.60	179.40	182.20	185.00	186.65	188.30	189.95
B Wastewater Treatment	13.34	13.38	13.39	13.37	13.38	13.39	13.41	13.43	13.46
C Waste Incineration	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16
D Other Waste	10.00	11.00	12.00	13.00	14.00	15.00	16.00	17.00	18.00
7 Other	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
International Aviation and Marine	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table A.2 — continued

GHG source and sink categories	1989	1990	1991	1992	1993	1994	1995
National total	588.54	587.37	576.25	574.64	577.95	581.45	580.19
1 All Energy (Fuel Combustion + Fugitive)	22.32	25.24	23.75	21.77	23.90	24.08	24.62
A Fuel Combustion	18.45	20.98	19.24	17.34	19.23	19.28	19.44
1 Energy and Transformation Industries	0.16	0.16	0.18	0.13	0.12	0.11	0.13
2 Industry (ISIC)	0.44	0.45	0.43	0.45	0.45	0.46	0.49
3 Transport	4.32	4.27	4.42	4.15	3.90	3.75	3.61
4 Comm./Inst., Resid., Agri./Forest./Fish.	13.53	16.09	14.20	12.61	14.76	14.96	15.20
5 Other Combustion Activities	0.01	0.01	0.01	0.01	0.01	0.01	0.01
B Fugitive Emissions from Fuels	3.88	4.27	4.51	4.42	4.67	4.80	5.19
1 Solid Fuels	0.01	0.02	0.01	0.01	0.01	0.01	0.01
2 Oil and Natural Gas Fuels	3.86	4.25	4.49	4.41	4.65	4.79	5.18
2 Industrial Processes	0.11	0.11	0.11	0.10	0.11	0.11	0.11
3 Solvent and Other Product Use	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4 Agriculture	214.97	208.08	199.89	201.67	204.24	209.13	208.92
A Enteric Fermentation	151.02	146.01	138.65	139.81	141.75	145.93	145.84
B Manure Management	27.31	26.53	25.63	26.18	26.73	27.44	27.32
C Rice Cultivation	0.00	0.00	0.00	0.00	0.00	0.00	0.00
D Agricultural Soils	35.58	35.48	35.56	35.63	35.71	35.71	35.71
E Prescribed Burning of Savannas	0.00	0.00	0.00	0.00	0.00	0.00	0.00
F Field Burning of Agricultural Residues	1.07	0.05	0.05	0.05	0.05	0.05	0.05
G Other Agriculture Activities	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5 Land Use Change & Forestry	126.84	126.84	126.84	126.84	126.84	126.84	126.84
A Wood & Woody Biomass Stock Change	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B Forest and Grassland Conversion	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C Abandonment of Managed Lands	0.00	0.00	0.00	0.00	0.00	0.00	0.00
D Other Land Use Change Activities	126.84	126.84	126.84	126.84	126.84	126.84	126.84
6 Waste	224.29	227.10	225.65	224.25	222.86	221.29	219.69
A Solid Waste Disposal on Land	191.60	193.25	191.65	190.05	188.45	186.85	185.25
B Wastewater Treatment	13.54	13.66	13.81	13.99	14.19	14.22	14.22
C Waste Incineration	0.16	0.19	0.19	0.22	0.22	0.22	0.22
D Other Waste	19.00	20.00	20.00	20.00	20.00	20.00	20.00
7 Other	0.00	0.00	0.00	0.00	0.00	0.00	0.00
International Aviation and Marine	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table A.3: **N_2O emissions in Gg.** IPCC Table 7a — Summary report for national greenhouse gas inventories. Estimation from CORINAIR national annual data, allocated to IPCC source and sink categories. (Note: * not included in national totals.)

Umweltbundesamt
Federal Environment Agency - Austria

GHG source and sink categories	1980	1981	1982	1983	1984	1985	1986	1987	1988
National total	10.24	10.13	10.20	10.17	10.12	10.28	10.47	10.45	10.79
1 All Energy (Fuel Combustion + Fugitive)	2.79	2.70	2.77	2.77	2.71	2.86	3.08	3.06	3.41
A Fuel Combustion	2.79	2.70	2.77	2.77	2.71	2.86	3.08	3.06	3.41
1 Energy and Transformation Industries	0.12	0.11	0.11	0.09	0.10	0.09	0.10	0.12	0.10
2 Industry (ISIC)	0.13	0.13	0.12	0.11	0.11	0.11	0.12	0.12	0.11
3 Transport	1.83	1.78	1.83	1.86	1.77	1.90	2.01	1.95	2.33
4 Comm./Inst., Resid., Agri./Forest./Fish.	0.69	0.67	0.69	0.69	0.72	0.73	0.84	0.85	0.85
5 Other Combustion Activities	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
B Fugitive Emissions from Fuels	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1 Solid Fuels	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2 Oil and Natural Gas Fuels	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2 Industrial Processes	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60
3 Solvent and Other Product Use	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
4 Agriculture	3.47	3.45	3.44	3.42	3.43	3.43	3.41	3.40	3.39
A Enteric Fermentation	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B Manure Management	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C Rice Cultivation	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
D Agricultural Soils	3.39	3.38	3.37	3.35	3.36	3.36	3.34	3.33	3.32
E Prescribed Burning of Savannas	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
F Field Burning of Agricultural Residues	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
G Other Agriculture Activities	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5 Land Use Change & Forestry	2.63	2.63	2.63	2.63	2.63	2.63	2.63	2.63	2.63
A Wood & Woody Biomass Stock Change	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B Forest and Grassland Conversion	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C Abandonment of Managed Lands	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
D Other Land Use Change Activities	2.63	2.63	2.63	2.63	2.63	2.63	2.63	2.63	2.63
6 Waste	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
A Solid Waste Disposal on Land	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B Wastewater Treatment	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C Waste Incineration	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
D Other Waste	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7 Other	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
International Aviation and Marine*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01

