FOURTH NATIONAL COMMUNICATION of the Austrian Federal Government

in Compliance with the Obligations under the
United Nations Framework Convention on Climate Change
(Federal Law Gazette No. 414/1994),
according to Decisions 11/CP.4 and 4/CP.5
of the Conference of the Parties

The Fourth National Communication of Austria under the Framework Convention on Climate Change was drafted, co-ordinated and compiled by the Federal Ministry of Agriculture, Forestry, Environment and Water Management, Unit V/4 (Martin Kriech, Barbara Kronberger, and Christopher Lamport). The *Umweltbundesamt* has elaborated the chapter on emission inventory information. The chapters on the effects of climate change and on research and systematic observation have been drafted by the Institute of Meteorology of the University of Natural Resources and Applied Life Sciences in Vienna (Herbert Formayer). Essential information on developing country issues has been contributed by the Austrian Development Agency (Erwin Künzi) and the Federal Ministry of Foreign Affairs. Further contributions have been provided by several units of the Federal Ministry of Agriculture, Forestry, Environment and Water Management, by the Federal Ministry of Finance, the Federal Ministry on Transport, Innovation and Technology, the Federal Ministry of Economics and Labour, the Federal Ministry of Education, Science and Culture, by the Länder Lower Austria, Upper Austria, Vienna and Vorarlberg and by environmental NGOs.

Amendments to the draft report have been contributed by the members of the Interministerial Committee for the Co-ordination of Measures on the Protection of the Global Climate (IMC Climate) in the meeting of the IMC Climate in spring 2006 and in further discussions.

Vienna, September 2006

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Executive Summary

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1.1 Introduction

The United Nations Framework Convention on Climate Change (UNFCCC) was signed by 158 countries, including Austria, within the scope of the UN Conference on Environment and Development (UNCED) held in Rio in June 1992. Austria, as the 58th country Party, ratified the UNFCCC on 27 February 1994.

Parties are obliged to prepare National Communications, in order to communicate their activities undertaken with a view to meeting commitments under the Convention. They shall report inter alia on the following: greenhouse gas inventory information; measures to mitigate greenhouse gas emissions; measures to counteract adverse effects of climate change; measures to promote research and systematic observation; financial support for developing countries; initiatives to enhance the transfer of technology between Parties; and measures to foster education and public awareness with respect to climate change.

Austria has submitted its First National Communication in September 1994, its Second National Communication in July 1997 and its Third National Communication in November 2001. This document is Austria's Fourth National Communication, by which Austria is complying with the obligation of communicating information to the Secretariat of the UNFCCC as specified under Art. 12 of the Convention.

The most noteworthy development since the Second National Communication is the Kyoto Protocol to the Convention on Climate Change, which contains concrete reduction targets for greenhouse gas emissions for Annex I Parties. Austria signed the Kyoto Protocol in April 1998 and ratified it on 31 May 2002 as one of the 15 Member States of the European Union, who have agreed to fulfil their commitments under the Kyoto Protocol jointly according to Art. 4 of the Protocol. This report serves to fulfil also the reporting obligations according to Art. 7.2 of the Protocol.

1.2 National Circumstances relevant to Greenhouse Gas Emissions and Removals

Austria is a land-locked country in central Europe with an area of 83,858 km^2. A large part of Austria is covered by the eastern Alps; about 40 % of the total area lies more than 1000 m above sea level. Forests make up more than 40 % of the Austrian total territory; the agricultural area including alpine pastures has a comparable share. The Austrian political system is a Federation with 9 federal provinces, each of which has its own government and parliament. Government responsibilities are shared between federation, federal provinces and local authorities. Austria acceded to the European Union in 1995 and ceded some areas of national jurisdiction to the community.

Austria's total permanent population has reached 8.12 million inhabitants in 2003; after a stagnation in the 1980ies the increased by more than 500,000 since 1985. Less than one third of all Austrians live in 5 cities with more than 100,000 inhabitants each; about half of the population lives in communes with 1,000 to 10,000 inhabitants.

Gross domestic product (GDP) at current prices was € 237 billion in the year 2004 with a per capita GDP of € 29,000. Nominal GDP growth in 2004 was 4.4 %, real GDP growth 2.4 %. Industrial production showed an increase of 49 % between 1995 and 2004. The Austrian energy profile shows a high share of renewable energy, above all hydropower and biomass, with each providing about one tenth of the total primary energy supply. With a gross domestic consumption per capita of 171 MJ and a final energy consumption per capita of 132 MJ respectively in 2004 Austria belongs to the countries with low energy consumption among industrialised countries. With an increase of more than 70 % in final energy consumption since 1990 the transport sector exhibits the strongest increase; however, the amount of road fuel that is sold in Austria but consumed abroad has become significant in the last years.

1.3 Greenhouse Gas Inventory Information

The Fourth National Communication lists Austria's greenhouse gas emissions as reported in the annual inventory submission from April 2005. It contains data on carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF_6) for the years 1990–2003. The emissions of the indirect greenhouse gases nitrogen oxides (NO_x), non-methane volatile organic compounds (NMVOC), carbon monoxide (CO) and sulphur dioxide (SO_2) are reported as well. Summary tables according to the common reporting format, including CO_2 equivalent and emission trend tables, are shown in Annex B of this report.

The emissions of the 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).

The total emissions of the greenhouse gases CO_2, N_2O, CH_4, HFCs, PFCs and SF_6 (without emissions/removals from “Land-Use Change and Forestry”) amounted to 91.57 Tg CO_2 equivalent in the year 2003. The emissions of CO_2 clearly dominate the GHG emissions in Austria with 76.21 Tg or 82 % compared to 9 % for CH_4, 6 % for N_2O and 2 % for F-gases. The ranking of the (sub)sectors according to their relative contribution is as follows:

1A3: Transport (25.1 %)
1A1: Energy Industries (17.6%)
1A4: Commercial/Institutional, Residential etc. (16.7%))
1A2: Manufacturing Industries and Construction (15.7%)
2: Industrial Processes (12.1%)
4: Agriculture (8.0%).
6: Waste (3.7%)

CO_2 emissions per capita amounted to 9.39 t in 2003 and total greenhouse gas emissions per capita to 11.28 t CO_2 equivalent.

Total greenhouse gas emissions in 2003 were 16.6 % above the base year emissions (base year 1990 for CO_2, CH_4, N_2O and 1995 for F-gases). The increase in emissions is caused mainly by the 26 % increase in the sector “Energy”, which could not be compensated by the decrease the sectors “Waste“ and “Agriculture”.

The increase in the sector "Fuel Combustion" is largely determined by the continuously increasing emissions from transport (cf. Fig. 1.1).

Table 1.1: Emissions of greenhouse gases in Austria 2003

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Total GHG
	Gg CO_2 equ.						
National Total (without LUCF)	**76 213.26**	**7 806.62**	**5 542.26**	**1 308.22**	**102.54**	**593.52**	**91 566.42**
National Total (Net emissions)	*63 440.70*	*7 806.62*	*5 542.26*	*1 308.22*	*102.54*	*593.52*	*78 793.87*
1. Energy	**67 857.30**	**653.33**	**820.00**				**69 330.63**
A. Fuel Combustion	67 624.26	332.14	820.00				68 776.41
B. Fugitive Emissions from Fuels	233.04	321.19	0.00				554.22
2. Industrial Processes	**8 151.09**	**7.30**	**883.38**	**1 308.22**	**102.54**	**593.52**	**11 046.05**
3. Solvent and Other Product Use	**193.60**		**232.50**				**426.10**
4. Agriculture	**0.00**	**3 989.38**	**3 359.68**				**7 349.06**
5. Land-Use Change and Forestry	***-12 772.55***	***0,00***	***0,00***				***-12 772.55***
6. Waste	**11.27**	**3 156.61**	**246.70**				**3 414.59**
7. Other	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**

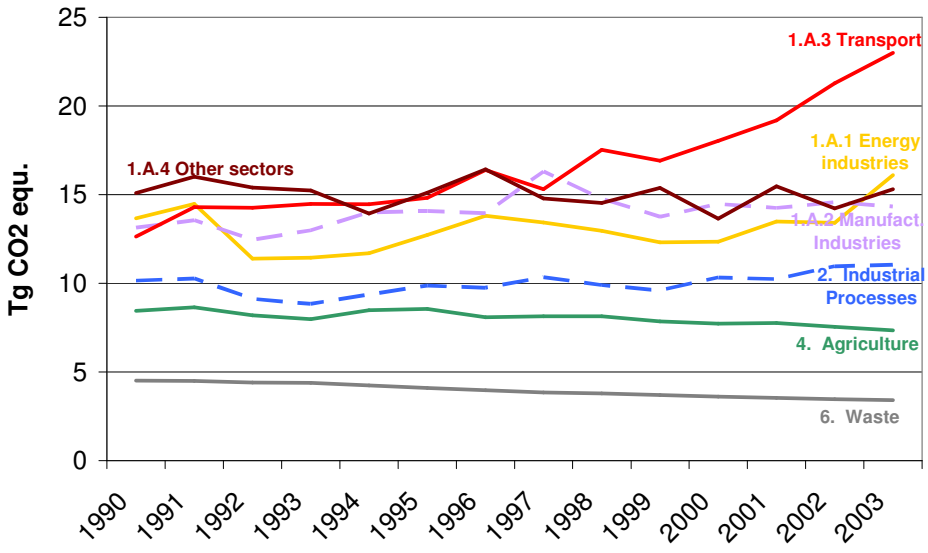

Figure 1.1: GHG emission, split by sector

1.4 Policies and Measures

The Ministry for Agriculture and Forestry, Environment and Water Management co-ordinates the overall Austrian policy with respect to climate change. However, jurisdiction for policies and measures to mitigate greenhouse gas emissions are distributed among several federal ministries and other policy making and implementing entities, namely the federal provinces (*Länder*) and the municipalities. To provide assistance related to climate change research and to support the co-ordination of policies and measures, different committees have been established. These are the *Interministerial Committee to Coordinate Measures to Protect Global*

Climate (IMC Climate Change) and the *Kyoto Forum*, responsible for coordination of climate change policies between the federal state, the *Länder* and municipalities.

On the basis of this institutional framework, a national programme was developed; the *Climate Strategy 2010* was adopted by the federal government and the council of provincial governors in 2002. The effects of the Climate Strategy have recently been evaluated. Based on that evaluation, an update of the strategy (*Climate Strategy II*) is currently in progress. The *Climate Strategy II* is planned to be adopted by end 2006. It should be highlighted that most *Länder* (e.g. Vienna, Upper Austria, Lower Austria, Salzburg) have already adopted their own regional climate change programmes, taking into account specific regional circumstances, needs and areas of competence. These programmes ideally supplement the national programme, which can only describe framework conditions and guidelines for provincial action.

A series of important measures has been implemented over the past years. With respect to energy demand, technical minimum standards and support schemes for energy efficient construction of buildings have been developed further as well as subsidies for biomass and solar space heating systems; third party financing programmes for the thermal rehabilitation of public building have been implemented. Measures to increase the share of renewable energy sources in electricity production (Green Electricity Act) and to promote district heating from renewable energy sources and high efficiency waste incineration have been set. The Landfill Regulation has drastically reduced total organic carbon content of waste fractions disposed to landfills. Measures in the transport sector range from fuel consumption based taxes and promotion of bio fuels to awareness-raising and support of projects for sustainable transport. Support for sustainable agriculture and ecological farming is granted.

Energy related taxes are complemented by support for energy efficiency measures in industry. The use of fluorinated gases has been restricted by law. About 200 energy intensive installations from manufacturing and energy industries are covered by the EU emissions trading scheme, which entered into effect in 2005.

There is still space for enhancement and intensification of several measures that have been implemented. Together with some additional measures, that are still in the planning stage, these measures are expected to have significant additional greenhouse gas mitigation potential.

1.5 Projections and the Total Effect of Policies and Measures

For the amendment of Austria's National Climate Strategy, efforts have been undertaken to estimate the development of greenhouse gas emissions according to implemented and adopted measures and the effect of planned measures. These most recent figures (mid 2006) from the draft *National Climate Strategy II* are based on energy projections, CO_2 projections for the EU-ETS sectors and expert judgements and are available for the year 2010. They show greenhouse gas emissions of 91.7 million tons CO_2 equivalent in the "With Measures" scenario and 77.3 million tons in the "With Additional Measures" scenario for the year 2010 (see also Table 1.3).

Table 1.2: Projected total emissions according to expert judgements for the draft National Climate Strategy II

	Emissions				With Measures	With Add. Measures
	1990	1995	2000	2004	2010	2010
Energy demand (CO_2+N_2O+CH_4)	15.07	15.3	13.9	14.7	14.4	10.8
Energy supply (CO_2+N_2O+CH_4)	13.71	12.7	12.5	15.6	17.3	13.6
Waste (CO_2+N_2O+CH_4)	3.56	3.1	2.6	2.6	2.2	2.1
Transport (CO_2+N_2O+CH_4)	12.76	14.9	18.1	23.9	21.7	16.9
Industry (CO_2+N_2O+CH_4, incl. process)	22.11	22.6	23.4	23.8	26.9	25.2
Agriculture (CH_4+N_2O)	9.12	9.1	8.3	7.9	7.7	7.2
HFCs, PFCs, SF_6	1.60	1.5	1.3	1.5	1.4	1.4
other (incl. solvent use)	1.00	1.0	1.1	1.3	0.9	0.9
Land-use, land-use change and forestry (Art. 3.3 KP)					-0.7	-0.7
Total	**78.94**	**80.2**	**81.3**	**91.3**	**91.7**	**77.3**

In addition, model calculations have been performed in 2005, which provide a "With Measures" scenario and a "With Additional Measures" scenario up to 2020. The calculations have been performed by the Austrian Institute of Economic Research and by the Umweltbundesamt; the model for emission calculations is based on the methods of the emissions inventory. Beside the energy model separate methods and models have been used for transport, agriculture, solvents and F-gases. These calculations show a slight decrease of GHG emissions from 2003 to 2010 of about 2 % and an increase from 2010 to 2020 of 7 % in the "With Measures" scenario. Additional measures will lead to a 12 % decrease from 2003 to 2010; the model calculations show an increase of 8 % from 2010 to 2020. Table 1.3 and Figure 1.2 give an overview of the expected development. The trend is comparable to the more recent projections from the draft *National Climate Strategy II*. Both calculations indicate that the Kyoto Target can only be reached by substantial use of the Kyoto Mechanisms.

Table 1.3: Projected greenhouse gas emissions 2005–2020 (in million tons CO_2 equivalent) according to the inventory methods based model.

	Emissions				With Measures				With Additional Measures			
	1990	1995	2000	2003	2005	2010	2015	2020	2005	2010	2015	2020
Total	78.57	80.16	81.08	91.57	89.01	89.93	92.10	96.26	88.21	80.97	84.13	87.31

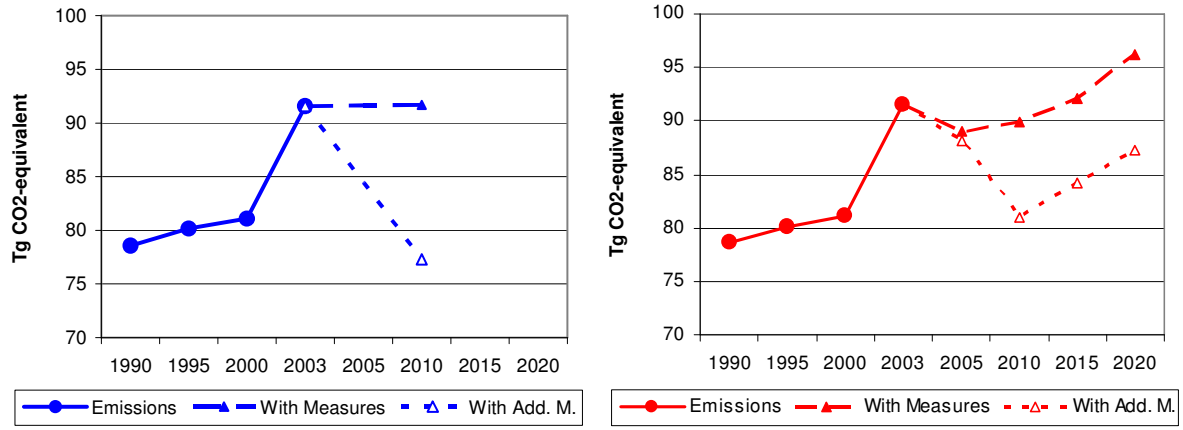

Figure 1.2: Greenhouse gas emissions in Austria – projections according to the expert judgements of the draft Climate Strategy II (left) and the inventory methods based model (right)

The aggregate effect of *implemented and adopted* policies and measures, which are listed in Chapter 4 of this report, is estimated at about 8 million tons CO_2 equivalent for the year 2010 according to expert judgements. The effect of planned measures as estimated in the draft *Climate Strategy II* is about 14 million tons for the year 2010. A lower figure results from the model calculations for the year 2010; the effect is expected to stay at the same level until 2020.

Both the draft strategy and the model calculations indicate that the actual approach is appropriate to show demonstrable progress in greenhouse gas mitigation by 2005 and to follow Austria's Kyoto target under the EU burden sharing agreement. The remaining gap of about 7 Mt CO_2 equivalent between expected emissions during the commitment period 2008-2010 and the assigned amount of 68.7 Mt CO_2 equivalent should be bridged mainly by utilising the project-based flexible instruments of the Kyoto Protocol.

1.6 Vulnerability Assessment, Climate Change Impacts and Adaptation Measures

Austria is 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 is situated higher than 500 m above sea level and 40% higher than 1,000 m, showing a distinct small-scale orographic structure. A significant climate change can already be observed: Mean annual temperature has increased in the order of 1–2°C within the last 50 years, the share of snowfall in total precipitation has decreased even in high altitudes, and glacier inventories show losses in area and volume. Although projections of climate changes are difficult to obtain and rather uncertain for mountain environments due to the limitations of current climate models, some conclusions based on current knowledge can be drawn.

It must be assumed that the length of time that snow cover remains 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 the altitude. Changes in the natural water balance would have a serious impact on run-of-river power stations, which have a considerable share in electricity production in Austria.

Changes in intensity and frequency of precipitation, temperature increase, glacier retreat and degradation of mountain permafrost could affect the frequency of natural hazards such as landslides, mudslides and avalanches.

Mountains support a relatively broad distribution of climates and a high diversity of habitats within a small physical area. Changes in temperature and precipitation may lead to vegetation shifts and in some instances to extinction of species. Results of ongoing Austrian field studies make it possible 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.

Reduced snow cover will have a negative impact on Austria's winter tourism, which accounts for about 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. Mountain agriculture is likely to be particularly affected by an alteration in the balance of the agricultural ecosystems caused by climate change.

Current adaptation measures are either motivated by impacts of observed climate change or – serving the reduction of natural hazards – have climate change adaptation as a co-benefit. The former range from irrigation channels and insurance instruments in agriculture to artificial snow making facilities in skiing resorts. Furthermore the development of a detailed research strategy concerning adaptation measures in forests and of a training concept to disseminate the resulting recommendations is one of the elements of the Austrian National Forest Programme.

As far as measures against natural hazards are concerned, the Forest Engineering Service on Torrent and Avalanche Control acts as a federal service throughout Austria. Responsibility comprises risk assessment and hazard zone mapping, technical and biological counter-measures as well as quick intervention services in the event of natural disasters. Budget for avalanche, erosion and torrent control measures is spent by different levels of administration. Research is carried out in close co-operation with universities and other research institutions; a recent research programme with participation of many institutions focussed on the development of modelling tools for simulation of hydrology or avalanches, for example. Particular attention is given to the preservation and improvement of forests with respect to their protective function against erosion and avalanches.

1.7 Financial Resources and Transfer of Technology

The Global Environmental Facility (GEF) was set up in 1991 in order to help developing countries and, to some extent, countries with economies in transition, cope with four major environmental problems of basic and world-wide importance, among them the issue of global warming. Austria has provided contributions to the GEF since 1991; the Austrian participation in the GEF has been financed in addition to existing commitments and payments to other international financial institutions. From 2001 to 2004, Austria provided about EUR 25 million.

With respect to bilateral financial assistance, it must be mentioned that projects of the Austrian official development assistance (ODA) have to comply with the target of environmental sustainability; a considerable share of projects has environment protection as main or significant additional target. Programme and project aid of the Federal Ministry for Foreign Affairs amounted to EUR 414 million from 2001 to 2004, which was about 18 % of total Austrian ODA. Several priority regions in Africa, the Himalayas and Central America with a large share of least developed countries are supported in long-term partnerships. Further project-based support was granted by

other ministries, Länder, municipalities and Austrian NGOs. More than EUR 500 million were contributed to the EU development assistance funds by Austria during this period.

Bilateral efforts on projects of special relevance for climate change mitigation have been concentrated on technical assistance for sustainable use and management of natural resources and on transfer of technology and know-how in the areas of renewable energy sources, energy efficiency and cleaner production.

Austria has also contributed to multilateral institutions like the International Development Association, the African and the Asian Development Fund and the International Fund for Agricultural Development. These contributions cannot be attributed specifically to the implementation of the Convention, as such attribution has to be done at the level of each of the institutions in accordance with the activities they have financed.

Austria is a member of institutions and initiatives that have the exchange of research results and transfer of technology as a main target, e. g. the International Energy Agency (IEA) and the Climate Technology Initiative. Austria participates in several Implementing Agreements of the IEA which deal with “climate-friendly” technologies or measures, e.g. in the areas of solar energy, biomass and wind energy. Furthermore many projects funded by ODA, by NGOs and industry facilitate the transfer of environmentally sound technologies and know-how to developing countries. Even if transfer of technology is not the main goal of a project, the use of environmentally sound technologies within the project facilitates access to and understanding of these technologies for people involved in the developing countries.

1.8 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 programmes, at both the national and the international level. Climate system research and research on climate change impacts are heavily influenced by the Alps, which cover almost two thirds of the surface area of Austria. A considerable share of research projects is focused on issues specific for alpine regions. With respect to mitigation technologies, biomass and solar energy are of special interest to Austrian researchers.

Research programmes on sustainable development have been set up by different ministries concerned. Projects related to climate change (impacts, adaptation, mitigation) are carried out by a large number of university institutes as well as by extra-university institutions like the Central Institute for Meteorology and Geodynamics, the Federal Environment Agency and research institutes of the Federal Ministry of Agriculture and Forestry, Environment and Water Management. A special focus on climate change is given within the research programme “StartClim”, which was brought into being in 2002 and which is financed by private-public-partnership.

A dense network of observing stations for meteorological and hydrological parameters has been brought about by the rather heterogeneous meteorological

patterns in the alpine region. Austria's instrumental time series are amongst the longest in Europe and go back as far as the 18th century. The high altitude meteorological observatory at Hoher Sonnblick (at 3106 metres above sea level) has been operating continuously since 1886, which is the longest continuous and homogeneous meteorological time series for high altitudes worldwide. Austrian data are exchanged within international networks such as the World Weather Watch, the GCOS surface network, the Global Atmosphere Watch, CLIMAT and the Global Terrestrial Network – Glaciers. During the recent years Austria has increasingly engaged in space-based observation programmes.

1.9 Education, Training and Public Awareness

Environmental education in schools is an inter-disciplinary instruction principle and issues related to climate protection, such as energy saving and renewable energy, have received increased attention during the recent decades. For more than 20 years, the Forum Environmental Education has been developing and promoting educational programmes, supported by both the Ministry of Education and the Ministry of Environment. Awareness of climate issues in schools is strengthened by various initiatives at Federal and Länder level, e. g. by competitions and workshops. Austria also plays an active role in the OECD/CERI network "Environment and School Initiatives".

Training programmes and seminars have been established by public institutions and regional energy agencies for different target groups. Reliable and independent advisory services on energy issues, which are offered free of charge to private households by energy agencies and several non-profit environmental consulting organisations and partly by the Länder authorities themselves, have received enormous interest from the population throughout recent years. Related programmes directed especially at small and medium enterprises exist in many Länder. The Federal Ministry of Agriculture and Forestry, Environment and Water Management launched the eight-year initiative “klima:aktiv” with a series of target-group oriented programmes in the areas construction and energy efficiency, transport and mobility, communities and renewable energy sources. Training and advisory services dealing with sustainable farming and forestry are offered by the regional Chambers of Agriculture to their members.

There is substantial public awareness on climate change issues in Austria. Campaigns and initiatives are organised and funded by the Federal Ministry of Agriculture and Forestry, Environment and Water Management and by the Länder; they usually focus on concrete recommendations and incentives for measures to protect the climate system, for example in the areas energy, transport and agriculture. Particular mention must be made of the Climate Alliance, which is a partnership between more than 1000 European local authorities and indigenous rainforest peoples with the goal of protecting the earth’s atmosphere. In Austria more than 600 municipalities and all federal provinces have joined the Climate Alliance. Climate Alliance Austria does not only contribute to public awareness of the global dimension of climate change, but has initiated many successful and impressive mitigation projects at community level.

Chapter 2

National Circumstances relevant to Greenhouse Gas Emissions and Removals

CONTENTS

This chapter provides an overview of background information about Austria relevant to this report with respect to geography, climate, population, economic performance, energy use, environment and social indicators, industry, agriculture and forestry.

2.1 Government structure

Austria is a federal state comprised of nine federal provinces. Government responsibilities are shared by three levels of territorial authority, the federation ("Bund"), the nine federal provinces ("Länder") and the local authorities ("Gemeinden", municipalities).

The head of the Austrian state is the federal president („Bundespräsident"), who is directly elected by the people and represents the Republic of Austria internationally. He appoints the federal chancellor („Bundeskanzler"), who is the head of the Federal Government and, at the suggestion of the Bundeskanzler, the federal ministers. The "Nationalrat" and the "Bundesrat" are the two houses of Parliament, the main legislative body. The Nationalrat is elected every four years on the basis of an electoral system of proportional representation; the members of the Bundesrat are nominated by the parliaments of the provinces, the "Landtage".

Every federal province ("Land") has its own regional government ("Landesregierung") headed by the provincial governor ("Landeshauptmann"); the members of the Länder governments corresponding to the federal ministers are the "Landesräte".

A characteristic of Austria's political structure is the so-called "social partnership", the system of co-operation and co-ordination of interest between different interest groups, especially employers and employees. Several national federations are key players in the system, like the Federal Chamber of Labour, the Austrian Economic Chamber, the Austrian Chambers of Agriculture and the Austrian Trade Union Federation. The umbrella federations of the social partners also have influence as regards political opinion forming and decision-making.

Legislative and executive competences are distributed between the federation and the Länder according to the regulations on this matter in the Federal Constitution Act. 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") according to Art. 15a of the Federal Constitution Act in which they agree to undertake certain actions, jointly or separately.

2.2 Population Profile

Austria's total permanent population reached 8.12 million inhabitants in 2003. After declines in the late 1970ies and stagnation in the early 1980ies this represents an increase of more than 500,000 since 1985, which is mainly due to immigration. The population increase was only slightly higher in urban communities compared to rural

communities. The population density is about 97 inhabitants per square kilometre total area or 258 per square kilometre settlement area.

In 2003, 16 % of the Austrian population was younger than 15 years of age, 35 % was between the ages of 15 and 39, 33 % between 40 and 64 and almost 16 % was 65 years old or older. The Austrian population is aging; in 2030 a fourth of all Austrians is expected to be 65 years or older and only about 40 % younger than 40 years. Future trends of Austrian population growth and age structure will be primarily determined by immigration policies. The number of births per woman has been continuously decreasing from the 1960ies to the end of the 1990ies and is currently at 1.39. The balance of births has decreased in the 1990ies and shows a birth-deficit in 2003. Life expectancy at birth is 75.9 years for male and 81.6 years for female persons. (Source: Statistics Austria)

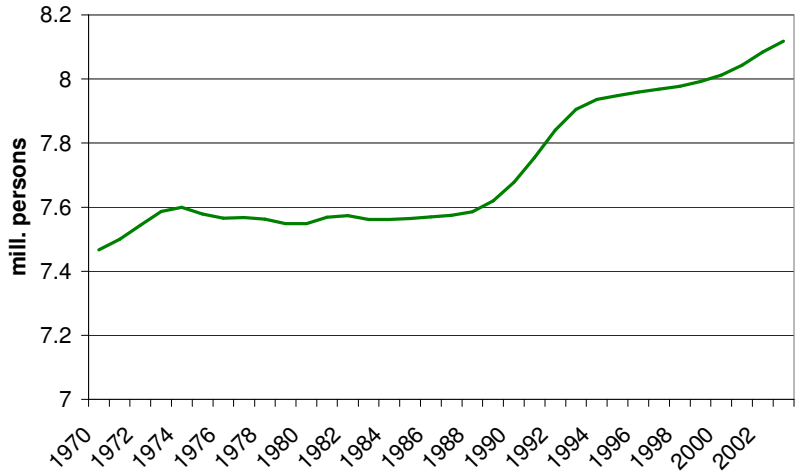

Fig. 2.1: Development of Austrian Population 1970–2004

2.3 Geographical Profile

Austria is located in southern central Europe, between 49°01' and 46°22' north and from 9°32' to 17°10' east, covering part of the eastern Alps and the Danube region. It is land-locked and has common borders with eight other countries. Due to its situation in the centre of Europe, Austria is quite exposed to activities of its neighbouring countries, e. g. to transit traffic and cross-border air pollution.

Austria's total surface area covers 83,858 km^2 with a share of 37.5 % settlement area. The landscape falls into five main sections: The dominating Eastern Alps (63 % of total area), the Alpine and Carpathian foothills (11 %), the eastern foreland which is part of the low-lying Pannonic plains (11 %), the Vienna basin (4 %) and the Granite and Gneiss Highland north of the Danube which is part of the Bohemian massif (10 %). Land-use is dominated by forests (more than 40 % of total area), one third of total area is used for agriculture and about 10 % are alpine pastures.

About 70 % of Austria's surface is situated higher than 500 m above Sea level (maSl), 40 % higher than 1000 m; the landscape shows a very distinct orographic structure. Given the fact that ecosystems in mountainous regions are highly sensitive to changes, it is obvious that large parts of Austria are highly vulnerable to climatic changes.

2.4 Climate Profile

Austria belongs to the central European transitional climatic zone; climate is crucially influenced by the Alps, which are situated in a transitional area of the Mediterranean, the Atlantic Ocean and continental Europe. Austria can be divided into three climatic zones: The eastern part shows a continental Pannonian climate (mean temperature for July usually above 19°C, annual rainfall often less than 800 mm), while the central Alpine region has the characteristic features of the Alpine Climate (high precipitation, short summers, long winters). The remaining part of the country belongs to the transitional central European climatic zone, which is characterised by a wet and temperate climate (mean temperature for July 14–19°C, annual precipitation 700–2000 mm, depending on location, exposure and altitude). As Austria is a country with a highly structured relief, a lot of small-scale climatic processes occur caused by orographic conditions.

Mean daily temperature in Vienna (about 200 maSl) in January is 0.1°C (July: 20.2°C), the number of days per year with minimum temperature below 0°C is 66. In alpine regions temperatures can become considerably lower, e.g. in St. Jakob at 1,400 maSl mean daily temperature in January is -7.5°C (July: 13.2°C), the number of days per year with minimum temperature below 0°C is 197. This may explain why almost one third of final energy consumption in Austria is used for space heating.

Since 1880 an increase of about 1.5°C in average temperatures has been measured in Austria, a trend, which could be observed in all regions, whereas precipitation shows no homogeneous trend. In the western part, a rising tendency was observed during the 20th century; in the east and south precipitation has shown a falling tendency since the 1940ies. Exceptionally warm years could be observed during the last fifteen years. In Vienna, 2000, 1994, 2002 and 2003 were the years with the highest average temperature since the beginning of measurements in 1775; summer 2003 was the warmest summer ever measured. Since 1989, two third of the winter seasons showed heating degree days below the 25 year average (cf. Fig. 2.2). 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 19th century. This tendency has increased since the early 1980ies. (Source: Central Institute for Meteorology and Geodynamics, Institute of Meteorology of the University of Natural Resources and Applied Life Sciences, Vienna)

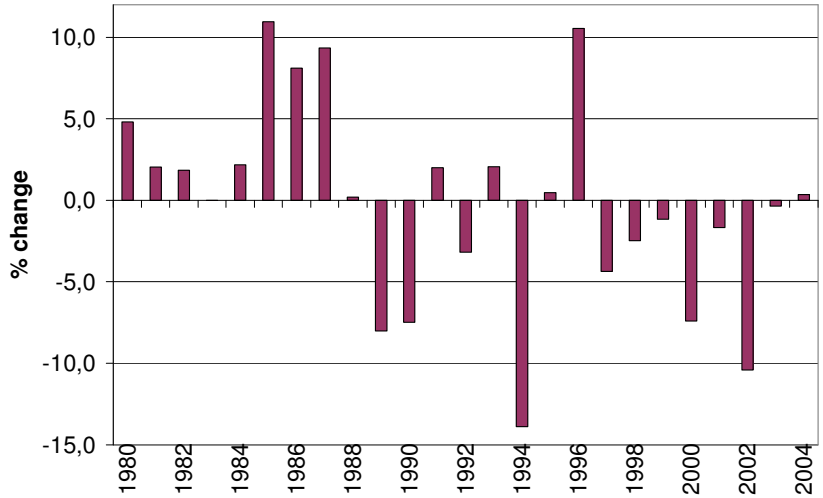

Fig. 2.2: Heating degree days in winter (Jan–Mar and Nov–Dec), deviation from mean value for 1980–2004 (Source: Statistics Austria)

2.5 Economic Profile

In 2004 Austria's GDP at current prices was € 237 billion. With a per capita GDP of € 29,000 Austria lists in the top ranks of the world. Both the opening of Central and Eastern Europe in 1989 and the accession of Austria to the European Union in 1995 have been shaping the growth and structure of the Austrian economy. Austria has the characteristics of a small open economy, with imports amounting to 46.1 % percent of GDP and exports reaching 51.0% of GDP. Austria's main trading partner is its neighbour Germany with a 32 % share of total exports and 43 % share of total imports. Trade with the new EU member states and economies in transition of Central and Eastern Europe has almost tripled from 1995 to 2004.

Table 2.1: Development of GDP in the period 1980-2004 (Source: Statistics Austria)

	GDP at Current Prices		**GDP Price Index**		**GDP/capita**
	Bio €	% Change	Index	% Change	€
1980	76.32	+ 7.3	62.1	+ 1.8	10 110
1985	103.07	+ 5.5	66.8	+ 2.6	13 620
1990	136.33	+ 7.8	77.7	+ 4.6	17 760
1991	146.59	+ 7.5	80.5	+ 3.6	18 900
1992	155.47	+ 6.1	82.4	+ 2.4	19 830
1993	160.27	+ 3.1	82.7	+ 0.3	20 270
1994	168.94	+ 5.4	84.9	+ 2.7	21 290
1995	175.53	+ 3.9	86.5	+ 1.9	22 080
1996	181.87	+ 3.6	88.8	+ 2.6	22 850
1997	185.14	+ 1.8	90.4	+ 1.8	23 240
1998	192.38	+ 3.9	93.6	+ 3.6	24 120
1999	200.03	+ 4.0	96.8	+ 3.3	25 030
2000	210.39	+ 5.2	**100.0**	+ 3.4	26 260
2001	215.88	+ 2.6	100.8	+ 0.8	26 840
2002	220.69	+ 2.2	101.8	+ 1.0	27 300
2003	226.97	+ 2.8	103.2	+ 1.4	27 960
2004	237.04	+ 4.4	105.8	+ 2.4	29 000

The sectoral composition of Austria's GDP has been remarkably stable at least in terms of the 2004 GDP shares of primary production (1.9 %), secondary production (30.3 %) and tertiary production (67.8 %). Austria is one of the few countries in the world with a considerable share of exports from tourism. Obviously this sector is highly vulnerable to weather conditions. This is one way in which climate change might impact not only the tourist regions, but also the economy as a whole.

2.6 Energy

Compared to other industrialized countries the Austrian energy sector has a rather high share of renewables that amounted to 9.4 % hydro power and 12 % other renewables (mainly biomass) of total gross energy consumption in 2004. Public awareness of the importance of renewables is high since they also offer economic opportunities; this may be illustrated by the fact that Austria is among those countries with the highest installed area of solar collectors per capita in Europe.

Nevertheless energy supply in Austria is still heavily dependent on fossil fuels, with shares of 12 % of coal products, 43 % of oil products, and 23 % of natural gas of total gross energy consumption in 2004. After considerable changes in the 1970ies and 1980ies, the share of fuels has been quite stable since the mid 1990ies, with a slight increase in natural gas only (see Figure 2.3). Around two thirds of gross energy consumption stem from imports, a share that has been also rather stable. Whereas gross energy consumption per capita has increased by more than one third since the mid 1970ies to 171 GJ/cap in 2004, gross energy consumption per GDP (at 2000 prices) has decreased by about 20 % to 6,3 MJ/€ (see also Figure 2.5).

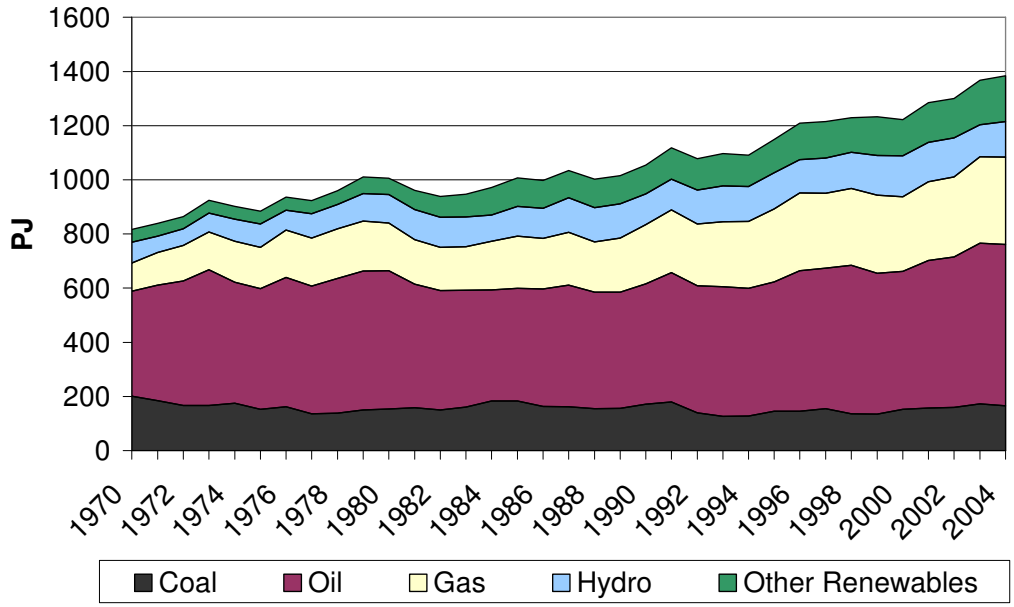

Fig. 2.3: Gross energy consumption 1970–2004 (Data: Statistics Austria)

Final energy consumption is characterized by increasing shares of gas (18 %) and district heating (5 %), see Figure 2.4. The share of coal has been continuously reduced to 2%; oil has held a constant share of since the 1980ies (44 % in 2004).

Renewables including waste now comprise about 11 %, electricity 19 %. More than two third of electricity is generated by hydro power.