Table A.3 — continued

GHG source and sink categories	1989	1990	1991	1992	1993	1994	1995
National total	11.06	11.61	12.12	12.24	12.36	12.62	12.78
1 All Energy (Fuel Combustion + Fugitive)	3.69	4.31	4.81	4.97	5.05	5.33	5.51
A Fuel Combustion	3.69	4.31	4.81	4.97	5.05	5.33	5.51
1 Energy and Transformation Industries	0.11	0.14	0.17	0.12	0.11	0.12	0.13
2 Industry (ISIC)	0.10	0.10	0.10	0.10	0.10	0.09	0.11
3 Transport	2.63	3.14	3.61	3.85	3.91	4.20	4.34
4 Comm./Inst., Resid., Agri./Forest./Fish.	0.83	0.92	0.92	0.88	0.92	0.91	0.92
5 Other Combustion Activities	0.02	0.02	0.02	0.02	0.02	0.02	0.02
B Fugitive Emissions from Fuels	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1 Solid Fuels	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2 Oil and Natural Gas Fuels	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2 Industrial Processes	0.60	0.60	0.60	0.55	0.58	0.57	0.55
3 Solvent and Other Product Use	0.75	0.75	0.75	0.75	0.75	0.75	0.75
4 Agriculture	3.38	3.31	3.32	3.32	3.33	3.33	3.33
A Enteric Fermentation	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B Manure Management	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C Rice Cultivation	0.00	0.00	0.00	0.00	0.00	0.00	0.00
D Agricultural Soils	3.31	3.30	3.31	3.32	3.33	3.33	3.33
E Prescribed Burning of Savannas	0.00	0.00	0.00	0.00	0.00	0.00	0.00
F Field Burning of Agricultural Residues	0.07	0.00	0.00	0.00	0.00	0.00	0.00
G Other Agriculture Activities	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5 Land Use Change & Forestry	2.63	2.63	2.63	2.63	2.63	2.63	2.63
A Wood & Woody Biomass Stock Change	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B Forest and Grassland Conversion	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C Abandonment of Managed Lands	0.00	0.00	0.00	0.00	0.00	0.00	0.00
D Other Land Use Change Activities	2.63	2.63	2.63	2.63	2.63	2.63	2.63
6 Waste	0.00	0.01	0.01	0.01	0.01	0.01	0.01
A Solid Waste Disposal on Land	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B Wastewater Treatment	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C Waste Incineration	0.00	0.01	0.01	0.01	0.01	0.01	0.01
D Other Waste	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7 Other	0.00	0.00	0.00	0.00	0.00	0.00	0.00
International Aviation and Marine*	0.01	0.01	0.01	0.01	0.01	0.01	0.01

GHG source and sink categories	1990	1991	1992	1993	1994	1995
National total	490.67	460.78	431.92	419.10	411.48	406.06
1 All Energy (Fuel Combustion + Fugitive)	169.78	164.22	145.12	139.54	131.54	125.99
A Fuel Combustion	161.01	154.58	135.40	129.86	121.61	116.27
1 Energy and Transformation Industries	0.39	0.47	0.29	0.24	0.20	0.22
2 Industry (ISIC)	1.16	1.06	1.13	1.10	1.12	1.22
3 Transport	107.36	107.10	93.31	82.06	73.69	67.98
4 Comm./Inst., Resid., Agri./Forest./Fish.	51.96	45.82	40.54	46.33	46.48	46.74
5 Other Combustion Activities	0.14	0.13	0.13	0.12	0.12	0.11
B Fugitive Emissions from Fuels	8.78	9.64	9.72	9.68	9.93	9.71
1 Solid Fuels	0.00	0.00	0.00	0.00	0.00	0.00
2 Oil and Natural Gas Fuels	8.78	9.64	9.72	9.68	9.93	9.71
2 Industrial Processes	20.67	20.86	21.12	21.25	21.52	21.65
3 Solvent and Other Product Use	173.74	149.21	139.12	131.73	131.83	131.83
4 Agriculture	2.38	2.38	2.38	2.38	2.38	2.38
A Enteric Fermentation	0.00	0.00	0.00	0.00	0.00	0.00
B Manure Management	0.00	0.00	0.00	0.00	0.00	0.00
C Rice Cultivation	0.00	0.00	0.00	0.00	0.00	0.00
D Agricultural Soils	2.22	2.22	2.22	2.22	2.22	2.22
E Prescribed Burning of Savannas	0.00	0.00	0.00	0.00	0.00	0.00
F Field Burning of Agricultural Residues	0.16	0.16	0.16	0.16	0.16	0.16
G Other Agriculture Activities	0.00	0.00	0.00	0.00	0.00	0.00
5 Land Use Change & Forestry	123.54	123.54	123.54	123.54	123.54	123.54
A Wood & Woody Biomass Stock Change	0.00	0.00	0.00	0.00	0.00	0.00
B Forest and Grassland Conversion	0.00	0.00	0.00	0.00	0.00	0.00
C Abandonment of Managed Lands	0.00	0.00	0.00	0.00	0.00	0.00
D Other Land Use Change Activities	123.54	123.54	123.54	123.54	123.54	123.54
6 Waste	0.57	0.58	0.65	0.66	0.67	0.67
A Solid Waste Disposal on Land	0.00	0.00	0.00	0.00	0.00	0.00
B Wastewater Treatment	0.00	0.00	0.00	0.00	0.00	0.00
C Waste Incineration	0.57	0.58	0.65	0.66	0.67	0.67
D Other Waste	0.00	0.00	0.00	0.00	0.00	0.00
7 Other	0.00	0.00	0.00	0.00	0.00	0.00
International Aviation and Marine*	0.60	0.71	0.76	0.74	0.77	0.82

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Table A.4: **NMVOC emissions in Gg.** IPCC Table 7a — Summary report for national greenhouse gas inventories. Estimation from CORINAIR national annual data, allocated to IPCC source and sink categories. (Note: * not included in national totals.)

GHG source and sink categories	1990	1991	1992	1993	1994	1995
National total	196.66	202.14	193.56	180.80	177.95	175.90
1 All Energy (Fuel Combustion + Fugitive)	171.57	177.10	168.54	156.53	153.64	152.45
A Fuel Combustion	167.25	172.79	164.35	153.13	150.23	149.06
1 Energy and Transformation Industries	14.78	12.62	11.09	8.30	7.13	7.17
2 Industry (ISIC)	19.43	16.39	16.21	14.50	12.71	13.97
3 Transport	105.37	114.29	109.86	102.93	103.84	101.42
4 Comm./Inst., Resid., Agri./Forest./Fish.	27.21	29.02	26.72	26.92	26.08	26.04
5 Other Combustion Activities	0.46	0.47	0.48	0.48	0.47	0.47
B Fugitive Emissions from Fuels	4.32	4.32	4.19	3.40	3.41	3.38
1 Solid Fuels	0.00	0.00	0.00	0.00	0.00	0.00
2 Oil and Natural Gas Fuels	4.32	4.32	4.19	3.40	3.41	3.38
2 Industrial Processes	17.88	17.79	17.18	16.74	17.05	16.25
3 Solvent and Other Product Use	0.00	0.00	0.00	0.00	0.00	0.00
4 Agriculture	6.16	6.17	6.18	6.19	6.19	6.19
A Enteric Fermentation	0.00	0.00	0.00	0.00	0.00	0.00
B Manure Management	0.00	0.00	0.00	0.00	0.00	0.00
C Rice Cultivation	0.00	0.00	0.00	0.00	0.00	0.00
D Agricultural Soils	6.15	6.17	6.18	6.19	6.19	6.19
E Prescribed Burning of Savannas	0.00	0.00	0.00	0.00	0.00	0.00
F Field Burning of Agricultural Residues	0.01	0.01	0.01	0.01	0.01	0.01
G Other Agriculture Activities	0.00	0.00	0.00	0.00	0.00	0.00
5 Land Use Change & Forestry	0.82	0.82	0.82	0.82	0.82	0.82
A Wood & Woody Biomass Stock Change	0.00	0.00	0.00	0.00	0.00	0.00
B Forest and Grassland Conversion	0.00	0.00	0.00	0.00	0.00	0.00
C Abandonment of Managed Lands	0.00	0.00	0.00	0.00	0.00	0.00
D Other Land Use Change Activities	0.82	0.82	0.82	0.82	0.82	0.82
6 Waste	0.23	0.26	0.84	0.52	0.24	0.20
A Solid Waste Disposal on Land	0.00	0.00	0.00	0.00	0.00	0.00
B Wastewater Treatment	0.00	0.00	0.00	0.00	0.00	0.00
C Waste Incineration	0.23	0.26	0.84	0.52	0.24	0.20
D Other Waste	0.00	0.00	0.00	0.00	0.00	0.00
7 Other	0.00	0.00	0.00	0.00	0.00	0.00
International Aviation and Marine*	4.73	5.53	5.90	5.75	6.05	6.41

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Table A.5: **NO_x emissions in Gg.** IPCC Table 7a — Summary report for national greenhouse gas inventories. Estimation from CORINAIR national annual data, allocated to IPCC source and sink categories. (Note: * not included in national totals.)