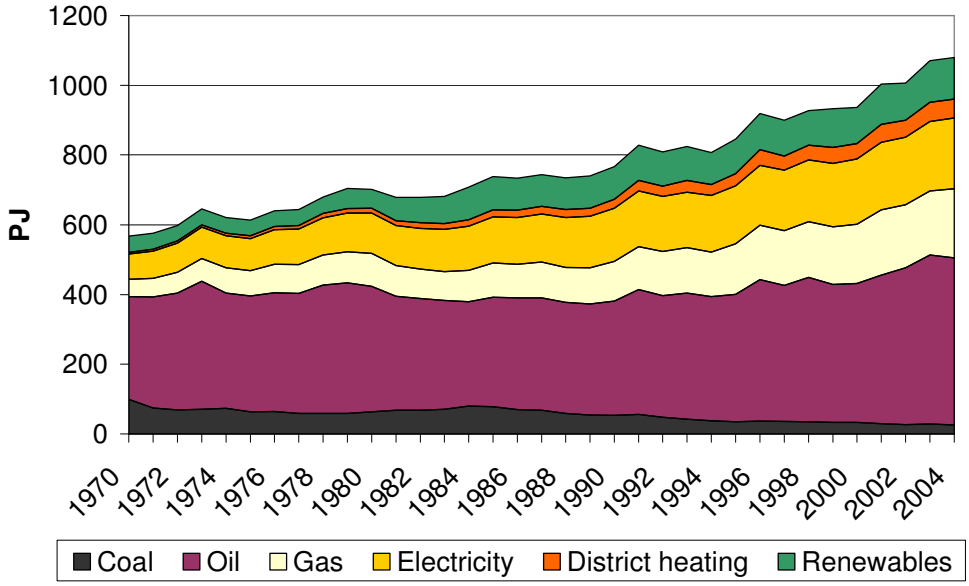

Fig. 2.4: Final energy consumption 1970–2004 (Data: Statistics Austria)

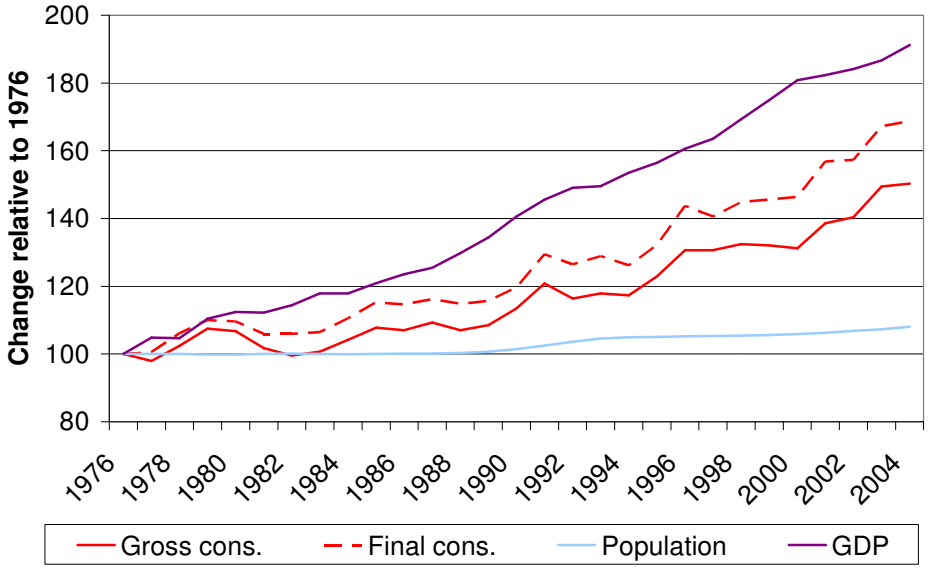

Fig. 2.5: Gross inland and final energy consumption, population und GDP at constant prices 2000; development relative to 1976 values (Data: Statistics Austria)

The share of private households in final energy consumption shows a falling tendency (1990: 32 %, 2004: 27%); the share of goods production has stayed quite constant during the last two decades (2004: 28 %). The share of transport shows a continuously increasing tendency (1970: 19 %, 1990: 25 %, 2004: 31 %). It should be mentioned that the amount of road fuel, that is sold in Austria but consumed abroad (fuel tourism), has become significant in the last years; for diesel fuel it is estimated to be up to one third of total consumption. This is due to the fact that prices have been slightly lower than in most neighbouring countries, that important routes for long-distance freight traffic cross Austria and that the integration of eastern neighbour

states into the European economic area led to additional traffic demand especially on transit routes. The consumption figures of 2004 and 2005 indicate that fuel tourism has been stabilised on significant level.

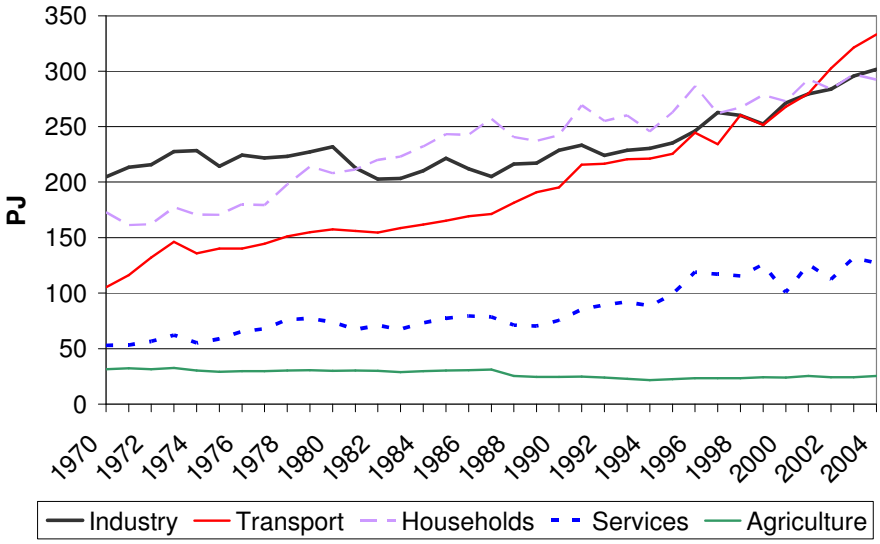

Fig. 2.6: Final energy consumption according to sectors1970–2004 (Data: Statistics Austria)

2.7 Transportation

Economic and demographic development in the past decades entailed an enormously increased transport performance in terms of passenger as well as freight transport. The number of passenger cars rose from 1.2 million in 1970 to 4.1 million in 2004, the total number of motor vehicles from 2.2 million to 5.6 million. The share of diesel fuelled passenger cars has increased enormously from 14 % in 1990 to 46 % in 2004.

In 2004 Austria's passenger transport amounted to approx. 134 billion passenger kilometres. Since 1990 passenger transport rose by more than 30%. The biggest increase could be noticed in the flight sector – about 200 % increase in the period of 1990 to 2004. 82 billion passenger kilometres were travelled by passenger cars, 27 billion by public transport. Above all, transport by passenger cars and air transport, which have continuously gained in importance since the 1980ies, are expected to go on rising.

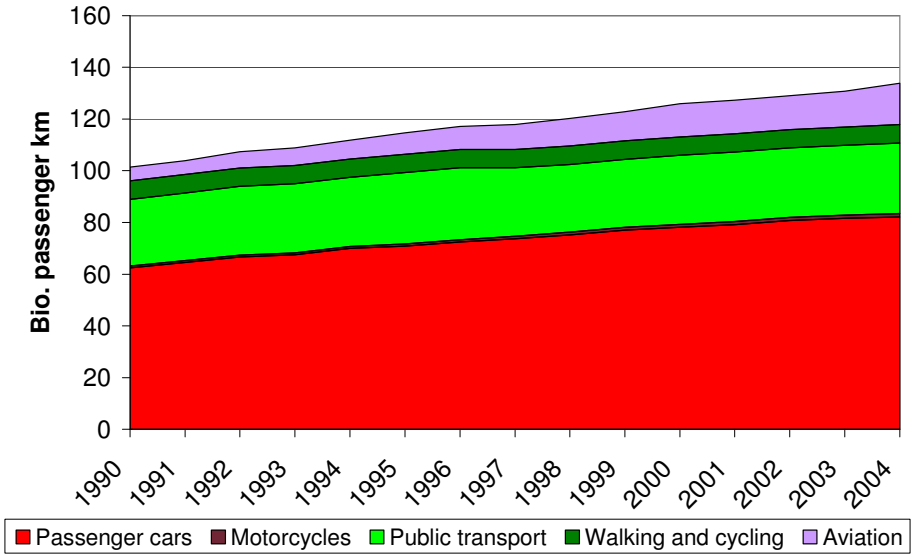

Fig. 2.7: Trend in passenger transport 1990–2004 (Source: Umweltbundesamt)
Remark: aviation transport demand contains national and international flights (pkm abroad: includes the whole distance to the abroad destination; only starts are considered)

The total performance in freight transport in 2004 amounted to nearly 60 billion ton kilometres, of which road transport counted for 38 billion, rail for 16 billion and ship for 3 billion ton kilometres. Therefore, freight transport is also predominated by the proportion of road transport. Since 1990 the amount of freight transports almost doubled.

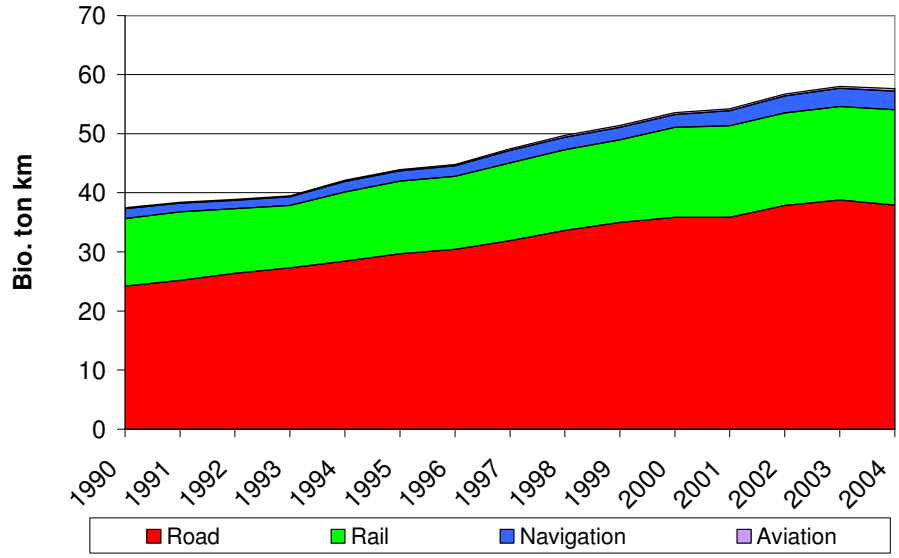

Fig. 2.8: Trend in freight transport 1990-2004 (Source: Umweltbundesamt)

CO_2 emissions caused by transport have been increasing steadily during the recent years. The main sources are passenger cars and lorries. In contrast to the trends in transport demand, CO_2 emissions show a slight decrease in the mid 1990ies and a disproportionately high increase afterwards. This is due to fuel tourism. Due to lower fuel prices in comparison to the neighbouring countries and other reasons (see previous section) a part of the fuel sold in Austria is consumed abroad. As the calculation has to be based on the fuel sold, this fuel and the emissions are allocated to the Austrian inventory. A recent study showed that about one third of the

greenhouse gas emissions are caused by fuel tourism, mainly caused by long-distance freight transport.

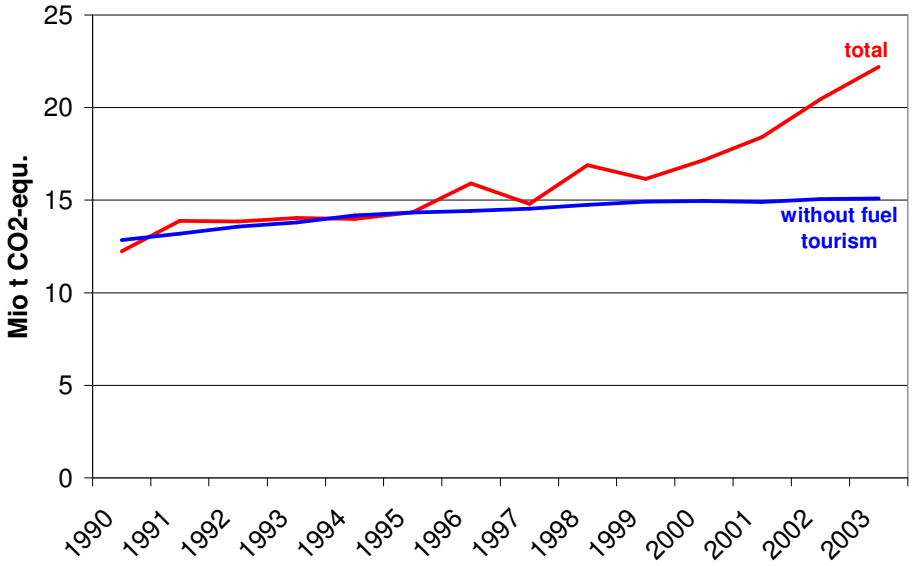

Fig 2.9: Greenhouse gas emissions of road transportation – total and without fuel tourism. (Source: Umweltbundesamt)

2.8 Industry

With regard to the growth of its industrial sector, Austria ranks among the leaders within the EU countries. Industrial production showed an increase of 49 % between 1995 and 2004. Compared to other industrialized countries basic materials industries still play a decisive role in Austria.

Some 30 % of Austria's economic productivity is derived directly from industry. The most important branches of goods production are machines and steel construction, electrical and electronic appliances, chemicals, iron and metal goods, food and vehicles. Turnover per employee in manufacturing industries was € 192,400 in 2004; gross value added per employee was € 60,700.

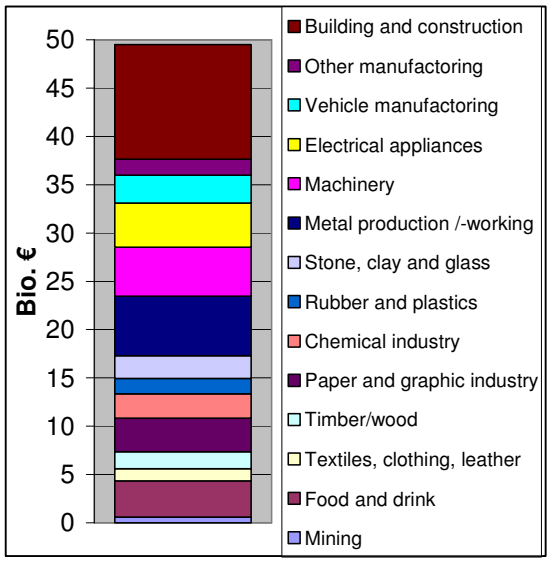

Fig. 2.10: Gross value added 2004 (Data: Statistics Austria)

€ 5.35 billion, that is 2.27 % of GDP, were spent for research and technology development in 2004, compared to a share of 1.36 % in 1990. A 3 % share of RTD expenditure in GDP is targeted for 2010 to strengthen the competitiveness of Austrian products and production.

Austria's industry has been successful in the decoupling of growth of production and energy consumption since the mid 1970ies by energy-saving and efficiency-raising measures. After a steady decrease of about 5 million tons altogether, starting in the early 1980ies, CO_2 emissions from energy consumption in manufacturing industries and construction did not begin to rise until the mid 1990ies. In 2004, they were 9 % above the 1990 level. Emissions from production processes have developed quite similar.

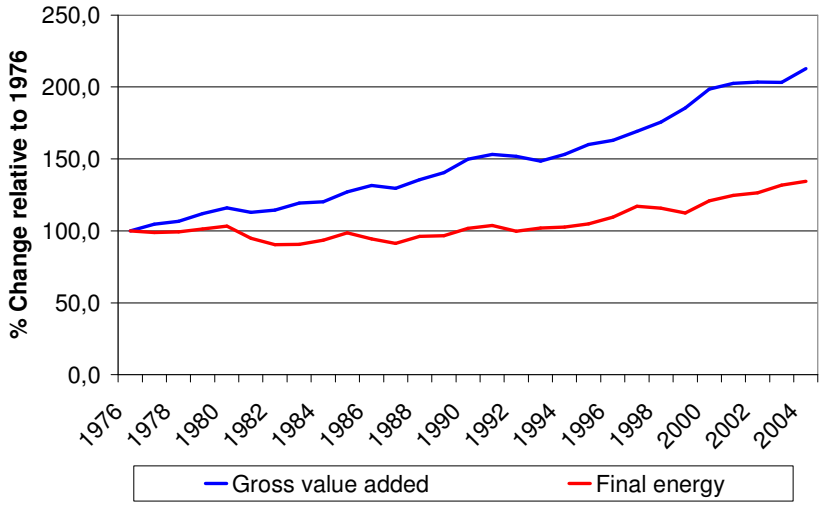

Fig. 2.11: Gross value added at 2000 prices and final energy consumption in manufacturing industry (Data: Statistics Austria)

2.9 Waste

According to the draft *Federal Waste Management Plan 2006* the total estimated amount of waste generated in Austria in 2004 was about 54 million tons. Excavation material accounted for 22 million tons, while hazardous waste is estimated at 1.1 million tons/a or 2 % of total waste. The change in total mass compared to the *Federal Waste Management Plan 2001* (1999: 49 million tons) is mainly due to an increase of excavation material, wood waste, waste from households and flue ash from waste incineration plants.

About 10 % of total waste excluding excavation material is incinerated for energy recovery; 71 % is collected for conditioning, recycling and recovery; 19 % undergo other treatments.

Waste from households and similar institutions rose by 10 % between 1999 and 2004 to 3.4 million tons (418 kg waste per capita). In 2004, 7.7 % went directly without pre-treatment to sanitary landfills, compared to 28.5 % in 1999 and 63.1 % in 1989. Including residues from treatment, 24 % of household waste was disposed of in landfills (1999: 43.1 %, 1989: 74.8 %). As a result of separate collection, 1.3 million tons of secondary material (glass, paper, metal, …) and 0.5 million tons of organic waste were collected in 2004. The share of secondary material collected separately for recovery/recycling has increased from 13 % in 1989 to 36 % in 2004, the share of organic waste collected separately for composting from 1 % to 16 %. (See also Figure 2.12)

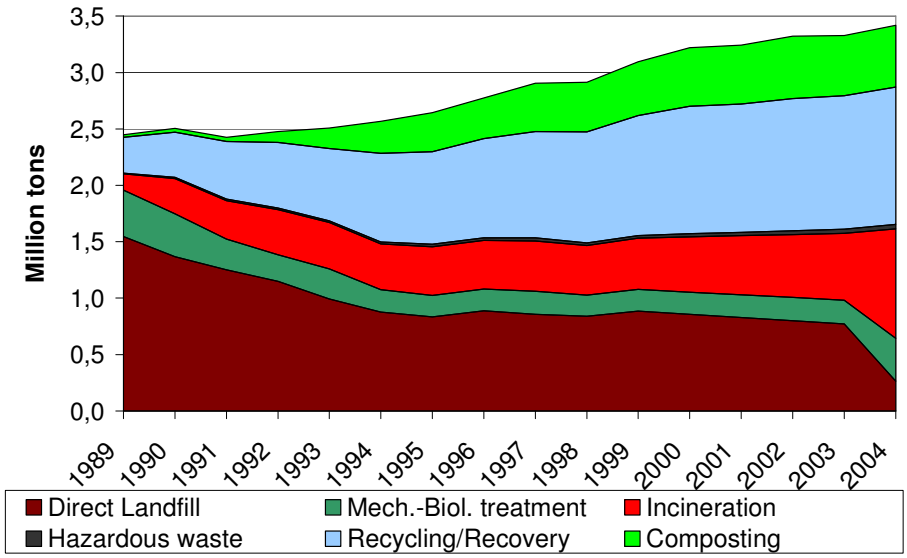

Figure 2.12: Household waste, treatment and recycling 1989–2004 (Source: Umweltbundesamt)

Due to the Landfill Ordinance of 1996 the disposal of waste containing more than 5 % of total organic carbon (TOC) is prohibited in general and exceptionally allowed under certain circumstances until 31 December 2008 at the latest. Since 1991, methane emissions caused by waste management have been decreasing.

2.10 Building stock and urban structure

About 38 % of Austria's total area is, in principle, available for settlement, with a smaller share of only 25 % in the Alpine region. Population density in this area is 258 persons/km². One fifth of all Austrians (1.6 million), live in Vienna, the only Austrian city with more than one million inhabitants. 8 % live in the four cities with more than 100,000 inhabitants each, these being Graz, Linz, Salzburg and Innsbruck. About one half of all Austrians live in communes with between 1,000 and 10,000 inhabitants, only 5 % in communes with less than 1000 inhabitants and 16 % in communes with more than 10,000 up to 100,000 inhabitants. Two thirds live in municipal communes, one third in rural communes.

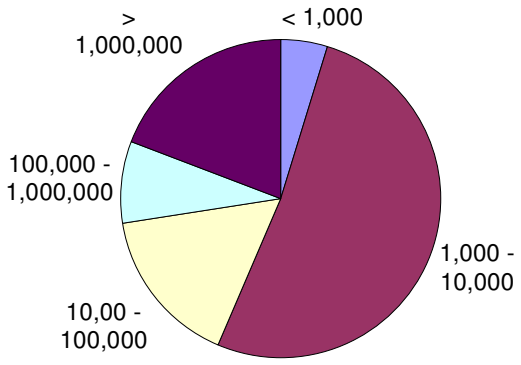

Figure 2.13: Population distribution according to size of communes (Data: Statistics Austria)

In recent decades, the number of households and dwellings increased to a much higher extent than population did. While in 2001 the number of households (3.34 million) was 30 % higher than in 1971 and the number of dwellings (3.86 million) 45 % higher, population growth was 7 % during the same time. The percentage of single households has grown from 25 % in 1971 to 34 in 2001. On average, 2.4 people live in a household. The tendency towards single households is projected to continue. Average useful floor space has increased from 84 m² per dwelling in 1991 to 91 m² in 2001 and from 33 m² per person to 38 m².

Almost half of the dwellings are located in buildings with one or two dwellings, less than one third in buildings with more than 11 dwellings. 19 % of the dwellings (principal residences) were built before 1919; 21 % between 1919 and 1960; 32 % between 1961 and 1980; and 28 % after 1981. Since 1980 the share of dwellings with central heating and district heating has risen from 33 to 66 %.

2.11 Agriculture and forestry

The agricultural area, including alpine pastures, has a share of approximately 41 % of the Austrian total territory while forests make up about 47 %. In the Alpine regions forestry and extensive grassland production with cattle stocking dominate, while arable farming is concentrated on the lowlands and basins and especially in the east of the country. In 2004 the share of agriculture and forestry in GDP was 1.9 %. The agricultural quota of the working population amounts to 5 %.

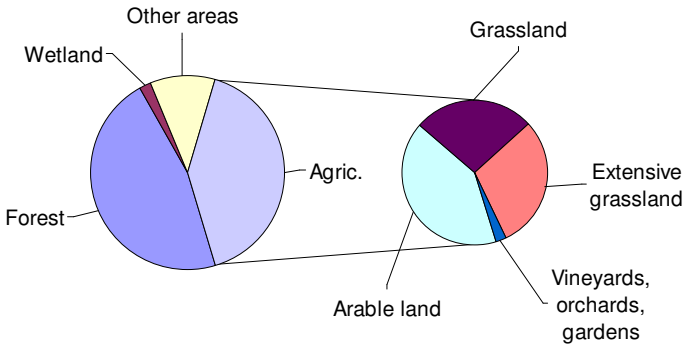

Figure 2.14: Land cover / land use in Austria 1999

According to the 2003 Farm Structure Survey about 190,000 agricultural and forestry holdings are managed in Austria, of which more than one third are mountain farms. The number of holdings has decreased by more than one third since 1980. Despite increased structural change, Austrian agriculture and forestry are small-structured; 61 % of the holdings comprise less than 20 hectares and only 4 % more than 100 hectares. About two third of the holdings and of the agricultural area are situated in less favoured areas (mountainous areas, other less favoured areas and small-structured areas). Of the total agricultural area, the share of arable land is 42 %,

grassland 28 %, extensive grassland 28 % and other types of agricultural land use (vineyards, orchards and house gardens, vine and tree nurseries) 2 %.

Output of agriculture in 2004 amounts to 5.8 billion €; the share of plant production is 46 %, of animal products 45 % and of other agricultural activities and services 9 %. 2.05 million heads of cattle were counted in 2004, which is 21 % less than in 1990. The number of pigs decreased by 15 % to 3.13 million. Domestic production was 10 % higher than domestic consumption for meat in 2003, 24 % higher for wheat but 6 % lower for cereal altogether.

The number of organic farms increased from 200 in 1980 and 1,539 in 1990 to 19,826 in 2004; 9 % of arable land are managed according to organic criteria. 78 % of all agricultural enterprises are participating in the Austrian agri-environmental programme "ÖPUL"; the results are reduced use of fertilisers, the increased application of organic methods and the expansion of crop rotation.

Wooded area increased in average 5,100 hectares per year in the last years, mainly in agricultural areas and alpine pastures. Spruce has the highest share in species with 61 %; however, mixed forest stands with a higher percentage of leaf-wood have been increased to reduce the ecological disadvantages of monoculture. During recent years, the annual felling quantity has been about only two third of the annual growth. As a result, growing stock in Austria's forests has increased to approx. one billion cubic metres of solid timber.

Because of their protective functions, mountain forests are of great importance to Austria. A third of these sensitive ecosystems need restoration, which is made difficult especially by damage done by game and grazing. Austrian forests represent the largest carbon reservoir and have been a net carbon sink during recent decades.

Chapter 3

Greenhouse Gas Inventory Information

CONTENTS

This chapter presents an overview of the Austrian national inventory system and detailed information on emissions of the greenhouse gases CO_2, N_2O, CH_4, HFCs, PFCs and SF_6. Total emissions amounted to about 91.6 million tons CO2 equivalent in the year 2003 and were dominated by CO_2 with a share of 83 %. The sector 'Transport' showed the strongest increase in emissions since the base year. In the historical perspective, CO_2 emissions increased parallel to the economic development until 1975 and have shown fluctuations between 67 and 57 Tg until the end of the 1990ies.

3.1 National Inventory System

As a Party to the United Nations Framework Convention on Climate Change (UNFCCC), Austria is required to produce and regularly update National Greenhouse Gas (GHG) Inventories. The *Umweltbundesamt* is identified as the single national entity with overall responsibility for the national inventory by law. The responsibilities for the inventory planning, preparation and management are specified and are all allocated within the *Umweltbundesamt*.

The national greenhouse gas inventory is prepared by the inspection body for GHG inventories within the *Umweltbundesamt* which will soon be accredited as inspection body according to the International Standard ISO 17020 *General Criteria for the operation of various types of bodies performing inspections*. The accreditation audit of the *Umweltbundesamt* as inspection body took place in September 2005. Official conclusion of the accreditation took place in early 2006. The Quality Management System (QMS) also includes the necessary procedures to ensure quality improvement of the emission inventory. These comprise documentation and attribution of responsibilities of any discrepancy found and of the findings by UNFCCC review experts in particular.

The inventory preparation, including identification of key categories, uncertainty estimates and QC procedures, is performed according to the 2000 Intergovernmental Panel on Climate Change (IPCC) Good Practice Guidance and Uncertainty Management of Greenhouse Gas Inventories. An update of uncertainty estimates is planned for 2006. The inventory management as part of the QMS includes a control system for data and calculations, for records and their archiving as well as documentation on QA/QC activities. This ensures the necessary documentation and archiving for future reconstruction of the inventory and for the timely response to requests during the review process.

Part of the legal and institutional arrangements in place as basis for the national system concerns the data availability for the annual compilation of the GHG inventory. The main data source for the Austrian inventory preparation is the Austrian statistical office (*Statistics Austria*). The compilation of several statistics is regulated by law; the compilation of the national energy balance is regulated by contracts only. Other data sources include reporting obligations under national and European regulations and reports of companies and associations.

Detailed information on the national inventory system will be provided in Austria's report according to Decision 13/CMP.1.

3.2 Inventory Methodology

The Austrian greenhouse gas inventory for the period 1990 to 2003 (NIR 2005 submitted to the UNFCCC secretariat in April 2005; Anderl et al., 2005) was compiled according to the recommendations for inventories set out in the UNFCCC reporting guidelines according to Decision 18/CP.8, the Common Reporting Format (CRF) (version 1.01), Decision 13/CP.9, the new CRF for the Land Use Change and Forestry Sector, the IPCC 1996 Guidelines for National Greenhouse Gas Inventories, which specify the reporting obligations according to Articles 4 and 12 of the UNFCCC [IPCC Guidelines, 1997] as well as the IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories [IPCC GPG, 2000].

Austria, as many other European Countries, uses the CORINAIR calculation method (Core Inventory Air) for quantifying national emissions. The national project covering the entire present assessment of Air Emissions in Austria during the reported period is the Austrian Air Emission Inventory (*¨Osterreichische Luftschadstoff-Inventur – OLI*).

The OLI figures for Austria's national emissions resulting from the project mentioned above have been transferred to the Revised IPCC 1996 Revised Guidelines format using CORINAIR standard procedures, in order to comply with UNFCCC reporting obligations to ensure comparability of the reported data. No corrections (neither for temperature nor for electricity production share from hydropower) have been applied. Bunker fuels have not been included in the national totals, but tabled separately. No CO_2 emissions have been attributed to feed stocks.

The data are reported using the Common Reporting Format, particularly the summary tables thereof. The following UNFCCC standard indicators are applied when necessary:
NO (not occurring): for emissions by sources and removals by sinks of greenhouse gases that do not occur for a particular gas or source/sink category.
NE (not estimated): for existing emissions by sources and removals by sinks of greenhouse gases which have not been estimated.
IE (included elsewhere): for emissions by sources and removals by sinks of greenhouse gases estimated but included elsewhere in the inventory instead of the expected source/sink category.
0: for emissions by sources and removals by sinks of greenhouse gases which are estimated to be less than one half the unit being used to record the inventory table, and which, therefore, appear as zero after rounding.

3.3 Emissions in 2003

Austria's CO_2 emissions amounted to 76.21 Tg in 2003, which is an 83% share of all greenhouse gas emissions. Total emissions of the greenhouse gases CO_2, N_2O, CH_4, HFCs, PFCs and SF_6 were 91.6 Tg in the year 2003, with the transport sector contributing about one quarter of total emissions, followed by energy industries and other energy sectors[1] with about one sixth each.

[1] The subsector 'Other Sectors' comprises Commercial/Institutional, Residential and Agriculture/Forestry/Fisheries.

3.3.1 Total emissions of direct greenhouse gases

The total emissions of the greenhouse gases CO_2, N_2O, CH_4, HFCs, PFCs and SF_6 (given as CO_2 equivalents based on the global warming potential GWP evaluated for a reference period of 100 years; factors according to the IPCC Second Assessment Report) amounted to 91.57 Tg in the year 2003 (see Table B.1). The ranking of the (sub)sectors according to their relative contribution is as follows (cf. Figure 3.1):

1A3: Transport (25.1%)
1A1: Energy Industries (17.6%)
1A4: Other Sectors (16.7%)
1A2: Manufacturing Industries and Construction (15.7%)
2: Industrial Processes (12.1%)
4: Agriculture (8.0%)
6: Waste (3.7%)

If the emissions of subsector 'Manufacturing Industries and Construction' (1A2) and sector 'Industrial Processes' (2) were summed up as one industrial sector, this one sector would be even larger than the transport sector (27.7%[2] versus 25.1%).

The emissions of CO_2 clearly dominate the GHG emissions in Austria with 76.21 Tg or 83.2% compared to 8.5% for CH_4 and 6.1% for N_2O. F-Gases: HFCs 1.4%, PFCs 0.1% and SF_6 0.6%.

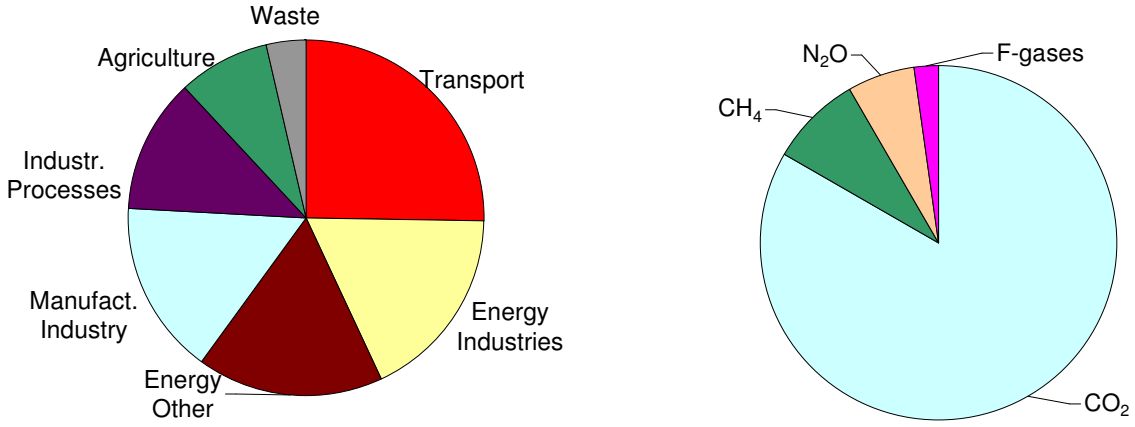

Figure 3.1: GHG emissions 2003 (excluding land-use change and forestry), split into sectors and gases

3.3.2 CO_2

CO_2 had the largest share of all greenhouse gases with emissions of 76.21 Tg in 2003. This amounted to 83% of all greenhouse gas emissions in Austria (see Table B.2).

[2] There may be slight differences due to rounding errors.

The sector 'Fuel Combustion' (1A) accounted for 67.62 Tg or 88.7% with the subsector 'Transport' (1A3) showing the largest contribution to sector 1A with 22.69 Tg or 29.8%. The next largest subsectors were 'Energy Industries' (1A1) with 16.03 Tg (21.0%) and 'Other Sectors' (1A4) with 13.01 Tg (19.8%). The sector with the second largest contribution was 'Industrial Processes' with 8.15 Tg or 10.7%, this contribution being significantly lower compared to subsector 'Manufacturing Industries and Construction' (1A2) with 14.16 Tg (18.6%). The sector 'Land Use Change & Forestry' (5) was a sink in 2003 amounting to minus 12.77 Tg CO2 due to the increase in Biomass Stock Change.

3.3.3 CH_4

In 2003 the CH_4 emissions of Austria were estimated to be 371.74 Gg (see Table B.2). The sector 'Agriculture' (4) shows the largest contribution with 189.97 Gg (51.1%), with the subsector 'Enteric Fermentation' (4A) showing a contribution of 147.32 Gg (39.6 %). The sector 'Waste' (6) accounted for 150.31 Gg or 40.4% and 'Solid Waste Disposal on Land' (6A) is the most important subsector with emissions as high as 134.71 Gg (36.2%).

3.3.4 N_2O

In 2003 the N_2O emissions of Austria were estimated to be 17.88 Gg (see Table B.2). The sector 'Agriculture' (4) showed the largest contribution with 10.84 Gg (60.6%), with the subsector 'Agricultural Soils' (4D) showing a contribution of 8.57 Gg (47.9%). The next largest subsectors were 'Chemical Industry' (2B) and 'Fuel Combustion' (1A) with 2.85 Gg (15.9%) and 2.65 Gg (14.8%) respectively.

3.3.5 HFCs, PFCs, SF_6

In 2003 the actual and potential emissions of HFCs, PFCs and SF_6 were estimated to be 2.00 Tg and 3.71 Tg, respectively (see Table B.2). The main contributions of the total actual HFC emissions of 1308 Gg CO_2 equivalent originated from the use of HFCs in the foam blowing industry (41% of total emissions of HFCs, PFCs and SF_6) and mobile/stationary refrigeration (23% of total emissions of HFCs, PFCs and SF_6).

Estimation of total PFC emissions resulted in 102.54 Gg CO_2 equivalent originating mainly from the semiconductor industry. Estimation of total SF_6 emissions resulted in 593.52 Gg CO_2 equivalent. The semiconductor industry (19% of total emissions of HFCs, PFCs and SF_6) and production of noise insulate windows (9% of total emissions of HFCs, PFCs and SF_6) are the main emission sources.

3.3.6 Indirect greenhouse gases

NMVOC: The main contributions to the total of 182.30 Gg of NMVOC emissions in Austria (see Table B.2) originated from the following sectors (subsectors):

3: Solvent and Other Product Use (45.3%)
1A4: Other Sectors (27.73%)
1A3: Transport (13.0%)

NOx: The main contributions to the total of 229.03 Gg of NO*x* emissions in Austria (see Table B.2) originated from the following sectors (subsectors):

1A3: Transport (59.2%)
1A4: Other Sectors (16.5%)
1A2: Manufacturing Industries and Construction (14.6 %)

CO: The main contributions to the total of 801.78 Gg of CO emissions in Austria (see Table B.2) originated from the following sectors (subsectors):

1A4: Other Sectors (50.8%)
1A3: Transport (23.3%)
1A2: Industrial Processes (21.1%)

SO2: The main contributions to the total of 34.14 Gg of SO_2 emissions in Austria (see Table B.2) originated from the following sectors (subsectors):

1A2: Manufacturing Industries and Construction (34.8%)
1A4: Other Sectors (29.7%)
1A1: Energy Industries (24.7%)

3.3.7 Land-use, land-use change and forestry

The main sink is subcategory *5 A Forest Land* with net removals of 13 060 Gg CO_2 in 2003. Small emissions arise from the other subcategories, where emissions from all other subcategories together amounted to 287 Gg CO_2 in 2003.

3.4 Trend of emissions from 1990 to 2003

Austria's total greenhouse gases showed an increase of 16.6% from the base year to 2003 (CO_2: +24.4%). In the period from 1999 to 2003 Austria's total greenhouse gases increased by 13.9%, CO_2 emissions increased by 18%. Figure 3.2 presents the trend in total GHG emissions 1990-2003 in comparison to Austria's Kyoto reduction target of 13% from the base year 1990 (BY). Figures 3.3 and 3.4 show the GHG emissions trend split into sectors and gases.

The figures for the year 1990, which were included in the Third Austrian National Communication, have been recalculated to obtain consistent numbers.

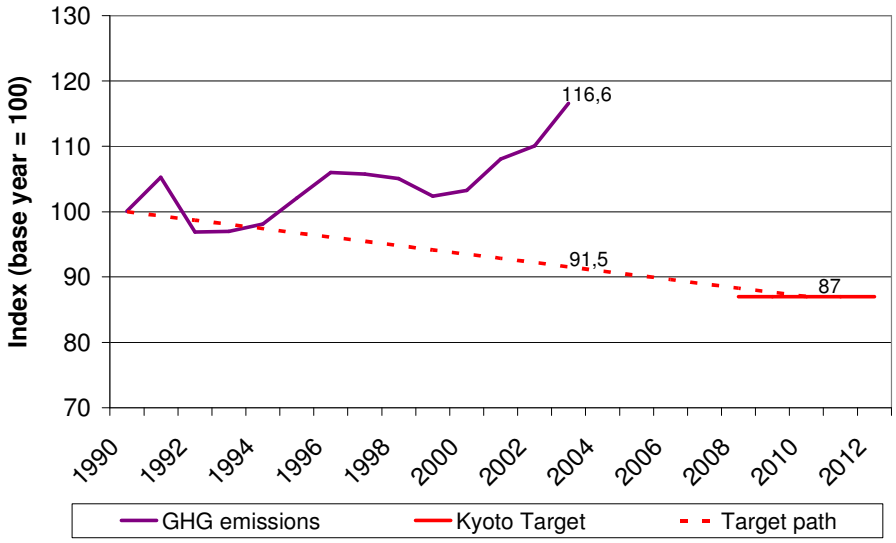

Figure 3.2: Trend in total GHG emissions 1990-2003 (excluding land-use change and forestry) and Kyoto Target

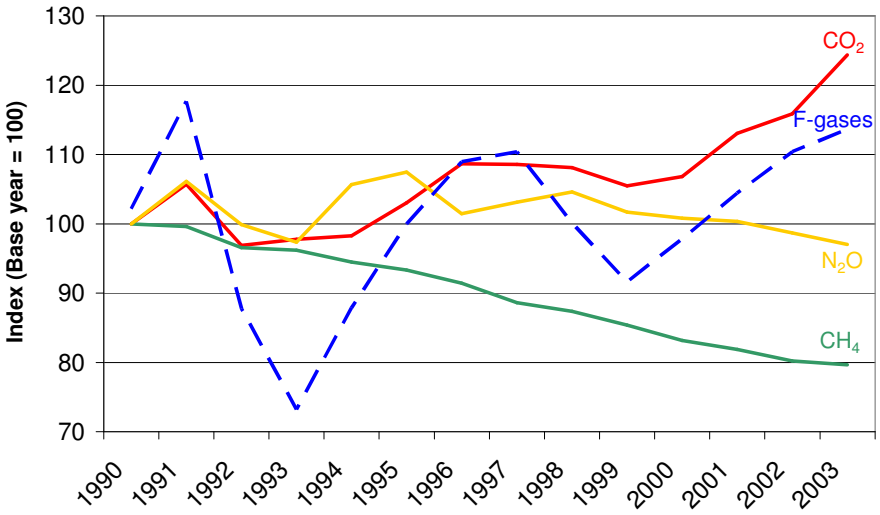

Figure 3.3: GHG emission trend (excluding land-use change and forestry), split into gases

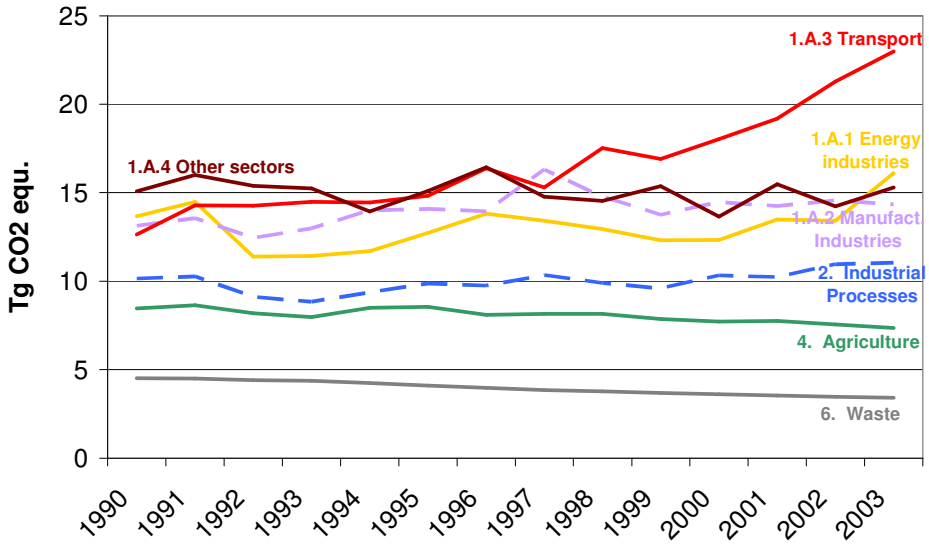

Figure 3.4: GHG emission trend, split by sectors

3.4.1 CO_2

CO_2 emissions have been fluctuating at the beginning of the decade, and after an increase until 1996 followed by a decrease, emissions seemed to have stabilized on this level. However, since 2000 emissions are strongly increasing again, from 2000 to 2001 by 6.1%, the next year by 2.5% and again from 2002 to 2003 by 7.4%. This resulted in a total increase of 24.4% from 1990 to 2003. Quoting in absolute figures, CO_2 emissions increased from 61.26 to 76.21 Tg during the period from 1990 to 2003 mainly due to higher emissions from transport, which increased by 83% (cf. Fig. 3.5).