GHG source and sink categories	1990	1991	1992	1993	1994	1995
National total	1333.01	1350.23	1176.32	1150.03	1131.87	1145.62
1 All Energy (Fuel Combustion + Fugitive)	997.79	1014.26	897.52	868.76	833.09	819.91
A Fuel Combustion	994.59	1013.90	897.07	868.31	832.57	819.36
1 Energy and Transformation Industries	0.95	1.08	1.04	0.72	0.65	0.98
2 Industry (ISIC)	6.58	6.46	6.64	6.60	6.61	6.93
3 Transport	475.13	500.85	445.41	402.88	368.70	344.84
4 Comm./Inst., Resid., Agri./For./...	511.33	504.91	443.40	457.52	456.02	466.05
5 Other Combustion Activities	0.60	0.60	0.59	0.58	0.58	0.56
B Fugitive Emissions from Fuels	3.20	0.36	0.45	0.46	0.52	0.55
1 Solid Fuels	0.00	0.00	0.00	0.00	0.00	0.00
2 Oil and Natural Gas Fuels	3.20	0.36	0.45	0.46	0.52	0.55
2 Industrial Processes	329.31	330.06	272.84	275.31	292.81	319.76
3 Solvent and Other Product Use	0.00	0.00	0.00	0.00	0.00	0.00
4 Agriculture	1.50	1.50	1.50	1.50	1.50	1.50
A Enteric Fermentation	0.00	0.00	0.00	0.00	0.00	0.00
B Manure Management	0.00	0.00	0.00	0.00	0.00	0.00
C Rice Cultivation	0.00	0.00	0.00	0.00	0.00	0.00
D Agricultural Soils	0.00	0.00	0.00	0.00	0.00	0.00
E Prescribed Burning of Savannas	0.00	0.00	0.00	0.00	0.00	0.00
F Field Burning of Agricultural Residues	1.50	1.50	1.50	1.50	1.50	1.50
G Other Agriculture Activities	0.00	0.00	0.00	0.00	0.00	0.00
5 Land Use Change & Forestry	0.00	0.00	0.00	0.00	0.00	0.00
A Wood & Woody Biomass Stock Change	0.00	0.00	0.00	0.00	0.00	0.00
B Forest and Grassland Conversion	0.00	0.00	0.00	0.00	0.00	0.00
C Abandonment of Managed Lands	0.00	0.00	0.00	0.00	0.00	0.00
D Other Land Use Change Activities	0.00	0.00	0.00	0.00	0.00	0.00
6 Waste	4.41	4.41	4.47	4.46	4.47	4.45
A Solid Waste Disposal on Land	0.00	0.00	0.00	0.00	0.00	0.00
B Wastewater Treatment	0.00	0.00	0.00	0.00	0.00	0.00
C Waste Incineration	4.41	4.41	4.47	4.46	4.47	4.45
D Other Waste	0.00	0.00	0.00	0.00	0.00	0.00
7 Other	0.00	0.00	0.00	0.00	0.00	0.00
International Aviation and Marine*	1.54	1.80	1.92	1.87	1.97	2.08

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Table A.6: **CO emissions in Gg.** IPCC Table 7a — Summary report for national greenhouse gas inventories. Estimation from CORINAIR national annual data, allocated to IPCC source and sink categories. (Note: * not included in national totals.)