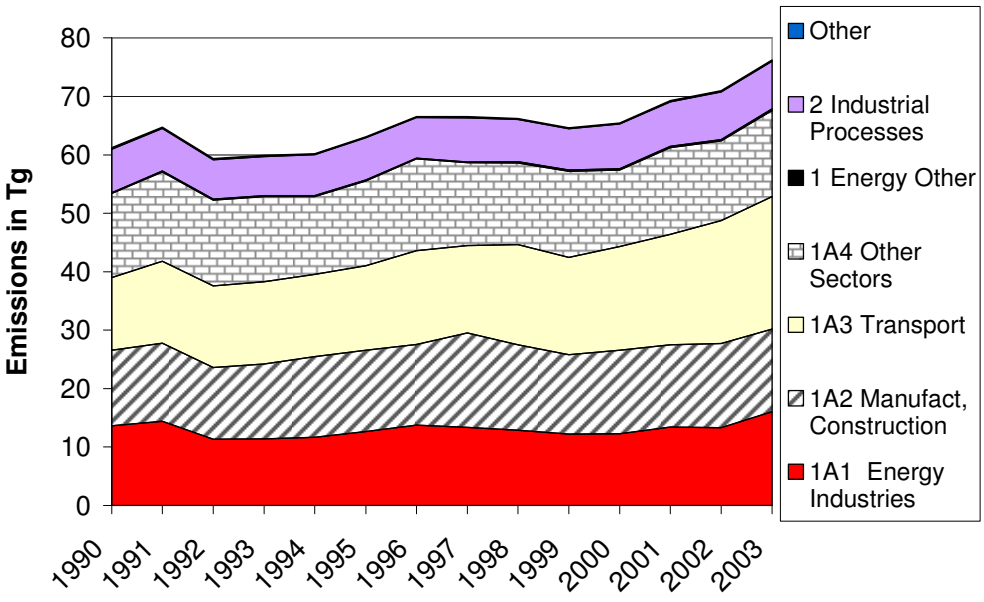

Figure 3.5: CO_2 emission trend

According to the Climate Convention Austria's CO_2 emissions should have been reduced to the levels of 1990 by 2000, but the CO_2 stabilisation target for 2000 could

not be met. However, the Member States agreed to jointly fulfil this goal and the EC was successful in doing so.

3.4.2 CH_4

CH_4 emissions decreased steadily during the period from 1990 to 2003, from 9798 to 7807 Gg CO_2 equivalent. In 2003 CH_4 emissions were 20.3% below the level of the base year, mainly due to lower emissions from solid waste disposal sites.

3.4.3 N_2O

N_2O emissions in Austria fluctuated from 1990 to 1995, increasing by 7% over this period. Since then emissions have a moderate decreasing trend, resulting in 5 542 Gg CO_2 equivalent compared to 5 712 in the base year, this is 3% below the level of the base year. The decrease is mainly due to lower N_2O emissions from agricultural soils.

3.4.4 HFCs, PFCs and SF_6

HFC emissions increased remarkably during the period from 1990 to 2003 from 219 to 1308 Gg CO_2 equivalent. In 2000 HFC emissions were 136% above the level of the base year (1995). HFCs are used as substitutes for HCFCs (Hydrochlorofluoro-carbons; these are ozone depleting substances), the use of which have been banned for most applications.

PFC emissions show the inverse trend as HFC emissions. PFC emissions decreased remarkably during the period from 1990 to 2003, from 1079 to 103 Gg CO_2 equivalent. In 2003 PFC emissions were 49% below the level of the base year (1995). PFCs are side products of aluminium production, which was terminated in Austria in 1992, since then the main source of PFC emissions is semiconductor manufacture.

SF_6 emissions in 1990 amounted to 503 Gg CO_2 equivalent. They increased steadily until 1996 reaching a maximum of 1 218 Gg CO_2 equivalent. Since then they are deceasing, in 2003 SF_6 emissions amounted to 594 Gg CO_2 equivalent, which is 48% below the level of the base year (1995). The main sources of SF_6 emissions are semiconductor manufacture, magnesium production and filling of noise insulating windows.

3.4.5 Indirect greenhouse gases

NMVOC: Emissions decreased from 286 to 182 g Gg during the period from 1990 to 2003. In 2003 NMVOC emissions were 36% below the level of 1990. The largest reductions since 1990 were achieved in the sectors 'Transport' and 'Solvent and Other Product Use'.

NO_X: Emissions increased from 211 to 229 Gg during the period from 1990 to 2003. In 2003 the NO_X emissions were 9% above the level of 1990. An increase in the sector 'Transport' could not be compensated for by the decrease in the sectors 'Energy Industries' and 'Industry'.

CO: Emissions decreased from 1 244 to 802 Gg during the period from 1990 to 2003. In 2003 CO emissions were 36% below the level of 1990. The trend in CO emissions is decreasing in all sectors, with especially large reductions in the sectors 'Transport' and 'Industry'.

SO_2: Emissions decreased from 76 to 34 Gg during the period from 1990 to 2003. In 2003 SO_2 emissions were 55% below the level of 1990. The largest reductions since 1990 were achieved in the sectors 'Other Sectors', 'Energy Industries' and 'Manufacturing Industries and Construction'.

3.4.6 Land-use, land-use change and forestry

Land use change and forestry is a net sink in Austria. CO_2 removals from that category amounted to 9013 Gg CO_2 in the base year, which corresponds to 11% of national total GHG emissions (without LULUCF) compared to 14% in the year 2003. The trend in net removals from LULUCF is plus 42% over the observed period.

3.5 Fuel split of CO_2 emissions

In 2003 sector 'Fuel Combustion' (1A) accounted for 67.62 Tg emissions of CO_2. Liquid fuels contributed 56% or 38.17 Tg, gaseous fuels 24% or 16.57 Tg and solid fuels 18% or 12.13 Tg. The remaining 1.1 Tg emissions of CO_2 are summed up under 'Other fuels'. Emissions from the combustion of biomass are not taken into account as they are not relevant for CO_2 emissions.

A comparison of the fuel split from 1990 to 2003 shows that the CO_2 emissions from the sector 'Fuel Combustion' increased by 26.6% or 14.2 Tg. The liquid and gaseous fuels show an increase of 10.12 and 5.48 Tg CO_2, respectively, whereas the solid fuels had a decrease of 1.78 Tg.

Chapter 4

Policies and Measures

CONTENTS

An overview of the policy-making process and details on policies and measures for climate change mitigation are presented in this chapter. Additional information, which is related to policies and measures and required by the Kyoto-Protocol, and a summary table on policies and measures can be found at the end of the chapter.

4.1 Policy-making Process

Decisions related to policies and measures can be taken at different levels: Legislative measures at the Federation level and the level of the Länder ("federal provinces"), administrative measures at federal and Länder level, and at the level of districts and municipalities. The Federal Constitution Act contains detailed provisions on the distribution of jurisdictions between the Federation and the Länder. For different issues, the Constitution Act prescribes either legislative and executive power of the Federation, or legislative power for the Federation and executive power for the Länder, or legislative power of the Federation with respect to fundamental principles and legislative power of the Länder with respect to implementation issues as well as executive power of the Länder, or legislative and executive power of the Länder. With regard to climate change, jurisdiction for important fields is shared among the different levels. Private business affairs of Federation, Länder and municipalities (e.g. procurement) are managed independently.

4.1.1 The Federation

Legislation at the Federation level usually starts as a government proposal by drafting a bill in one of the ministries – although, in a "normal", but rarely practised, procedure on grounds of the constitution, the parliament takes the initiative for legislation. The ministry co-ordinates its work with other ministries and takes into consideration the opinions of different interest groups. The bill is then submitted to the Council of Ministers (government). Since unanimity is required in the Council of Ministers, consensus on a bill needs to be provided both politically (i.e. between the parties represented in the government) and technically (between ministries involved). The bills accepted by the Council of Ministers are passed as government bills to the Parliament. The two chambers of the Parliament (Nationalrat and Bundesrat) have legislative power.

The implementation of laws at the Federation level is the responsibility of the appropriate ministers, who are either named in the law in question or whose jurisdiction derives from the Federal Ministries Act. In practice the implementation of laws is the domain of the administration, i.e. of the ministries and their subordinate administrative units. To a great extent, the Länder implement federal laws by way of "indirect federal administration" where the Länder authorities are subject to instructions from the ministers.

Some examples of Federation jurisdiction with respect to climate change are: issues of trade, industry and mining, emissions trading, taxation, price regulation and crisis management for energy supply, transport (e.g. regulations on motor vehicles, infrastructure issues with respect to national railways, roads and waterways).

4.1.2 The *Länder* (Federal Provinces)

The parliaments of the nine provinces or *Länder* ("Landtage") are responsible for legislation in those matters, for which the Federal Constitution Act does not assign jurisdiction to the Federation. Administration in the *Länder* is subordinate to the *Länder* governments. The *Länder* governments are elected by the Länder parliaments; in the majority of the Länder, the governments are proportionally comprised of members of the parties represented in the Länder parliament.

Some examples of *Länder* jurisdiction with respect to climate change are: issues of residential building construction and residential heating; road construction and public transport; and regional planning.

However, Article 15a of the Federal Constitution Act leaves open the possibility to come to agreements among the *Länder* or between *Länder* and the Federation in order to harmonise policies under the respective legal areas of jurisdiction. No party can be forced to enter into an agreement.

In some important climate change-related policies, jurisdiction is distributed among the Federation and the *Länder*, e.g. energy policy, waste management and agriculture.

4.1.3 The Municipalities

Local councils as well as mayors and councillors in charge are subject to democratic voting. Municipalities have executive jurisdiction within the borders set by the Federal Constitution Act and by legislation of the Federation and the Länder. The Federal Constitution Act provides for autonomy in matters of local interest, which can be pursued within the municipal borders (e.g. building inspection, fire precaution, local planning). With respect to private business affairs, municipalities act as economically autonomous organisations. This authorization is widely used, e.g. to hire staff, construct buildings and run enterprises for ensuring the needs of every day life like drinking-water supply, waste disposal or nursery schools.

Policies and measures with respect to climate change at the municipal level range from land-use planning, public transport and local road construction to public buildings and procurement.

4.1.4 Institutional Arrangements for Designing a National Climate Change Programme

The Federal Ministry for Agriculture and Forestry, Environment and Water Management has a co-ordinating function with respect to the overall climate change policy in Austria. However, jurisdiction for measures to reduce greenhouse gas emissions and to fulfil the other obligations of the UNFCCC is distributed among several federal ministries and other territorial authorities (*Länder*, municipalities). To support the co-ordination of measures, different committees have been established.

The *Interministerial Committee to Coordinate Measures to Protect Global Climate* (IMC Climate Change) was founded in 1991 during the preparations for the UNFCCC. It is established at the Federal Ministry for Agriculture and Forestry, Environment and Water Management and consists of representatives of the federal ministries concerned by the subject matter, representatives of the Austrian system of social partnership and a common representative of the *Länder*. It advises the Minister for Agriculture and Forestry, Environment and Water Management on matters concerning climate change activities at the federal level, a. o. for those related to the FCCC and for editing of the National Communications.

After the negotiation of the Kyoto-Protocol and after Austria had committed itself to the demanding 13% reduction target within the EU burden sharing agreement, the *Kyoto-Forum* was established at the Federal Ministry for Agriculture and Forestry, Environment and Water Management in 1999 as an initiative to combine the efforts of the different levels of state. The *Kyoto-Forum*, comprising high-level representatives of the Länder and of the associations of municipalities and towns, shall support and supervise the strategy for reaching the Kyoto-target.

After extensive discussions in these committees and in sectoral working groups Austria's *Climate Strategy 2010* was adopted by the federal government and the council of provincial governors in 2002. After three years of implementation, the effects of *Climate Strategy* have recently been evaluated by independent consultants. The resulting report (Benke et *al*., 2006) provides one of the tools to adapt the Climate Strategy over the coming months. To that end, three sectoral working groups have been re-established (energy, transport, economic instruments) and are mandated to explore and propose the most promising additional policies and measures that could safeguard Austria's compliance with the Kyoto target during the first commitment period. Currently, work to review Austria's *Climate Strategy* is under way. The strategy, referred to as *Draft Climate Strategy II* in this document, has not yet been adopted by the Austrian Federal Government. This package of additional policies and measures is planned to be adopted by the end of 2006. The planned measures shown in this chapter refer to the draft as of August 2006.

It should be highlighted that most *Länder* (e.g. Vienna, Upper Austria, Lower Austria, Salzburg) already formulated their own regional climate change programmes, taking into account specific regional circumstances, needs and areas of jurisdiction. These programmes ideally supplement the national programme, which can only describe at an abstract level framework conditions and guidelines for provincial action.

4.2 Policies and Measures and their Effects

The highly fragmented responsibilities for climate change mitigation among the different levels of state (Federation, *Länder*, municipalities) caused some difficulties for coherent monitoring and evaluation of policies and measures in the past. This is due to a lack of complete and comparable information on policies and measures and also to the fact that many measures, e.g. in energy consumption, transport or waste management, are not undertaken primarily for the purpose of climate change mitigation. A variety of other environmental, social and economic needs are

responsible for specific action. Only in recent years increasing attention has been given to GHG mitigation, which had up to then only been seen as a positive, but rarely measured and evaluated, side effect. As a consequence, estimation of effects on greenhouse gas emissions is impossible for many individual measures undertaken in the past.

In order to improve monitoring and evaluation of policies and measures, the federation and the *Länder* are invited to report progress on the basis of a set of performance indicators that were elaborated by an ad-hoc working group on monitoring, also taking into account indicators that need to be reported on in the framework of the EU decision on GHG monitoring mechanism.

In the following section, GHG mitigation effects are – in most cases – indicated for policy packages or whole sectors. Only in specific cases effects can be assumed for individual measures. Even if effects could be specified for each individual measure, those could not be simply summarised to express the total effect of measures within a sector because of strengthening or weakening impacts between policies and measures. In general, mitigation effects described below are derived from the latest studies and projections.

4.2.1 Energy

Austria's energy policy was laid down recently in the Energy Report 2003 of the Federal Government to the Parliament (FMEL, 2003). Apart from measures that are of an exclusive energy policy nature (e.g. liberalisation of markets, regulatory issues, security of supply), the measures of the Energy Report 2003 correspond to those of the Austrian *Climate Strategy 2010*, just as the results of the ongoing review of the Climate Strategy will be taken into account in the next Energy Report.

In the *Climate Strategy 2010,* policies and measures in the energy sector are broken down into the energy supply and the energy demand sectors. Energy supply (CRF 1.A.1 – "Energy Industries") comprises emissions from electricity generation and district heating, as well as emissions from refineries. Data exclude emissions from autoproducer power plants in the manufacturing industry. Energy demand (CRF 1.A.4. – "Other Sectors") mainly represents emissions from individual heating and hot water preparation in buildings (dwellings, trade and public services), being responsible for around 90% of total emissions covered under "other sectors" (rest: non-heating fuel demand in agriculture and forestry). In some cases, cross-cutting impacts take place, e.g. district heating influences both emissions on the energy supply and energy demand sides; electric heating or cooling as well as electricity demand for, e.g., household appliances have no direct impact on demand side emissions but influence emissions on the supply side (electricity generation).

For reasons of consistency with the *Climate Strategy 2010* and the specific sub-sectoral approaches, policies and measures are described separately for space heating/hot water/electricity demand and energy supply (electricity and district heating) in the following section. Crosscutting impacts of individual policies and measures are highlighted in a transparent manner.

4.2.1.1 Energy Demand

Categories of the Common Reporting Format affected: 1.A.4. ("Other Sectors")
GHG affected: CO_2 (almost exclusively)

CO_2-emissions, which are responsible for roughly 97% of GHG-emissions from the sector, increased slightly over the period 1990-2003 (without adjustments for heating degree days). After a stabilisation at a level significantly above the 1990 level, emissions even declined sharply between 1996 and 1998. Climate adjusted data show stable emissions over the whole period, although the number of dwellings increased substantially from 3.0 million principal residences to 3.3 million between 1990 and 2003, mainly due to population growth. At the same time, average numbers of persons per dwelling fell from 2.6 to 2.4 while net square metres per dwelling increased. Also trade and public service sectors had rising demand for building net square meters. Efficiency of heating systems and buildings could be improved accordingly, due to technical progress, strengthened legal standards and better public support schemes for energy efficient buildings and heating systems.

Renewable energy sources for heating in households, notably individual wood-fired heating systems, came under increasing pressure during the 1990ies. The number of households with wood-fired systems shrank by 27% between 1993 and 2003, mainly due to price pressure from fossil fuels and a general trend towards more comfortable heating systems. The relative market share declined from 21% in 1990 to 14.3% in 2003. However, modern wood heating systems, which can be fired comfortably with "pellets" and wood-chippings, stopped or probably even reversed the negative trend over the past years. This development was also significantly influenced by rising energy prices for fossil fuels and improved support schemes for bio-heating systems (see below). Also positive, from an environmental perspective, is a more than 150% increase in households with district heating since 1990, holding a market share of almost 20% in 2003.

Installation of gas-fuelled systems in households increased substantially between 1990 and 2003 by 42.5%. The relative increase of oil-fuelled systems amounted to 6%. However, in recent years (1999 to 2003), oil-based systems showed a revised trend with a decreasing share by 2% (gas: +4%). Coal-fired systems in households were reduced by more than 85% since 1990, with a still shrinking market share of only 2% in 2003. It should also be mentioned that density of thermal solar use is among the highest in Europe. About 2.8 million square metres were installed by the end of 2004, corresponding to 0.34 square meters per resident.

The strategy to reduce GHG emissions from space heating is based on the following pillars:

- Thermal improvement of existing building stock
- Enhanced technical standards for new buildings
- Increasing share of renewable energy sources and district heating
- Increasing boiler efficiency
- Increased use of heat pumps
- Switching to fuels with lower (fossil) carbon content

The most important instruments with regard to these targets are *Technical Construction Regulations*, *Housing Support Schemes* (both under sole jurisdiction of the *Länder*) and *Federal Funds* to support district heating and entrepreneurial use of renewable energy sources and efficiency improving measures (trade, industry and agriculture). The federal level is also responsible for civil law with respect to residential matters.

Implemented Policies and Measures

M1 Minimum thermal standards for buildings

Implementing entities: Länder
GHG affected: CO_2
Type of policy: regulatory

Thermal minimum standards for buildings are defined in the Technical Construction Regulations of the *Länder*. In all regulations, the thermal standard of buildings is determined by way of U-values (=k-values) for different construction components (see table below) and/or certain energy demand codes for the whole building in line with the new Directive of the European Community on the energy performance of buildings (see below under M4).

In most provinces it is a prerequisite for receiving financial support through the housing support schemes that energy demand indicators are better than the corresponding minimum standards of the Technical Construction Regulations (see below).

Table: minimum U-values in Technical Construction Regulations of the *Länder*

Component (selection)	Burgenland	Carinthia	Lower Austria	Upper Austria*	Salzburg	Styria	Tyrol	Vorarlberg	Vienna*	"Energy Saving-Agreement"
Exterior walls	0,38	0,40	0,40	0,50	0,35	0,40-0,50[1]	0,35	0,35	0,50	0,50
Roofs	0,20	0,25	0,22	0,25	0,20	0,20	0,20	0,25	0,25	0,25
Windows	1,70	1,80	1,80	1,90	1,70	1,90	1,70	1,80	1,90	1,90
Exterior doors	1,70	1,80	1,80	1,90	1,70	1,70	1,70	1,90	1,90	1,90
Ceiling against unheated space	0,35	0,40	0,40	0,45	0,40	0,40	0,40	0,40	0,45	0,45

* Limited expressiveness for Upper Austria and Vienna since building-energy codes apply which are more demanding than the sum of U-values for individual components.

The *Länder* of Burgenland and Salzburg have improved U-values since Austria's Third National Communication and most *Länder* meanwhile go well beyond the minimum standards set forth in an "Energy Saving Agreement", signed in 1995 by the

[1] Differentiation between one-/two-family houses and larger residential buildings

nine provinces and the federation according to Article 15a of the Federal Constitution Act.

In case of the provinces of Upper Austria, Salzburg and Vienna, minimum energy codes for buildings, which depend on heated floor space or volume or geometry of buildings, are applied primarily. U-values for individual construction components only have supplemental character in these cases, since the energy code for the whole building provides for a much better standard then by application of the summarised U-values for individual parts.

In general, Technical Construction Regulations apply to newly constructed buildings only (except, e.g., change of windows). As long as no obligatory standards for renovation measures exist, thermal standards of the old building stock therefore need to be influenced mainly by other instruments, especially public support schemes for renovation (see below).

M2 Housing support schemes – Constitutional Treaty between Federation and Länder
Implementing entities: Länder
GHG affected: CO_2, HFC
Type of policy: promotive

The *Länder* administer subsidies of more than 2 billion € annually for housing support programmes. Therefore, a majority of dwellings is constructed or renovated with public support. The financial support allocated to housing support schemes is guaranteed by the Financial Distribution Act (allocating federal tax revenues to executive bodies on federal, provincial and municipal level) for the years 2005–2008 and needs to be re-negotiated for periods thereafter.

The large amount of public money involved in the housing sector is of significant relevance for heating related energy demand and CO_2 emissions. Specific schemes can give relevant incentives for more sophisticated energy solutions, like solar heating systems, optimised thermal insulation or even “zero-energy-houses”. Therefore, the Environment Minister, representing the federal government, entered into a constitution based treaty (according to Art. 15a of the Federal Constitution) with the *Länder* aiming at optimising the use of subsidies for housing schemes by introducing minimum standards with respect to energy profiles. This type of treaty is legally binding and needs to be implemented in legal terms by the Parties until January 2007.

The agreement provides for:

- shift of subsidies from construction of new dwelling to thermal renovation of existing dwellings;
- high quality standards for thermal renovation, including the whole building shell (exterior walls, windows and doors, ceilings and roof);
- maximum energy performance codes for newly constructed buildings that go well beyond standards that are foreseen in general construction codes;
- replacement of old fossil fuel heating systems by highly efficient systems based on renewable energy (solar or biomass) or natural gas.

A common reporting format, including performance indictors, will provide for homogenous monitoring of the effects induced by housing schemes in terms of CO_2 emissions reductions and associated costs.

M2.1 Thermal insulation of dwellings
Implementing entities: Länder
GHG affected: CO_2, HFC
Type of policy: promotive

A large proportion of existing dwellings in Austria were built between 1950 and 1980. Technical building standards of that period by far did not meet today's requirements in terms of energy efficiency. Consequently, thermal standards of a large proportion of Austrian dwellings are very low. Austria's Climate Strategy therefore sets an important priority on thermal renovation of buildings by shifting and fine tuning of housing subsidies and improving thermal minimum standards.

Almost all *Länder* introduced new support schemes for thermal renovation of dwellings over the past years. The above mentioned treaty between the *Länder* and the Federation provides for a further shift in quality of renovation schemes. Housing support for thermal renovation needs to cover the whole thermal shell of buildings, including walls, roofs, windows, doors and cellar ceilings. In every single case the amount of support has to be differentiated according to the achieved reduction in heating demand. To achieve the required total effect of renovation schemes, the *Länder* shall make efforts to shift significant amounts of housing support from new construction to renovation.

M2.2 Support schemes for energy efficient construction
Implementing entities: Länder
GHG affected: CO_2, HFC
Type of policy: promotive

In the past, public support programmes for construction of new dwellings have not had the intended effects concerning CO_2 emissions, as they have lacked sufficient quality standards. During recent years, all *Länder* have started to introduce specific incentive schemes for energy efficient construction (improved insulation, zero energy houses etc.) and the use of renewable energy sources, such as heating systems based on biomass and solar installations.

The new treaty between the Länder and the Federation on quality standards for housing support scheme now provides for a further fundamental improvement. To be eligible to subsidisation, certain building codes (heating demand), which are generally much stricter than the combined effectiveness of U-values of the technical construction regulations (compare table under M2), need to be achieved by constructors, providing that each subsidised dwelling now fulfils the standard of "low energy buildings". Consequently, buildings just fulfilling the existing technical construction standards are not eligible to any public financing from housing support schemes.

M2.3 Housing support for use of renewable energy
Implementing entities: Länder
GHG affected: CO_2, HFC
Type of policy: promotive

Most *Länder* in Austria support the replacement of old heating systems within their housing schemes, although most of these programmes are more targeted towards reducing air pollutants than greenhouse gas emissions. The *Climate Strategy* and the new treaty between the Federation and the *Länder* follow the intention that replacements should only gain support if old fossil fuel systems are replaced by highly efficient systems based on renewable energy (solar or biomass) or natural gas, when available. Promotion – both in terms of financial support and information campaigns - for the energetic use of biomass in households is important to compensate for rather shrinking market shares in comparison to natural gas and fuel oil. Especially wood pellets technologies have proved to be competitive with fossil fuels, both with respect to fuel prices and handling convenience.
In addition, the *Länder* continue to promote the connection with existing or new (often biomass-fired) district heating, which is a specifically successful strategy to mitigate GHG emissions in urban areas or rural communities.

M3 Third Party Financing ("Contracting") for public buildings
Implementing entities: Federation, Länder, Municipalities
GHG affected: CO_2
Type of policy: economic/voluntary

The energy performance contracting (EPC) market in Austria already has left first steps behind. The learning-by-doing period with this fairly new instrument for cost-effective energy-saving measures has already led to substantial GHG-reductions in the sector of public buildings. A further stimulation of demand within the energy performance contracting market can be expected not only in the segment of public buildings but also in the private service sector, in industry and – under certain circumstances - even for residential buildings.

Third Party Financing (TPF) proofed to be an effective instrument in areas where energy demand could be reduced significantly by means of measures and investments with "save" pay-back periods of between 5 and 10 years. The third party investor guarantees by contract a certain amount of energy cost reductions, which (or parts of which) are the "salary" for the investments and demand-side energy services for a specified period. The instrument seems to be tailor-made for the public building sector, as it responds effectively to the stringency of rather short-term budget time frames and a tendency to rather limited cost awareness and responsibility.

After the impressive success of a pilot contracting initiative for school buildings (described in NC3) the federal government decided in March 2001 to launch a Programme on Third Party Financing (Contracting) for energy-saving investments in federal public buildings.

About 300 properties were selected for the project with about 500 suitable buildings for EPC. After two years of project management, remarkable results can already be monitored. For nearly 400 buildings, suitable energy saving contractors have already

been found. Average savings of 20% of the annual energy costs are guaranteed for these buildings within the contract period (ten years).

The 300 selected properties belong to the following agencies of the federal government:

- Federal Ministry for Education, Science and Culture
- Federal Ministry of Finance
- Federal Ministry of Justice
- Federal Ministry for Economy and Labour
- Federal Ministry for Agriculture, Forestry, Environment and Water Management

Public high schools are currently mostly affected by the programme.

The project is handled by a cooperative association of the Ministry of Economic Affairs and Labour (BMWA), the Ministry of Agriculture and Forestry, Environment and Water Management (BMLFUW) and the Federal Building Property Company (Bundesimmobiliengesellschaft – BIG). The cooperative association is advised in technical and organizational matters by the Austrian Energy Agency (AEA).

The federal government – as building owner and user – will be able to save about 1.4 million € in energy costs annually during the ten-year contract because it participates immediately in the savings. After the end of the contract duration, i.e. after the measures pre-financed by the contractor have been refinanced from the savings, the federal government then enjoys the benefits of the entire energy savings (approx. 6.9 Mio. €/year). Because EPC involves a service that also includes technical operations, inspection and parts of the maintenance tasks, significant savings also arise in this area. An estimate shows annual cost savings in the magnitude of 2 to 3 million € just in the operating, inspection and maintenance of the technical energy systems. After the expiration of the contract, it can be expected that the costs for this item will rise again as the contractor is no longer responsible for the systems and separate maintenance contracts will have to be concluded once again.

The savings are associated with significantly lower expenses for the preparation and processing of the initiative. The one-time expense for the professional processing and handling of the invitation to tender is approximately 700,000 € (divided among two years). An annual 113,000 € will be incurred during the contract period for the ongoing project controlling.

Through the contracting offensive, 10 % of the CO2 emissions will be saved among all BIG owned buildings used by the federal government. Through ongoing general renovations of additional federal buildings, another 7% of the CO2 emissions can be reduced in the coming years. Therefore the initiative is expected to result in a total reduction of CO_2 emissions by 70-100.000 t p.a. by 2012.
As such, the federal government will not only achieve the Kyoto goals within its organization, but also fulfil its role as a model for private building managers.

Similar *Contracting Programmes* also take place in the *Länder*; in some cases in direct conjunction with funding schemes (see above M2). Several new initiatives are planned to improve conditions and raise the acceptance of this relatively new instrument with respect to public provincial and municipal buildings.

Adopted Policies and Measures

M4 Improvement of technical building standards and energy codes for buildings

Implementing entities: Länder
GHG affected: CO_2
Type of policy: economic/information

The *Länder* already reached a technical agreement on a common scheme for an energy code for buildings. Such an instrument, which is also recommended by the so called SAVE directive (93/76/EEC) of the European Community, is expected to give appropriate price signals on the real estate market since energy consumption of houses, apartments and offices become transparent for the consumer. Further progress in this direction is to be expected from the Directive on the Energy Performance of Buildings (2002/91/EG). Member States need to implement the laws, regulations and administrative provisions necessary to comply with this Directive by 2006.

The basic objective underlying this Directive is to promote the improvement of the energy performance of buildings within the EU, ensuring in so far as possible that only such measures as are the most cost-effective are undertaken.

The Directive covers four main elements:

- Establishment of a general framework of a common methodology for calculating the integrated energy performance of buildings.
- Application of minimum standards on the energy performance to new buildings and to certain existing buildings when they are renovated.
- Certification schemes for new and existing buildings on the basis of the above standards and public display of energy performance certificates and recommended indoor temperatures and other relevant climatic factors in public buildings and buildings frequented by the public.
- Specific inspection and assessment of boilers and heating/cooling installations.

The preparations in Austria to bring the Directive into force are still under way and the implementation into national law will be finished during 2006.

Regarding to the Austrian allocation of rights and duties the main part of the implementation has to be worked out through the Länder. Meanwhile the Länder are working on a uniform implementation, which means that they have to reach a consensus in several questions as the Länder have mainly different regulations in the affected topics.

The methodical basics for calculating the energy performance and for the energy performance certificate are regulated in the already elaborated directive “Energieeinsparung und Wärmeschutz” of the Austrian Institute for Construction Technique (OIB). This directive is currently in survey.

Legal prerequisites for the issuance of energy performances certificate for owners, prospective buyers or tenants will be brought into force through the “Energieausweis-Vorlagegesetz”.

Planned Policies and Measures

The measures described above already cover the most relevant aspects relating to energy demand; however, additional mitigation potentials are expected in these areas. An intensification of M2, M3 and M4 is planned.

Estimated total GHG emissions reduction from planned policies and measures, excluding effects of electricity demand side measures: 3.6 Mt CO_2-equiv.

4.2.1.2 Energy Supply

CO_2 emissions from energy supply in Austria depend considerably on annual climatic conditions. As a consequence, the share of electricity production from renewable hydropower varied between 57% and 73% over the past years (2004: 61%), with respective impacts on emissions from caloric electricity generation. At the same time, CO_2 emissions from district heating corresponded to temperature-induced heating energy demand during the winter season.

The role of renewable energy sources and efficient district heating systems

In 2004, renewable energy sources accounted for 21.5% of gross domestic energy consumption (1990: 20.8%). Hydropower held a share of 9.4%, wood and bio fuels accounted for around 10%. In absolute numbers, energy production from renewables increased considerably since 1990, when a level of 219 PJ was reached. In 1999, 288 PJ of gross domestic energy consumption was produced by renewable energy sources. Production did further increase in recent years and reached a level of 300 PJ in 2004.

Electricity production

A further orientation of the Austrian energy supply system towards renewable energy sources is technically, and due to substantial potentials, possible, even under the assumption of rising energy demand, however, economic aspects and system impacts need to be considered accordingly. This will require a combination of various technologies in an inter-connected system of centralised and decentralised plants to meet the different customers’ demands. Generally spoken, the liberalised electricity market within the European Union is an advantage in terms of market access for independent power producers. On the other hand, increasing pressure on end consumer prices for electricity can be a market entrance barrier for new technologies, such as wind power, PV etc. The Green Electricity Act responds to that barrier with fix feed-in tariffs, which cover supplemental costs of electricity production from “new

renewables" (see below). This policy has led to a noticeable increase in the electricity supply from clean sources such as wind energy, biogas, biomass, etc.

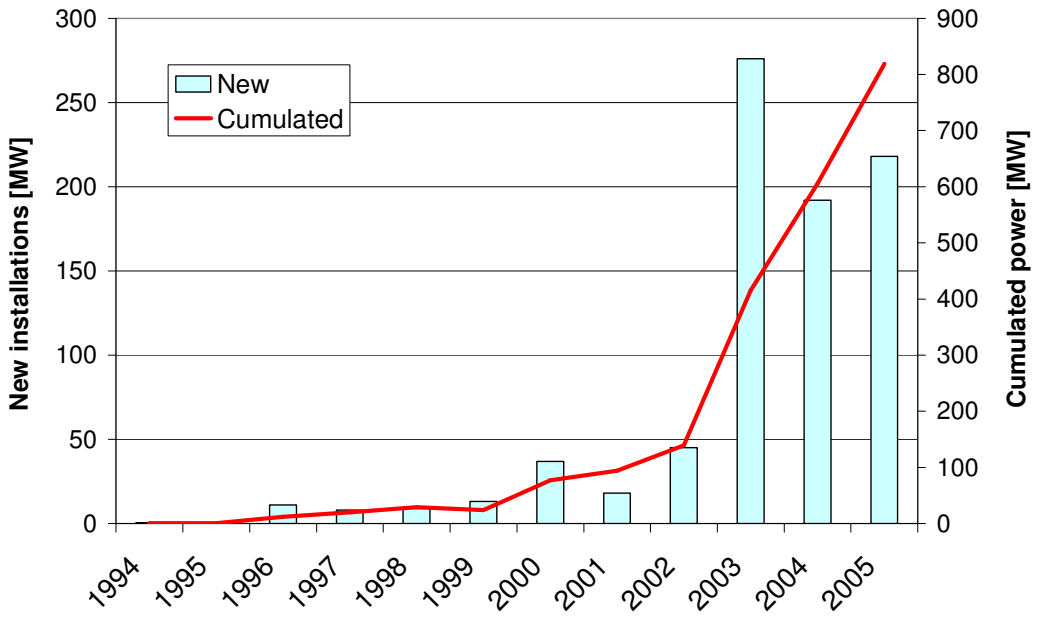

Fig. 4.1: Development of wind energy (new installation per year and cumulated power) (Data: E-Control GmbH)

Table 4.1: Development of domestic production of renewable energy sources in Austria in relation to gross domestic energy consumption 1997-2004 (Data: Statistics Austria)

	1997	1998	1999	2000	2001	2002	2003	2004
Gross domestic energy consumption (TJ)	**1.211.711**	**1.229.329**	**1.225.448**	**1.217.160**	**1.285.911**	**1.302.177**	**1.387.085**	**1.394.573**
Domestic energy production from RES (TJ)	**264.042**	**262.013**	**288.619**	**284.850**	**291.689**	**289.303**	**281.794**	**300.083**
Solar, geothermal, heat pumps.	5.716	6.175	6.870	7.417	7.042	7.568	8.107	8.627
Biomass/ Bio fuels	47.939	44.714	55.732	54.961	61.341	60.705	72.456	76.183
Firewood	67.206	64.881	65.936	58.624	64.482	60.782	63.872	60.734
Wind/photovoltaic	80	171	190	252	634	755	1.358	3.367
Sub-total	**120.941**	**115.941**	**128.728**	**121.254**	**133.498**	**129.810**	**145.793**	**148.911**
Hydropower	129.979	133.788	145.775	150.621	144.674	143.752	118.363	131.122
Sub-total	**250.920**	**249.728**	**274.502**	**271.876**	**278.172**	**273.562**	**264.156**	**280.033**
Burnable waste	13.122	12.284	14.117	12.974	13.517	15.741	17.637	20.050
Gross domestic energy consumption	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**
Domestic energy production from RES	**21,79%**	**21,31%**	**23,55%**	**23,40%**	**22,68%**	**22,22%**	**20,32%**	**21,52%**
Solar, geothermal, heat pumps	0,47%	0,50%	0,56%	0,61%	0,55%	0,58%	0,58%	0,62%
Biomass/ Bio fuels	3,96%	3,64%	4,55%	4,52%	4,77%	4,66%	5,22%	5,46%
Firewood	5,55%	5,28%	5,38%	4,82%	5,01%	4,67%	4,60%	4,36%
Wind/photovoltaic	0,01%	0,01%	0,02%	0,02%	0,05%	0,06%	0,10%	0,24%
Sub-total	**9,98%**	**9,43%**	**10,50%**	**9,96%**	**10,38%**	**9,97%**	**10,51%**	**10,68%**
Hydropower	10,73%	10,88%	11,90%	12,37%	11,25%	11,04%	8,53%	9,40%

Sub-total	**20,71%**	**20,31%**	**22,40%**	**22,34%**	**21,63%**	**21,01%**	**19,04%**	**20,08%**
Burnable waste	1,08%	1,00%	1,15%	1,07%	1,05%	1,21%	1,27%	1,44%

Heat production:

The situation is different for bio-energy heating systems without power generation. Tariff policy or new economic instruments, like quota and trading systems, are not applicable in the same way as for electricity from renewables. "Traditional" investment funding, therefore, has to take place. The use of bio-energy in regional district heating systems has already gained considerable status in Austria. This is to a large extent due to existing public support schemes, granted both by the federal government and the Länder, and in many cases co-funded by the European Union. By the end of 2004, 1002 biomass district heating systems with a total performance of 1132 MW existed, predominantly in rural areas. Further 600 so called biomass microsystems were in operation by the end of 2003, especially for heating of building complexes like hotels, swimming baths, schools etc. Federal support for energy from biomass projects amounted to around 15 million € in 2004, supplemented by a further approximately 9 million € from the *Länder* and the EU.

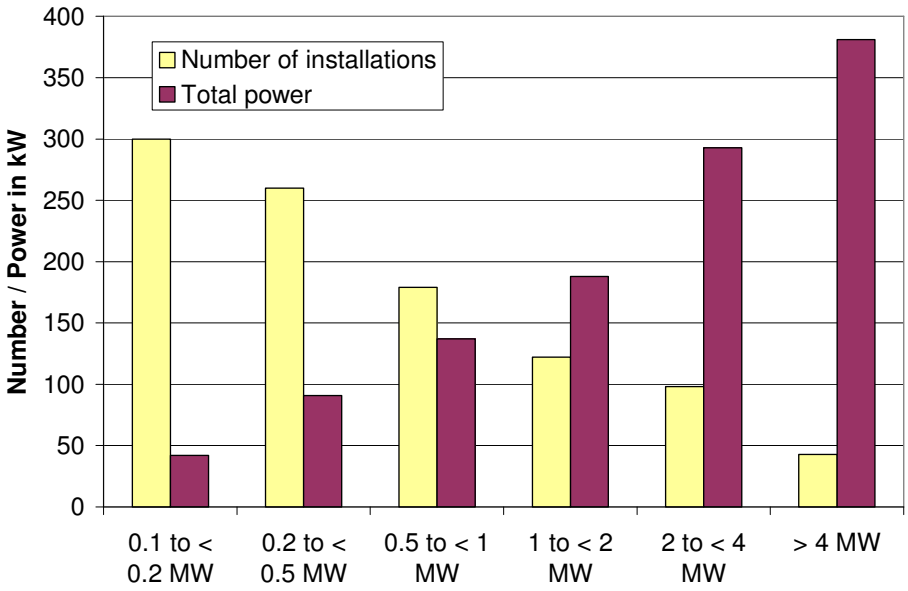

Fig. 4.2 District heating systems (divided into number and power) (Data: Austrian Energy Agency)

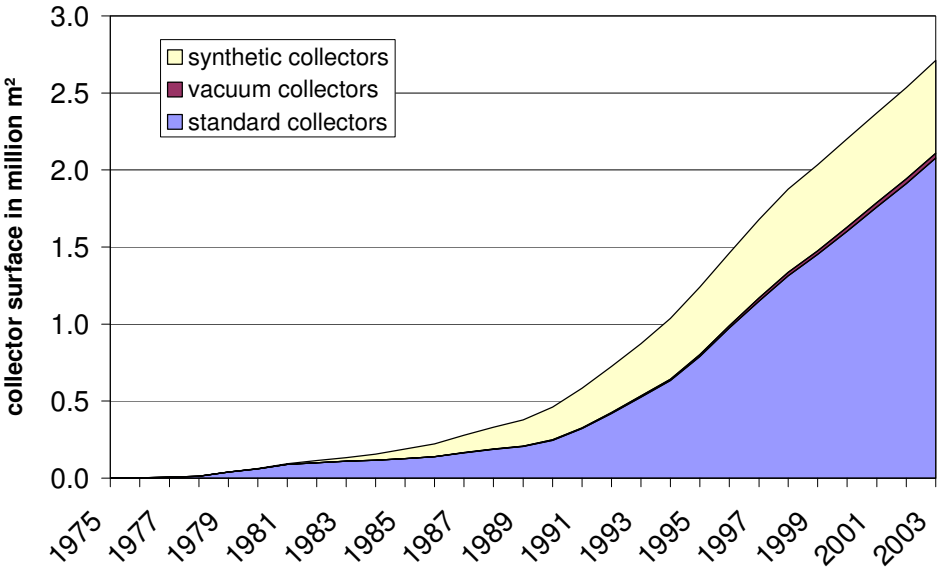

Fig. 4.3 Development of solar panels in Austria (cumulated square metres installed; Data: G. Fanninger)

Implemented Policies and Measures

M5 Promotion for electricity from renewable energy sources
Implementing entities: Federation, Länder
GHG affected: CO_2, CH_4
Type of policy: regulatory / economic

Austria has a leading role with regard to the production of electricity from renewable energy sources. In 1997 the share of electricity demand met by renewables stood at 70%.This was taken as the base level for the target under Directive 2001/77/EC on the promotion of electricity produced from renewable energy sources: Austria has committed itself to a rise in the share of gross domestic consumption accounted for by “green” electricity from 70% to the indicative target of 78.1% in 2010. According to a footnote in the EU Directive on Electricity Production from Renewable Energy Sources Austria has limited this increase to around 5 TWh.

Directive 2001/77/EC was implemented through the Green Electricity Act (BGBl I No. 149/2002 amended by BGBl. I No. 105/2006). The Act not only addresses the main issues raised by the Directive but also unifies the system for promoting alternative energy forms, which had hitherto been disparate. The Green Electricity Act entered into effect on 1 January 2003 and is aimed at:

- A single federal support payment scheme for “other” green power, small hydro and combined heat and power (CHP) was introduced;
- A uniform feed-in tariff scheme was introduced for all eligible renewable energy sources;
- The minimum target contribution from small hydro in 2008 was raised from 8 % to 9 % of total supply;
- The minimum target contribution from “other” green power in 2008 was set at 4 %;

- Increasing the share of “green” power from 70% (status in 1997) to the indicative target of 78.1% in 2010 in accordance with Directive 2001/77/EC;
- The targets for “other” green power and small hydro relate to Austria as a whole;
- Uniform feed-in tariffs and surcharges (support contributions) were introduced for the whole of Austria. In the case of small hydro power this resulted in a changeover from a certificate to a feed-in tariff system on 1 January 2003.

Under this support system the control area managers have a take or pay obligation in their role as “green” power balancing group representatives. They must allocate “green” power to the electricity traders in proportion to the latter’s annual sales volume.

The feed-in tariffs are fixed by the Minister of Economic Affairs and Labour in consultation with the Minister of Justice and the Minister of Agriculture and Forestry, Environment and Water Management, as well as the *Länder* (Feed-in Tariff Order, FLG II No. 508/2002 of December 2002).

This order applies to all new plant licensed up to the end 2004 and built up to June 2006, as well as existing small hydro plants. Due to an amendment of the Feed-in Tariff Order Biomass-plants and hydropower-plants have to build up until the end of 2007.

The entry into force of the Green Electricity Act led to a substantial expansion of green electricity generating capacity as a whole. In absolute terms the greatest increase between the first half of 2003 and the same period of 2005 was in wind power capacity (from 131 GWh to 711 GWh). Small hydro makes the largest contribution to power supplies, at 4,000 GWh per year. According to E-Control forecasts, the 4 % target for “other” green power (wind, biomass, etc.) by 2008 will be reached already in 2005.

The table below shows the evolution of Austrian green power output (in GWh) supported by fixed feed-in tariffs from 2002 to 2006 (figures for 2006 estimated on the basis of accredited capacity).

Table 4.2 Subsidised renewable electricity [in GWh] from 2002-2006 (2006 estimated) (Data: E-Control GmbH)

Energy source	**2002**	**2003**	**2004**	**2005**	**2006**
Wind	203	366	924	1,320	1,680
Solid biomass	95	99	313	551	1,365
Biogas	20	42	102	219	300
Liquid biomass	3	2	18	33	84
PV	3	11	12	13	12
Other supported green power	88	78	76	65	110
Total "other" green power	**412**	**598**	**1,445**	**2,200**	**3,551**
Small hydro	4,243	3,386	3,995	3,558	4,411
Tot. supported renewable electricity	**4,655**	**3,984**	**5,440**	**5,759**	**7,962**

In case of combined heat and power the Directive 2004/8/EC of 11 February 2004 on the promotion of cogeneration based on a useful heat demand in the internal energy market has to be implemented in national law until 21 February 2006.

The purpose of this Directive is to increase energy efficiency and improve security of supply by creating a framework for promotion and development of high efficiency cogeneration of heat and power based on useful heat demand and primary energy savings in the internal energy market, taking into account the specific national circumstances especially concerning climatic and economic conditions.

As most articles in the Directive are recommendations only the following three articles of the Directive have to be implemented in Austria:

- Uniform calculation methodology for efficiency criteria of cogeneration (article 4)
- Guarantee of origin of electricity from high-efficiency cogeneration (article 5)
- Establishment of an analysis of the national potential for the application of high-efficiency cogeneration, including high-efficiency micro-cogeneration (article 6)

The implementation of these articles is according to the responsible Ministry of Economic Affairs and Labour well under way.

M6 Public support for renewable energy projects and district heating
Implementing entities: Federation, Länder
GHG affected: CO_2
Type of policy: promotive

Most renewable energy projects still cannot be realized economically without public support. Climate change response measures in the field of renewable energy and energy efficiency have been supported through federal funding schemes with a total amount of 163.5 million € between 2002 and 2005.

Federal Environment Fund

Implementing entity: Federation

The Federal Environment Fund is enabled to fund environment projects with a total budget frame of 69.2 million € in 2005. Over the past years, increasing priority has been given to climate change related domestic projects. In 2005, 81% of the funding sum was dedicated to domestic projects with direct implications on GHG emissions, and that share will even be extended. For the budget period 2006, the total budgetary frame shall been increased to reach 80.2 million EURO, which means, that starting from a granting frame 2003 of 47.238 € the annual granting frame was raised year by year by 11 million EURO. All *additional* funding (i.e. 66 million € from 2004 to 2006) will be channelled for climate change purposes.

Over the past years, funding focused on biomass and biogas district heating, entrepreneurial biomass central heating systems, solar panels and energy efficiency measures, small hydro and wind power stations and thermal renovation of entrepreneurial buildings.

Since the Green Electricity Act stipulates that feed-in tariffs have to be set at a level that makes the production of electricity from renewable sources competitive, the Federal Ministry of Environment has phased out subsidies for those technologies.

Table 4.3 Climate change related funding in Austria under the Federal Environment Fund and CO_2 emissions mitigation effects, 2002-2005

Year	Investment costs (EUR)	Subsidies (EUR)	CO_2-reduction (t/a)	Lifetime CO2-reduction (t)	EUR/t CO_2
2002	194 401 556	45 972 927	675 727	9 857 735	4.66
2003	169 529 763	35 779 725	686 468	8 720 278	4.10
2004	265 530 178	50 646 662	553 215	9 071 663	5.58
2005	299 104 456	55 505 783	634 334	10 226 482	5.43
Total	928 565 953	187 905 096	2 558 744	37 876 158	4.96

Rural funding schemes for energy from biomass

Implementing entities: Federation, Länder, EU

The Ministry for Agriculture and Environment, the *Länder* and the European Union also provide funding for rural biomass energy projects. Total public funding for those projects, like district heating from wood chippings, biogas CHP or individual biomass heating systems in average amounted to roughly 14 million € annually over the past years, involving total investment costs of 39 million €.

A remarkable development can be observed in case of biogas energy installations, also due to the minimum feed-in tariffs guaranteed by law (see measure M5). In 2004 and 2005 alone, electricity capacity of biogas plants could be increased by more than 400%. At present a total capacity of 71 MW_{el} have been approved and has to be build up until the end of 2007. Mostly affected by that development are agricultural plants, which on the basis of methane from crop and manure produce electricity and heat. Emissions situation can be improved in a multiple way:

- N_2O emissions from use of mineral fertiliser can be avoided due to high fertilising value of residues;
- CH_4 emissions from livestock can be avoided to a large extent;
- use of fossil fuels can be substituted.

Improved coordination of climate change-related funding schemes

The above-mentioned Federal Environment Fund and the rural funding have had some overlapping and conflicting objectives in the past. The Environment Fund focuses on the support of entrepreneurial projects, whereas the rural funding follows agricultural targets. Taking effect from 2001, a better coordination with respect to funding objectives and administration of the Federal Environment Fund (see above) and the rural funding scheme guarantees more effective funding than in the past. Apart from more efficient and effective funding, it can be expected that *more* public funding will be given for renewable energy projects. This is due to a step-by-step increase of both federal *and* provincial money (see above).

Planned Policies and Measures

M7 Further development of targets for renewable energy sources and implementation of the EU directive on renewables

Implementing entities: Federation
GHG affected: CO_2
Type of policy: regulatory/economic

The EU Directive on Electricity Production from Renewable Energy Sources sets indicative targets for each Member State for the year 2010 (see also above). According to that legal act, Austria has to set an indicative national target that takes into account the reference value laid down in the directive, equivalent to an increase of the share of electricity from renewable energy sources from 70% in 1997 to 78.1% in 2010. The figures include large hydro as well as a broader definition of the term "biomass" and are, therefore, not directly comparable with "new renewables" targets from the Electricity Act. According to a footnote in the EU Directive on Electricity Production from Renewable Energy Sources Austria has limited this increase to around 5 TWh ("Austria states that 78.1 % would be a realistic figure, on the assumption that in 2010 gross national electricity consumption will be 56.1 TWh"). In the opinion of the European Commission the increase of electricity demand up to 2010 has to be taken into account; in that case the indicative target would be equivalent to additional 19–20 TWh electricity from renewable energy sources by 2010 compared to around 39 TWh supplied by all renewables in 1997 (due to an annual increase of more than 2% according to latest energy scenarios; Kratena and Wüger, 2005).

In addition, a new EU directive on electricity production from efficient CHP plants makes necessary further efforts of increase the share of that environmentally friendly way of fossil fuel use.

An amendment to the Green Electricity Act has been adopted by Parliament in 2006 (BGBl. I No. 105/2006). According to the adopted legislation, the share of "new" renewable energy sources for electricity production (wind, biomass, PV, geothermal) has to reach 10% of total production in 2010. In addition, a new investment funding scheme is planned for medium sized hydropower plants (10-20 MW) and highly efficient fossil fuel CHP plants.

However, the targets will only be in reach when supplementary efforts will be made to slow down the growth in electricity demand. Measures to that end are described in Austria's *Climate Strategy 2010* (adopted by government in 2002), e.g. contracting initiatives, energy consulting, "green public purchasing" etc.

M8 Energy Efficiency Programme

Implementing entities: Federation, Länder
GHG affected: CO_2
Type of policy: promotional

The main driving factor for rising CO_2 emissions from energy supply (mainly electricity production) over past years was the increase rate in electricity demand of

annually about 2.3%. Despite increased electricity production from wind, biomass and other renewables, the share of production from caloric power plants (mainly coal and gas fired) was also increased to cover demand. Additional policies and measures are therefore needed to further decouple energy demand growth from GDP growth.

At EU level, the Council and the Parliament decided on a directive on energy efficiency and energy services by March 2006. The main target of the directive is to decrease energy end use intensity by 9 percent over a period of 9 years. The directive needs to be legally implemented by Member States until spring 2007. As a first step, Member Sates are obliged to elaborate energy efficiency action plans which need to be reported to the European Commission by 30 June 2007.

Due to Austria's Draft Climate Strategy II, efforts are in a planning stage to considerably decrease energy end use intensity in the households, services and industry sectors with a view to meeting an indicative target of 2% annually. Details of the programme, including financial aspects, are still under discussion. The Climate Strategy evaluation report showed that reduction in electricity demand in the mentioned sectors could result in a cut of CO_2 emissions in the energy supply sector by approximately 1.2 million tons annually.

In addition to M7 and M8, an intensification of M6 is considered.

Estimated GHG emissions reduction from planned measures in the Energy Supply Sector (without contribution from EU ETS): 2.2 Mt CO_2-equivalent p.a.

4.2.2 Waste Management

Categories of the Common Reporting Format affected: 6., 1.A.1. 1.A.4.
GHG affected: CH_4, CO_2

In 1990, CH_4 emissions from waste management sources in Austria amounted to 6.2 Mt CO_2 equivalent. This was the highest level ever measured from the sector, but emissions were considerably reduced in the years following. In 1999, emissions amounted to 5.2 Mt (minus 16%) and the trend analyses projects a further significant reduction by 2010, not only of methane, but also of CO_2 emissions from other sectors (households, energy, and industry) due to waste incineration in Combined Heat and Power (CHP) plants.

Considering that in 1990 the Waste Management Act entered into force, a mitigation trend in emissions was expected. The success is mainly due to improved landfill gas recovery and rising quota of separate collection and treatment of waste (e.g. packaging waste, bio waste).

Waste management, namely waste incineration, also has significant influence on CO_2 emissions, both in a positive and negative way. Combustion of plastics (and co-firing of fossil fuels) causes additional CO_2 emissions, but it avoids long term CH_4

emissions from organic carbon. When the incineration plant is equipped with CHP technology, waste incineration also avoids large quantities of CO_2 emissions in other sectors (households, energy industry). On condition of energy efficiency and other high technical standards, which reduce "traditional" pollutants to an absolute minimum (environmental impact assessment!), incineration seems to be the environmentally most attractive way of residual waste[2] treatment.

Implemented Policies and Measures

M9 Waste Management Act 1990, amended 2002

Implementing entities: Federation, Länder
GHG affected: CH_4, CO_2
Type of policy: regulatory

At the national level the *Federal Waste Management Act* 2002 (Abfallwirtschaftsgesetz 2002) determines the objectives and principles of waste management in Austria, in general. Furthermore it regulates the collection and treatment of hazardous waste in any respect. The collection and treatment of non-hazardous waste is also regulated by provincial governments.

The Overall Targets of the Waste Management Act are defined as follows:

1. Minimisation of waste management's impacts on human beings, fauna, flora and natural environment;
2. Preservation of energy and other resources;
3. Minimisation of landfill volume;
4. Final disposal of waste only when guaranteed, that following generations will not be endangered.

Consequently, Austrian waste management policy follows as leading principles:

1. Prevention of waste;
2. Waste recovery (recycling or incineration with energy recovery);
3. Controlled disposal of waste, which cannot be further utilised (after biological, thermal or chemical-physical treatment).

These principles are also in line with the Council Directive 75/442/EEC on Waste, although most Austrian standards, implemented by regulations, go beyond those at the community level. This does not necessarily cause legal conflicts, as far as domestic provisions do not distort competition in the common market.
The Waste Management Act is implemented through several regulations. The most important of these in terms of potential GHG reductions is the Landfill Regulation.

[2] I.e. waste from households and similar waste fractions from businesses after separation of matters for recycling.

M10 Landfill Regulation 1996

Implementing entity: Federation
GHG affected: CH_4
Type of policy: regulatory

The Landfill Regulation is one of the most important instruments for implementing overall targets of the Waste Management Act (see above). The regulation also implements Council Directive 99/31/EC on Landfills.

The leading principles of the Landfill Regulation are:

1. Reduction of total organic compounds and minimisation of total volume of landfills as a direct consequence;
2. Classification of landfills (e.g. demolition waste, residual waste etc.);
3. No final deposition without prior treatment, which reduces reactivity of waste (e.g. mechanical-biological treatment);
4. High technical standards for landfills to minimise overall impact on the environment.

Methane emissions from landfills are a consequence of Total Organic Carbon (TOC) of waste fractions disposed on landfills. The Landfill Regulation sets very strict limits in this respect. TOC may not exceed 5 percent by volume. As a consequence, e.g., no residual waste (from households and comparable fractions from business) may be disposed of, without prior treatment (mechanical, biological, physical).

Landfill management (private and municipal) have to comply fully with the high standards of the landfill regulation since 2004 (in certain circumstances 2008), effectively banning deposition of untreated residual waste since 2004. This implied an extension of waste treatment capacities other than landfilling. Residual matter from thermal or mechanical-biological treatment will have to be disposed of in mass waste landfills with very limited content of methane gas and other pollutants.

Implicit impact of the landfill regulation on incineration

In 1996, 33.5% of residual waste was combusted in incineration plants. In the expected scenario for 2010, 50% of residual waste will be incinerated, and the other 50% will be subject to mechanical-biological treatment. In an enforced scenario, the share of waste incineration is likely to reach a dimension of 60%, with beneficial impacts on GHG mitigation when electricity and heat are produced by efficient co-generation.

M11 Landfill Charge Act 1989 ("Clean-up of Contaminated Sites Act")

Implementing entity: Federation
GHG affected: CH_4
Type of policy: fiscal

Leading principles:

1. Disposal of waste on landfills (domestic or abroad) is subject to a charge
2. Rate of charge depends on type of waste

3. Charge raised step by step until 2006
4. Supplemental charges for disposal on landfills without gas recovery
5. Revenue of charge earmarked for clean-up of contaminated land

The effectiveness of Austrian waste policies and specifically the Landfill Regulation (see below) is directly supported by the landfill charge. The charge for residual waste is 87 € per tonne. A supplemental charge of 29 € applies when the landfill is not equipped with a landfill seal, and another 29 € for landfills without landfill gas recovery of current technical standard. On "worst case" landfills, which rarely exist anymore, the charge can, therefore, total up to 145 € per tonne. The charge for residual waste is lowered to 26 € per tonne for landfills meeting the state of the art according to the Landfill Regulation 1996.

The high costs of full compliance with the Landfill Regulation in combination with the landfill charge will implicitly benefit waste recovery (recycling or incineration with energy recovery).

M12 Efficient energy recovery from waste

Implementing entities: Federation (Ministry of Environment), Länder
GHG affected: CH_4, CO_2
Type of policy: promotive

High energy efficiency of waste incineration plants can even result in further GHG mitigation effects, when taking into account energy induced CO_2 emissions from other sectors. Therefore, on the basis of the Environmental Subsidy Act a subsidy was introduced for incineration plants with an energy efficiency rate of at least 65%. District heating grids should be extended in parallel and in conjunction with space planning measures.

M13 Other programmes to launch waste prevention and recovery

Implementing entities: Federation (Ministry of Environment), Länder
GHG affected: CH_4, CO_2
Type of policy: research, agreements, information

In order to step up the implementation of waste prevention and recovery measures, the Federal Ministry of Agriculture and Forestry, Environment and Water Management has established working groups composed of representatives of the economic, scientific and administrative sectors to develop prevention and recovery concepts for specific sectors of the industry. It is the objective of these **sector-specific concepts** to describe and quantify the waste prevention and recovery potentials for various industrial sectors in Austria. The industrial sectors can be selected on the basis of studies on relevant substances.

Apart from the sector-specific concepts, there are numerous other **programmes and initiatives** aimed at implementing waste minimisation potentials. Amongst these, the following should be primarily mentioned:

- PREPARE programmes examine and actively implement waste minimisation in selected companies, covering as many industrial sectors as possible.
- ÖKOPROFIT programmes compile empirical information on integrated environmental protection within a given region, e.g. an urban area, by covering a sufficient number (around 30) of small and medium-sized companies.
- PREGAS is a project for the reduction of hazardous waste in Styria that directly addressed those companies, which according to waste statistics were identified as particularly affected and called upon them to participate in the project.
- Ecological management consulting is offered in several *Länder* of Austria.
- NUS (Lower Austrian Environmental System) supports and subsidises environmental efforts of Lower Austrian enterprises, institutions and municipalities.

M14 Definition of technical state of art for mechanical-biological treatment of waste

Implementing entity: Federation
GHG affected: CH_4, CO_2
Type of policy: standardization

Operators of future mechanical-biological waste treatment sites need better investment security with respect to technical standards, which are to be fulfilled by law. Under the leading role of the Ministry of Environment, a directive for the definition of technical state of art, as referred to in legal acts, has been published.

Estimated GHG emissions reductions from implemented measures in the Waste Management Sector: 1.1 Mt CO_2 equivalent p.a.
No substantial further reduction effects expected in comparison to NC3

4.2.3 Transport

Categories of the Common Reporting Format affected: 1.A.3. (Transport)
GHG affected: CO_2, N_2O

Different from other sectors with more or less stable or falling emissions trends since 1990, the transport sector in Austria shows an extraordinary growth. Since 1990, CO_2 emissions from transport have been growing by 83% from 12.4 Mt in 1990 to 22.7 Mt in 2003. Transport induced emissions of N_2O increased from 0.17 Mt CO2 equivalent in 1990 to 0.28 Mt in 2003.

Emissions trends in the transport sector depend on a variety of different driving forces, among them the economic development, changing living patterns, the opening and expansion of the EU toward the east and infrastructure needs and developments. One of the main causers of the extraordinary growth in the transport sector is the increasing “fuel tourism” due to the lower fuel prices in Austria in

comparison to the neighbourhood countries. Approximately 25-30% of transport fuels sold in Austria are used outside the country, both by lorries and private cars. However, due to the reporting guidelines, emissions from transport fuel sold within Austria need to be captured by the national inventory on greenhouse gas emissions.

Today, private traffic is responsible for around 55% of total transport emissions. Although private mobility still continues to rise, a slight decrease of emissions from private transport can be expected within the next years due to continuous improvement of fuel economy and the use of biofuels. This is not the case for business transport, giving rise to the expectation that emissions from lorries will still increase in the following years.

Policies and measures in the transport sector aim to stabilise and reverse the current emissions trend as early as possible by introducing a mix of different instruments, such as regulatory, fiscal and awareness-raising, and under participation of all levels of policy-making (Federation, *Länder*, municipalities).

Implemented Policies and Measures

M15 CO_2 labelling and other measures to reduce emissions from passenger cars

Implementing entity: Federation
GHG affected: CO_2
Type of policy: information, regulatory

Federal law has implemented EU directive 1999/94/EC on compulsory labelling for new passenger car's fuel consumption and per kilometre CO_2 emissions by February 2001. The label, classifying each type of new cars, and other transparent and comparable information on CO_2 emissions is of major importance for public awareness with respect to climate change and a prerequisite for consumers making their choice for "climate friendly" cars.

The labelling scheme is one element of an EU strategy to bring down average CO_2 emissions from new passenger cars to 120 g/km (corresponding to an average fuel consumption of about 5 litres/100 km for petrol engines and 4.5 litres/100 km for diesel engines) by 2010 at the latest, adopted by the Council of Ministers and the European Parliament. In 2004, the average level of CO_2 emissions from newly registered cars in Austria was 168 g/km for petrol engines and 159 g/km for diesel engines. The most important step towards that ambitious target was the conclusion of agreements between the European Commission and European, Japanese and Korean associations of car manufacturing industries (ACEA, JAMA and KAMA), covering more than 95% of the European market for passenger cars. According to these agreements, average CO_2 emissions from newly registered cars will not be higher than 140 g/km by the year 2008. For reaching that target in Austria, a reduction of about 3% per year of the average CO_2 emissions is necessary. That still leaves a gap of 20 g/km, which has to be bridged by supplementary measures. Apart from the labelling scheme, the Commission is also considering a common European framework for fiscal measures to reduce CO_2 emissions from passenger cars, covering fuel taxes (EU minimum rates already apply), registration and circulation

taxes. To that end, possible ways and options are under scrutiny; taking into account already successfully implemented fiscal measures in several Member States.

M16 Fuel consumption based taxation

Implementing entity: Federation
GHG affected: CO_2
Type of policy: fiscal

Passenger car registration tax in Austria is based on standard fuel consumption, giving a clear incentive to buy energy efficient cars. The highest tax rate is 16% for cars exceeding a certain standard fuel consumption (petrol engines: 11 litres; diesel engines: 10 litres). Extremely efficient cars (less than two litres diesel or three litres petrol) are exempted from the tax. Tax base is the net price of the car. The registration tax is part of the tax base of VAT.

Furthermore annual current taxes on passenger cars and motor bicycles have been increased in 2000 by about 50 %. Tax is based on motor power and therefore indirectly on fuel consumption, as there is a clear increase of fuel consumption with increasing power.

M17 Mileage-based toll for lorries

Implementing entity: Federation
GHG affected: CO_2
Type of policy: fiscal

Internalisation of external costs of road transport is one of the leading principles of Austrian transport policies. Accordingly, a non-discriminatory mileage based highway toll for lorries and trucks with a total weight of more than 3.5 tons was introduced on 1st January 2004.

The former timely based “vignette”, which had to be purchased for highways use with vehicles, has been partly replaced by the electronic mileage-based system. Lorries with a total weight of more than 3.5 tons are now charged under the new system, whereas for passenger cars the “vignette”-system continues to apply.

M18 Promotion of “bio fuels”

Implementing entity: Federation
GHG affected: CO_2
Type of policy: regulatory

In November 2004, the Bio Fuel Directive 2003/30/EC was transposed into Austrian national law with an amendment to the Fuel Ordinance. This amendment stipulates that all companies that put fuels in circulation must, from 1 October 2005, replace 2.5% of the total energy quantity put in circulation by biofuels. From 2007, this percentage will increase to 4.3%, and in 2008 the target of 5.75%, as stipulated in

the Directive, will have to be achieved. Together with the amendment to the Fuel Ordinance, the Mineral Oil Tax has been revised. Accordingly, tax concessions will be granted with a biofuel share of at least 4.4% (for diesel since 1. October 2005, for gasoline starting at 1 October 2007). However, to be able to profit from the tax concessions, the fuel must also be sulphur-free (less than 10 mg sulphur per kg of fuel). The use of pure biofuels as motor fuel is exempt from tax.

Further enforcement of biofuels promotion is in a planning stage. A higher than the above mentioned share of 5.75%, taking effect after 2008, could be reached by means of increased use of pure biofuel. As a second pillar, biogas should reach considerable shares as a motor fuel by 2010, starting with promotion programs for natural gas driven cars as a first step (e.g. for public transport and taxi fleets). It should be mentioned that the Council of the European Union in its meeting on 23/24 March 2006 considered a target of 8 % for the proportion of biofuels with respect to the development of the EU energy policy.

M19 Support of combined transport

Implementing entity: Federation
GHG affected: CO_2
Type of policy: public investment, promotion

In the framework of Austrian transport policy, combined transport is considered to be of central importance for solving present and future problems with regard to freight transport by road caused by Austria's geographical and topographical situation. Due to increased traffic flows both within and through Austria, in particular on the roads, Austria has been introducing early measures for the support of environment-friendly modes, such as rail or combined transport. Furthermore Austria participates in several international projects (AlpFRail, Bravo) and agreements (Brenner Action Plan 2005, Declaration of Zurich) to improve the conditions for combined transport.

In the time-period between the years 1983 and 2004 a total of about 8.5 Mio. loading units have been transported in accompanied and unaccompanied transport in Austria. In the year 2005 199.418 trucks where transported on rolling roads in Austria. Additionally 773.787 loading units (11.862.809 tons) were transported in unaccompanied transport in 2005.

Within the *Programme for the promotion of combined goods transport road/rail/ship* 2003–2008 approximately 3 million € per year are provided to support investments in installations, systems and equipment for combined transport. The programme aims at improved co-operation between road, rail and shipping as well as optimised traffic flows. Support is provided up to a maximum of 30 % of the accountable investment costs for physical investments and up to a maximum of 50 % of the accountable costs for feasibility studies and training measures.

Rail transport which is considered to be of public interest, e.g. for environmental reasons, may be ordered as "public services" by the Federation. A preliminary remuneration of 46 million € was agreed upon for public service operations carried out in the framework of combined transport (unaccompanied combined transport in transit through Austria and all rolling road connections) for the year 2005. The final

remuneration depends on the results achieved (i.e. the number of consignments transported).

Rail infrastructure and terminals, which are financed by public money according to the Austrian Federal Railways Act, must be open for third parties. Further measures to promote combined transport exist, like exemptions from weekend and night driving bans on lorries for routes to terminals.

M20 Promotion of public transport systems

Implementing entity: Länder, municipalities, Federation
GHG affected: CO2
Type of policy: promotive, information

Public transportation plays from an historical point of view an important role in Austria. Nevertheless there is a trend in the modal split in favour of motor vehicles. As a countermeasure public authorities have promoted unified fares systems; since the end of the 1990ies the areas of 8 transport and tariff associations cover the whole of Austria. These associations of public transport operators and public authorities offer unified fares to the passengers within their areas. Transport operators can profit by synergies within a larger system; public funding is granted for temporary losses due to the unified tariff structure as well as for services that are in the public interest but uneconomic from a business point of view. During the last years the Länder in co-operation with municipalities have started to optimise the public transportation network based on comprehensive regional traffic concepts. These concepts are based on better understanding of regional and local transport demands and aim at increased linking between different operators. High technical quality in the transportation systems, optimised time-tables and sufficient information for passengers are key features of a successful strategy to promote public transportation.

M21 Model projects and programmes for environmentally sound mobility

Implementing entities: Federation (Ministries for Environment and Transport) and partner institutions (e.g. Austrian Federal Economic Chamber, Land Salzburg and communities)
GHG affected: CO_2
Type of policy: information, education, R&D

The Ministry of Environment initiated several pilot and model projects in the area of mobility management aiming at a reallocation of passenger transport from private cars towards public transport services, cycling and walking. In three different project categories, covering business (employees mobility behaviour), large events and tourism, it was possible to show that alternative mobility concepts find high acceptance when appropriate information (e.g. on schedules) is provided and services manage to adapt to the needs of people.

In recent years (since NC3) these initiatives included the following model projects:

The pilot project "soft mobility – car free tourism": The project is being carried out cooperatively by the Ministry for Environment, the Ministry for Transport, the Ministry for Economic Affairs, *Land* Salzburg and the model community Werfenweng (skiing resort as well as summer tourism destination in Salzburg/Austria) with financial support of the European Union. The pilot project follows different policy objectives in the fields of environment, transport, tourism and technology, as formulated, for example, in the National Environment Plan, the EU Environment Action Programme or the Alps Convention. Locally, the model projects follow an improvement of living quality for inhabitants and guests by reducing transport-related environmental impact (air quality, congestion, noise, safety…). A broad variety of local measures and initiatives, ranging from improved environmental sound transport connections (both for journey to the destination and local/regional transport) and baggage/shuttle services to the availability of alternative vehicles in the communities (e.g. rental service with electric cars, scooters and bikes, car-sharing etc.) and electronic travel information systems which cover all modes and regional/interregional services of transport. The high acceptance of the concept can be illustrated by a remarkable growth in overnight accommodations.

Alps Mobility II – "Alpine Pearls": This successful transnational cooperation continues from an Austrian pilot project with additional new project partners from Switzerland and France. The project started in May 2003 and will end in September 2006. Lead partner is the Austrian Ministry of Agriculture, Forestry, Environment and Water Management. The focus of the project is the creation of innovative eco-tourism offers „Alpine Pearls", combining interesting places for tourists with the advantages of Sustainable Mobility with environmentally sound transport means. A travel package through the Alps will be realised, using only environmentally sound transport means, like railway, busses, bicycles, zero-emission-vehicles, riding or walking. Some villages in the Alps will be „Pearls of the Alps", fulfilling certain mobility and tourism standards in the sense of sustainability according to a fixed criteria catalogue.

„Alpine Awareness": Partners of Italy, France, Germany and Austria are implementing this project. Its duration is from 2003 till 2006, lead partner is the Province of Belluno, Italy. It focuses on awareness for the causes and effects of the negative impacts transport has on environment and health. It is often low in both the local population and visitors to the Alpine Region, thus leading to unsustainable mobility patterns.

MOBILALP: Partners of Austrian, France and Italy are realizing this project under French lead partnership. The project will end in 2007. It is facing common mobility issues – the participating territories gather together in order to develop innovative sustainable mobility offers and services for transport users at local and regional level.

Pilot projects on sustainable transport and Tourism in Sensitive Areas on the Example of the Lake Neusiedl/Fertö tó-Region (2002-2007): An umbrella project covering different pilot projects is initiated, financed and implemented by three federal ministries as well as *Land* Burgenland and of many local implementation partners like private businesses, communities and tourism alliances and is supported by the community initiative INTERREG of the European Regional Development Funds. The region of Lake Neusiedl/Fertö-tó was chosen as model region as this ecologically especially sensitive world heritage region requires a special sensitive handling with transport and infrastructure. With the umbrella project transnational

model measures are to be developed and implemented to bring in line the requirements of Environment and World heritage site, Mobility and Transport, Economy and Tourisms in the sense of a sustainable transnational regional development. In five working modules (Pilot projects for innovative public transport in model communities, Regional public transport and transborder mobility centres, Ecomobility and Ecotourism, Sustainable logistics and regional (business) development, Customised sustainable infrastructure and new vehicle technologies) different projects are realised in cooperation between the neighbouring countries Austria, Hungary and Slovakia.

Mobility management for business: Five pilot projects with companies and public institutions, carried out by the Ministry for Environment in Cooperation with the Austrian Federal Economic Chamber, showed large potential for traffic avoidance and reallocation for employees' every-day travel to work and other business-related transport demands. The model projects not only showed positive environmental outcomes but also economic advantages for companies and employees (e.g. "job-tickets" for public transport, less need for creation of parking facilities etc.). In order to promote a broader application of sound mobility partnerships for business and employees, measures in this field can also be financially supported under the Federal Environment Fund after an amendment of the relevant law in 2000. Several cases of promotion were already successfully completed. In order to motivate as much as possible enterprises to implement mobility management, the Ministry for Environment started in the context of "**klima:**aktiv→**mobil**" - the initiative for climate protection - a motivation and consulting campaign for operational traffic measures.

M22 Public awareness-raising measures

Implementing entities: Federation, Länder
GHG affected: CO_2
Type of policy: information, education

Measures focused on raising public awareness with regard to climate-friendly modes of mobility constitute an integrative part of policies and measures in the traffic and transport field. The new law on passenger car's labelling was mentioned above under "implemented policies and measures". Further measures of the federation, the *Länder* and municipalities, such as regional centres for mobility management, education and training schemes, labels on transport intensity of food products etc., are in a planning stage. Model projects of federal ministries, as described under M21, will be carried on.

ECO-DRIVING Austria ("Spritspar-Initiative"): The Austrian Federal Ministry of Agriculture, Forestry, Environment and Water Management, in co-operation with the Austrian Energy Agency and the Federal Branch Association of Driving Schools started aiming to accelerate the establishment of ECO-DRIVING in Austria. The programme is part of the "klima:aktiv->mobil" initiative of the government with the aim to reduce greenhouse gas emissions from all sectors. In a first step, the ECO-DRIVING programme consists of three initiatives: An ECO-DRIVING championship for drivers aiming at a fuel saving driving style, certification of some 30 driving teachers as ECO-DRIVING-trainers, ECO-DRIVING trainings for professional drivers

in co-operation with vehicle fleet operators. The programme is accompanied by radio spots, print media coverage, leaflets with tips to save fuel etc.

The European carfree day*:* A goal of this European initiative is it to sensitize the citizens for pollution free mobility to create awareness for transport problems and offer sustainable solutions. Walking, cycling and use of public transport is especially promoted on 22 September since the year 2000. In Austria the carfree day 2005 was one of the most successful public awareness campaigns regarding transport. With the slogan "save fuel – go with bus and train!" and a peak participation of 323 cities and municipalities altogether it shows that the increasing problem of road traffic in the municipalities causes people to check critically their own transport behaviour.

Further measures in the context of **klima:aktiv→mobil** comprise:

- Upgrading of the national campaign for “ecodriving” with the elements competition, certifying of “ecodriving trainer” and co-operation with fleet operators
- mobility management for business – motivation and consulting campaign (already above stated)
- communal/regional mobility management ("traffic savings communities"/ ”mobility centres”
- mobility management for schools
- environmentally friendly mobility in tourism & leisure
- mobility management for land use planning
- mobility management for public administration
- program for shaping of opinions to promote climatic-friendly mobility accompanying and in addition to above-named focuses and the main messages "ecodriving" and "clean air – to do everything for our children"

M23 Promotion of energy efficient and alternative motor concepts

Implementing entity: Federation, EU
GHG affected: CO_2
Type of policy: promotive, research

New and alternative motor concepts, like electric vehicles, fuel cells, bio diesel, hydrogen and hybrid vehicles are being promoted by means of pilot programmes (e.g. in tourist areas and ecologically sensitive regions, towns and public service), strengthened emissions and fuel standards (in line with respective EU policies) and research and technological development programmes.

M24 Promotion of walking and cycling

Implementing entities: (Federation), Länder, municipalities
GHG affected: CO_2
Type of policy: promotive, information, education

The attractiveness of walking and cycling instead of driving is a matter of safe and convenient infrastructure and multi-functionality of urban areas and settlements (short distances between housing, shopping facilities and working). In the framework

of UNECE and WHO several initiatives will be started on this topic. Walking and cycling is climate-protection, is good for the environment, for the personal fitness and traffic safety, and has therefore perfect synergies to be implemented. In the nation-wide pilot-projects of the programme “School Mobility Management Plans” (see above) this focus on walking and cycling on the way to and from school is also prevalent.

The "**master plan cycling**" is one of the implementation of the Austrian strategy against PM (particulate matter), the Austrian climate strategy and the WHO-CEHAPE. It is done in parallel with the strategy “klima:aktiv→mobil”, the “mobility management program”, in particular also the awareness raising campaign. Principal purpose of this master plan is promoting cycling. Cycling is the most sustainable form of transport and with benefits for health, environment, climate and its even fun. Supporting measures in favour of bicycle traffic are connected with comparatively small financial expenditure and high effectiveness - compared to other means of transport. Increased shares of cycling are an important component for the fulfilment of environmental political goals and obligations. Forces are to be bundled for the promotion of the bicycle traffic, synergies created and impulses to be set in the whole of Austria for increasing the share of cycling. The master plan can be compiled into a joint concrete program of measures of the Federation and the *Länder* to promote cycling.

Planned Policies and Measures

M25 Further internalisation of externalities from road transport

Implementing entities: Federation, EU
GHG affected: CO_2
Type of policy: fiscal, economic

Actual costs structure for goods transportation on roads does not sufficiently reflect damages caused by trucks, neither on infrastructure nor in terms of environmental and health costs (“external costs”). Mileage-based road tolls will significantly improve the situation with respect to costs-coverage for infrastructure and is also expected to reduce demand for road transport services. However, the existing legal situation within the EU does not allow full reflection of environmental costs and other externalities in road duties; but discussions, starting from the Commission’s *White Paper on Fair and Efficient Transport pricing*, are gradually moving towards that direction. Austria is among those Member States arguing strongly in favour of internalisation of external costs, at least for “sensitive regions” like the Alps. That should also enable Member States to finance railway infrastructure across modes of transport.

Also for passenger cars, the Austrian *Climate Strategy* faces the necessity of cost-internalisation. Taxes and tolls on road use should, therefore, be modified in a way that better reflects impact on human health and environment.

Tax incentives for the promotion of bio-fuels were introduced (M18). Fuel taxes in Austria were increased in 2004 in accordance with the "Directive restructuring the Community framework for the taxation of energy products and electricity"

(2003/96/EC) and should be further developed at EU level. Currently taxes on motor fuels still are relatively low compared to some neighbour states with the effect that a large share (approximately 25%) of motor fuel sold in Austria is used outside the country because of the existing price differences ("fuel tourism").

The existing Car Registration Tax, which is designed as a sales tax, should also be further differentiated in the future in order to put cars with high petrol or diesel consumption in a more disadvantageous position, whereas highly efficient cars already now benefit from low tax rates.

However, the federal government has not made a decision yet on an appropriate mix of fiscal measures to meet greenhouse gas reduction targets in the transport sector.

In addition to M25, an increased use of biofuels is in the planning stage, see M18.

Expected GHG emissions reduction from planned policies and measures in the Transport Sector: 4.8 Mt CO_2 equivalent

4.2.4 Industry

Categories of the Common Reporting Format affected: 1.A.2. (Manufacturing Industries and Construction), 2. (Industrial Processes)
GHG affected: mainly CO_2[3]

The industry sector has been successful in decoupling production output and energy demand over the past two decades. CO_2 emissions decreased from around 25 Mt to 20 Mt between 1980 and 1990, were kept stable during the 1990ies but increased again over the past years due to considerable production growth of certain energy intensive activities like steel, cement pulp & paper. Data include emissions from industry's own electricity production.

Policies and measures for the manufacturing industry, therefore, aim at supporting a continuation of efforts undertaken by companies to decouple emissions and come to absolute reductions. A mix of promotive and economic instruments is envisaged in order to make sure that industry is able to cut emissions in a cost-effective way, especially by implementation of the EU's Emissions Trading Scheme (ETS).