	Emissions 1995				Emissions 1990			
Factor / Tg	CO_2 1	CH_4 21	N_2O 310	Total	CO_2 1	CH_4 21	N_2O 310	Total
National total	62.02	12.18	3.96	78.17	61.88	12.33	3.60	77.81
1 All Energy (Fuel Combustion + Fugit.)	50.30	0.52	1.71	52.53	48.62	0.53	1.34	50.49
A Fuel Combustion	47.95	0.41	1.71	50.07	46.49	0.44	1.34	48.26
1 Energy and Transformation Indust.	11.05	0.00	0.04	11.09	12.41	0.00	0.04	12.46
2 Industry (ISIC)	7.39	0.01	0.03	7.44	7.22	0.01	0.03	7.26
3 Transport	15.88	0.08	1.35	17.30	13.97	0.09	0.97	15.03
4 Comm./Inst., Resid., Agri./For./...	13.58	0.32	0.28	14.19	12.85	0.34	0.28	13.47
5 Other Combustion Activities	0.04	0.00	0.01	0.05	0.04	0.00	0.01	0.05
B Fugitive Emissions from Fuels	2.35	0.11	0.00	2.46	2.14	0.09	0.00	2.23
1 Solid Fuels	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2 Oil and Natural Gas Fuels	2.35	0.11	0.00	2.46	2.14	0.09	0.00	2.23
2 Industrial Processes	11.30	0.00	0.17	11.47	12.70	0.00	0.19	12.89
3 Solvent and Other Product Use	0.41	0.00	0.23	0.64	0.54	0.00	0.23	0.77
4 Agriculture	0.00	4.39	1.03	5.42	0.00	4.37	1.03	5.39
A Enteric Fermentation	0.00	3.06	0.00	3.06	0.00	3.07	0.00	3.07
B Manure Management	0.00	0.57	0.00	0.57	0.00	0.56	0.00	0.56
C Rice Cultivation	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
D Agricultural Soils	0.00	0.75	1.03	1.78	0.00	0.75	1.02	1.77
E Prescribed Burning of Savannas	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
F Field Burning of Agricultural Resid.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G Other Agriculture Activities	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5 Land Use Change & Forestry		2.66	0.82	3.48		2.66	0.82	3.48
A Wood & Woody Biomass Stock Ch.		0.00	0.00	0.00		0.00	0.00	0.00
B Forest and Grassland Conversion	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C Abandonment of Managed Lands		0.00	0.00	0.00		0.00	0.00	0.00
D Other Land Use Change Activities	0.00	2.66	0.82	3.48	0.00	2.66	0.82	3.48
6 Waste	0.01	4.61	0.00	4.62	0.01	4.77	0.00	4.78
A Solid Waste Disposal on Land	0.00	3.89	0.00	3.89	0.00	4.06	0.00	4.06
B Wastewater Treatment	0.00	0.30	0.00	0.30	0.00	0.29	0.00	0.29
C Waste Incineration	0.01	0.00	0.00	0.02	0.01	0.00	0.00	0.01
D Other Waste	0.00	0.42	0.00	0.42	0.00	0.42	0.00	0.42
7 Other	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
International Aviation and Marine*	1.21	0.00	0.00	1.21	0.89	0.00	0.00	0.89

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Table A.7: **Greenhouse gas emissions in Austria 1995 and 1990.** Values in Ceq. (Note: Minus values of CO_2 relate to carbon uptake and are not included in national totals. * not included in national totals.)

		Emissions CO_2 [Tg]	Activity		Emission-factor [g/PJ]
1A1	ENERGY AND TRANSFORMATION INDUSTRIES				
1A1a	Electricity and Heat Production				
	Hard Coal	4.02	PJ	39.63	0.097
	Brown Coal	2.39	PJ	22.80	0.101
	Brown Coal Briquettes	0.02	PJ	0.23	0.098
	Biomass	0.00	PJ	1.00	0.000
	Waste	0.00	PJ	0.08	0.010
	Gasoil-light	0.24	PJ	3.02	0.078
	Gasoil-medium	0.05	PJ	0.65	0.078
	Gasoil	1.49	PJ	19.44	0.079
	Diesel Oil	0.01	PJ	0.11	0.078
	Kerosene	0.00	PJ	0.00	0.078
	Natural Gas	4.14	PJ	75.07	0.055
	LPG	0.04	PJ	0.65	0.064
1A1c	Solid fuel transformation and other Energy Industries				
	Natural Gas	0.02	PJ	0.33	0.055
1A2	INDUSTRIES				
	Hard Coal	0.15	PJ *	7.19	0.094
	Brown Coal	0.22	PJ	2.53	0.097
	Brown Coal Briquettes	0.12	PJ	1.23	0.097
	Coke	0.10	PJ	2.57	0.100
	Fuel Wood	0.00	PJ	0.18	0.000
	Biomass	0.00	PJ	7.06	0.000
	Waste	0.20	PJ	20.50	0.010
	Gasoil-light	0.35	PJ	4.52	0.078
	Gasoil-medium	0.09	PJ	1.17	0.078
	Gasoil	2.05	PJ	30.18	0.078
	Diesel Oil	0.00	PJ	0.05	0.078
	Kerosene	0.00	PJ	0.01	0.078
	Natural Gas	4.00	PJ	73.64	0.055
	LPG	0.12	PJ	1.93	0.064
1A3	TRANSPORT				
1A3a1	International Aviation				
	Kerosene	0.89	PJ	12.47	0.071
1A3a2	Domestic civil aviation				
	Kerosene	0.06	PJ	0.80	0.071
	Petrol	0.01	PJ	0.12	0.074

* The CO_2 emissions of 5,57 PJ used in Iron/Steel Industries are included in “2 - Industrial Processes”