Implemented policies and measures

M26 Promotion of energy efficiency measures and renewable energy projects

Implementing entity: Federation
GHG affected: CO_2
Type of policy: promotive

[3] In difference to other countries Austrian industry causes only small proportions of N2O emissions; fluorinated gases HFC, PFC, SF6) are covered under a separate section, due to cross-cutting character of measures

Energy-saving measures and the use of renewable energy sources in industry gain public support under the scheme of the Federal Environment Fund. About 250 industrial projects with climate change mitigating effects were supported between 2000 and 2003, resulting in CO_2 mitigation effect of 645 000 tons annually. Specific attention was given to biomass boilers and cogeneration (bio fuels or natural gas), thermal solar energy and district heating from industrial boilers.

Planned policies and measures

Part of the mitigation impact from planned measures M7 and M8 has to be allocated to the industry sector.

Estimated GHG emissions reduction from planned measures in the industry sector (without contribution from EU ETS): 0.5 Mt CO_2-equivalent p.a.

4.2.5 Agriculture and Forestry

Categories of the Common Reporting Format affected: 4. (Agriculture), 5. (Land-Use Change and Forestry)
GHG affected: CH_4, N_2O, (CO_2: indirect effect on energy demand)

Agricultural and forest production is on the one hand directly affected by climatic changes and therefore might need to develop adaptation strategies (see chapter 6). Nevertheless, agriculture and forestry can play a future key role as suppliers of renewable energy sources and other sustainable raw materials. Wood is virtually unrivalled as a fuel. When wood is burned, a neutral carbon balance is maintained. The product range includes firewood billet, wood chips and wood pellets, heating systems for ready-cut wood and tiled stoves, as well as pellet- und automatic wood-chip heating or biomass-based district heating systems. Austria has a leading position internationally in biomass utilization. To push biomass, the Green Electricity Act promoting the further development of renewable sources of energy - including wood - was passed in 2002 and amended in 2004. Austria has a leading position internationally in the percentage share of renewable sources of energy (27%) in total energy consumption, as well in the percentage share of biomass (13%). It is noteworthy that wood already accounts for up to 98% of the bio-energy.

Currently, about 17% of the Austrian households use wood for heating. Apart from individual installations, the increasing number of biomass heating plants is particularly encouraging. Austria-wide, some 700 biomass-based district heating networks with capacities of 1 to 30 megawatts are in operation. Not only communities but also industrial enterprises count more and more the environmentally friendly heat from wood. For ecological and economic considerations, but also with a view to Austria's energy independence, a further increase is both necessary and possible. Some 40% of the total domestic energy consumption is used alone to supply the Austrian households with heat. *(Source: Österreichischer Waldbericht 2004)*

On the other hand, the agriculture and forestry sector is affected by climate change as an emitter of greenhouse gases. Agricultural production contributes to climate

change especially with methane and N_2O-emissions. CO_2-emissions from agriculture are statistically covered by other sectors in the emissions inventory, especially transport (off-road vehicles; 1.A.3.) and “other energy sectors” (1.A.4.).

Implemented Policies and Measures

M27 Extension of ecological farming

Implementing entities: Federation, Länder, EU
GHG affected: CH_4, N_2O
Type of policy: promotive

In the agricultural sector use of mineral fertiliser (nitrogen, phosphate, potassium) continues to decrease due to measures administered under the Austrian Programme for Environmentally Compatible Agriculture (*Österreichisches Programm zur Förderung einer umweltgerechten, extensiven und den natürlichen Lebensraum schützenden Landwirtschaft, ÖPUL*), which is co-financed by the EU, and because of structural changes in the general economic framework. Meanwhile, an improved *ÖPUL* programme is in force and a new programme taking into consideration the evaluation results found so far is being elaborated. Table 4.3 shows the progress with respect to use of mineral fertilisers.

Table 4.4: Fertiliser sales per year (1 July to 30 June) 1994–2004 (Data: Agrarmarkt Austria)

Fertilisers	1994/95	1995/96	1996/97	1997/98	1998/99	1999/00	2000/01	2001/02	2002/03	2003/04
	Crop year(1)									
Nitrogen(N)	128,0	125,3	131,8	127,5	119,5	121,6	117,1	127,6	94,4	100,8
Phosphorus (P_2O_5)	53,5	52,3	60,0	57,3	53,5	48,5	47,2	47,2	45,2	39,4
Potassium (K_2O)	60,6	59,8	71,6	61,5	59,7	55,2	53,9	50,1	50,0	49,5
Total	**242,1**	**237,4**	**263,4**	**246,3**	**232,7**	**225,3**	**218,2**	**224,9**	**189,6**	**189,7**

1)

At the same time, the share of organic farming increased substantially until the late 1990ies. Rising consumers’ demand for food products from organic farming also backed that development. In 2004, about 20,000 organic farms, i.e. 13.1 % of the farms registered under IACS existed in Austria, representing about 14.4% of the farmland of those farms which are registered under IACS. The federal government, the *Länder* and the EU gave compensation payments to organic farmers amounting to 90.62 million € in 2004.

M28 Cultivation of oil-seed crops

Implementing entities: Federation, Länder
GHG affected: CO_2
Type of policy: promotive, fiscal

Oil-seeds from rape and sun flower are also used as substitutes for mineral oil products (diesel). Oil-seeds acreage was around 7 500 ha for this purpose in 1999

and 2000, after 3 000 ha on average between 1997 and 1998. To support the development, liquid bio fuels have been entirely exempted from mineral oils taxes.

M29 Maintenance and extension of vital forests

It has been a guiding principle of Austrian forest management policy for more than 100 years to use forests in an economically sustainable manner, balancing the relevant ecological, economic and social functions. Austria is one of the most densely wooded countries in Central Europe with forests covering more than 47% of the federal territory, which is almost two thirds higher than the European average. According to the Austrian Forest Inventory 2000/2002 (abbreviated AFI 2000/2002), the forest as a characteristic element of the Austrian landscape has grown to cover a total area of 3.96 million hectares. Ever since the beginning of the Austrian Forest Inventory in 1961 a continuous increase in forest cover has been observed in Austria. Compared with the first inventory period 1961/1970, the forest cover has increased by almost 270,000 hectares to date.

Based on the latest forest inventory, sustainability of the Austrian forest cover is certainly guaranteed. Even in the regions of eastern Austria that traditionally have a low level of forest cover, a marked increase in forest cover has been observed. The issue of a further increase in forest cover, especially in the regions already abundant with forest, must be decided by the responsible political sectors, especially within the scope of rural development.

In Austria, ozone, nitrogen oxides, sulphur dioxide, nitrogen, acid and sulphur inputs, as well as locally hydrogen fluoride, ammonia and heavy metal inputs are the main pollutants directly affecting the forest. The provisional European ozone criterion AOT 40 (limit: 10 ppm*h over the vegetative period) is exceeded almost everywhere in Austria. With increasing altitude, the ozone concentrations also increase markedly. Forests on the timber line are therefore exposed to the highest concentrations. Effect-related sulphur dioxide limits (25 µg/m³, Second Ordinance against Forest-Damaging Air Pollutants) are rarely exceeded in forest regions, impacts of sulphur pollution can be demonstrated with leaf analyses.

Austrian forest management mainly focuses on the targets to maintain the biodiversity, productivity, regeneration capacity and vitality of forests and to improve adaptation to changing – specifically climatic – conditions. Therefore, the preservation of forest gene resources is important in Austria. The preservation of a high genetic diversity is necessary for adaptability and adaptation of forests to environmental conditions, especially in the light of climate change. Forest stands of high genetic values should be represented as much as possible in all growth areas, and their presence should be guaranteed in the long term.

An effective measure to ensure comprehensive adaptability is *in situ* conservation. Thereby, forests are preserved at their natural site in order to disturb the constant genetic adaptation processes as little as possible. The goal of the *in situ* conservation measure “gene reserve forests” is to ensure that the genetic information is passed from one generation to the next using natural regeneration. There are currently 312 gene reserve forests in Austria with a total area of 8,877.7 hectares. Gene reserve forests are identified based on the criteria: representativeness, naturalness of

stocking, minimum size, adaptation, conditions for natural regeneration, and boundary-adjusted site. In addition, special measures (*ex situ* conservation measures) are taken to preserve the forest gene resources. Since 1975, 63 conservation and seed plantations with a total area of 109.6 hectares have been created for 20 species.

In order to be able to cope with the diverse interest in the utilisation of forests in future, all the national institutions, public and private interest groups, and all forest stakeholders are called upon to further develop a responsible forest management. For this purpose, the Federal Minister of Agriculture, Forestry, Environment and Water Management initiated a broad-based social dialogue process in April 2003 to develop an Austrian Forest Programme. Under the motto "The forest concerns us all!", all forest stakeholders are invited to participate actively in the Austrian Forest Dialogue. The aim of the Forest Dialogue is to develop a comprehensive forest programme by the end of 2005, in which concrete proposals for political action on all major forest issues will be presented. The forest programme to be developed in the course of the Austrian Forest Dialogue is also a major contribution towards implementation of the Austrian Sustainability Strategy.
(Source: Österreichischer Waldbericht 2004)

Planned Policies and Measures

M30 Further enforcement of measures to reduce methane and N_2O emissions

Implementing entities: Federation, Länder
GHG affected: CH_4, N_2O
Type of policy: promotive, information, training

A lot of measures within the agri-environmental programme contribute directly or indirectly to GHG emission reduction (e.g. manure management and reduced use of mineral fertilisers). These measures will be given even more emphasis in the future programme. As an accompanying measure, training programmes for farmers on ecologically sound production methods will be improved and intensified.

In the current agri-environmental programme, in areas sensitive to groundwater aspects a particular measure was offered: spreading of liquid manure close to the soil, which has proved to be efficient in reducing methane emission. Thus, it is planned to offer this measure as climate protection measure to all farmers.

In order to raise consumers' demand for food products from organic farming "from the region", public service facilities are recommended to offer "organic" meals and products in restaurants (e.g. in schools, hospitals etc.). Some *Länder* and municipalities consider introducing obligatory quotas for calls for tender in this respect.

Estimated GHG emission reduction from planned measures in the agriculture sector: 0.1-0.5 Mt CO_2-equivalent p.a. (uncertain future production activity)

GHG removals by sinks in the forestry sector: projections under development

4.2.6 Fluorinated Gases

Categories of the Common Reporting Format affected: 2 F (Consumption of Halocarbons and Sulphur Hexafluoride)
GHG affected: HFC, PFC, SF_6

Emissions of fluorinated gases showed an uneven trend during the past decade. Ozone layer depleting "Montreal gases" are on a clear phase-out track, while other gases, covered by reduction targets in the Kyoto Protocol due to high global warming potentials, are expected to emerge as ozone layer-friendly substitutes. This is specifically the case for HFC emissions, which increased steadily between 1990 and 1999, without a trend reversal in sight for coming years, without additional measures. A sharply decreasing trend was observed for PFCs, which stabilised at a low level. SF6 emissions showed an up and down trend, without serious expectations of a considerable increase in the future. The three Kyoto F-gases together made a share of around 2% of total greenhouse gas emissions in 1999 and were expected to reach 3-4% in 2010 in the business-as-usual scenario of the previous National Communication (2001).

Implemented Policies and Measures

M31 Regulation on bans and restrictions of HFCs, PFCs and SF_6

Implementing entity: Federation
GHG affected: HFC, PFC, SF_6
Type of policy: regulatory

In December 2002, the relevant Austrian Ordinance entered into force. It aims at reducing and phasing-out respectively the use of HFCs, PFCs and SF_6 in all relevant applications on the basis of the Federal Chemicals Act. That measure has been the most important step of the Austrian government's strategy to mitigate or avoid future GHG emissions from fluorinated gases. Without the regulation, emissions were expected to grow by about 50% by 2010, mainly due to increased use of HFCs as a substituting substance for ozone layer depleting CFCs (e.g. for cooling or insulation materials).

Applications affected by the reduction and phase-out plan are:

- Insulation material (HFC)
- Construction foams (HFC)
- Refrigeration (HFC)
- Stationary and mobile air conditioning (HFC)
- Fire-fighting systems
- SF_6 in sound-absorbing windows
- SF_6 in tires
- SF_6 insulated switchgear installations and semi-conductors

Experiences of the past showed that the European Commission often initiated a European legislative process in order to harmonise product related environment

protection measures and policies of individual member states in order to avoid a fragmented market. With respect to applications for fluorinated gases, the Commission presented a proposal in 2003 which was then discussed during a 1st and a 2nd reading by the Council and the European Parliament, and which was approved by a Conciliation Committee in January 2006. This Regulation is expected to enter into force around June or July 2006. A safeguard clause will enable Denmark and Austria (the 2 countries with existing national legislation) to maintain their stricter provisions.

M32 Public procurement and support measures

Implementing entities: Federation, Länder
GHG affected: HFC, PFC, SF_6
Type of policy: contractual, promotive

In order to give incentives to the market for "early phase-out", prior to full entry into force of the above-mentioned regulation, the Federation and the *Länder* are capable to refrain from the use of products equipped with fluorinated gases within public procurement guidelines, either for deliveries (e.g. cooling equipment) or construction services. Practicable options to that end are to be evaluated.

Some provinces have also integrated or have the intention to integrate a ban of fluorinated gases in housing support schemes, meaning that applicants can only expect public financial support when they refrain from using construction products equipped with those gases. Given the dominant role of public housing support for new construction of dwellings, regional construction business is expected to quickly make use of available alternatives, also accelerating adaptation and price-cuttings on behalf of producers.

Adopted Policies and Measures

M33 Avoidance of leakage

Implementing entities: federation (Ministry for Environment)
GHG affected: HFC, PFC, SF_6
Type of policy: regulatory

The EU Regulation which will enter into force in mid-2006 aims at reducing emission by leakage control and inspections on a regular basis, especially in the sector of refrigeration and air conditioning, but also in other smaller sectors. This will help to reduce emissions from existing equipment, in addition to the national measures by chemicals legislation mentioned under M31.

Expected GHG emissions reduction from implemented policies and measures for fluorinated gases: 1.2 Mt CO_2 equivalent

4.2.7 Cross-cutting Policies and Measures

Implemented measures

M34 Energy related taxes and earmarking for climate change related measures

Implementing entity: Federation, Länder
GHG affected: CO_2
Type of policy: fiscal, promotive

Austria introduced an energy tax on electricity and natural gas in 1996. The tax rates were 0.0074 €/kWh for electricity and 0.044 €/m³ for natural gas. In 2000 the tax rate for electricity was doubled to 0.015 €/kWh in order to compensate for demand, driving electricity price-cuttings as a consequence of the electricity market liberalisation.

In 2004 the taxes on natural gas and mineral oil for heating purpose were increased significantly (approx. 50%) and tax on coal was introduced (for actual rates see table). These changes, together with an adjustment of the maximum energy tax burden for energy intensive companies, were sufficient to meet the requirements of the council directive 2003/96/EC of 27 October 2003 concerning the restructuring of the community framework for the taxation of energy products and electricity. The revenue of the energy tax amounts to 785 million € in 2005.

The requirements arising from directive 2003/30/EC of the European parliament and of the council of 8 May 2003 on the promotion of the use of biofuels or other renewable fuels for transport led to changes in the mineral oil taxation in Austria (for actual rates see table). The total revenue of the mineral oil tax amounts to 3.6 billion € in 2004.

Table 4.5: Energy tax rates Austria, June 2006

Fuels	tax rate in Cents
petrol (unleaded) with a content of sulphur not exceeding 10 mg/kg	41.7/l
petrol (unleaded) with a content of sulphur exceeding 10 mg/kg	43.2/l
diesel with a share of biofuels of at least 4.4% and a content of sulphur not exceeding 10 mg/kg	29.7/l
diesel with a share of biofuels of less than 4.4% and/or a content of sulphur exceeding 10 mg/kg	32.5/l
pure biofuels	0/l
fuel oil (extra light)	9.8 /l
fuel oil (light, medium and heavy	6/kg
natural gas (households	6.6/m^3
natural gas (industry)	6.6/m^3
electricity	1.5/kWh
coal	5/kg

Implemented / planned measures

M35 Implementation of EU Emissions Trading Scheme

Implementing entity: Federation, EU
GHG affected: CO_2
Type of policy: economic instrument

By implementation of EU directive 2003/87/EC, the European Emissions Trading Scheme (EU ETS) entered into effect by 1 January 2005. In case of Austria, around 200 energy intensive installations from industry and energy production sectors are covered by the scheme. Those installations are responsible for around 36% of Austria's total domestic GHG emissions (or 40% of CO_2 emissions). Within the affected sectors, between 85 and 90% of emissions are covered.

The emissions cap for the EU ETS sectors during the pilot trading phase 2005-2007 provides for CO_2 emissions reductions of approximately 1.65 Mt (in comparison to business as usual scenarios). Excess emissions need to be compensated by purchase of additional allowances on the market. By 30 June 2006, Member States are obliged to submit their National Allocation Plans for the second trading phase, 2008-2012, to the European Commission for approval. The draft National Allocation Plan of Austria for the second trading phase is currently under preparation, being one of the instruments for Member States to comply with Kyoto Protocol targets during the commitment period 2008-2012.

M36 Austrian JI/CDM Programme

Implementing entity: Federation
GHG affected: CO_2, CH_4, N_2O, F-Gases
Type of policy: economic instrument

The Austrian JI/CDM Programme aims to contribute to achieving the Austrian reduction commitment under the Kyoto Protocol through the application of the project-related Flexible mechanisms, Joint Implementation and Clean Development Mechanism.

Within the scope of the Programme are:

- Purchase of emission reduction credits from JI or CDM projects, which lead to avoidance or reduction of greenhouse gas emissions;
- financing of particular immaterial services, such as Baseline Studies etc., which are necessary with respect to JI or CDM projects.

Based on the amendment of the Environmental Support Act the Programme was launched in August 2003. Kommunalkredit Public Consulting (KPC) was appointed for the Programme Management.

Several calls for JI and CDM projects have been published since the launch of the programme and a relevant number of projects are already contracted, corresponding to emissions reductions in the order of 7.5 Mt CO_2-equivalent during the commitment period 2008-2012. A purchase budget of 36 million € annually from 2006 to 2012 is guaranteed by law (after 1 million € in 2003, 12 million € in 2004 and 24 million € in 2005). The total budget available for purchase of emissions reductions therefore will amount to 289 million €.

Austria's efforts to make use of the Kyoto Protocol flexible instruments are supplemental to domestic efforts, described in this section. Implemented and adopted as well as planned domestic policies and measures are envisaged to lead to an emission reduction of more than 20 Mt CO_2-equivalent annually, whereas JI and CDM projects will contribute at least 7 Mt CO_2-equivalent.

4.3 Policies and measures no longer in place

"Small hydro"-Trading Scheme

In Austria's Third National Communication, a green certificate trading scheme for small hydropower was described under measure M13. The scheme has been replaced only one year after implementation by a feed-in tariffs system due to political reasons. Minimum quota for small hydro power (9% of electricity supply) is still in place.

4.4 Further Information with Respect to the Kyoto Protocol

Austria has established a *national allowances registry* pursuant to the Emissions Allowances Act, BGBl. I Nr. 46/2004, by which EU Directive 2003/87/EC was transposed into national law. The registry is part of the EU emissions trading scheme, which entered into force on 1 January 2005. From 1 January 2008 the EU trading scheme will be included in the international emissions trading system under the Kyoto Protocol. Austria's national registry is therefore prepared to enter directly into the emissions trading system under the Kyoto Protocol. Detailed information on the registry will be provided in Austria's report according to Decision 13/CMP.1.

The *administrative and legislative arrangements* for the implementation of the national Climate Strategy are different for each of the strategy's elements. As described in the first section, areas of jurisdiction are spread among ministries as well as between the Federation, *Länder* and municipalities. That is why there is no uniform legal basis for national measures to mitigate climate change. The legal basis for the many measures ranges from e. g. the Environmental Support Act and the Green Electricity Law at Federation level to the Technical Construction Regulations for buildings on *Länder* level. Administrative procedures for implementation and monitoring are comparable different for the diversity of measures. Some information is given on a measure by measure basis in the relevant subsections of this chapter. Enforcement rules are laid down in the respective legal acts as appropriate. All legal acts are published; information on environmental strategies (including monitoring) is made available to the public.

The Austrian government has adopted the Austrian *Strategy on Sustainable Development* in April 2002. Protection of the climate system is one of the main targets of the strategy, and the Climate Strategy constitutes an integral part of the Strategy on Sustainable Development. The measures of the Climate Strategy aim a. o. at enhancing energy efficiency, sustainable forest management and agriculture,

promotion of renewable energy sources and at reducing emissions in the transport sector (see also the brochure “Sustainable Austria – Global Responsibility”, http://www.umweltnet.at/filemanager/download/7554/).

Austria is aware of the need to reduce *greenhouse gas emissions from aviation and shipping*. Austria promotes the issue on an international level by supporting the EU work on that subject in the ICAO. Austria also supports the idea of including aviation in the EU emissions trading scheme.

The Kyoto Protocol is, in principle and in general, designed to *minimize adverse effects* on specific sectors, specific industries or specific trade partners of a Party, including the adverse effects of climate change, on international trade, and social, environmental and economic impacts on other parties. This is due to the fact that it does not limit action to a single gas or sector, that the use of it’s flexible mechanisms guarantees that possible impacts are distributed on various fields of action, that the Clean Development Mechanism aims at both promoting sustainable development in countries with continuing development needs and at reducing greenhouse gas emissions, and that it requests action to support the least developed countries. By striving to implement all the features that the Protocol has integrated Austria is naturally working to minimize not only adverse effects of climate change but also any adverse effects due to the reduction of greenhouse gases.

Table: Summary of policies and measures by sectors

No. of PaM	Name of policy or measure	Objective and/or activity affected	GHG affected	Type of instrument	Status	Implementing entity or entities	Estimate of 2010 mitigation impact in Mt CO_2 equ.
	1.1 Energy demand						
M1	Minimum thermal standards	Energy-savings in buildings	CO_2	regulatory	implemented	*Länder*	n.q.
M2	Housing support schemes	Energy-savings in dwellings (new and renovation) and use of renewable energy	CO_2	promotive	implemented / planned	*Länder*	n.q.
M3	"Contracting" for public buildings	Energy-savings in public and private sector buildings	CO_2	economic / voluntary	implemented / planned	Federation, *Länder*, municipalities	n.q.
M4	Improvement of technical building standards and Energy codes for buildings	Energy-savings in buildings; energy performance certificates	CO_2	economic / information	adopted / planned	*Länder*	n.q.
Aggregate effects of planned policies and measures in energy demand sector							*3.6*
	1.2 Energy Supply						
M5	Electricity from renewable energy sources	Raising share of renewable energy sources in electricity supply	CO_2, CH_4	regulatory / economic	implemented	Federation	n.q.
M6	Public support for renewable energy projects and district heating	Raising share of heat production from renewable energy sources and CHP	CO_2, CH_4	promotive	implemented	Federation, *Länder*, EU	n.q.
M7	Further development of targets for "green electricity"	Raising share of renewable energy sources in electricity supply	CO_2, CH_4	regulatory / economic	planned	Federation	1.0
M8	Energy Efficiency Programme (implementation of Energy Efficiency Directive)	Reduction of energy end use intensity	CO_2	promotive	planned	Federation, *Länder*	1.2
Aggregate effects of planned policies and measures in energy supply sector (excl. effect from EU ETS – M35)							*2.2*
	2. Waste Management						
M9	Waste Management Act 1990	Framework law regulating waste management – minimisation of environmental impacts	CH_4, CO_2	regulatory	implemented	Federation (framework), *Länder* (executing laws)	n.q.

M10	Landfill Regulation 1996	Minimisation of waste landfilling	CH_4	regulatory	implemented	Federation (framework), *Länder* (executing laws), municipalities	n.q.
M11	Landfill Charge Act 1989	Reduction of disposal of waste on landfills; earmarking of revenue for clean-up of contaminated land	CH_4	regulatory / fiscal / economic	implemented	Federation	n.q.
M12	Efficient energy recovery from waste	energy recovery from waste incineration (CHP)	CH_4, CO_2	promotive	implemented	Federation	n.q.
M13	Other programmes to launch waste prevention and recovery	prevention of waste; higher share of energy recovery / recycling	CH_4, CO_2	voluntary, information, research, promotive	implemented (continuous process)	Federation, *Länder*	n.q.
M14	Technical state of art for mechanical-biological treatment of waste	Better investment security for operators of waste treatment sites with respect to technical standards	CH_4	standardization	implemented	Federation	n.q.
Aggregate effects of planned policies and measures in waste management sector							*0*
	3. Transport						
M15	CO_2 labelling and other measures to reduce emissions from passenger cars	Raising market share of advanced engine technologies with low fuel consumption	CO_2	Information / regulatory	implemented	Federation, EU	n.q.
M16	Fuel consumption based taxation	Fiscal incentive for low fuel consumption vehicles	CO_2	fiscal	implemented	Federation	n.q.
M17	Mileage based toll for lorries	Internalisation of external costs of road transport	CO_2	fiscal	implemented	Federation	n.q.
M18	Promotion of bio fuels	Minimum shares for transport fuels from renewable energy sources	CO_2	regulatory / fiscal	implemented / planned	Federation	0.7
M19	Support of combined transport	Shift from road-only freight transport to combined transport road/rail/ship	CO_2	public investment, promotion	implemented	Federation	n.q.

M20	Promotion of public transport systems	Increase the share of public transport in passenger transport by promoting and optimising transport and tariff associations	CO_2	promotive, information	implemented	Länder, municipalities, Federation	n.q.
M21	Model projects and programmes for environmentally sound mobility	Model projects with the aim to raise public awareness and to demonstrate new technologies	CO_2	information / education / demonstration / research	implemented	Federation, *Länder*, municipalities	n.q.
M22	Public awareness-raising measures	Influencing mobility behaviour of private and business drivers / demanders		information	implemented	Federation	n.q.
M23	Promotion of energy efficient and alternative motor concepts	Reduction of fleet fuel consumption	CO_2	promotive	implemented	Federation	n.q.
M24	Promotion of walking and cycling	Shifting modal split, improving living conditions and safety	CO_2	promotive, information, education	implemented	(Federation), *Länder*, municipalities	n.q.
M25	Further internalisation of externalities of road transport	Further orientation of taxes on mileage and fuel consumption	CO_2	fiscal, economic	planned	Federation, Länder	4.3
Aggregate effects of planned policies and measures in transport sector							*4.8*
	4. Industry						
M26	Promotion of energy efficiency and renewable energy	Energy-savings and increasing share of renewables in industry	CO_2	promotive	implemented	Federation	n.q.
Aggregate effects of planned policies and measures in industry sector (incl. effects from M7 and M8, excl. effects from EU ETS – M35)							*0.5*
	5. Agriculture and Forestry						
M27	Extension of ecological farming	Protection of rural environment (soil, water, natural and cultural habitate); production of high quality food	CH_4, N_2O	promotive	implemented	Federation, *Länder*, EU	n.q.
M28	Cultivation of oil-seed crops	Extension of crops for production of bio-fuels	CO_2	promotive, fiscal	implemented	Federation, *Länder*	n.q.
M29	Maintenance and extension of vital forests	Maintaining biodiversity, productivity, regeneration capacity and vitality of forests	CO_2	research, information, regulatory	implemented	Federation, *Länder*	n.q.
M30	Further enforcement of	Protection of rural environment	CH_4, N_2O	promotive	planned	Federation,	n.q.

	measures to reduce methane and N_2O emissions	with more specific focus on GHG mitigation				*Länder*, EU	
Aggregate effects of planned policies and measures in agriculture and forestry sector							*0.1-0.5*
	6. Fluorinated Gases						
M31	Partial phase-out of HFCs and SF_6	Substantial reduction of emissions of gases with high GWP	HFC, SF_6	regulatory	implemented	Federation	n.q.
M32	Public procurement and support measures	Substantial reduction of emissions of gases with high GWP	HFC, SF_6	promotive, public procurement	Implemented	Federation, *Länder*	n.q.
M33	Avoidance of leakage	Substantial reduction of emissions of gases with high GWP	HFC, SF_6	regulatory	adopted	Federation	n.q.
	7. Cross-cutting PaMs						
M34	Energy related taxes	Revenue-raising with positive side-effect of potential GHG reductions	CO_2	fiscal	implemented	Federation	n.q.
M35	Implementation of EU Emissions Trading Scheme	Cost-effective GHG emissions reductions for large stationary emitters	CO_2	economic / flexible instrument	implemented / planned	Federation, EU	5.5 (including overlapping effects from sectors 1.2 and 4)
M36	Austrian JI/CDM-Programme	Public purchase of ERUs and CERs	CO_2, CH_4, N_2O, F-gases	flexible mechanism	implemented / planned	Federation	8.0-9.0
Aggregate effects of planned cross-cutting policies and measures							*~14.0*

Chapter 5

Projections and the Total Effect of Policies and Measures

CONTENTS

In the following sections, the results of greenhouse gas emissions projections for the different sectors and further information, like model description, sensitivity analysis and important input parameters, are presented.

5.1 Approach for Projections

For the amendment of Austria's National Climate Strategy, efforts have been undertaken to estimate the development of greenhouse gas emissions according to implemented and adopted measures and the effect of planned measures. These most recent figures (mid 2006) from the draft National Climate Strategy II are based on energy projections, CO_2 projections for the EU-ETS sectors and expert judgements and are available for the year 2010. The draft Climate Strategy II has not yet been adopted by the Austrian Federal Government. The projection data shown in this chapter refer to the draft as of August 2006.

In addition, model calculations have been performed in 2005, which provide a "With Measures" scenario and a "With Additional Measures" scenario up to 2020. The calculations have been performed by the Austrian Institute of Economic Research and by the Umweltbundesamt; the model for emission calculations is based on the methods of the emissions inventory.

5.1.1 Projections According to the Draft National Climate Strategy II

In the framework of a consensual process to formulate an amendment to the National Climate Strategy ("Climate Strategy II") towards the Kyoto target under the EU burden sharing agreement, model based projections in combination with experts' judgements have been utilized to determine the expected development of greenhouse gas emissions according to the structure of the draft strategy. The sectoral differentiation shown below, therefore, corresponds to the structure of Chapter 4. The figures reflect not only the outcome of the energy projections of the Austrian Institute of Economic Research (Kratena, 2005) and bottom-up calculations from the assessment report on the implementation of the "Climate Strategy I" (Benke et al., 2006). They also take into account recent CO_2 emissions projections for the sectors of the EU emissions trading scheme (Dunkel et al., 2006), which were contracted by the Federal Chamber of Commerce, the Federation of Austrian Industry, the Association of Electricity Companies, the Federal Ministry of Economics and Labour and the Federal Ministry of Agriculture, Forestry, Environment and Water Management and which were the basis for an interministerial consensus on the National Allocation Plan and the strategy.

Results from the draft Climate Strategy II are shown in Table 5.1. Total greenhouse gas emissions are expected to be slightly higher than 90 million tons in 2010 with implemented and adopted measures and to be substantially lower (around 77 million tons) with planned measures. As indicated in Table 5.1, the Kyoto Target can only be reached by substantial use of the Kyoto Mechanisms (8-9 Mt annually).

The projections of the draft Climate Strategy II and the model calculations presented in the following section show comparable trends.

Table 5.1: Projected total emissions according to expert judgements for the draft National Climate Strategy II

	Emissions				With Measures	With Add. Measures
	1990	1995	2000	2004	2010	2010
Energy demand (CO_2+N_2O+CH_4)	15.07	15.3	13.9	14.7	14.4	10.8
Energy supply (CO_2+N_2O+CH_4)	13.71	12.7	12.5	15.6	17.3	13.6
Waste (CO_2+N_2O+CH_4)	3.56	3.1	2.6	2.6	2.2	2.1
Transport (CO_2+N_2O+CH_4)	12.76	14.9	18.1	23.9	21.7	16.9
Industry (CO_2+N_2O+CH_4, incl. process)	22.11	22.6	23.4	23.8	26.9	25.2
Agriculture (CH_4+N_2O)	9.12	9.1	8.3	7.9	7.7	7.2
HFCs, PFCs, SF_6	1.60	1.5	1.3	1.5	1.4	1.4
other (incl. solvent use)	1.00	1.0	1.1	1.3	0.9	0.9
Land-use, land-use change and forestry (Art. 3.3 KP)					-0.7	-0.7
Total	**78.94**	**80.2**	**81.3**	**91.3**	**91.7**	**77.3**

5.1.2 Projections from the Inventory Methods Based Model

Model calculations have been performed in 2005, which provide a "With Measures" scenario and a "With Additional Measures" scenario up to 2020. The "With Measures" scenario comprises implemented and adopted policies and measures up to 25. January 2005, the "With Additional Measures" takes into account planned policies and measures comparable to those described in Chapter 4.[1]. The energy model has been developed by the Austrian Institute of Economic Research (IER). Energy scenarios have been calculated by IER as part of a contract with the Federal Ministry of Agriculture, Forestry, Environment and Water Management; these calculations are based on earlier work that had been commissioned by the Federal Ministry of Economics and Labour (Kratena and Wüger, 2005). Energy data have been used as input for the emission projections for CO_2, CH_4, N_2O and F-gases calculated by the Umweltbundesamt project for the forecast of air emissions with the name EMIPRO (Anderl et *al.*, 2006). Beside the energy model separate methods and models have been used for transport, agriculture, solvents and F-gases. Resulting emissions for the sectors energy, industrial processes, agriculture and waste are shown below. Results are presented according to the CRF structure.

Energy (CRF 1)

For emissions from fuel combustion (IPCC sector 1) the "With Measures" scenario indicates that CO_2 emissions from energy will be at a level similar to 2003 in 2010 and will slightly increase until 2020. The "With Additional Measures" scenario shows emissions decreasing by more than 10 %

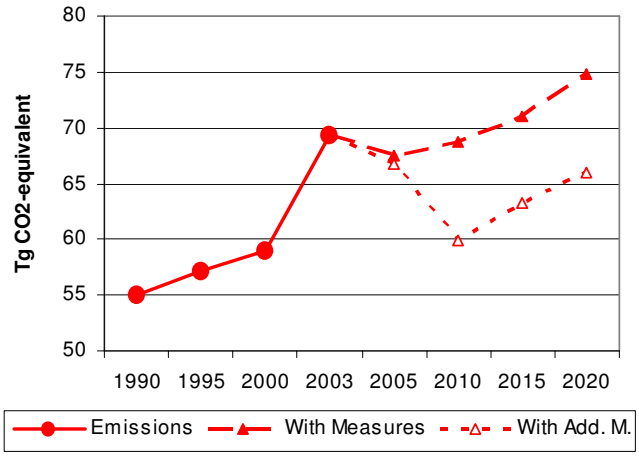

Figure 5.1: Projected emissions from fuel combustion

[1] As the "With Additional Measures" scenario was developed mid 2005, it could not exactly match the planned policies and measures of the draft National Climate Strategy II, which is described in Chapter 4 and which is planned to be adopted by the end of 2006.

until 2010 and rising afterwards to a level well below the 2003 emissions. Table 5.2 and Figure 5.1 show details for projected total emissions from fuel combustion.

Table 5.2: Projected emissions from fuel combustion (CRF 1) by gas

	Emissions				With Measures				With Additional Measures			
	1990	1995	2000	2003	2005	2010	2015	2020	2005	2010	2015	2020
in Tg (CO_2) / Gg (CH_4, N_2O)												
CO_2	53.53	55.67	57.62	67.86	66.20	67.58	69.88	73.75	65.48	58.76	62.24	64.94
CH_4	35.56	33.46	28.89	31.11	28.79	27.91	26.99	25.96	28.63	27.15	26.53	25.43
N_2O	2.17	2.68	2.55	2.65	2.38	1.93	1.73	1.68	2.37	1.83	1.66	1.61
in Tg CO_2 equivalent												
CO_2	53.53	55.67	57.62	67.86	66.20	67.58	69.88	73.75	65.48	58.76	62.24	64.94
CH_4	0.75	0.70	0.61	0.65	0.60	0.59	0.57	0.55	0.60	0.57	0.56	0.53
N_2O	0.67	0.83	0.79	0.82	0.74	0.60	0.54	0.52	0.74	0.57	0.52	0.50
Total	54.95	57.20	59.01	69.33	67.54	68.76	70.99	74.81	66.82	59.90	63.32	65.98

The projected development is dominated by the subsectors energy industries and transport. Whereas emissions from manufacturing industries and construction show a slight increase and emissions from the residential and commercial sector a continuous decrease for both scenarios, the “With Additional Measures” scenario indicates a considerable decrease of transport emissions until 2010. After the enormous increase of transport emissions during the last years, which is caused to a high extent by fuel tourism, fuel tourism is expected to stagnate. That effect together with the biofuel directive leads to a slight decrease of emissions until 2010 also in the “With Measures” scenario. Emissions from energy industries are expected to decrease slightly until 2010 in the “With Additional Measures” scenario and to increase afterwards to a level comparable to the “With Measures” scenario. For details see Tables 5.3–5.6.

Table 5.3: Projected emissions from energy industries (CRF 1 A 1) and fugitive emissions (CRF 1 B) by gas

	Emissions				With Measures				With Additional Measures			
	1990	1995	2000	2003	2005	2010	2015	2020	2005	2010	2015	2020
in Tg (CO_2) / Gg (CH_4, N_2O)												
CO_2	13.72	12.80	12.44	16.26	15.20	16.81	18.19	21.27	14.89	14.16	17.44	20.33
CH_4	13.37	14.12	14.75	15.60	14.78	15.67	15.92	16.27	14.78	15.67	15.92	16.27
N_2O	0.15	0.16	0.18	0.22	0.18	0.19	0.21	0.24	0.18	0.19	0.21	0.24
in Tg CO_2 equivalent												
CO_2	13.72	12.80	12.44	16.26	15.20	16.81	18.19	21.27	14.89	14.16	17.44	20.33
CH_4	0.28	0.30	0.31	0.33	0.31	0.33	0.33	0.34	0.31	0.33	0.33	0.34
N_2O	0.05	0.05	0.06	0.07	0.06	0.06	0.07	0.08	0.06	0.06	0.07	0.08
Total	14.05	13.15	12.81	16.66	15.56	17.20	18.59	21.69	15.26	14.55	17.84	20.75

Table 5.4: Projected emissions from Manufacturing Industries and Construction (CRF 1 A 2) by gas

	Emissions				With Measures				With Additional Measures			
	1990	1995	2000	2003	2005	2010	2015	2020	2005	2010	2015	2020
in Tg (CO_2) / Gg (CH_4, N_2O)												
CO_2	12.97	13.90	14.30	14.16	14.79	15.43	16.37	17.40	14.42	14.98	15.99	16.99
CH_4	0.39	0.45	0.47	0.47	0.48	0.49	0.52	0.55	0.47	0.48	0.51	0.54
N_2O	0.51	0.55	0.55	0.53	0.51	0.45	0.43	0.43	0.51	0.44	0.42	0.43
in Tg CO_2 equivalent												
CO_2	12.97	13.90	14.30	14.16	14.79	15.43	16.37	17.40	14.42	14.98	15.99	16.99
CH_4	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
N_2O	0.16	0.17	0.17	0.16	0.16	0.14	0.13	0.13	0.16	0.14	0.13	0.13
Total	13.14	14.08	14.48	14.34	14.96	15.58	16.51	17.54	14.59	15.12	16.13	17.14

Table 5.5: Projected emissions from Transport (CRF 1 A 3) by gas

	Emissions				With Measures				With Additional Measures			
	1990	1995	2000	2003	2005	2010	2015	2020	2005	2010	2015	2020
in Tg (CO_2) / Gg (CH_4, N_2O)												
CO_2	12.40	14.47	17.74	22.69	21.76	21.43	22.03	22.77	21.76	15.93	15.59	15.36
CH_4	2.91	1.99	1.29	1.07	0.87	0.56	0.42	0.35	0.87	0.52	0.36	0.29
N_2O	0.55	1.02	0.89	0.91	0.77	0.47	0.34	0.29	0.77	0.40	0.28	0.24
in Tg CO_2 equivalent												
CO_2	12.40	14.47	17.74	22.69	21.76	21.43	22.03	22.77	21.76	15.93	15.59	15.36
CH_4	0.06	0.04	0.03	0.02	0.02	0.01	0.01	0.01	0.02	0.01	0.01	0.01
N_2O	0.17	0.32	0.28	0.28	0.24	0.15	0.10	0.09	0.24	0.12	0.09	0.07
Total	12.64	14.83	18.04	23.00	22.02	21.58	22.14	22.87	22.02	16.06	15.68	15.44

Table 5.6: Projected emissions from residential, commercial, institutional and other (CRF 1 A 4 and 1 A 5) by gas

	Emissions				With Measures				With Additional Measures			
	1990	1995	2000	2003	2005	2010	2015	2020	2005	2010	2015	2020
in Tg (CO_2) / Gg (CH_4, N_2O)												
CO_2	14.43	14.49	13.14	14.74	14.45	13.91	13.30	12.31	14.40	13.70	13.23	12.25
CH_4	18.89	16.90	12.38	13.96	12.66	11.19	10.14	8.80	12.51	10.49	9.75	8.34
N_2O	0.95	0.95	0.93	0.99	0.91	0.81	0.75	0.71	0.91	0.79	0.74	0.70
in Tg CO_2 equivalent												
CO_2	14.43	14.49	13.14	14.74	14.45	13.91	13.30	12.31	14.40	13.70	13.23	12.25
CH_4	0.40	0.35	0.26	0.29	0.27	0.23	0.21	0.18	0.26	0.22	0.20	0.18
N_2O	0.30	0.29	0.29	0.31	0.28	0.25	0.23	0.22	0.28	0.25	0.23	0.22
Total	15.12	15.14	13.69	15.34	15.00	14.40	13.75	12.71	14.94	14.16	13.67	12.65

Industrial Processes (CRF 2) and Solvents (CRF 3)

As shown in Figure 5.2, both scenarios indicate no significant changes for emissions from industrial processes including F-gases (CRF 2) and solvents and other product gases (CRF 3) until 2010 and an increase of about 7 % between 2010 and 2020. For details see Table 5.7.

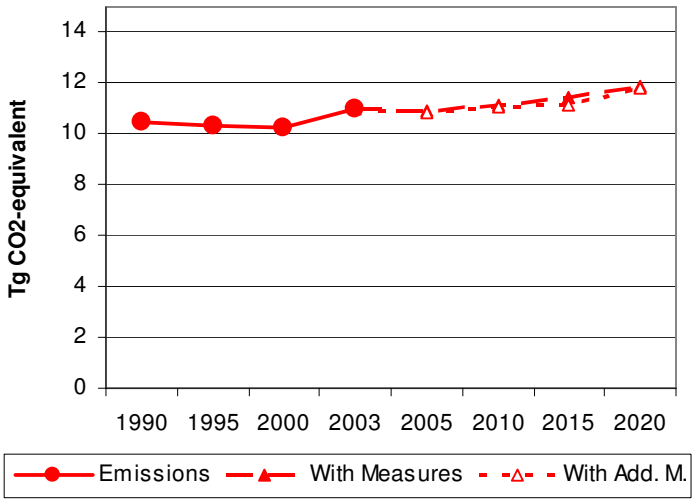

Figure 5.2: Projected emissions from ind. processes

Table 5.7: Projected emissions from industrial processes including F-gases (CRF 2) and solvents and other product gases (CRF 3) by gas

	Emissions				With Measures				With Additional Measures			
	1990	1995	2000	2003	2005	2010	2015	2020	2005	2010	2015	2020
in Tg (CO_2) / Gg (CH_4, N_2O)												
CO_2	7.71	7.44	7.83	8.34	8.82	9.04	9.41	9.81	8.75	8.96	9.14	9.71
CH_4	0.36	0.34	0.35	0.35	0.34	0.36	0.37	0.39	0.34	0.36	0.37	0.39
N_2O	3.69	3.52	3.82	3.60	1.93	1.96	1.99	2.02	1.93	1.96	1.99	2.02
in Tg CO_2 equivalent												
CO_2	7.71	7.44	7.83	8.34	8.82	9.04	9.41	9.81	8.75	8.96	9.14	9.71
CH_4	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
N_2O	1.14	1.09	1.18	1.12	0.60	0.61	0.62	0.63	0.60	0.61	0.62	0.63
HFCs	0.22	0.56	1.02	1.31	0.86	0.68	0.58	0.55	0.86	0.68	0.58	0.55
PFCs	1.08	0.07	0.07	0.10	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12
SF_6	0.50	1.14	0.63	0.59	0.50	0.68	0.68	0.81	0.50	0.68	0.68	0.81
Total	10.66	10.31	10.74	11.47	10.89	11.13	11.4	11.91	10.82	11.05	11.14	11.82

Agriculture (CRF 4)

Both scenarios indicate a slight decrease of GHG emissions up to 2010 and a slight increase afterwards. The expected decrease in methane emissions is due to a reduced number of cattle. Further factors are reduced fertilizer use and improved manure management. For details see Table 5.8.

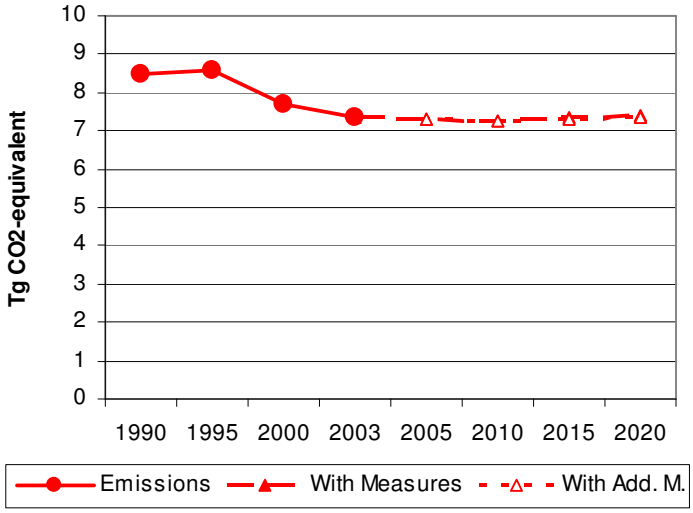

Figure 5.3: Projected emissions from agriculture

Table 5.8: Projected emissions from Agriculture (CRF 4) by gas

	Emissions				With Measures				With Additional Measures			
	1990	1995	2000	2003	2005	2010	2015	2020	2005	2010	2015	2020
in Tg (CO_2) / Gg (CH_4, N_2O)												
CO_2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CH_4	219.15	211.77	197.73	189.97	196.37	195.56	198.13	201.70	196.37	194.61	197.16	200.74
N_2O	12.43	13.26	11.52	10.84	10.20	10.17	10.23	10.16	10.20	10.16	10.19	10.11
in Tg CO_2 equivalent												
CO_2	0.00	0.00	0,00	0,00	0,00	0,00	0,00	0,00	0.00	0.00	0.00	0.00
CH_4	4.60	4.45	4.15	3.99	4.12	4.11	4.16	4.24	4.12	4.09	4.14	4.22
N_2O	3.85	4.11	3.57	3.36	3.16	3.15	3.17	3.15	3.16	3.15	3.16	3.13
Total	8.46	8.56	7.72	7.35	7.29	7.26	7.33	7.38	7.29	7.24	7.30	7.35

Waste Management (CRF 6)

Emissions in this sector are mainly caused by methane. The “With Measures” scenario indicates a continuous decrease of emissions. Implemented measures will reduce emissions to the half of 1990 levels in the year 2020. No additional measures are expected. For details see Table 5.9.

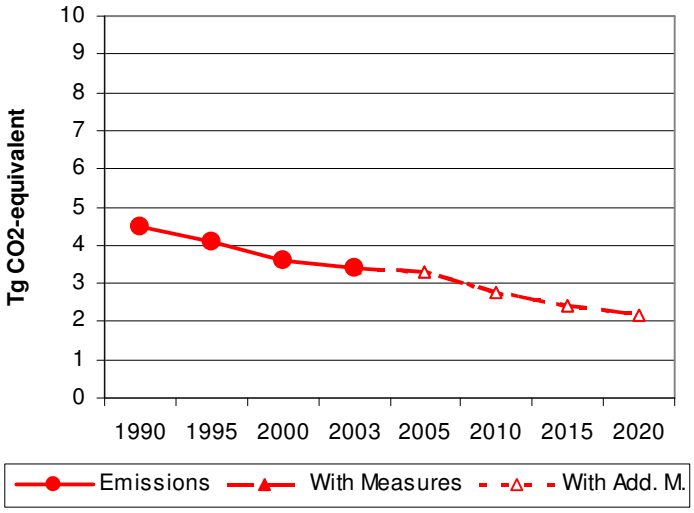

Figure 5.4: Projected emissions from waste

Table 5.9: Projected emissions from waste management (CRF 6) by gas

	Emissions				With Measures				With Additional Measures			
	1990	1995	2000	2003	2005	2010	2015	2020	2005	2010	2015	2020
in Tg (CO_2) / Gg (CH_4, N_2O)												
CO_2	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
CH_4	211.49	189.80	160.94	150.31	143.27	118.64	98.95	86.57	143.27	118.64	98.95	86.57
N_2O	0.13	0.34	0.68	0.80	0.89	0.90	0.96	1.06	0.89	0.90	0.96	1.06
in Tg CO_2 equivalent												
CO_2	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
CH_4	4.44	3.99	3.38	3.16	3.01	2.49	2.08	1.82	3.01	2.49	2.08	1.82
N_2O	0.04	0.11	0.21	0.25	0.28	0.28	0.30	0.33	0.28	0.28	0.30	0.33
Total	4.50	4.10	3.60	3.41	3.30	2.78	2.39	2.16	3.30	2.78	2.39	2.16

Total Emissions (Without Land Use Change and Forestry)

The summary of all sectors shows that emissions are expected to decrease from 91.6 Tg CO_2 equivalent in 2003 to 89.9 Tg in 2010 and to rise again after 2010 in the "With Measures" scenario. The "With Additional Measures" scenario indicates a stronger decrease to 81.0 Tg in 2010 but also shows rising emissions after 2010. In both scenarios emissions of CH_4 and N_2O show a continuously falling trend, whereas CO_2 emissions increase after 2010.

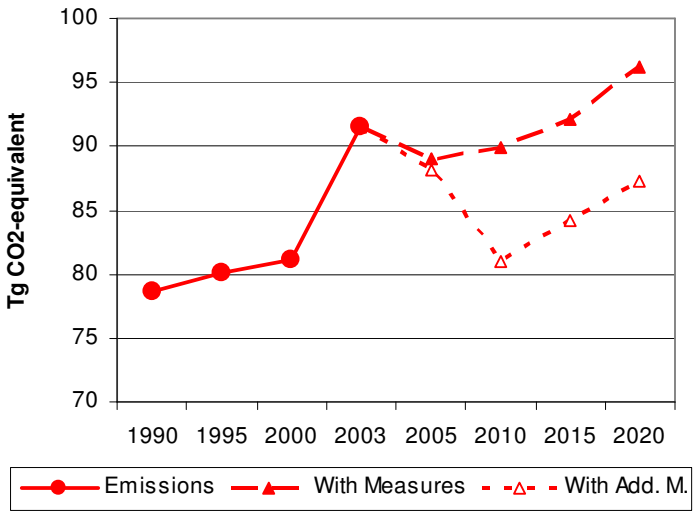

Figure 5.5: Projected total emissions without LULUCF

Table 5.10: Projected total emissions (without LUCF) by gas according to the inventory methods based model

	Emissions				With Measures				With Additional Measures			
	1990	1995	2000	2003	2005	2010	2015	2020	2005	2010	2015	2020
in Tg (CO_2) / Gg (CH_4, N_2O)												
CO_2	61.26	63.12	65.45	76.21	75.03	76.63	79.30	83.56	74.23	67.74	71.39	74.67
CH_4	466.56	435.37	387.92	371.74	368.77	342.47	324.44	314.62	368.62	340.76	323.01	313.13
N_2O	18.43	19.80	18.58	17.88	15.40	14.96	14.91	14.91	15.39	14.84	14.80	14.79
in Tg CO_2 equivalent												
CO_2	61.26	63.12	65.45	76.21	75.03	76.63	79.30	83.56	74.23	67.74	71.39	74.67
CH_4	9.80	9.14	8.15	7.81	7.74	7.19	6.81	6.61	7.74	7.16	6.78	6.58
N_2O	5.71	6.14	5.76	5.54	4.77	4.64	4.62	4.62	4.77	4.60	4.59	4.59
F-Gases	1.80	1.77	1.72	2.00	1.47	1.47	1.37	1.47	1.47	1.47	1.37	1.47
Total	78.57	80.16	81.08	91.57	89.01	89.93	92.10	96.26	88.21	80.97	84.13	87.31

5.2 Assessment of Aggregate Effects of Policies and Measures

Chapter 4 shows a comprehensive listing of policies and measures contained in the National Climate Strategy. Implemented and adopted policies and measures represent an important part of the whole strategy. It has to be mentioned, however, that the highly fragmented responsibilities for climate change mitigation among the Federation, Regions and Municipalities still cause some difficulties for coherent monitoring and evaluation of the effects of policies and measures. That is due to a lack of complete and comparable information on policies and measures and also due to the fact that some measures were undertaken, primarily for other environmental, social or economic needs and that GHG mitigation had been a positive, but rarely measured and evaluated, side effect.

The aggregate effect of *implemented and adopted* policies and measures is therefore derived from the sum of potentials of the individual measures, which are based on bottom-up evaluation from the first assessment report on the implementation of the National Climate Strategy I (Benke et al., 2006) and additional expert judgements according to the draft Climate Strategy II. The effect is 7.9 Tg CO_2 equivalent for 2010 in total (CO_2 6.1 Tg; CH_4 0.8 Tg; N_2O 0.7 Tg; HFCs, PFCs and SF_6 0.4 Tg).

The effect of *planned* policies and measures has been judged in the draft Climate Strategy II for the year 2010 as 14.4 million tons for all greenhouse gases. Another approach to derive the total effect of planned policies and measures is to take the difference of the “With Measures” and the “With Additional Measures” scenario from the calculations with the inventory methods based model. The model calculations (which were done during 2005 and which could not exactly take into account the policies and measures described in the draft Climate Strategy II) show a lower effect for the year 2010 (by more than 4 Mt) than the draft strategy (see Table 5.11). The main reason is that the model calculation did not take into account the contribution of the EU ETS during the trading period 2008-2012, by which the cap for trading sectors will be substantially reduced. Further differences do exist with regard to CH_4 and N_2O emissions, where the draft Climate Strategy II detects a considerably higher additional reduction potential than model calculations have shown:

Table 5.11: Aggregate effect of planned policies and measures according to the inventory based model

	2005	2010	2015	2020
in Tg (CO_2) / Gg (CH_4, N_2O)				
CO_2	0.80	8.89	7.91	8.89
CH_4	0.15	1.71	1.43	1.49
N_2O	0.01	0.12	0.11	0.12
in Tg CO_2 equivalent				
CO_2	0.80	8.89	7.91	8.89
CH_4	0.00	0.03	0.03	0.03
N_2O	0.00	0.04	0.03	0.03
HFCs, PFCs, SF_6	0.00	0.00	0.00	0.00
Total	0.80	8.96	7.97	8.95

Both the *planned* policies and measures of the draft strategy and the “With Additional Measures” scenario of the model calculations indicate that the actual approach is

appropriate to show demonstrable progress in greenhouse gas mitigation by 2005 and to follow Austria's Kyoto target under the EU burden sharing agreement. The remaining gap of 8-9 Mt CO_2 equivalent between expected emissions during the commitment period 2008-2010 and the assigned amount of 68.7 Mt CO_2 equivalent should be bridged by utilising the project-based flexible mechanisms of the Kyoto Protocol.

5.3 Methodology

For the inventory based model energy consumption is projected with the macroeconometric energy and environment model PROMETEUS of the Austrian Institute for Economic Research. Resulting figures for energy demand in the Austrian economy are split according to the subsectors of the Austrian greenhouse gas emission inventory and emissions are calculated in accordance with inventory methodology. Emissions for the other sectors are again calculated based on emission factors from the Austrian greenhouse gas inventory and activity projections up to 2020. Information on the methods can be found in the subsections 5.3.1–5.3.6 below.

For the projections of the draft Climate Strategy II also the CO_2 projections, which have provided the basis for the decision on the National Allocation Plan, have been an important input. The scope of that work is restricted to the sectors affected by the EU emissions trading scheme. Information can be found in subsection 5.3.7.

5.3.1 The Energy Model

Model based energy and environmental analysis is carried out with different types of models, where especially disaggregated computable general equilibrium (CGE) models, energy system models and macroeconometric energy & environment models can be distinguished. An overview of models in use in different European research institutions has been established recently in the TRANSUST project (within the 5th Framework Programme of the EU-Commission). The main objective of the TRANSUST project was model comparison by revealing the relevant features and differences between classes of models (www.transust.org). The model used in Austria (PROMETEUS) is a macroeconometric energy & environment model. In the following a short description of the most important features of PROMETEUS is given.

Production
Production and energy demand is described by flexible forms of cost functions like Translog and Generalized Leontief. Both can be seen as second order approximations to any cost function (Berndt, 1991, Morrison, 1989, 1990). For Translog we have:

(1) $$\ln C = \alpha_0 + \sum_i \alpha_i \ln p_i + \tfrac{1}{2}\sum_i \sum_j \gamma_{ij} \ln p_i \ln p_j + \alpha_y \ln Y + \tfrac{1}{2}\gamma_{yy}(\ln Y)^2 + \sum_i \gamma_{iy} \ln p_i \ln Y$$

whereas for Generalized Leontief we get:

(2) $$C = Y\sum_i \sum_j \alpha_{ij}(p_i p_j)^{1/2}$$

with variable costs (C), input prices (p_i) and output (Y)

The Translog model is used for factor demand at the sectoral level with labour, energy, materials and capital as inputs. For inter-fuel substitution at the sectoral level the Generalized Leontief model is applied. Additionally the concept of 'quasi fixed' capital stock (in the sort run) is introduced. The total costs therefore also include fixed costs of capital, measured at the 'shadow price' of capital which is given by the variable cost reducing impact of capital (for fixed capital in the Translog case, s.: Berndt, Hesse, 1986). Capital is only flexible in the long run and the model is complemented by stock adjustment functions for the capital stock, where the actual stock adjusts to the 'optimal' given by the differential between the 'shadow price' and the user costs of capital. For services and households a slightly different approach from the model for industry is used. For these two sectors technological components for energy demand are taken into account at the total level of energy demand as well as the level of inter-fuel substitution (s.: Kratena, Wueger, 2004).

Factor demand for LEM (Labour, Energy, Materials) with 'quasi' fixed capital stocks

From a Translog cost function for Labour (L), Energy (E) and Materials (M) and capital K as the "quasi-fixed" factor in each industry we derive factor demand by Shephard's Lemma and end up with a system of 3 factor demand equations, one equation for the 'shadow price' and one price equation, where we assume 'mark up pricing' (s. Berndt, Hesse, 1986 and Flaig, Steiner, 1990). For energy the factor demand equation is:

(3) $$\frac{p_E E}{C} = \alpha_E + \gamma_{EE} \ln(p_E) + \gamma_{LE} \ln(p_L) + \gamma_{ME} \ln(p_M) + \rho_{KE} \ln K + \rho_{EY} \ln Y$$

All equations have been estimated on time series data in Austria (1988 – 2003). The parameter estimates are the starting point for driving own and cross price elasticities. The symmetric "Hicks Allen elasticities of substitution" (AES) $\sigma(ij)$ are linked to the price elasticities $e(ij)$ by:

(4) $$e(ij) = \sigma(ij)\, S_j,$$

where S_j is the cost share of factor j In total we get the following elasticities in the Translog case:

(5) $$\sigma_{ij} = (\gamma_{ij} + S_i S_j)/(S_i S_j)$$
$$\sigma_{ii} = (\gamma_{ii} + S_i^2 - S_i)/ S_i^2$$
$$e_{ij} = (\gamma_{ij} + S_i S_j)/S_i$$
$$e_{ii} = (\gamma_{ii} + S_i^2 - S_i)/ S_i$$

Inter-fuel substitution

Total energy demand E with costs of EC is split up into coal, oil, gas, and electricity starting from the Generalized Leontief-cost function. Additionally technical progress is considered via a deterministic trend (t) :

(6) $$EC = E\,[\sum_i \sum_j a_{ij}(p_i p_j)^{1/2} + \sum_i d_{it} p_i t^{1/2} + \sum_i g_{tt} p_i t]$$

Again we derive fuel demand via Shephard's Lemma, e.g. for electricity:

(7) $$\frac{EL}{E} = \alpha_{EL,EL} + \alpha_{EL,CO}\left(\frac{p_{CO}}{p_{EL}}\right)^{1/2} + \alpha_{EL,OIL}\left(\frac{p_{OIL}}{p_{EL}}\right)^{1/2} + \alpha_{EL,GAS}\left(\frac{p_{GAS}}{p_{EL}}\right)^{1/2} + \delta_{EL}t^{1/2} + \gamma_{tt}t$$

Cross- and own price elasticities are given by :

(8) $e_{ij} = ½[\alpha_{ij}\ (p_i/p_j)^{-1/2}]/a_i$

Table 5.11 shows the own price elasticities for total energy from the factor demand model (for *LEM*) and the single fuel elasticities from the inter-fuel substitution model.

Electricity generation

Again the starting point is a cost function with variable and fixed factors where the total costs of thermal power generation G_{EL} yield together with fixed capital costs of non-thermal renewable generation (r = hydro, wind and photovoltaics) $\sum_r Z_{rk} K_r$ the total costs of generation C_{EL} :

(9) $$C_{EL} = G_{EL} + \sum_r Z_{rk} K_r$$

(10) $$Z_{rk} = -\frac{\partial G_{EL}}{\partial K_r}$$

In (10) we see the shadow price of renewable generation. The explicit cost function is :

(11) $$C_{EL} = Q_{EL}\left[\sum_i \frac{e_i}{\eta_i} p_i + \sum_r Z_{rk} e_r k_r^h\right]$$

In (11) the e_i are the output shares of *i* variable factors (coal, oil, gas, etc.) in total generation Q_{EL} and η_i and p_i are the corresponding efficiencies and input prices. The specific capital input of renewables (in constant prices of a base year) per unit of capacity (in MW) is given with assumptions on annual generation hours as(K_r/Q_r) = k_r^h. As renewables have (by assumption of energy balances) an efficiency equal 1 the substitution elasticity between renewables and thermal always is given by $1/\eta_i$,,. From (11) we can derive the impact of renewable capital on costs of thermal generation, i.e. the shadow price of renewable capacity, which depends on thermal generation input prices (more specific on: $\sum_i \frac{p_i}{\eta_i}$) and on capital input requirements per unit of renewable generation. The latter are described by 'learning curves' where k_r^h depends on installed capacity ("learning by doing"). Capital stock adjustment, i.e. investment dynamics for renewables depends on the relation of thermal generation input prices to the user costs of capital for the renewable energy source. The elasticity of the capital stock (the installed capacity in MW) on this price relation is 1.17 for wind and 0.78 for photovoltaics. Within thermal generation we use again the Generalized Leontief cost function to split up into coal, gas and renewables The own and cross price elasticities in thermal generation are described in Table 5.12.

Table 5.11: Own price elasticities of energy demand

	TOTAL	Coal	Oil	Gas	Electricity
Agriculture	0,000	-	-0,018	-0,169	-0,001
Mining and Quarrying	-1,619	-	-0,527	-1,184	-0,160
Food, Beverages and Tobacco	-1,662	-	-0,120	-0,011	0,000
Textiles and Leather	-0,508	-	-0,311	-0,506	-0,002
Wood and Wood Products	-0,956	-	-0,139	-1,122	-0,062
Pulp, Paper and Printing	-0,317	-0,068	-2,333	-0,403	-0,002
Chemical (incl.Petro-Chemical)	-0,270	0,000	-0,032	0,000	-0,004
Non metallic Mineral Products	-0,787	-0,008	-0,047	-0,036	-0,029
Iron and Steel	-0,453	-0,078	-0,392	-1,012	-0,065
Non-Ferrous Metals	-0,210	-	-0,077	-0,223	-0,051
Machinery	-0,716	-	-0,078	-0,087	-0,376
Transportation Equipment	-1,534	-	-0,260	-0,074	-0,022
Non Specified (Industry)	-0,737	-	-0,041	-0,181	-0,413
Commerce - Public Services	0,000	-1,742	-0,204	-0,111	-0,016
Housholds	-0,050	-1,000	-0,065	-0,151	-0,060

Table 5.12: Own and cross price elasticities in thermal generation

	Coal	Gas	Renewables
Coal	-0,45	0,46	-0,01
Gas	0,32	-0,54	0,22
Renewables	-0,01	0,75	-0,74

Strengths and Weaknesses of the Model

In PROMETEUS the energy system and the economy are fully integrated into one disaggregated model. This might be seen as a major difference compared to pure energy system models (like MARKAL), where the economy is introduced exogenously. Besides this advantage another strong point in PROMETEUS is that almost all parameters are based on econometric estimates with time series for Austria. This feature enables the model to describe and quantify the dynamic adjustment path as a reaction to shocks in model simulations.

The main disadvantage is the missing detail of modelling the energy system and the missing link between technologies and energy demand at a detailed level. The missing detail of the energy system does not refer to the model framework, as the model is constructed on the detailed data base of IEA energy balances (about 4,000 variables in each period). Rather it refers to the detail of modelling of all the underlying technological processes. Models of the energy system like MARKAL differentiate between multiple sets of technologies for a large range of sectors (also in industry). The emphasis in PROMETEUS is on estimating the average reaction of energy demand to *all relevant* variables, where technology represents only one factor of influence.

5.3.2 Emissions from Fuel Combustion

Results of the energy projections are used by the Umweltbundesamt to derive emission projections for CO_2, CH_4 and N_2O in EMIPRO (Storch et al, 2005). As the economic sectors of energy model do not correspond to the IPCC sectoral structure, however, fuel consumption has to be assigned to the IPCC sub-sectors (a fact which

leads to some additional uncertainty in the resulting emission projections). Calculation of emissions is done according to the emissions factors of the Austrian greenhouse gas emission inventory.

Only the calculation of the transport emissions is based on models different to the model described in subsection 5.3.1:

- AUTRAF, a simple model for predicting transport demand values in Austria: AUTRAF results from a simple multiple linear regression, where the recorded transport volumes and vehicle mileages in the past are used as dependent variables and the GDP, population, the fuel prices, the motorization etc. are used as independent variables.
- For the calculation of road emissions the GLOBEMI model is used. GLOBEMI was developed for the calculation of emission inventories in larger areas. Input parameters are amongst other the vehicle stock of each category split (cars, light duty vehicles, …) into layers according to the propulsion system (SI, CI,..), cylinder capacity classes or vehicle mass, the emission factors of the vehicles according to the year of first registration and the passengers per vehicle and tons payload per vehicle.
- The energy consumption and the emissions of the off-road in Austria are calculated with the model GEORG (Grazer Emissionsmodell für Off Road Geräte). The model GEORG has a fleet model part, which simulates the actual age and size distribution of the vehicle stock via age and size dependent drop out rates (probability that a vehicle is scrapped until next year). With this approach the stock of each category of mobile sources is calculated according to the year of first registration and the propulsion system (gasoline 4-stroke, gasoline 2-stroke, diesel>80kW, diesel<80kW).

5.3.3 Emissions not related to Fuel Combustion

Fluorinated gases represent 2–3% of current and expected greenhouse gas emissions in Austria. The “with measures” projection for these substances is based on industry surveys and expert judgements (Bichler et al., 2001). This study shows projected data for 2008. For the “With Measures” scenario of the current report, the overall increase of about 1 Tg CO_2 equivalent from 1999 to 2008 (according to Werenskiold and Unterberger) is projected forward as a continued linear increase until 2020; emissions of PFCs and SF_6 are assumed to be constant after 2008. For the “With Additional Measures” scenario, expert judgements for the year 2008 from the National Climate Strategy are used (FMAFEW, 2001), with the additional assumption of a linear development after 2008 for HFCs and no changes in emissions after 2008 for PFCs and SF_6. The projection must be seen as a conservative estimation. The share of F-gases in total greenhouse gas emissions and the reliability of available data about development during the next years did not justify setting up a special model on F-gas emissions in Austria.

The basis for the data of the Austrian air emission inventory 2004 for emissions from *Solvents* is a survey (Windsperger et al., 2002), where the stock of solvents used in Austria in the various applications is determined by a combination a bottom up and a top down approach. In this survey the stock of solvents annually used and solvent emissions (NMVOC) for 2000 and 2010 are calculated. The data of the Austrian air

emission inventory 2004 is based upon a current estimation, which is generally higher than the data of the year 2000, because in the year 2000 the use of wind screen washing fluid in households was not included. For the year 2010 the changes in percentage of the consumption of solvents and NMVOC emissions from 2000 to 2010 on SNAP level are applied on annual values of the OLI 2004 also sorted on SNAP level. The CO_2 emissions are calculated with the "emission factors" t CO_2 / t NMVOC of the year 2000. The projection of *Other Product Use* is a constant extrapolation of the inventory data from 2003.

Emission scenarios for the agricultural sector are calculated based on the methodology used for the Austrian Greenhouse Gas Inventory. A comprehensive description can be found in the Austrian National Inventory Report 2005 (Anderl et al., 2005). Input Parameters for the projection of the activity data have been estimated by the Federal Research Institute for Alpine Regions Gumpenstein (Pöllinger and Ofner, 2004) and with the Positive Agricultural Sector Model Austria (PASMA), developed by the Austrian Institute of economic research (WIFO) (Sinabell and Schmid, 2005). The major driving forces of the sector development are the prices on farm commodity markets, technological progress and policy variables.

For the emission projection for *waste* ("solid waste disposal on land", "wastewater handling", "waste incineration" and "other waste treatment") the same methods as described in the National Inventory Report 2005 are used. For the calculation of the country specific emission projections of the main important emission group "solid waste disposal on land" the directly deposited waste is separated into two categories: "residual waste" and "non residual waste". "Residual waste" corresponds to waste from households and similar establishments directly deposited at landfills without any treatment. It originates from private households, administrative facilities of commerce, industry and public administration, kindergartens, schools, hospitals, small enterprises, agriculture, market places and other generation points covered by the municipal waste collecting system. The methodology of Tabasaran and Rettenberger for CH_4 is used. "Non Residual Waste" is directly deposited waste other than residual waste but with biodegradable lots (e. g. bulky waste, construction waste, mixed industrial waste, road sweepings, sewage sludge, rakings, residual matter from waste treatment). For the calculation the methodology of Marticorena was used. The deposited Non Residual Waste was split up into two groups (well biodegradable waste with a half-life period of 1–20 years, hardly biodegradable waste with a half-life period of 20–100 years) and the incidental quantity of gas was calculated for each group. Because of a half-life period of more than 2.500 years the emissions of very hardly biodegradable waste are not relevant and were not considered.

Based on investigations by Umweltbundesamt the quantities of produced "residual waste" increase constantly until the year 2020 (2003–2010: +1.5 % per year; 2010–2015 +0.78 % per year; 2015–2020 +0.68 % per year).

5.3.4 Differences to the Third National Communication

The model based projections contained in the Third National Communication show a 17 % increase of CO_2 emissions for 2010 compared to 1990 in the "With Measures"

scenario, whereas the latest model-based projections indicate a 25 % increase for the same period. Total GHG emissions projected for 2020 are about 8 % higher compared to the projections in the Third National Communication. This is mainly due to higher projections for emissions from fuel combustion. Differences in other sectors are mainly related to changes in emission factors and go along with recalculated inventory data for these sectors.

One of the reasons for the increase in projected CO_2 emissions may be the fact that economic growth in the production sector was higher than expected during the last years. Furthermore recent and forthcoming expansions of production capacity in steel industry have been taken into account in the new projections.

The models used have been improved. The first version of WIFO's energy system model (DAEDALUS) has been used for the energy scenarios to 2020 published in 2001 (Kratena and Schleicher, 2001). In the course of some contracts, commissioned a. o. by the Federal Ministry of Economics and Labour, the model has been updated and developed in order to capture other and new features of the Austrian energy system. Besides the full integration of the energy system and the disaggregated economic model into one model system that concerns:

- detailed modelling of electricity and heat generation taking into account new technologies for renewables and learning curves for these technologies.
- econometric estimation of all parameters based on a fully revised data set for energy balances (in IEA format) and for National Accounts (data by industries).

In general most changes compared to the energy scenarios from 2001 can be due to new model parameters based on the new data set of energy balances. These new data also comprise the development from 2000 to 2003, where some important changes, especially in the Austrian electricity sector, occurred.

For the first time, a comprehensive all sector model for emission projections has been established at Umweltbundesamt, which is based on inventory methods as far as possible and on macroeconomic models.

5.3.5 Sensitivity Analyses

Small differences in key input parameters may have considerable impact on the resulting emissions; sensitivity analyses allow for a quantitative estimation of these impacts. For the energy projections, changes in energy prices compared to the “With Measures” scenario have been quantitatively estimated:

- The sensitivity scenario with 50 % higher oil price (Brent) from 2005 onwards resulted in a 4–5 % reduction in final energy consumption in manufacturing industry and almost no effect on households and services, transformation energy showed a 1.5 % reduction. Gross inland consumption was reduced by 2.5–3 %, with largest effects for oil products (4–6 % reduction), similar effects for coal and gas (about 3 %) and less than 1 % increase for renewable energy sources.
- The sensitivity scenario with 50 % lower oil price (Brent) from 2005 onwards resulted in a 7–8 % increase in final energy consumption in manufacturing industry and less than 1 % increase in households and services, transformation energy showed a 2 % increase. Gross inland consumption increased by 4–4.5 %,

with largest effects for oil products (7–9 % increase), similar effects for coal and gas (about 4–4.5 %) and about 1 % reduction for renewable energy sources.

Effects on CO_2 emissions in a similar order can be expected.

5.3.6 Key Variables and Trends

Information about key input parameters for the models is necessary to allow for an interpretation of the results, just as knowledge about the economical and mathematical foundations of the model itself. Table 5.13 lists figures for some of the parameters. However, it must be kept in mind that this kind of information cannot replace thorough analysis of the modelled scenarios. Some characteristic results of the scenario calculations are shown for easier understanding of the emissions trends. The figures relate to the "With Measures" scenario. Parameters, which are input for the models, are printed in **bold**.

Table 5.13: Key variables and trends of the model calculations

	1990	1995	2000	2005	2010	2015	2020
GDP growth, real 2000 [mill. €]	144 584	162 246	187 707	201 604	224 998	250 861	276 970
GDP growth, real 2000 [%]	+5.0	+ 2.2	+ 4.0	+2.2	+2.2	+2.2	+2.0
Production value growth in manufact. indust., real 2000 [%]		~ + 2.7			~ + 3.2		+3.3
Oil price Brent, real 2000 [€/bbl]				26.12	30.87	30.87	30.87
Population [million pers.]	7.68	7.95	8.01	8.13	8.26	8.35	8.40
Number of dwellings [million]	3.27	3.42	3.63	3.74	3.81	3.92	4.03
Private cars [million]	2.8	3.4	3.8	4.2	4.4	4.6	4.8
Energy prices of Households, price base 2005 [%]							
fuel oil				100	102.5	107.2	112.1
electricity				100	103.5	105.6	107.8
gasoline				100	85.9	85.9	85.0
Final energy consumption [PJ]	774	853	955	1 095	1 146	1 212	1 280
Steel production from Basic oxygen steelmaking [1000 tons]	3 922	4 529	5 366	6 510	6 575	7 060	7 440
cattle [1000 head]	2 584	2 326	2 155	1 989	1 941	1 905	1 896
waste deposition in landfills [1000 tons]	2 859	1 912	1 980	971	794	810	823

5.3.7 CO_2 Projections for the Sectors Affected by the EU-ETS

Business as usual CO_2 projections for the second period of the EU emissions trading (2008–2012) have been developed based on the extrapolation of four components: Production, energy consumption, energy related CO_2 intensity and process related energy intensity. The structure of the market relevant for a particular branch of industry is examined to determine the production. The production of a branch is calculated based on projections for inland demand and exports/imports. The technology relevant parameters energy and CO_2 intensities are projected based on historical trends, information on investments planned by industry and comparisons with other countries.

Chapter 6

Vulnerability Assessment, Climate Change Impacts and Adaptation Measures

CONTENTS

Austria consists to a considerable extent of alpine and hilly regions. This is an important reason for its vulnerability to possible climate change impacts. Impacts and vulnerability are described in the first two parts of this chapter. Adaptation measures which are either motivated by impacts of observed climate change or have adaptation as a co-benefit are shown in the third part.

6.1 Expected Impacts of Climate Change

Observations show that mean annual temperature has increased in the order of 1–2°C within the last 50 years and several years of the last two decades belong to the warmest years since the beginning of regular weather recording. Observations as well as modelling data serve as basis to describe impacts of climate change on physical, ecological and socio-economic systems.

6.1.1 Impacts on Physical Systems

6.1.1.1 Hydrology

Climate-driven hydrology in mountain regions is determined to a large extent by orography itself. Mountainous regions are very effective in extracting moisture from the ambient atmospheric flow via various orographic precipitation mechanisms. Such precipitation is important not only in the considered mountainous area itself, but is often highly relevant for the fresh-water management in large neighbouring regions. In the case of the Alps, more than 100 million people rely on the Alpine rivers Rhine, Rhone and Danube for their fresh-water supply (MAP, 1996).

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 (IPCC, 2001, 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. The European research project PRUDENCE (Christensen et al, 2002) implies a shift in the seasonal cycle of the precipitation in the alpine region with an increase of precipitation during winter and a decrease in summer. New results from the global climate model ECHAM5 from the Max Planck Institute Hamburg, confirms this findings (Brasseur, 2005). 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.

Austria's average annual rainfall is around 1,100 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). Several 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 towards shorter or longer dry spells (averages and extremes). The flood statistics does not show a clear result in connection with the climate change. The number of flood events per year and the annual flood maxima reveal positive linear trends in the periods from 1972 to 1981 and from 1982 to 1991, but this is not the case for the annual daily maxima of precipitation during the period 1952-1991 (Nobilis and Lorenz, 1997).

A particular sensitive hydrological system to climate change is the lake Neusiedl at the Austrian/Hungarian border. This shallow lake (~ 1,5 m) has no natural drain and its water level is mainly defined by precipitation on the lake and evaporation (Boroviczeny, F. et al., 1992). Results from a lake model (Eitzinger et al, 2005) indicate an observed increase of lake evaporation of 10 % for the period 1991-2004 compared to 1961-1990; when regional climate change scenarios are applied a further increase up to 25 % till 2040 seems possible.

There is no detailed assessment of possible climate change impacts on hydrology and water resources for the whole of Austria yet, but several studies on certain aspects of the problem exist, like studies focusing on 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; Nachtnebel *et al.1999;* Bogardi *et al.*, 1996). Due to the extreme events in summer 2002 (flood) and 2003 (heat and drought) the two coordinated research programmes “FLOODRISK” and “StartClim” (http://www.austroclim.at/index.php?id=40) where established. The participation of Austrian scientists in the international framework “GLOWA-DANUBE” is expected to extend knowledge on the upper Danube basin.

6.1.1.2 Mountain Cryosphere

The effects of temperature and precipitation changes on glaciers’ behaviour 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.

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 historically did (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, but even at Hoher Sonnblick in 3106 m altitude the share of snowfall in total precipitation has decreased during the last decades by ten percent (see Fig. 6.1).

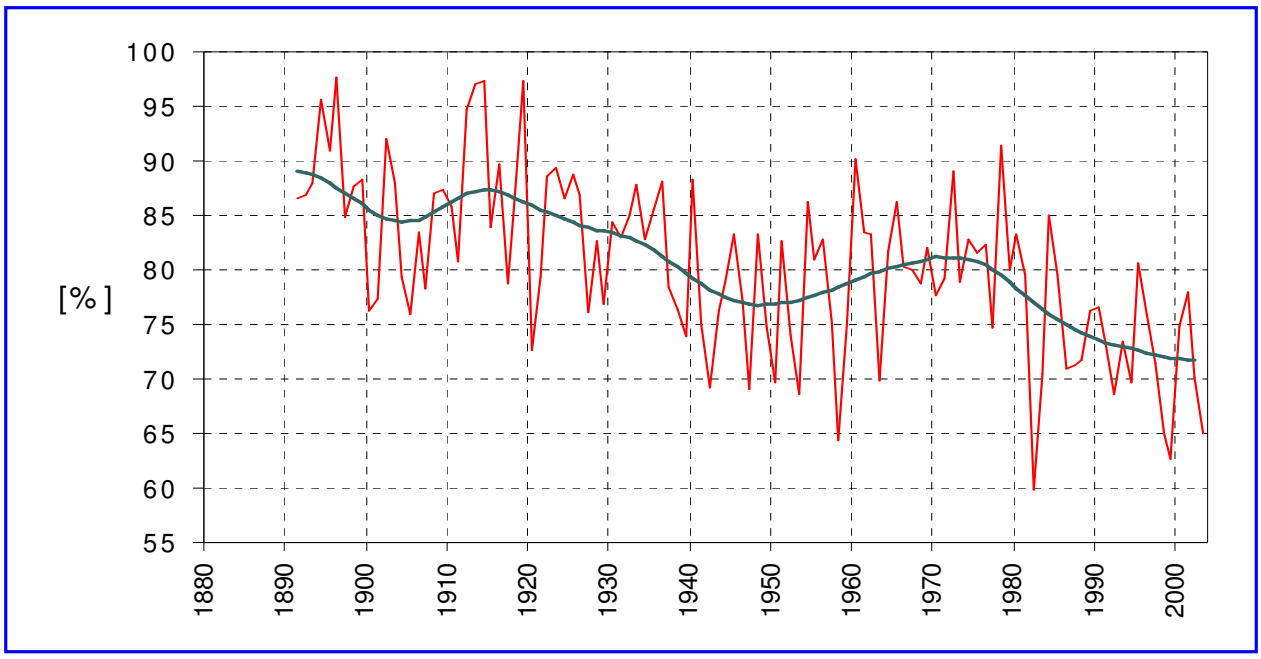

Fig. 6.1: Share of snowfall in total precipitation at the Station Hoher Sonnblick (3106 m) since 1890. The share decreased from approximately 85 % to less than 75 %. (Schöner, 2003)

Inferences in regard to the future of Austrian glaciers are possible from long-term observations, particularly from the past decades. The mass balance of glaciers is determined predominantly by summer temperature, winter precipitation and by changes in surface reflectivity introduced by summer snowfall. During recent years even large areas 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 (see Fig. 6.2). Especially the hot and dry summer 2003 induced an extreme ice melt in the whole Alpine region. It was estimated that up to 10 % of the total ice mass of the Alps decreased in this single summer (Häberli, 2004)

In Austria, the first complete glacier inventory was compiled from aerial photography taken in 1969. Since then, significant changes in glaciated areas have taken place in the Alps. In order to document and investigate these changes a new glacier inventory for Austria was initiated. Aerial photographic surveys have been carried out in 1996 - 1999. The digital photogrammetric analysis is finished and the glaciological interpretation is in process.