Table A.8: Fuel split of CO_2 emissions 1990

		Emissions CO_2 [Tg]	Activity		Emission-factor [g/PJ]
1A3b	Road transport				
	Petrol	8.05	PJ	110.75	0.074
	Diesel oil	5.23	PJ	70.51	0.074
1A3c,d,e	other transportation (navigation, railways . . .)				
	Diesel	0.61	PJ	8.25	0.074
	Petrol	0.01	PJ	0.09	0.074
	Hard Coal	0.01	PJ	0.06	0.093
1A4	COMM./INST., RESIDENTAL, AGRI./FORESTRY/FISHING				
1A4a	Commercial/institutional				
	Hard Coal	0.01	PJ	0.08	0.093
	Brown Coal	0.05	PJ	0.48	0.108
	Brown Coal Briquettes	0.06	PJ	0.66	0.097
	Coke	0.28	PJ	3.06	0.092
	Fuel Wood	0.00	PJ	41.78	0.000
	Biomass	0.00	PJ	11.13	0.000
	Waste	0.00	PJ	0.39	0.010
	Gasoil-extra light	0.50	PJ	6.68	0.075
	Gasoil-light	2.20	PJ	28.64	0.077
	Gasoil-medium	0.20	PJ	2.60	0.078
	Kerosene	0.03	PJ	0.38	0.078
	Natural Gas	0.85	PJ	15.53	0.055
	LPG	0.12	PJ	1.87	0.064
1A4b	Residental				
	Hard Coal	0.37	PJ	4.01	0.093
	Brown Coal	0.14	PJ	1.34	0.108
	Brown Coal Briquettes	0.37	PJ	3.80	0.097
	Coke	1.21	PJ	13.18	0.092
	Fuel Wood	0.00	PJ	49.39	0.000
	Gasoil-extra light	3.48	PJ	46.46	0.075
	Gasoil-light	0.05	PJ	0.66	0.077
	Gasoil-medium	0.01	PJ	0.08	0.078
	Natural Gas	2.04	PJ	37.00	0.055
	LPG	0.12	PJ	1.92	0.064
	Petrol	0.00	PJ	0.06	0.074
1A4c	Agriculture/Forestry/Fishing				
	Peat	0.00	PJ	0.01	0.000
	Diesel	0.72	PJ	9.78	0.074
	Petrol	0.00	PJ	0.03	0.074

Table A.8 — continued

		Emissions CO_2	Activity		Emission-factor
		[Tg]			[g/PJ]
1A1	ENERGY AND TRANSFORMATION INDUSTRIES				
1A1a	Electricity and Heat Production				
	Hard Coal	2.82	PJ	29.80	0.094
	Brown Coal	1.70	PJ	15.48	0.104
	Brown Coal Briquettes	0.02	PJ	0.23	0.101
	Biomass	0.00	PJ	1.84	0.000
	Waste	0.00	PJ	0.00	0.010
	Gasoil-light	0.25	PJ	3.26	0.077
	Gasoil-medium	0.04	PJ	0.53	0.078
	Gasoil	1.24	PJ	15.57	0.079
	Diesel Oil	0.01	PJ	0.09	0.078
	Kerosene	0.00	PJ	0.00	0.078
	Natural Gas	4.95	PJ	89.98	0.055
	LPG	0.01	PJ	0.08	0.064
1A1c	Solid fuel transformation and other Energy Industries				
	Natural Gas	0.02	PJ	0.38	0.055
1A2	INDUSTRIES				
	Hard Coal	0.21	PJ *	5.88	0.094
	Brown Coal	0.27	PJ	2.83	0.097
	Brown Coal Briquettes	0.03	PJ	0.34	0.097
	Coke	0.08	PJ	2.36	0.100
	Fuel Wood	0.00	PJ	0.12	0.000
	Biomass	0.00	PJ	8.42	0.000
	Waste	0.22	PJ	22.97	0.010
	Gasoil-light	0.31	PJ	4.03	0.078
	Gasoil-medium	0.11	PJ	1.39	0.078
	Gasoil	1.62	PJ	24.62	0.078
	Diesel Oil	0.01	PJ	0.11	0.078
	Kerosene	0.00	PJ	0.01	0.078
	Natural Gas	4.64	PJ	84.91	0.055
	LPG	0.11	PJ	1.67	0.064
1A3	TRANSPORT				
1A3a1	International Aviation				
	Kerosene	1.21	PJ	16.90	0.071
1A3a2	Domestic civil aviation				
	Kerosene	0.08	PJ	1.08	0.071
	Petrol	0.01	PJ	0.12	0.074
1A3b	Road transport				
	Petrol	7.55	PJ	103.25	0.074
	Diesel oil	7.46	PJ	100.57	0.074

* The CO_2 emissions of 5,57 PJ used in Iron/Steel Industries are included in "2 - Industrial Processes"