For two of the most important glacier areas of Austria, the Ötztaler Alpen and Stubaier Alpen, the inventory of glacier boundaries, area-elevation distributions, and spatial and volumetric changes has been completed. These regions represent about 45% of the ice-covered area of Austria and reflect very well the general trend observed for all Austrian glaciers. The analysed glaciers show a 15% decrease in area and a total loss of ice volume of about 2 km³ between 1969 and 1997 (Lambrecht et al., 2005) These results are in good agreement with the long-term variations of Hintereisferner, a large valley glacier, where mass balance measurements are available since 1952/1953. The analysis of all glaciers, however, shows a high variability, especially in the fluctuations of smaller glaciers.

As an example, the height difference for Hintereisferner between the two inventory states is displayed in Fig. 6.2. This glacier lost 11.2 % of its area, which is similar to the general trend. Basically all elevation bands show a height loss, and thus a reduction of ice thickness, with maximum values at the modern glacier tongue.

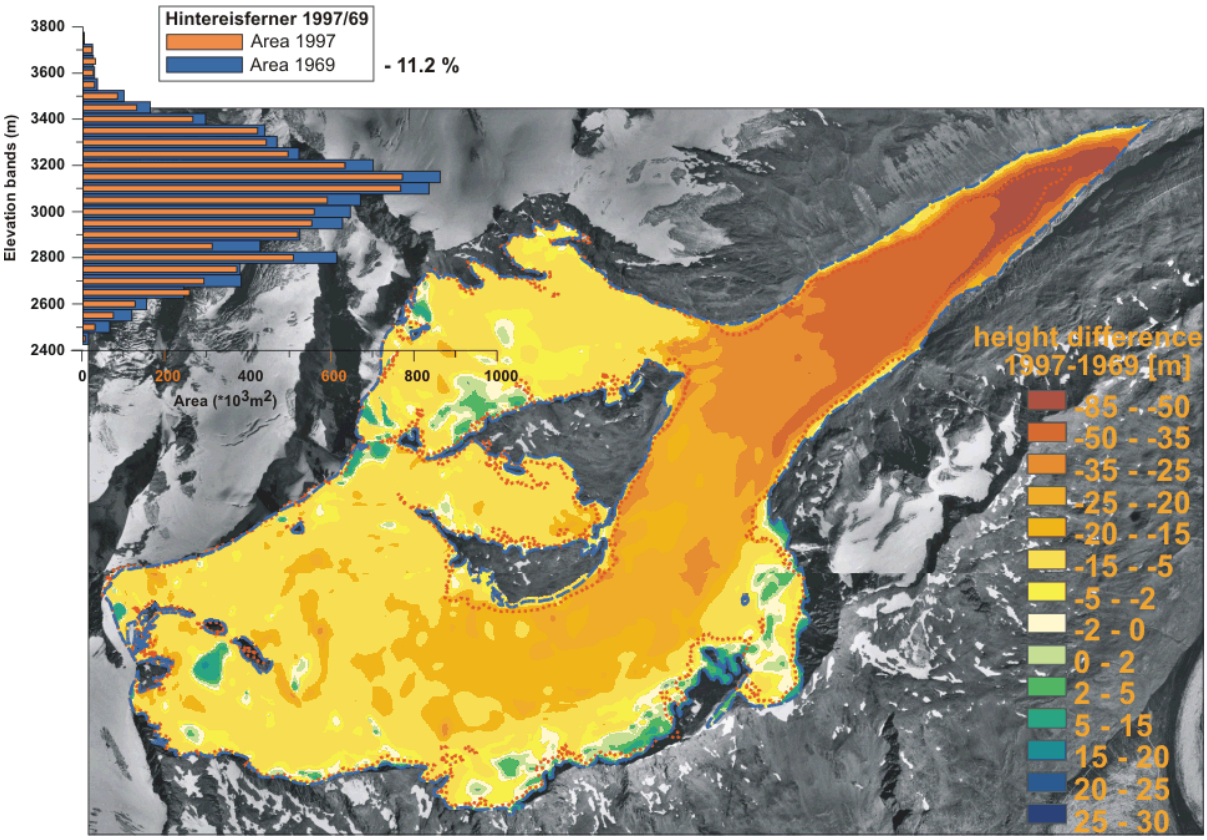

Fig. 6.2: Height difference between 1997 and 1969 for Hintereisferner. The inlet (top left) shows the area-elevation distribution for Hintereisferner. The dotted red line shows the glacier boundary in 1997, the broken blue one the boundary in 1969.

6.1.1.3 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 limited, especially for heavy precipitation events. But analyses of the drought and heat wave in central and west Europe in summer 2003 clearly showed a significant increase in the probability for such events during the last decades (Schär et al, 2004) due to the observed warming trend. Scenarios for the end of this century indicate that situations like summer 2003 will occur nearly every second year.

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).

Regional climate change scenarios from the project PRUDENCE indicate an increase of precipitation intensity and most models also show an increase in extreme

precipitation especially in winter in the alpine region (Frei et al, 2005). Several studies focus on the so-called Vb cyclone. This weather pattern caused heavy damage in Austria in 1999, 2002 and 2005. Scenarios from the GCM ECHAM5 indicate a decrease of the probability for this weather pattern in the future (Brasseur, 2005), but no information about a potential increase in intensity can be gained from the GCM.

6.1.1.4 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 rockfall 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; Heuberger, 1966), and to the reduced cohesion of the soil through permafrost degradation (Haeberli *et al.*, 1990).

6.1.1.5 Avalanches

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.). On average, more than two dozen persons per year were killed by avalanches in the last decades, most of them, however, during ski-mountaineering. According to control measurements, the number of avalanches threatening settlements is presently decreasing due to successful reforestation and/or avalanche control measures. Nevertheless disastrous avalanches still occur as in Galtür 1999, where 38 people were killed in their houses.

As almost two thirds of all avalanches start below the potential timberline, afforestattion is an option to prevent avalanches. At the research station in Obergurgl (2,000 maSl) 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. As most regional climate change scenarios for the alpine region indicate an increase of winter precipitation (e.g. PRUDENCE) and also an increase in precipitation intensity, an increase in danger potential is very plausible.

6.1.2 Impacts on Ecological Systems

6.1.2.1 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.

6.1.2.2 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. 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).

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 centre 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.

In addition to the impact of climatic change on the altitudinal vegetation 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 refuges from re-establishing at higher, adjoining mountains (Grabherr *et al.*, 1995). At lower altitudes, Mediterranean tree species can replace 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.

6.1.2.3 Ecosystem Responses and Forest Growth

There are a number of ecosystem models currently available that can be used to test the sensitivity of forest ecosystems to changes in environmental conditions. In climate impact research two major modelling approaches are distinguished to evaluate the impacts of a changing climate: gap-models (e.g., Shugart 1998, Lexer and Hönninger 2001) and mechanistic ecosystem models (e.g., Running and Hunt 1993, Hasenauer et. al. 1999, Merganicova et al. 2005). Recently, hybrid modelling approaches have been emphasized which combine the strengths of both approaches while trying to overcome their weaknesses (e.g., Seidl et al. 2005, Jäger et al. 2004). Research currently focuses on the implementation of management routines and the inclusion of pests and diseases into the models.

A number of modelling 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, Lexer et. al. 2000). 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. Based on a large-scale simulation study based on data of the Austrian Forest Inventory and employing three transient climate scenarios Lexer *et al.* (2000) concluded that climate change conditions of approximately 1°C warming and precipitation change of +/- 7% seemed to characterize some kind of threshold beyond which the severity of potential adverse climate change impacts might increase substantially.

The mechanistic ecosystem models calculate the net primary production (NPP) of forests. Austrian scientists (Hasenauer et. al., 1999) have used such a model to simulate forest growth in Austria during the period 1961–1990 and validated the results with the data of the Austrian Forest Inventory. They found a good correlation between the simulated and the measured results. It could be shown, that the observed trends in the NPP during this period could be explained by the temperature rise and the resulting changes in the length of the growing season.

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, Orthofer et al., 2000). In several international projects (e.g. EU FP5 SilviStrat) the effects of climate change on forest-growth and potential adaptation strategies are investigated.

Currently attempts are on the way to use improved model variants for advanced climate change impact studies including the development of adaptive forest management strategies (e.g., Seidl et al. 2005, Merganicova et al. 2005, Jäger et al. 2004).

6.1.2.4 Alpine Protection Forests

In Alpine regions, forests play an essential role in reducing significantly risks of erosion and avalanches, thereby providing an indispensable prerequisite for habitation in these regions. However, it has to be recognized that forests in mountain regions are highly sensitive to changes in climate conditions, and that this is particularly true in areas close to the timberline. In these areas, only small changes of temperature or snow cover duration are bound to have significant impacts on the extent of the forests. In estimating the impact on Alpine protection forests, it has to be taken into account that an increased atmospheric concentration of carbon dioxide can increase the net photosynthesis and thereby enhance the growth of trees.

The limits of life as well as the influence of temperature on the growing conditions of the most important tree species in the Austrian mountain regions have been a main focus in Austrian research within the last decades (Forschungsstelle für Lawinenvorbeugung, 1961, 1963; Aulitzky, 1963; Tranquillini, 1979; Aulitzky et al., 1982, Ozenda, 1988), with the goal to initiate highland reforestation and thus to accelerate the shift of forests upward to today's timberline. This development might be favoured by a warmer climate. However, at the time of the upward shift of the timber line the composition and structure of forest communities will also change. Norway spruce, with approximately 61% the most abundant and important timber species in Austria, would be reduced, particularly in lower regions in favour of oak and other deciduous tree species (Lexer et al. 2002).

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* (Spangl, 1996; 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, ozone levels can reach eight-times the critical level for forests. 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. This implies serious long-term consequences (Türk, 1996; Mayer, 1992; Wotawa and Kromp-Kolb 2000).

During the last few decades different air pollutants (especially ozone) 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 Tyrolean 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).

Depending on the site conditions of mountainous highlands, reforestation of a damaged forest may require long time periods of up to several hundred years (Mayer, 1992). In case of Tyrol, for about half of the 12,000 ha of forests on slanting ground, technical control measures (like snow bridges) worth some1,4 billion Euros are expected to be necessary, and a reforestation time of about 200 years (Heumader, 1987).

6.1.3 Impacts on Socio-economic Systems

6.1.3.1 Mountain Agriculture

Mountains contribute to a not-insignificant proportion of the world's agricultural production in terms of economic value. 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, Eitzinger et al.,2003). In general the negative effects of climate change (water stress) can be compensated with several adaptation measures (e.g. shift of seeding). If the precipitation during summer decreases in future as some scenarios indicate, a higher spatial discrimination due to soil properties will occur and the probability of extreme years like 2003 with enhanced yield loss due to water stress will rise.

While crop yields may rise if moisture is not limited, increases in the number of extreme events may offset potential benefits. Linked to 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.

In mountain agriculture grass production plays an important role. As adaptation strategies are limited, this sector is very vulnerable to climate change. Especially water deficit has been a problem within the last years. In 2003 the estimated yield loss due to water stress in Austria exceeded 200 Mio. Euro (Buchgraber et. al, 2004).

The agroclimatic impact of climate change might overlap with other factors being 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 and 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 content of organic matter and consequently reduced carbon absorption and an increase in gaseous emissions.

6.1.3.2 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.

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 glaciers receding today cause operating problems in storage power plants due to more shifting activity and bigger particle volumes (Wagner *et al.*, 1996).

6.1.3.3 Commercial Timber Activities

Commercial utilization of mountain forests can be negatively 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,Schopf,1997).

These negative effects can be of the same magnitude or even higher than the positive impacts as CO_2 fertilizing and the lengthening of the growing season. Additional risk factors are the possibility of an increase of extreme events (e. g. storms).

6.1.3.4 Tourism

Resources required for tourism are climate-dependent, i.e. 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 tourist activities (Price, 1994).

The majority of Austrian 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. Ongoing research projects (e.g. STRATEGE, see Chap. 8) focus therefore on an integrated assessment for selected skiing resorts, where the individual sensitivity of the skiing resort to climate change is investigated and adaptive strategies are evaluated.

An analysis of Austrian meteorological data (Hantel et. al. 2000) showed similar results as the assumptions of Breiling. An increase of the European mean temperature of 1 K causes a decrease of snow cover duration in the most sensitive areas of approximately 4 weeks in winter and 6 weeks in spring. The sensitive areas are located at the altitude of ~600 maSl in Winter and at ~1400 maSl in spring. Additional warming of 1 K will not only influence the duration of snow cover; it will also shift the areas of the most sensitive altitude to 900 maSl in winter and 1900 maSl in spring.

6.1.3.5 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 (IPCC 2001, Berz, 1996, Jakobi, 1996, Loster 2000). 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, 2001; Döös, 1997), but the severe floods in 2002 and 2005 and the extreme hot and dry summer 2003 highlighted the potential impact of weather-related disasters in Austria. Within the research project StartClim2003 an analyses of the Austrian measures to prevent natural disasters and their interaction with the commercial insurance industry after the flood 2002 was carried out. The first steps for an optimization of these interactions are on the way.

6.1.3.6 Human Health

The extreme summer 2003 showed the importance of this aspect of climate change even in central Europe and triggered an intense research activity. In Austria, the StartClim2005 projects focus on this topic. An important feature is the interaction of heat waves, ozone and particulate matter concentrations. In general, higher temperatures and hyper thermal stress promote 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.

Due to extensive travelling, vector-borne[1] 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).

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.

6.2 Vulnerability Assessment

6.2.1 Introduction

In 1998, the General Assembly of the United Nations proclaimed the Year 2002 as the "International Year of Mountains" and sustainable mountain development forms the subject of Chapter 13 of Agenda 21. The Agenda 21 chapter on "Managing Fragile Ecosystems –Sustainable Mountain development" identifies mountains as "fragile or vulnerable ecosystems", as they are characterised by close and continuous interactions between human beings and nature, between natural processes and human activities (Madlener et. al. 2000).

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, 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.

Austrian-specific research about climate chance impact and especially vulnerability assessment was compiled in a summary report by the Austrian Academy of Sciences (ÖAW, 1992, 1993). In contrast to other alpine regions (e.g. BAYFORCLIM in Bavaria and the NFP-31 in Switzerland) no interdisciplinary multiyear research program concerning climate change impacts has been launched till now in Austria, but several activities were made within the last years to foster the climate change research in Austria.

In 2002, a platform of scientists was founded (AUSTROCLIM, www.austroclim.at) to promote the awareness of climate change. As a consequence of this activity, the first StartClim programme was started in 2003. StartClim is a bundle of several related small research projects focusing on a specific theme. In 2003 it was related to the

[1] Vector: an organism (as an insect) that transmits a pathogen.

floods in 2002, 2004 it focused on the extreme summer of 2003 and 2005 StartClim focuses on human health.

Also in 2003 the research programme RECLIP (REsearch for CLImate Protection) was started; within the project Reclip:more three university institutes and two research institutions cooperate to test and develop regional climate models for Austria and to produce dynamical downscaled climate change scenarios for impact research. In 2005 the "Alfred Wegener Center for Climate research" (WegCenter) was founded in Graz. Within this centre natural scientists and socio-economic researchers focuses on climate change related impacts.

As these activities have just started or are planned for the future, vulnerability assessment for Austria can only be stated by individual research disciplines (e.g. Hydrology).

6.2.2 Hydrology and Hydropower

In most Austrian climate change scenarios for hydrologic modelling, the 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. The newer regional climate change scenarios, which show a more pronounced precipitation decrease during summer in the alpine region (e.g. PRUDENCE, ECHAM5) have not yet been applied to Austrian hydrological impact studies.

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.

A moderate reduction of average precipitation and an enhanced evapotranspiration due to higher than average temperatures at the beginning of the 21st century – especially in the south east of Austria – lead to some troubles in drinking water supply in communities depending on small and shallow springs. Water quality has been affected too in summer 2003, as water temperature was much warmer than usually. A StartClim2005 project focuses on this issue, to define vulnerable regions in Austria and assess the potential impact of climate change.

A detailed study concerning the water balance of lake Neusiedl (Eitzinger et al., 2005) highlighted the sensitivity of this hydrological system, as the water balance of this lake is dominated by precipitation on and evaporation from the lake. The observed increase in temperature and also sunshine duration within the last decades enhanced the lake evaporation by 10 %. Within the last 15 years also a weak decrease in precipitation has been observed (~ 6 %) and the lake level was sinking, leading to some troubles in tourism (sailing). Assuming a temperature increase of 1.8 °C within the next 35 years a further increase of the lake evaporation by 15 % was found. Whereas critical lake levels for sailing occurred on average every 30th year in 1961-1990, the frequency increased to every 12th year in 1991-2004; in the scenario for 2040 the critical level was predicted to occur nearly every third year, assuming no change in yearly precipitation. A further result of that scenario was that the lake would almost totally vanish every 80th year on average. This loss of lake water could only be compensated by an increase of precipitation by 20 %, which is not very likely for this region. Lake Neusiedl is a famous European bird breeding region and a vanishing of this lake would have important impact on the European fauna. As summer tourism is an important regional economic factor, impacts of climate change on lake Neusiedl have become important for regional authorities.

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 57% and 73% and on average(1970-2004) accounts for 67%. Consequently Austria is among Europe's leading hydroelectric power countries. About 70% of the energy generated by hydroelectric power stations in Austria originate in run-of-river 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.

Impact studies (Nachtnebel et. al., 1999; Kuhn, 1999) showed no dramatic decrease in annual water runoff. The most important changes are the changes in the seasonal runoff pattern. But this result highly depends on the used climate change scenario and the application of the new ECHAM5 scenarios may exhibit a more pronounced change, even in the average annual runoff.

6.2.3 Cryosphere and Winter Tourism

The expected glacier changes can be put into relation to those experienced since the middle of the 19th century when the ice covered area in Austria was nearly twice as large as at the last glacier inventory (approximately 500 km^2 in 1969). Within the last decades this decrease of glaciated area has even accelerated and from 1969 till 1997 a further decrease of approximately 15 % of the total area was lost. This retreat of glaciers and permafrost will affect the slope stability and the water runoff during warm and dry summer periods.

In several studies (e.g. Breiling *et al.* 1997) the climate sensibility of the Austrian winter tourism was examined. General findings are:

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

- With an increase of temperature the number of ”good” seasons will decrease, and a further concentration of winter tourism in the midwinter months of January and February may take place.
- Lower-situated tourist resorts are disfavoured relative to those higher up.

6.2.4 Ecosystem Responses

6.2.4.1 Vegetation Migration

From finalised and ongoing research studies (Pauli et. al. 1996) the important conclusion can be drawn 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.

6.2.4.2 Forest Growth

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 a lack of regeneration in protection forests (FMAF, 1995; Schieler and Schadauer, 1993; Sterba, 1996). 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 inventory period between 1980 and 1990. The inventory period 1992–1996, however, exhibited a decrease in volume growth from 9.4 to 8.2 m^3/ha.yr (Büchsenmeister *et al.* 1997). However, it is important to note that possible effects on forest growth due to changing stand age, reforestation of agricultural land resulting in highly productive timber stands and treatment impacts are also included within these results (Hasenauer, 2000).

In most areas of Austria, precipitation is not a limiting factor. However, at the eastern and south-eastern edge of the Alps, the mean annual precipitation is low (~500 mm), so even a small decrease in precipitation or changes in precipitation patterns may have severe impacts on the stress scenario of the remaining forests.

Another important issue concerns secondary coniferous stands in areas below 1000 maSl. These stands are extremely sensitive to environmental stress factors and are highly susceptible to progressive loading of air pollution and climate change. These stands are considered to be degraded due to litter ranking in the past, grazing, and profit oriented wood production by promoting fast growing coniferous stands. It is expected that potential climate change (temperature increase, changes in precipitation pattern) may directly effect these forest ecosystems as well as indirectly by favouring insect outbreaks and/or fungi infections (Hasenauer, 2000; Lexer *et al.* 2002, Hoch *et al.* 2005, Netherer *et al.* 2004).

6.2.5 Agriculture

The main Austrian crop production is located in the eastern and north-eastern lowlands of the country. In these regions the yearly potential evapotranspiration has the same magnitude as the precipitation, Austrian crop production is therefore quite sensitive to shifts in soil water availability. Many studies and projects focused on this aspect and several adaptation strategies as technical measures, breeding of new cultivars or the shift of the seeding date are under discussion or have already been installed (see 6.3).

The grassland productions is not so sensitive to precipitation shifts, as it is mainly located in the mountainous regions with higher precipitation amounts on average, but the vulnerability to climate change is even higher than in crop production. This is because the adaptive potential is very low: Technical measures are too expensive and the possibilities in management are limited. Also a shift to crop production under climate change conditions is not possible in most cases, due to the inclination of the meadows. The year 2003 showed that even under current climate conditions extreme hot and dry years can cause enormous damage in grassland production.

6.2.6 Extreme Events and Geomorphological Processes

Heavy precipitation episodes often have significant impacts on the natural and socio-economic environments. There are generally major economic consequences related to mudslides and flooding. The flooding in the summer 2002 caused damage of some 3 billion Euros in Austria. The degradation of mountain permafrost is an additional consequence of persistently high temperatures which can lead to slope instabilities that threaten settlements and communication routes (Beniston, 2001).

Rockfall and landslide 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, 1996).

In Austria, 74% of all communities are endangered by torrents and avalanches. In some provinces (Carinthia, Vorarlberg, Salzburg, 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 of Lower Austria and Styria) (Andrecs, 1995).

6.3 Adaptation Measures

It belongs to the principles of the UNFCCC that Parties should take precautionary measures to anticipate and prevent the causes of climate change and to mitigate its adverse effects. The Austrian federal government till now puts priority on the mitigation of greenhouse gas emissions. It should be pointed out, however, that Austria as an alpine country is used to adapt to environmental risks since centuries. The permanent implementation of new adaptation measures motivated by socio-economic and land use changes is beneficial for adapting to a climatic change.

Austrian adaptation measures therefore can be distinguished into measures directly motivated by impacts of observed climate change and existing measures related to environmental risks, which can be or are going to be further optimised with respect to adaptation to climate change. Till now the direct climate change motivated adaptation measures are mainly initiated by private companies or local administrations. The extreme events during the last years, however, highlighted the demand for a broader and coordinated treatment of all potential adaptation measures. Within the ongoing international EC-founded research project AMICA "Adaptation and Mitigation – an Integrated Climate Policy Approach", an approach to combine long-term climate protection and short- and midterm adaptation measures at the local level shall be developed.

6.3.1 Potential of Adaptation

The flexibility and robustness of natural systems are critical components in assessing the socioeconomic 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, given sufficient resources, are likely to be more adaptable (and less expensive) 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.

In developed countries, the sensitivity of industry and human health to impacts of climate change is relatively low. Adaptation measures for agriculture, water resources and managed forests are possible but will cause some costs, whereas natural landscapes have rather limited adaptation potential.

6.3.2 Climate change induced adaptation measures

6.3.2.1 Agriculture

The temperature increase and moderate precipitation decrease observed in the eastern part of Austria lead to a reduced soil water content and to yield loss due to water stress in several years within the last decade. Several research projects focused on this problem to develop adaptive strategies. To highlight the broad spectrum of possible adaptation measures in agriculture, two examples of quite different measures applied in Austria are shown below.

Especially in the areas of intensive cultivation in eastern Austria, irrigation became a common technique within the last years, which lead to a decrease of the groundwater level. In the Marchfeld, Austria's most important area for crop production, the decrease of the groundwater level started 30 years ago, mainly driven by increasing irrigation. To avoid a further decrease and to accommodate the growing demand for irrigation water, the "Marchfeldkanal project" [2], financed by the Austrian government and the Land Niederösterreich, started in 1987. A water system of nearly 100 km length (see Fig. 6.3) brings water from the Danube into this dry region. In 2003 the final completion of the channel was reached. With the Marchfeldkanal 4000 to 6000 l/s of fresh Danube water flows into the Marchfeld, which directly can be used for irrigation from the channel and additional an enrichment of the groundwater by three percolation basins is achieved.

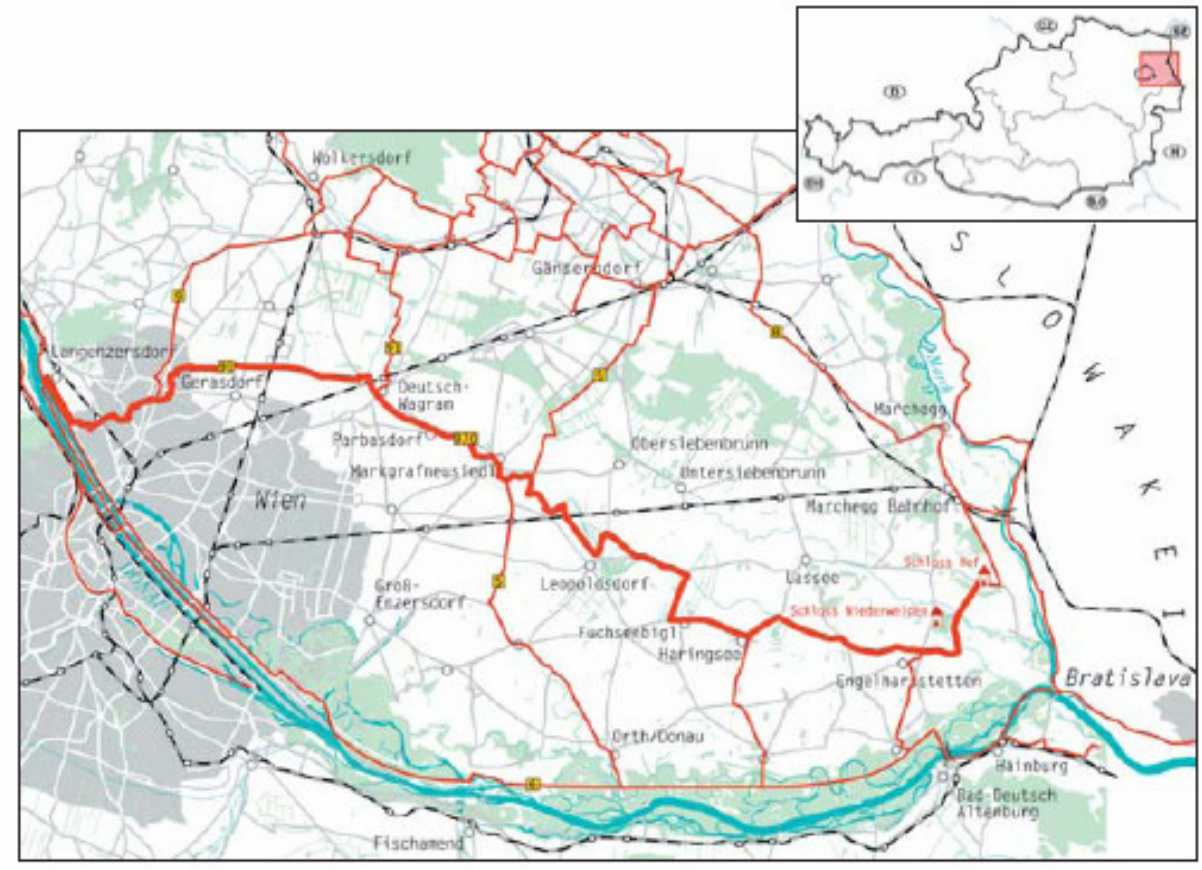

Figure 6.3: Map of the "Marchfeldkanal". The red line shows the net of channels and rivers that brings additional water from the Danube into the dry region of the Marchfeld.

[2] http://www.marchfeldkanal.at/home.htm

Irrigation is not always an appropriate measure against water stress in agriculture. For areas or crops where irrigation is not possible or too expensive, the "Österreichische Hagelversicherung", an Austrian insurance association specialized on agriculture, offers farmer an insurance against yield losses due to water stress for some crops. As within the last years the yield losses in grassland production due to water stress showed the vulnerability of this very important agricultural sector in Austria, pilot projects to develop a water stress insurance for grassland production have been initiated. Because other adaptation measures are not possible or have limited effects in grassland production, an insurance seems to be the only possibility to lower the vulnerability of this sector against climate change.

6.3.2.2 Forestry

First research projects have shown the vulnerability of Austrian forests regarding climate change and given some preliminary recommendations for adaptation measures as diversification in species and genetic resources. The necessity of adaptation measures in forestry has also been emphasized in the so-called "Austrian Forest Dialogue", a multi-stakeholder discussion forum on the future of Austrian forests. As a result of the dialogue, the national forest programme has been established in the year 2005. One of the elements of the national forest programme is the development of a detailed research strategy concerning adaptation and of an information and training concept to disseminate recommendations on this matter.

6.3.2.3 Tourism

Tourism is the most important economic sector in several Austrian regions. Outdoor activities, which are part of tourism in mountainous regions throughout the year, are sensitive to the weather conditions. Especially winter tourism is very sensitive to climatic change, due to its dependence on snow cover. To reduce that vulnerability, high investments in mainly technical adaptation measures are made by this sector. In Austria approximately 40 % of the skiing area (23.000 ha) is equipped with artificial snow making facilities. Every year about 176 mill. Euro are invested in these equipments and the investments are still increasing. That adaptation measure, however, is still under discussion with respect to its environmental impacts and its high resource requirements (approximately 1000–4000 m^3 freshwater and 25.000 kWh energy per ha and season; Hahn, 2004).

A further technical measure is tested at skiing resorts on Austrian glaciers. To mitigate the ice loss during summer near and under the infrastructure at the glacier, the ice is covered with white blankets. First results of these studies are promising. For more details see Chapter 8.

Austrian summer tourism will mainly benefit from the expected climate change. An exception might be the lake Neusiedl. As mentioned before, this shallow lake is endangered by an increase of evaporation due to temperature rise. Land Burgenland has financed several research projects to investigate the feasibility of water supply from the Danube to lake Neusiedl and its possible ecological effects. As lake Neus-

iedl is an important European bird habitat, the economic and ecologic effects are evaluated very carefully; a decision on that project has not yet been taken.

6.3.3 Protection against natural hazards

Preventive measures for protection against natural disasters have a high status in Austria and are perceived as state tasks. They extend from land-use planning to silvicultural and technical precaution measures. The measures are based on the documentation of damages and the investigation of their causes. Regarding a possible increase of extreme events and damages due to climate-change, protection against natural disasters is also of importance as an adaptation measure.

6.3.3.1 Avalanche, Erosion and Torrent Control Measures

Systematic measures date back to 1884, when the "Law setting out provisions for the safe discharge of mountain water" came into force under Emperor Franz Joseph and the forest Engineering Department for Torrent Control was established (RGBl. 117/1884). Nowadays, the Forest Engineering Service in Torrent and Avalanche Control as an agency of the Federal Ministry of Agriculture, Forestry, Environment and Water Management is responsible for natural hazards management. It has the overall responsibility for a sustainable safeguarding of the people, their habitat and settlement areas, and their cultural goods from torrents, avalanches and erosion. The Forest Engineering Service in Torrent and Avalanche Control pursues the concept of a sensible combination of forest biology, technical and regional planning protection measures within the scope of comprehensive natural hazard management. Its tasks include the planning, implementation and maintenance of active protection measures, hazard zone planning, consulting and expert activities, as well as support for the catchment areas.

Considerable amounts of the budget are spent for avalanche, erosion and torrent control measures. In 2005 for example, federal funds in the amount of € 69 million were invested in protective measures. The total investments including the contributions by federal provinces, municipalities etc. amounted to € 122 million.

6.3.3.2 Protection against floods

In 2004–2005 the research program FLOODRISK focused on all aspects of floods and flood prevention in Austria. With participation of many institutions recommendations with respect to meteorology/hydrology, geomorphology, economic aspects, spatial planning, flood control measures and disaster protection have been established. Some of the key results are:

- A more integrated approach to the management of floods should address all phases of the flood risk cycle, including activities and measures on prevention, protection, preparedness, emergency response and recovery after the flood event.
- Integrated flood risk management calls for the co-operation of all public authorities and other parties concerned, applying a broad range of tools at the different

stages of the flood cycle. Promoting public participation and awareness-raising are key prerequisites for the successful implementation.
- Flood events in the past few years have shown that even well-built flood control systems may fail if the discharge exceeds design values. This residual risk must be reflected in the planning process and has to be properly communicated to the public that is potentially affected.
- Within the next ten years a special effort should be made to identify inundation areas and to speed up hazard zone mapping.

The recommendations have party already been implemented and will further be implemented, e. g. in guidelines (for regional planning etc.) and with respect to public awareness.

6.3.3.3 Research and Documentation

The documentation of avalanches, floods, mudflow events or landslides and their impacts as well as research on their causes is a basic requirement for planning and realisation of preventive measures. Recording of events is done by regional administrative bodies, especially local communities. Documentation and evaluation at federal level is performed in co-operation of some institutions (Forest Engineering Service in Torrent and Avalanche Control, Institute of Mountain Risk Engineering at the University of Natural Resources and Applied Life Sciences Vienna, Institute for Natural Hazards of the Federal Forest Office). The above-mentioned institutes do research on the processes leading to natural hazards, on hazard assessment and mitigation concepts. Simulation models for hazard assessment of torrential flows, debris flows, snow avalanches, and rock fall have been developed at the university.

The program FLOODRISK, which was mentioned in the previous subsection, is another example for a comprehensive research initiative.

6.3.3.4 Improvement of the protective forest function

Functional forest improvement is an important element in the framework of the protection against hazards caused by torrents, avalanches and erosion. The mountain forest belt is crucial for the prevention of those natural hazards and permanent settlement in mountain valleys would not be possible without protective mountain forests. About 20 % of Austrian forests have protective function.

Due to the importance of the protective function of forests, the representatives of ministries, provincial governments and the interest groups of forest owners, territorial bodies, industry and hunting codified their mutual intentions in the Austrian protection forest strategy in 2002. Protection forest platforms have been established at Länder and Federation level to coordinate the measures necessary for the protection forests and ensure the necessary balance of interests.

Also in the year 2002 an amendment to the Forest Act was enacted to establish the new category “object protection forest”. These are forests that protect humans, human settlements or facilities or cultivated ground especially from elementary hazards

or damaging environmental impacts, and which require special treatment in order to achieve and secure their protective function or welfare function.

Projects for the rehabilitation and safeguarding of mountain forests with a protection function are developed by the Forest Engineering Service in Torrent and Avalanche Control in collaboration with the provincial forest services, the provincial Chambers of Agriculture, and qualified engineering consultants and engineers. The measures are implemented and supported mainly by the forest owners, many of whom belong to the mountain farming population. In 2003 for example, the Forest Engineering Service in Torrent and Avalanche Control, the provincial forest services and stakeholders implemented measures in a total of 222 area management projects. A total of € 14.3 million in funds were required for these projects, whereof the federal budget contributed about € 8.8 million, the provinces just over € 2.5 million, and contributions by stakeholders amounted to just over € 3 million.

6.3.3.5 Hazard Zone Mapping

The analysis and evaluation of the natural hazard potential in the catchment area of torrents and avalanches has developed into a nationwide information and knowledge base on natural hazards for the entire national territory in recent years. The preparation and re-evaluation of hazard zone maps is done by the Forest Engineering Service in Torrent and Avalanche Control. Hazard zone plans are now available for the greater part of Austria. The hazard zone plan is used as a basis for regional planning by the Länder and for the construction sector, but it does not have a normative character ex lege. The objective is to develop settlements away from threatening natural hazards.

Chapter 7

Financial Resources and Transfer of Technology

CONTENTS

Austria is contributing to the Global Environment Facility, which was set up to tackle climate change and other global environmental problems in developing countries, since its inception. In addition, Austria is offering financial support for the implementation of the convention in various forms and initiatives, above all by contributing to funds and programmes of the European Community, the UNFCCC Trust Fund, other MEAs and multilateral institutions. Bilateral ODA of Austrian Development Co-operation is another important source for funding UNFCCC related activities. Respective programmes target both mitigation and adaptation. Renewable energy and energy efficiency, protection and sustainable management of forest resources, 'climate proof' sustainable agriculture and rural development are preferred areas of co-operation in several developing partner countries. Besides, all bilateral assistance programmes and projects are subject to environmental sustainability assessments that implicitly integrate climate change related issues. The structure of this chapter follows the UNFCCC Reporting Guidelines on National Communications; information related to Art. 10 and 11 under the Kyoto Protocol is included in the relevant sections.

7.1 Provision of "New and Additional' Resources

Austrian ODA in general will increase in light of the decisions taken by the EU to implement the Millennium Development Goals. The EU has adopted a timetable for Member States to achieve 0.7% of GNI by 2015, with an intermediate collective target of 0.56% by 2010.

The Global Environmental Facility (GEF) was set up in 1991 as a three-year experiment (pilot phase) and, since restructuring in 1994, has seen substantive 2nd and 3rd replenishments. Its objective is to assist developing countries and, to some extent, countries with economies in transition in the protection of the global environment and promote thereby environmentally sound and sustainable economic development

With regard to the UNFCCC, GEF supports developing countries with measures that minimize climate change damage by reducing the risk, or the adverse effects, of climate change. GEF is an administrative umbrella, which receives financial resources from a variety of funds, the main source being the Global Environment Trust Fund (GET), also referred to as the 'Core Fund'.

The Austrian participation in the GEF is financed in addition to existing commitments and payments to other international finance institutions and may be called 'new and additional'. During the pilot phase Austria contributed a comparatively large share to GET (about US$35 million or about 2.7%) in order to underline its interest in international measures for the protection of the environment. In the 1st replenishment of the GET, Austria contributed US$20 million. In addition, Austria contributed financial resources for a bilateral GEF Consultant Trust Fund. From 2001 to 2004, Austria provided about US$ 25 million, see Table 7.1.

Austria, as member state of the EU, is committed to fulfil its share of the Bonn Political Declaration, as established under a polluter-pays-principle. The Austrian

share under the Bonn Declaration is an amount of 6.52 Mill US$, which Austria has reached for the year 2005 and will again reach for 2006.

Table 7.1: Financial contributions to the Global Environment Facility (GEF)

	Contribution (millions of EUR)			
	2001	2002	2003	2004
Global Environment Facility	5.38	5.38	7.16	7.31

7.2 Assistance to Developing Country Parties that are Particularly Vulnerable to Climate Change

Those countries that suffer most from climate change will be in the developing world. They have fewer resources for coping with storms, floods, drought, disease, and with disruptions to food and water supplies. Although regional and local effects will differ widely, some regions can be identified that are particularly vulnerable to the adverse effects of climate change.

Due to the size of the country and its limited resources, Austria's overall financial support to particularly vulnerable developing countries is limited. 2004 total ODA amounted to US$ 681 million. Roughly 50% (US$ 355 million) qualified as bilateral ODA. LLDC received US$ 66 million or about 20 % thereof.

A substantial portion of bilateral ODA or US$ 91 million is spent within the core programs of Austrian Development Co-operation (see also tables 7.2.-7.6.). Several priority regions and countries are supported in long-term partnerships (see http://www.mfa.gv/adc). In relation to climate change adaptation, the priority region for assistance is western Africa receiving in 2004 ODA US$ 8.5 million.

The following list gives a more focused overview on adaptation related support in particularly vulnerable developing countries in the areas of water development, agriculture, and soil conservation as far as they are not included in tables 7.2. to 7.6. further below.

Recipient country/region	Spending 2000-2004 for climate change adaptation (million US$)
Burkina Faso:	0.75
Cape Verde:	0.70
Ethiopia:	1.03
Kenya:	2.01
Mozambique:	0.27
Nepal:	0.72
Palestine:	2.79
Senegal:	4.94

Co-operation programmes in particularly vulnerable developing countries do not only contain support to adaptation, however, Austrian Development Co-operation bases its activities on the fact that poverty, inequality and insecurity, social conflicts, poor health, lack of access to education and training, as well as the depletion and degradation of natural resources are continuously increasing in developing countries in such a way that the development perspectives of all countries are affected. Contributing to poverty alleviation, to the prevention of conflicts, to the conservation and sustainable use of the natural resources consequently forms an overarching framework. Working to achieve the MDGs, which address all these issues, is fundamental objective.

Environmental sustainability, including measures related to climate change, is thus highly significant as an integral crosscutting issue of Austrian support to developing country Parties.

This crosscutting approach expresses itself on three levels.

- Possible effects and causes of climate change are treated alongside economic, social or environmental factors in programme and project development, for instance in standardised environmental programme or project appraisals.
- Climate change related interventions are taken into consideration as part of partner country strategies where high synergy concerning poverty reduction is identified.
- Mainstreaming the mitigation of and adaptation to climate change into national development strategies and action programmes, such as PRSPs, receives high attention in the policy dialogues with partner country institutions and NGOs.