Table A.9: Fuel split of CO_2 emissions 1995

		Emissions CO_2 [Tg]	Activity		Emission-factor [g/PJ]
1A3c,d,e	other transportation (navigation, railways..)				
	Diesel	0.78	PJ	10.47	0.074
	Petrol	0.01	PJ	0.09	0.073
	Hard Coal	0.00	PJ	0.05	0.093
1A4	COMM./INST., RESIDENTAL, AGRI./FORESTRY/FISHING				
1A4a	Commercial/institutional				
	Hard Coal	0.01	PJ	0.08	0.093
	Brown Coal	0.05	PJ	0.44	0.108
	Brown Coal Briquettes	0.04	PJ	0.43	0.097
	Coke	0.24	PJ	2.62	0.092
	Fuel Wood	0.00	PJ	34.02	0.000
	Biomass	0.00	PJ	11.08	0.000
	Waste	0.00	PJ	0.28	0.010
	Gasoil-extra light	0.46	PJ	6.17	0.075
	Gasoil-light	1.66	PJ	21.54	0.077
	Gasoil-medium	0.02	PJ	0.21	0.078
	Kerosene	0.02	PJ	0.24	0.078
	Natural Gas	1.19	PJ	21.68	0.055
	LPG	0.10	PJ	1.60	0.064
1A4b	Residental				
	Hard Coal	0.19	PJ	2.02	0.093
	Brown Coal	0.04	PJ	0.37	0.108
	Brown Coal Briquettes	0.19	PJ	1.91	0.097
	Coke	1.12	PJ	12.17	0.092
	Fuel Wood	0.00	PJ	52.29	0.000
	Gasoil-extra light	3.87	PJ	51.65	0.075
	Gasoil-light	0.15	PJ	1.94	0.077
	Gasoil-medium	0.01	PJ	0.14	0.078
	Natural Gas	3.28	PJ	59.58	0.055
	LPG	0.22	PJ	3.44	0.064
	Petrol	0.00	PJ	0.06	0.073
1A4c	Agriculture/Forestry/Fishing				
	Peat	0.00	PJ	0.01	0.000
	Diesel	0.72	PJ	9.78	0.074
	Petrol	0.00	PJ	0.03	0.074
1A5	OTHER COMBUSTION ACTIVITIES				
	Diesel	0.03	PJ	0.47	0.074
	Petrol	0.01	PJ	0.09	0.074

Table A.9 — continued

	National Total	1 All Energy (fuel combustion)	Electricity generation	District heating	Industry combustion	Traffic	Small consumers	Own use of energy sector	2 Industrial Processes
1955	29.75	26.36	3.79	0.00	8.30	4.66	6.61	3.00	3.38
1956	31.18	27.20	3.98	0.00	8.79	4.98	6.73	2.72	3.98
1957	32.35	27.98	4.10	0.00	8.86	4.91	7.31	2.80	4.37
1958	31.08	26.93	3.44	0.00	8.73	5.13	6.66	2.98	4.15
1959	32.12	27.77	4.47	0.00	8.87	5.31	6.41	2.71	4.35
1960	34.63	29.37	4.44	0.00	9.90	5.82	6.87	2.35	5.26
1961	35.26	30.21	5.63	0.00	9.71	6.10	6.64	2.13	5.05
1962	37.97	32.92	6.16	0.00	9.78	6.56	8.25	2.17	5.05
1963	41.24	36.29	6.95	0.00	9.83	7.07	10.25	2.19	4.94
1964	42.28	36.99	7.57	0.00	10.56	7.40	9.15	2.30	5.29
1965	41.77	36.34	6.09	0.00	10.66	7.83	9.40	2.37	5.43
1966	42.21	36.75	6.47	0.00	10.68	8.36	8.93	2.31	5.46
1967	43.19	38.07	6.60	0.00	10.63	8.51	10.09	2.23	5.12
1968	46.10	40.67	7.27	0.00	11.01	9.00	11.06	2.33	5.43
1969	50.73	44.69	9.08	0.00	11.76	9.37	12.09	2.40	6.03
1970	53.83	47.20	7.52	0.39	12.03	10.33	14.33	2.60	6.63
1971	56.15	49.48	10.11	0.38	12.26	10.67	13.46	2.60	6.66
1972	58.59	51.50	10.10	0.49	12.50	11.71	13.86	2.84	7.10
1973	62.23	55.06	9.90	0.89	12.87	12.67	15.83	2.90	7.18
1974	59.58	51.91	8.86	0.92	13.64	11.87	13.96	2.66	7.67
1975	57.40	50.62	8.65	0.95	12.35	12.12	13.93	2.64	6.78
1976	61.99	55.01	11.19	1.03	12.81	12.02	15.01	2.95	6.98
1977	59.18	52.39	8.84	1.07	12.26	12.49	14.85	2.88	6.79
1978	61.18	54.30	9.09	1.31	12.33	13.16	15.81	2.60	6.89
1979	63.56	55.87	9.15	1.29	12.29	13.67	17.13	2.34	7.69

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Table A.10: CO_2 emissions from 1955 to 1979 differentiated by sectors (in Tg).

	National Total	All Energy (fuel combustion)	Coal	Oil	Gas	Waste	Process
1955	29.75	26.36	18.35	5.48	2.53	0.00	3.38
1956	31.18	27.20	18.28	5.97	2.95	0.00	3.98
1957	32.35	27.98	18.41	6.31	3.25	0.00	4.37
1958	31.08	26.93	16.92	6.85	3.15	0.00	4.15
1959	32.12	27.77	16.23	7.81	3.73	0.00	4.35
1960	34.63	29.37	15.69	8.90	4.78	0.00	5.26
1961	35.26	30.21	15.50	9.76	4.95	0.00	5.05
1962	37.97	32.92	16.67	11.50	4.76	0.00	5.05
1963	41.24	36.29	18.24	13.30	4.74	0.01	4.94
1964	42.28	36.99	16.98	15.19	4.81	0.01	5.29
1965	41.77	36.34	15.44	16.31	4.59	0.01	5.43
1966	42.21	36.75	14.46	17.45	4.83	0.01	5.46
1967	43.19	38.07	14.03	19.44	4.59	0.01	5.12
1968	46.10	40.67	13.94	21.69	5.03	0.01	5.43
1969	50.73	44.69	14.49	24.13	6.07	0.01	6.03
1970	53.83	47.20	13.53	26.41	7.24	0.02	6.63
1971	56.15	49.48	12.18	29.30	7.99	0.02	6.66
1972	58.59	51.50	10.95	32.02	8.50	0.02	7.10
1973	62.23	55.06	10.87	35.09	9.05	0.05	7.18
1974	59.58	51.91	11.10	30.81	9.94	0.05	7.67
1975	57.40	50.62	9.72	31.30	9.55	0.05	6.78
1976	61.99	55.01	11.11	33.19	10.64	0.06	6.98
1977	59.18	52.39	9.00	32.77	10.56	0.06	6.79
1978	61.18	54.30	8.42	34.77	11.01	0.10	6.89
1979	63.56	55.87	8.93	35.46	11.34	0.14	7.69

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Table A.11: CO_2 emissions from 1955 to 1979 differentiated by fuels (in Tg).

Appendix B

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Appendix C

Abbreviations and Units

Units of Measurement

k...	kilo (10^3)
M...	Mega (10^6)
G...	Giga (10^9)
T...	Tera (10^{12})
P...	Peta (10^{15})
g	gramme
t	(metrical) ton
J	joule
ha	hectares
.../a	per year
.../d	per day

Abbreviations

ACCC	Austrian Council on Climate Change
AGBM	Ad hoc Group on the Berlin Mandate
ATS	Austrian Schilling
B-VG	Federal Constitution Act (Bundesverfassungsgesetz)
CFCs	chlorofluorocarbons
CH_4	methane
CHP	combined heat and power
CO	carbon monoxide
CO_2	carbon dioxide
COP	Conference of the Parties
CORINAIR	Coordination d'information environmentale projet partiel air
EDF	European Development Fund
ECE	(UN) Economic Commission for Europe
FCCC	(UN) Framework Convention on Climate Change
FEA	Federal Environment Agency – Austria
FMAF	Federal Ministry of Agriculture and Forestry
FMeA	Federal Ministry of Economic Affairs
FMEYF	Federal Ministry for the Environment, Youth and Family Affairs
FMfA	Federal Ministry of Foreign Affairs
GAW	Global Atmosphere Watch
GCM	global circulation model
GDP	gross domestic product
GEF	Global Environment Facility
GET	Global Environment Trust Fund
Gg	gigagram (1,000 tons)
GHG	greenhouse gas
GNP	gross national product
HDD	heating degree day
HFCs	partially hydrogenated fluorocarbons
HGV	heavy goods vehicle

ICAO	International Civil Aviation Organisation
IEA	International Energy Agency
IER	Austrian Institute of Economic Research
IGBP	International Geosphere-Biosphere Program
IHDP	International Human Dimensions Program (of Global Environmental Change)
IPCC	Intergovernmental Panel on Climate Change
LCP	least cost planning
n.a.	not available
n.e.	not estimated
NEP	National Environmental Plan
NGO	non-governmental organisation
NMVOC	non-methane volatile organic compound
NO_x	oxides of nitrogen
N_2O	nitrous oxide
ODA	Official Development Assistance
OECD	Organisation for Economic Cooperation and Development
ÖSTAT	Austrian Central Statistical Office
ÖFZS	Austrian Research Center Seibersdorf
PFCs	perflourocarbons
SADC	South African Development Cooperation
UNEP	United Nations Environment Program
USD	United States Dollar
VAT	value added tax
VOC	volatile organic compounds
WCRP	World Climate Research Program
WMO	World Meteorological Organisation
WWW	World Weather Watch / World Wide Web