7.3 Provision of financial resources

Bilateral assistance for the protection of the global climate system and in support of adaptation to the adverse effects of climate change is primarily granted through Austrian Development Co-operation.

7.3.1 Bilateral financial contributions

Austria applies the DAC Rio markers. Relevant financial data on bilateral financial contributions can therefore also be obtained through the regular reporting to the Creditor Reporting System.

A substantial share of about 45% or US$ 41 million of Austrian Development Co-operation's budget in 2004 were spent on measures with environmental objectives. Several further bilateral, project-based contributions are made by, e.g. the Ministry of Agriculture, Forestry, Environment and Water, the federal states, municipalities and Austrian NGOs, but these contributions are low in absolute and relative terms compared to those spent within the framework of Austrian Development Co-operation.

According to the cross-cutting nature of support to climate change outlined in chapter 7.2., activities that mitigate GHG emissions or assist adaptation focus on:

1) **Technical assistance** for sustainable use and management of natural resources respecting local needs, perceptions and knowledge, as well as measures in support of socio-cultural development and political integration of local populations in order to improve their livelihoods, and thereby

- reducing the vulnerability and increasing the capacities for adaptation to the effects of climate change,
- contributing to the conservation or rehabilitation of GHG-sinks.

Special emphasis is given to rural development in African partner countries, e.g. in Burkina Faso. Technical support to regional government institutions and civil society organisations is given to assist the local population to embark, among others, on reforestation measures and eco-farming. Similar co-operation programs are financed in Senegal, Mozambique and Ethiopia.

In Latin America, Austria finances the conservation of forests. In the Amazon region in Brazil and Colombia, indigenous communities are supported in the field of organisational development, education, health, food production and income generation. By doing so, sustainable regional development respecting the conservation of the tropical rainforests is facilitated.

In Nicaragua's Southwest tropical rainforests are threatened by the continuous immigration of peasants in search for land. Austria is supporting local NGO's in their efforts to improve the peasant's livelihood situation and create awareness of the problematic environmental situation caused by the forest destruction. The stabilisation of the settlement boundary and a sustainable management of the buffer-zone between that boundary and the remaining intact forest areas are the long-term goals of these efforts.

2) **Capacity building**, technology and know-how transfer related to initiatives in the field of renewable energy, energy efficiency and cleaner production.

Co-operation projects in eastern and south-eastern Europe are noteworthy. Austria was involved in the rehabilitation of the Drin hydropower plants in Albania, and assists the FYR Macedonia in the field of geothermal energy. In both countries, a program for the promotion of solar-thermal energy has been started recently. Environmental education, institutional support to organisations and government institutions responsible for environmental issues, as well as the transfer of technology with regard to environmentally sound and efficient production are further important components of bilateral co-operation throughout the region.

The long-standing relationship with Bhutan must be particularly highlighted. Austria is collaborating with the Department of Energy in Bhutan since several years in the field of hydropower infrastructure, maintenance and management training, rural electrification and efficient use of biomass.

Table 7.2: Bilateral financial contributions related to the implementation of the Convention 2000 (in US$ million)

	Mitigation						Adaptation		
Recipient country/region	Energy	Transport	Forestry	Agriculture	Waste management	Industry	Capacity-building	Coastal zone management	Other vulnerability assessments
Bhutan	4.82		0.24						0.33
Albania	1.30								
FYR of Macedonia	1.27								
Ethiopia				1.03					
Slovenia	0.87								
Chile			0.75		0.04				
South and Central Asia	0.64						0.09		
Nicaragua			0.66						
Uganda	0.64								
Cap Verde									0.41
Mozambique				0.36					
Burkina Faso			0.21	0.07					
Brazil			0.24						
Romania						0.14			
All other	0.32		0.24						

Table 7.3: Bilateral financial contributions related to the implementation of the Convention 2001 (in US$ million)

	Mitigation						Adaptation		
Recipient country/region	Energy	Transport	Forestry	Agriculture	Waste management	Industry	Capacity-building	Coastal zone management	Other vulnerability assessments
Bhutan	1.43								0.20
Nicaragua			0.76		0.23				
Ethiopia	0.16			0.70					
Brazil			0.58						
Colombia			0.28						
Albania	0.23								
Romania	0.20								
Mozambique				0.18					
Costa Rica			0.16						
Cap Verde							0.12		
Slovenia	0.11								
Burkina Faso			0.10						
Uganda	0.09								
FYR of Macedonia	0.04								
All other	0.05		0.03						

Table 7.4: Bilateral financial contributions related to the implementation of the Convention 2002 (in US$ million)

	Mitigation						Adaptation		
Recipient country/region	Energy	Transport	Forestry	Agriculture	Waste management	Industry	Capacity-building	Coastal zone management	Other vulnerability assessments
Slovenia	0.31					1.21			
Bhutan	0.73								0.20
Nicaragua			0.84						
Ethiopia	0.27			0.29					
Brazil			0.40						
Mozambique				0.37					
Colombia			0.14						
Costa Rica			0.14						
Uganda	0.09		0.02						
Burkina Faso				0.10					
Cap Verde							0.08		
El Salvador				0.07					
South and Central Asia							0.05		
Romania						0.02			
All other			0.02						

Table 7.5: Bilateral financial contributions related to the implementation of the Convention 2003 (in US$ million)

	Mitigation						Adaptation		
Recipient country/region	Energy	Transport	Forestry	Agriculture	Waste management	Industry	Capacity-building	Coastal zone management	Other vulnerability assessments
Bhutan	0.82		0.17						0.02
Ethiopia				0.70					
Cap Verde							0.38		
Brazil			0.36						
Burkina Faso				0.34					
Nicaragua			0.29						
South and Central Asia							0.25		
Costa Rica			0.24						
Slovenia	0.23								
Czech Republic	0.16								
Mozambique				0.10					
Bulgaria						0.10			
Colombia			0.08						
Cuba	0.07								
All other	0.22		0.02	0.01					

Table 7.6: Bilateral financial contributions related to the implementation of the Convention 2004 (in US$ million)

	Mitigation						Adaptation		
Recipient country/region	Energy	Transport	Forestry	Agriculture	Waste management	Industry	Capacity-building	Coastal zone management	Other vulnerability assessments
South-Eastern Europe	0.01					1.00			
Bhutan	0.94								
Nicaragua	0.06		0.82		0.03				
Ethiopia	0.05			0.50					
Cap Verde	0.42								
Mozambique				0.38					
Slovenia	0.37								
Slovakia	0.34					0.02			
Brazil			0.28						
Burkina Faso				0.25					
Colombia			0.15						
Romania						0.01			0.14
South and Central Asia	0.03						0.10		
Pakistan			0.10						
All other	0.03		0.07	0.3		0.5			

7.3.2 Multilateral financial contributions

For the first time, an Austrian Strategy vis-à-vis the International Financial Institutions (IFIs) has been developed (published in July 2005). The chapters on energy and the climate process form two central and clearly interlinked elements. Therein Austria endorses the continuous expansion of financing volumes for renewable energies as envisaged by some IFIs, in particular the World Bank. In the consultation process on the energy policy of IFIs, Austria is committed to a distinct promotion of renewable energy and energy efficiency projects and programs and seeks to heighten its involvement in IFIs' special programs for renewable energy. Potential allocations to thematic trust funds for renewable energies are being examined. Austria is striving for co-financing renewable energy and energy efficiency projects in key partner regions. In accordance with Austria's nuclear energy policy, IFIs should not finance nuclear facilities or projects involving the utilisation of nuclear energy.

IFIs should be promoted as project developers for JI/CDM and as participants in the carbon market. They should continue to be involved in the preparation of CDM projects in the pipeline. In addition to strengthening the market, IFIs also pay attention to the development component of CDM-projects, which is especially welcome from an overall strategic perspective. IFIs might be given support in offering financing instruments for JI/CDM projects and might be assisted in promoting project development capacity for JI/CDM projects. Finally, Austria remains actively engaged in the debate on the polluter pays principle within IFIs.

Financial contributions to multilateral institutions and programmes are shown in Table 7.6. The contributions listed there constitute the participation of Austria in capital increases and replenishment efforts, respectively, according to the needs of each of these institutions; therefore, most of these contributions cannot be specifically attributed to the implementation of the Convention. Such attribution has to be done at the level of each of the institutions in accordance with the activities they have financed.

Particularly noteworthy are the Austrian contributions to the UNIDO Cleaner Production Centres (CPC) programme. The programme aims at the creation of national capacities to promote cleaner production technologies, among other things. It specifically encourages increased energy efficiency and the utilisation of renewable energy.

Table 7.6: Financial contributions to multilateral institutions and programmes

	Institution or programme	Mio. EUR	Mio. EUR	Mio. EUR	Mio. EUR
		2001	2002	2003	2004
	Multilateral institutions:				
1.	World Bank	0	0	0	0
2.	International Development Association (IDA)	42.57	34.20	33.89	35.11
3.	International Finance Corporation (IFC)	0	0	0	0
4.	Multilateral Investment Guarantee Agency	0	0	0	0
5.	Consultative Group for Int. Agricult. Research (CGIAR)	1.62	0	1.80	1.80
6.	African Development Bank	0.37	0.34	0.29	0.27
7.	African Development Fund	8.61	10.64	9.71	10.36
8.	Asian Development Bank	0.16	0.16	0.16	0.16
9.	Asian Development Fund	7.77	8.10	9.13	8.41
10.	EBRD - Europ. Bank for Reconstr. & Development (OA)	5.64	6.41	6.41	6.41
11.	Inter-American Development Bank	0.60	0.48	0.27	0.11
12.	Fund for Special Operations	0.65	0.65	0.65	0.65
13	Inter-American Investment Corporation	0.34	0.31	0.26	0.24
14.	International Fund for Agricultural Develop. (IFAD)	12.10	0	2.66	0
15	Common Fund for Commodities	0	0	0.22	0.18
16	European Development Fund	0	5.30	58.30	62.01
17.	UNDP - core budget	3.55	4.50	3.61	5.57
	- specific programmes	0	0	0	0
18.	UNEP - core budget	0	0.36	0.09	0.40
	- specific progr. (voluntary)	0	0.03	0.05	0
19.	UNFCCC – core budget	0	0.16	0.08	0.11
	- Supplementary Fund (voluntary)	0	0	0.04	0
20.	Other				
	UNITAR (UN-Institut für Ausbildung und Forschung	0.03	0.00	0.00	0.08
	UNIDO - core budget	0.88	0.90	0.89	0.96
	WMO - World Meteorological Organisation	0.01	0.02	0.02	0.02
	IUCN - Int. Union for the Conservation of nature	0.03	0.03	0.04	0.03
	Multilateral scientific, technological and training programmes:				
1.	UNIDO Cleaner Production Centers	0.11	0.54	0.67	0.20
2.	UNIDO Investment and Technology Promotion Programme, Ethiopia and Tanzania	0	0.14	0.12	0

7.4 Activities Related to Transfer of Technology

Austria is a member of institutions and initiatives that have the exchange of research results and transfer of technology as a main target, e. g. the International Energy Agency and the Climate Technology Initiative. Bilateral assistance projects are another important means for technology transfer, often even if technology transfer is not the main target. Examples for technology transfer in the areas of solar energy, small-scale hydropower and biofuel are shown.

7.4.1 Technology transfer in energy technology and R&D collaboration programme of the International Energy Agency

Austria is a founding member of the International Energy Agency (IEA), which was founded in 1974. A lot of climate change issues are processed in so-called joint Implementation Agreements, where international partners collaborate on different research topics. Austria has joined several agreements, e. g. “Solar Heating and Cooling”, “Advanced Fuel Cells”, “Heat Pump Programme”, “Energy Conservation in Buildings and Community Systems Programme”, “Bioenergy”, “Research and Development of Wind Turbine Systems”, “Cooperation on Technologies and Programmes for Demand Side Management”, “Photovoltaic Power Systems”, “Hybrid and Electric Vehicles”, “Advanced Motor Fuels” or “Climate Technology Initiative”. The IEA’s Office of Non-Member Countries (ONMC) was established in 1993 to better understand the energy situation of non-member countries (developing countries in Africa and Asia) and regions, and to develop policy dialogue, co-operation and collaborative projects with these countries.

7.4.2 Austria’s participation in the 6th Framework Programme for Research &Development of the EU

Within the 6th Research Framework Programme of the European Union the Austrian Ministry of Transport, Innovation and Technology joins several so-called “European Research Area Networks” (ERA-Net). ERA-Net aims at encouraging the networking of research activities and the mutual opening up of national and regional research programmes. With respect to climate change issues the ERA-Nets “Bioenergy”, “Erabuild”, “Hydroenergy” and “Photovoltaic” need to be mentioned. Each ERA-Net is joined by about eight partners of different countries, including the new member states of the European Union from middle and eastern Europe.

7.4.3 Climate Technology Initiative

Austria is member of the Climate Technology Initiative (CTI, http://www.climatetech.net), which was established in 1995 at the Conference of Parties to the UNFCCC and has a new status as an IEA Implementing Agreement since 2003. Its mission is to promote the objectives of the UNFCCC by fostering

international cooperation for accelerated development and diffusion of climate-friendly technologies and practises for all activities and greenhouse gases.

The main principles of CTI are close collaboration with developing countries and economies in transition and partnership with stakeholders, including the private sector, non-government organisations (NGOs), and other international organisations. CTI performs a. o. capacity building and technical assistance for technology needs assessments as well as technology implementation activities and organizes seminars, symposia and training courses.

7.4.4 Capacity Building for CDM

Austrian Development Cooperation is supporting Capacity Building and preparation of CDM documents for a hydropower plant in Bhutan. This activity is embedded in the wider policy framework of Austrian Development Cooperation for Energy for Sustainable Development. The Austrian JI/CDM Programme supports NAIC Kyoto Parties with grants in the project development phase.

7.4.5 Further Initiatives

The intention of a regional GFSE meeting on district heating in South East Europe (Vienna, Nov 2003) was to stimulate improvements in the sector and change in politics. Links between policy and executing levels should be strengthened by focusing on the multi-causality of sustainable energy solutions, and awareness raising for innovative solutions, in particular on renewables for district heating.

A regional workshop of the Global Forum on Sustainable Energy (GFSE) for countries that are members of the International Centre for Integrated Mountain Development (Bhutan, Nov 2004) considered the theme of “Access to Rural Energy for Sustainable Development and Policies for Rural Areas” for countries of the Himalaya and Hindu Kush regions. The discussions focused primarily on renewable energy sources ranging from solar, biomass, hydro energy, as well as on integrated rural energy programs and financing among other subjects.

7.4.6 Selected Projects

Many projects funded by ODA, by NGOs and industry facilitate the transfer of environmentally sound technologies and know-how to developing countries. Even if transfer of technology is not the main goal of a project, the use of environmentally sound technologies within the project facilitates access to, and understanding for, these technologies for people involved in the developing countries. Use of environmentally sound technology is an important principle for Austrian ODA projects. However, in most cases it is rather difficult to separate the costs related to sound technology from total costs of a project and virtually impossible to get an estimation of the impact on greenhouse gas emissions.

The following tables will present some examples of the technology transfer aspects of aforementioned projects and of further initiatives. The listing is not at all exhaustive, since the ability to collect information on projects that are relevant to technology transfer is limited, especially as far as the private sector is concerned. Projects that are mentioned in the previous section are primarily supported by the programme and project aid of the Federal Ministry for Foreign Affairs; the other projects are supported by Austrian NGOs, Länder, private initiatives and ODA. More detailed information on some of the projects and their supporters can be found in the brochure "Energy Technologies for a Sustainable Development", which is available online (http://gpool.lfrz.at/gpoolexport/media/file/unidc3brosch.pdf).

Project/programme title: Hydropower plants Baso Chu			
Purpose: Supply of energy from renewable sources for Bhutan in order to improve health and life standard of the population; reduction in the consumption of fire-wood in order to safeguard forests and avoid deforestation			
Recipient country	**Sector**	**Total funding**	**Years in operation**
Bhutan	Energy supply	> US$ 15 million	Since 1995
Description: Hydropower plants with a capacity of 2.2 MW and 22 MW have been planned and installed and are being installed respectively in Bhutan. Work is carried out by local contractors. Austrian technology for electrical and mechanical equipment is used.			
Indicate factors which led to project's success: Emphasis on capacity development and training; close collaboration in a true partnership with the Department of Energy			
Technology transferred: Hydropower plant.			

Project/programme title: Geothermal System Kocani			
Purpose: Use of geothermal energy in order to supply the population with renewable heating energy			
Recipient country	**Sector**	**Total funding**	**Years in operation**
Zimbabwe	Energy supply	> US$ 0.50 million	Since 1998
Description: The geothermal field in Kocani is one of the major geothermal fields in Europe. In a depth of 350 to 500 meters, which is easy to reach from a technological point of view, comparatively high temperatures of about 75-78 degrees Celsius are reached. The geothermal water is used for energy supply and heating since 1987. Austria is involved to increase efficiency particularly with regard to long-distance community heating.			
Indicate factors that led to project's success:			
Technology transferred: Know-how concerning combined heat and power and long-distance community heating			

Project/programme title: Solar energy for Cuba			
Purpose: Supply of energy from renewable sources for doctors' surgeries in remote areas			
Recipient country	**Sector**	**Total funding**	**Years in operation**
Cuba	Energy supply	> US$ 0.3 million	Since 1998
Description: Only part of doctors' surgeries in rural Cuba are connected to the electric grid. For several doctors' surgeries, 400 W photovoltaic systems were installed to provide electricity for lighting and medical equipment. A hospital was equipped with a 2 kW photovoltaic system. Provision of proper information about maintenance of the systems and efficient use of electricity was an important part of the project. Furthermore, a textbook about the use of solar energy was prepared for use in schools and secondary technical colleges. (http://www.cubasolar.cu)			
Indicate factors which led to project's success:			
Technology transferred: Photovoltaic systems and information related to use of solar energy			

Project/programme title: Solar drying systems for crops

Purpose: Improvement of the quality of dried food through the use of improved solar drying systems

Recipient country	Sector	Total funding	Years in operation
Burkina Faso	Agriculture	> US$ 0.5 million	Since 1998

Description: Direct solar drying is a widespread method for food preservation, which however has some drawbacks (poorer quality of food because of contamination and infections and direct sunlight, labour intensive procedures). An indirect drying system, consisting of a solar absorber, which provides hot air, and separate drying chambers, has been constructed and tested. The system allows for the production of high quality dried fruits and vegetables within a much shorter drying period. Several systems have been installed. (http://www.aee.at/verz/artikel/entw22.html, in german only)

Indicate factors that led to project's success: Advantages of the principle (better quality, reduction in crop loss, less work) are immediately visible to the users. The design allows the systems to be built by local manufacturers.

Technology transferred: Advanced system for the use of solar energy for drying crops

Project/programme title: Integrated livestock development in North Gondar

Purpose: Improved sustainable livestock production and pasture development

Recipient country	Sector	Total funding	Years in operation
Ethiopia	Agriculture	> US$ 2.5 million	Since 2000

Description: The project works towards sustainably increasing livestock productivity of households in the project area. Important components alongside include manure management and the collection and use of biogas for cooking. Experiences so far were promising, although biogas use is still at a very early stage

Indicate factors which led to project's success: Intensive involvement of local inhabitants in planning and construction

Technology transferred: know-how regarding manure management, biogas equipment, handling of biogas energy

Chapter 8

Research and Systematic Observation

CONTENTS

Climate system research and research on climate change impacts strongly relate to the Alps, which cover almost two thirds of the surface area of Austria. With respect to mitigation technologies, renewable energy sources are of special interest fro Austrian researchers. Rather heterogeneous meteorological patterns in the alpine regions have also brought about a dense network of observing stations for meteorological and hydrological parameters; information on that issue can be found in the last part of this chapter.

8.1 General policy and funding of research and systematic observation

The Federal Government directly finances the basic infrastructure of universities and extra university research institutions. Public funds provide support for basic research as well as for applied research and technology development. With respect to environmental research, commissioned research for the leading ministries within several key areas and for other public authorities plays an important role.

8.1.1 Areas of competence and legal basis

The federal ministries and provincial governments bear responsibility for research issues within their own specialised areas of responsibility. A central position in co-ordination, administration and financing of research hold the Federal Ministry of Education, Science and Culture and the Federal Ministry of Transport, Innovation and Technology. The former is responsible for matters relating to universities and for non-university research institutions in the area of basic research and general scientific research; the latter is responsible for industry-related research, technology development and innovation funding and issues relating to the creation of priority areas of research in national research programmes by the Council for Research and Technology Development.

Essential questions concerning science, research and technology funding are governed mainly by the Research and Technology Funding Act (Forschungs- und Technologieförderungsgesetz), Research Organisation Act (Forschungsorganisationsgesetz) and the Universities Act 2002 (Universitätsgesetz 2002). The Research and Technology Funding Act sets up different, publicly financed research funds, which, in a subsidiary manner, support basic research projects and projects in the field of industry-related applied research and development. The Research Organisation Act determines principles and targets in publicly funded research and sets out legal and organisational rules for research activities by universities and federal scientific institutions. The Universities Act defines the set-up and structures of Austrian universities and their status as legal entities which may independently avail of their budgets.

8.1.2 General Strategy

Research expenditure has continuously increased from below 2 % of GDP in 2000 to 2.27 % in 2004 and is expected to rise to 2.35 % in 2005. A share of 3 % is envisaged for 2010. In order to achieve this objective, the “Council for Research and Technology Development” has prepared the “National Research and Innovation Plan” in order to establish a long-term strategy for Austrian research and innovation policy. The Council has been established in 2000; the council systematically advises the government – and, at their request, individual Federal ministries and provinces – on all research and technology policy questions and implementation measures at the federal level.

Main objectives of the Austrian R&D policy are a. o. promoting international mobility and networking, stimulating the cooperation between enterprises and research organisations and strengthening evaluation as the basis for political governance on R&D.

8.1.3 Funding

Publicly endowed independent funds (FWF, FFF, and ITF) finance basic and application-oriented research and technology developments. Support is rendered in the form of financing of individual and of complementary projects, grants and scholarships, and loans. Applied research and technology developments are promoted by intensified support of co-operation between science and industry (centres of competence, Fachhochschule stimulation actions, post-doctoral actions) and by financing the necessary infrastructure. Science and industry define their own common research programmes with reference to the framework of the new technology and research funding programmes. The day-to-day operation of the federal research institutions (predominantly the universities) and of independent institutions, such as the Academy of Sciences, and of umbrella organisations, is financed directly by public funding.

The Austrian Science Fund was set up as a bottom-up oriented instrument for basic research funding in 1967. About 90% of the subsidies go to university researchers, mainly for basic research. Funding is provided for individual research projects, programmes, publications, grants, and awards. Applications for subsidies are subjected to stringent international peer-review. The total budget spent in 2004 was more than EUR 100 million.

The Austrian Research Promotion Agency has been established in 2004 for financing of innovative projects in applied business-oriented research carried out by enterprises and co-operating scientific institutions. Support is given in the form of loans, interest rate subsidies and the assumption of liability. In 2004 about EUR 250 million were spent for projects.

8.1.4 Environmental Issues

Research on topics of environmental relevance is covered by a wide spectrum of activities and stimuli, ranging from the basic support of relevant university and extra-university institutes and specific, well-funded research programs to single projects, which are commissioned by individual public authorities for ad-hoc expert analyses as well as for studies in the longer term.

Environmental issues are part of the key areas of research commissioned by the Federal Ministry of Education, Science and Culture and the Federal Ministry of Transport, Innovation and Technology, the Federal Ministry of Agriculture and Forestry, Environment and Water Management, and the Länder. Funding focuses on well-defined, interdisciplinary fields of research of great interest to the public, e. g. the efficient use of energy and cleaner production or impacts of environmental change.

An overarching strategy has been developed by the three ministries concerned together with the Council for Research and Technology Development in the course of the initiative on “Research for Sustainable Development” (Forschung für Nachhaltige Entwicklung, FORNE). Parts of the initiative are the research programmes “proVISION” (Federal Ministry of Education, Science and Culture), “Technologies for Sustainable Development” (Ministry of Transport, Innovation and Technology) and “Pfeil05”/”Pfeil10” (Ministry of Agriculture, Forestry, Environment and Water Management). ProVISION deals with key questions like vulnerability of humans and nature, sustainable lifestyles and costs of environmentally responsible actions (http://www.umweltbundesamt.at/en/provision). Pfeil05 and its follow-up Pfeil10 deal with topics ranging from biodiversity to climate change, from biomass use to prevention of natural disasters.

Some environment related mid-term research programmes are administered by the Austrian Academy of Sciences, e. g. on alpine research, on hydrology, as well as the UNESCO Man and Biosphere program. The Austrian Academy of Sciences also hosts the Austrian National Committee on the Global Change Programmes, which is dedicated to establishing contacts with, and to funding Austrian contributions to the Global Research Programmes IGBP, WCRP and IHDP.

Several extra-university institutions, which are part of, controlled by, or (partly) funded by public authorities, perform tasks in environmental research and monitoring, among these the Central Institute for Meteorology and Geodynamics, the Federal Environment Agency, the Hydrographical Central Bureau, institutes of the Federal Ministry of Agriculture and Forestry, Environment and Water Management such as the Federal Research and Training Centre for Forests, Natural Hazards and Landscape (BFW), the Austrian Research Centers Seibersdorf, and Joanneum Research, as well as the environmental departments of the provincial governments.

A special focus on climate change is given within the research programme “StartClim”, which is financed by private-public-partnership. In 2002 Austrian climatologists founded the research platform AustroClim. Its goal is to meet the challenges that climate change poses to science and to support the necessary decisions in the political and economic sectors. Based on the initiative of the Federal Minister of Agriculture, Forestry, Environment and Water Management the comprehensive research programme StartClim under the scientific leadership of

Austroclim was brought into being in 2002. It focuses on selected topics (extreme events, heat and drought, climate change and human health).

8.2 Research

Research on the climate system and climate change issues is heavily influenced by the geographical situation of Austria, especially by the Alps. Alpine regions experience rather heterogeneous meteorological patterns on a small scale and are a serious challenge for climate modelling; they are also very sensitive to any climatic changes. Research on socio-economic aspects of climate change and on adaptation measures is increasing. Research on mitigation technologies with its traditional focus on biomass and solar energy is expanding to give solutions for the complex problems of future lifestyle.

8.2.1 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, confer *Appendix C, Table C.2*.

8.2.2 Modelling and Prediction, Including Global Circulation Models

In view of the limited resources available to a small country, the Austrian climate research community has refrained from entering into global circulation model (GCM) research as such. There are, however, modelling activities in special areas, e.g., diagnostic analyses of subsynoptic flows, or remote sensing applications to improve global climate models and climate forcing inputs via global observational constraints, 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. Special emphases is but on the development of limited area models (LAM) in climate mode for Austria. Within the project reclip:more, a research group including scientists from three universities and two research institutions, a systematical evaluations of the potential of different LAMs for Austria and the development of dynamical downscaled climate change scenarios is done.

For examples of research projects and activities in which Austria has been particularly active, confer *Appendix C, Table C.2*.

8.2.3 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: floods, forests, agriculture, glaciers, etc. As climate change impact is an interdisciplinary problem, the research programs StartClim, Floodrisk and ProVision have been launched within the last years, to meet this challenge. Within this programs not only the physical impacts are investigated, but also the socio-economic impacts and potential adaptation options are addressed.

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. But some studies are looking at the flat eastern part of Austria where agronomy is most important. In this area water shortage could lead to difficulties in the future. This research has been accelerated by the impact of the summer 2003. The research program StartClim2004 was dedicated to this problem.

For examples of research projects and activities in which Austria has been particularly active, confer *Appendix C, Table C.3*.

8.2.4 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.

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 600 municipalities in Austria representing more than 60 % of the Austrian inhabitants 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.

To foster the research on socio-economic aspects of climate change in Austria, in 2005 the Wegener Center for Climate and Global Change ("WegCenter" http://www.wegcenter.at/en/index.html) was founded in 2005. The WegCenter brings together about 30 researchers, research teams and scientists from fields such as geo- and climate physics, meteorology, economics, geography, and regional sciences.

For examples of research projects and activities in which Austria has been particularly active, confer *Appendix C, Table C.4*.

8.2.5 Research and development on mitigation and adaptation technologies

The research on mitigation technologies is high developed in Austria. As an example, the research project Reclip:tom works on the development of technical as well as political “cources of actions” to reduce the greenhouse gas emissions of Austria in a Kyoto-compatible way.

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.

The Federal Ministry of Transport, Innovation and Technology has developed research programs which aim, a. o., at reduced energy consumption and less environmental impacts. The Austrian Program on Technologies for Sustainable Development is a five-year research and technology program; it initiates and supports trendsetting research and development projects and the implementation of exemplary pilot projects. It consists of the subprograms

- "Building of Tomorrow", with a focus on residential and office buildings and methods for higher energy efficiency throughout the whole life-cycle of the building, for greater use of renewable energy sources, especially solar energy, and for greater use of sustainable raw materials and efficient use of materials;
- "Factory of Tomorrow", which aims at zero-waste and zero-emission production and focuses on innovative development regarding sustainable technologies and innovations in production processes and use of renewable raw materials;
- "Energy Systems of Tomorrow", which aims at using renewable energy sources – preferably available on a regional basis – to the greatest extent possible and at reducing greenhouse gas emissions as well as other negative environmental impacts to an ecologically and socially tolerable minimum.

A further programme of the Federal Ministry of Transport, Innovation and Technology supports sustainable development in various areas of transport technology and infrastructure.

The new launched inter-disciplinary research programs in Austria as well as the WegCenter in Graz have also a focal point on the development on adaptation techniques. Within the ongoing international research project AMICA an approach to combine long-term climate protection and short- and midterm adaptation measures on the local level shall be developed.

The ecosystem functions of forestry systems provide an additional strategy to mitigate and adapt to climate changes. Major research themes within this context are: 1) the implementation of adapted forest management to enhance the carbon pool in biomass and soil; 2) to predict how forest ecosystems will respond to expected changes of water supply, to an increased frequency of disturbances, and to populations of biotic stressors (fungi, insects) that expand their habitats; and 3) to analyze and increase the adaptability of forest tree populations by provenances research and selection programme.

For examples of research projects and activities in which Austria has been particularly active, confer *Appendix C, Table C.5*.

8.3 Systematic observations

Climate observations have a long tradition in Austria, going back to the 18th century. A dense network of observing stations for meteorological and hydrographical parameters is in operation; observations relating to mass balance of glaciers and species composition of ecosystems are reported to international data centres as well. During recent years, Austria has increasingly engaged in space-based observation programs.

Tables with detailed information on climate change observing systems in Austria can be found in *Appendix D* to this report.

8.3.1 Atmospheric climate observing systems

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 neighbours. 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. Due to this long experience with meteorological measurements, quality- and homogeneity control of the data are highly developed and long time homogeneous datasets are available.

To meet the demands of the complex topography of Austria, a dense network for observing atmospheric climate parameters is established. More than 600 stations are measuring at least temperature and precipitation. 80 of these stations are exchanged internationally within the WWW, 10 within CLIMAT, 2 within the GSN and 1 within the GAW program (see Table 8.1). Two institutions are responsible for station main-

taining and quality control; the Central Institute for Meteorology and Geodynamics (ZAMG) and the Hydrographical Central Office (HZB). The HZB is also responsible for the river discharge measurements (554 stations) and measurements of the ground water level (3066 stations).

Table 1. Participation in the global atmospheric observing systems

	GSN	GAW	WWW	CLIMAT
How many stations are in the responsibility of the Party?	**2**	**1**	**80**	**10**
How many of those are operating now?	**2**	**1**	**80**	**10**
How many of those are operating to GCOS standards now?	**2**	**1**	**80**	**10**
How many are expected to be operating in 2005?	**2**	**1**	**80**	**10**
How many are providing data to international data centres now?	**2**	**1**	**80**	**10**

All stations are in the responsibility of the Central Institute for Meteorology and Geodynamics (ZAMG). The Austrian GAW station is located at the "Hoher Sonnblick" at 3106 maSl. This high altitude meteorological observatory is operating continuously since 1896, which is the longest continuous and homogeneous meteorological time series for high altitudes worldwide. Since the last decade additional measurements (e.g. Ozone, UVB, Gamma –spectroscopy) are using the infrastructure of the observatory.

The measurements of atmospheric constituents are in the responsibility of the nine province governments and are gathered and published by the Federal Environment Agency. More than 120 stations are distributed all over the country and ad least are measuring Ozone and SO2.

For examples of activities in which Austria has been particularly active, confer *Appendix D, Table D.7*.

8.3.2 Terrestrial climate observing systems

Austria has a long tradition in glacier monitoring. Since the end of the 19th century length fluctuations of approximately 100 glaciers are observed continuously. But not only length measurements are performed as a matter of routine; on several glaciers mass balance measurements using the direct glaciological method are established since decades. All these data are reported internationally to the World Glacier Monitoring Service (see Table 8.2).

In Austria 18 reserves that are accredited by the Council of Europe and the following 6 sites are part of the UNESCO's Programme on "Man and the Biosphere":

- 1977: Gossenköllesee (Tirol)
- 1977: Gurgler Kamm (Tirol)
- 1977: Lobau (Wien)
- 1970: Neusiedler See (Burgenland)
- 2000: Grosses Walsertal (Vorarlberg, http://biosphaerenpark.grosseswalsertal.at/)
- 2005: Wienerwald http://www.biosphaerenpark-wienerwald.net

Table 8.2. Participation in the global terrestrial observing systems

	GTN-G*	GTN-G°	FLUX NET	TEMS	MAB
How many stations are in the responsibility of the Party?	**~100**	**9**	**4**	**2**	**4**
How many of those are operating now?	**~100**	**9**	**4**	**2**	**4**
How many of those are operating to GCOS standards now?	**~100**	**9**	**4**	**2**	**4**
How many are expected to be operating in 2010?	**~100**	**8**	**4**	**2**	**4**
How many are providing data to international data centres now?	**~100**	**9**	**4**	**2**	**4**

GTN-G*: Glaciers Length variations
GTN-G°: Glaciers Mass balance
TEMS: Terrestrial Ecosystem Monitoring Sites
MAB: UNESCO's Programme on "Man and the Biosphere" "Biosphärenreservate"

To describe the water runoff within this complex terrain more than 1300 stations with precipitation measurements, 554 stations for the river discharge measurements and 2793 stations for the ground water storage are established, but also more than 900 stations with snow depth measurements (responsible institutions HZB, ZAMG).

For examples of activities in which Austria has been particularly active, confer *Appendix D, Table D.7*.

8.3.3 Space-based observing programs

On January 1987 Austria became a full member of the European Space Agency (ESA). Since January 1994 Austria is also a member of the European Meteorological Organisation EUMETSAT. Austrians space based activities are coordinated by the former Austrian Space Agency, which has turned into the Aeronautics and Space Agency in 2004 and has become part of the Austrian Research Promotion Agency.

In addition to the involvement in the mandatory program of ESA (general activities including general studies, the technology program and the science program) Austria participates in the following global change relevant programs:
- Earth Observation Programme:
  - Earth Explorer
  - Earth Observation Envelope Programme (EOEP-2)
  - Polar Orbit Earth Observation Missions (ENVISAT and METOP)
  - GMES Earth Watch
  - Meteosat Second Generation (MSG)
- Programme for the Development of Scientific Experiments (PRODEX)
- General Support Technology Programme (GSTP).

Austria a. o. participates in GMES projects with respect to soil and forest monitoring, land use and vegetation monitoring and air quality and climate change.

For examples of activities in which Austria has been particularly active, confer *Appendix D, Table D.7*.

Chapter 9

Education, Training and Public Awareness

CONTENTS

Global warming and climate change pose a serious new threat to the survival of many species and to the well-being of people around the world. Action is needed to reduce greenhouse gas emissions toward the ultimate goals of stabilizing the earth's climate and eliminating the negative impacts of climate change. There is a clear need for governments to build public support for climate policies. Success in climate protection needs doubtlessly to be backed up by targeted educational work. Climate change issues in school education are the topic of the first part of this chapter. The following parts focus on training and advising programmes for the general public as well as for specific target groups and on raising public awareness on climate change.

9.1 Education

9.1.1 Framework

Since 1979, Environmental Education (EE) has been a *principle of instruction* and has been integrated into the curricula of general education and – since the beginning of the 1990s – also into those of the vocational school system. The *Constitutional Decree "Environmental Education in Schools"* (edited 1985, re-published 1994) defines main aims of EE: Action competence; experiencing of democratic attitudes and behaviour in order to enable the learners to be active in political life. This decree was the first national document to support EE-oriented project teaching and was the stimulus and the basis for the development of EE in Austria. In a new edition of this decree the implications with respect to school development and Education for Sustainable Development (ESD) will be considered.

In the *"Austrian National Strategy for Sustainable Development"* (2002, http://www.nachhaltigkeit.at/) which has been approved by the government and the parliament, the chapter "Quality of Life in Austria" focuses on education in two key objectives: "A Sustainable Life Style" (objective 1) and "Solutions through Education and Research" (objective 4).

The openness of the term Education for Sustainable Development provides space for innovations like interdisciplinary projects, community co-operation of schools in Local Agenda 21 processes, participatory programmes and developments, as well as research-based learning and impulses for local curriculum development.

The Austrian efforts of stabilizing the earth's climate are also assisted by the *agricultural education, training and extension institutions*. This is based on the long established guiding principle of socio-ecological agricultural policy, which also founds the combined competences of the Federal Ministry of Agriculture and Forestry, Environment and Water Management. Soil protecting and organic farming are deep seated objects of agricultural education and training programmes. These programmes also include biomass and biogas production. Furthermore the Austrian agricultural education, training and extension institutions create public awareness on ecological topics.

9.1.2 Federal initiatives

FORUM Umweltbildung ("FORUM Environmental Education")

Since 1983, this organisation has been operating on behalf of both the Ministry of Education and the Ministry of Environment, developing and promoting educational programmes (http://www.umweltbildung.at). The Forum represents the continuation of a successful inter-ministerial initiative, unique in Europe. It is indispensable for the continuous development and practical transformation of the Ministries' EE policy. Some examples of special activities of the FORUM:

- CD-ROM: climate:change – Why climate doesn't leave us cold. (2005)
  The CD-Rom points out causes and effects of global warming, explains how climate change can be stopped.
- Publication: climate:change – Causes, consequences and possible ways out (2005), 106 pages
  The booklet covers information on global warming, regional effects of climate change, how every single person can contribute to climate protection, etc. Both the CD-Rom and the booklet, are particularly designed for the needs of high school teachers.
- Publication: KonsUmsicht – Sustainable Consumption and Lifestyles. Perspectives and Impulses for youth education. (2004), 58 pages
- Journal environment & education (umwelt&bildung) of the FORUM Umweltbildung
  The quarterly journal environment & education regularly picks up climate related topics.
- Website: Interactive CO_2-calculator (2004)
  The CO_2-calculator is an interactive tool, which comprises three areas that are main causes of individual CO_2-emissions: Nutrition, mobility and habitation.
- Workshop: The Day After Tomorrow: Risk education through catastrophe-pedagogy? (2004)
- Workshop: learning:climate protection (2004)

Education Support Fund for Health Education and Education for Sustainable Development

Since 1992 this Fund has financed and promoted EE oriented project instruction in schools, since 1996 also Health Education projects. Schools and NGOs cooperating with schools are invited to submit projects, which are then evaluated by a commission. The financial endowment amounts to Euro 140,000 annually, about 1000 projects have been financed up to now.

National Environmental Performance Award for Schools and Educational Institutions (Umweltzeichen für Schulen und Bildungseinrichtungen)

This is a national and government-based award; its criteria were set in force by January 2002. About half of the 120 criteria relate to EE, school curriculum and school development. The other half refers to technical aspects like energy saving. The award is valid for four years after the obligatory external evaluation and has to be renewed afterwards.

The Ecologisation Programme (see below) serves as an important source for the formulation of pedagogical criteria.

Environmental Education in Teacher Education- The Network ENITE

ENITE is a research and development network which supports the development and study of initiatives in teacher education. At its first phase (1997 – 2000) teams of professors/associate professors, teachers and students at several teacher training institutions have worked in environment-related teacher education as part of a research project. The Forum Umweltbildung (see above) provides the home-base for the ENITE-network. Scientific supervision is provided by the Institute for Instructional School Development of the University of Klagenfurt.

A main outcome of the network was the ”National teacher Educator´s Course on ESD – BINE (= Bildung für eine Nachhaltige Entwicklung – Innovationen in der LehrerInnenbildung). This two years course (2003 – 2005) has invited educators from pedagogical colleges and universities to work on issues of sustainable development and its educational challenge.

The programme ”Ecologisation of Schools – Education for Sustainable Development ÖKOLOG”

ÖKOLOG is the first and main Austrian programme for schools at the interface of Environmental Education and School development. It is based on the approach of the International decentralised Network ”Environment and School Initiatives/ENSI” to EE and ESD, taking into account the challenges and opportunities of school autonomy and school programme development. Condensed to one sentence, ecologisation means shaping our interaction with the environment in an intellectual, material, spatial, social and emotional sense to achieve a lasting/sustainable quality of life for all. Schools define ecological, technical and social conditions of their environment and, on the basis of these results, define objectives, targets and/or concrete activities and quality criteria, to be implemented and evaluated.

The ÖKOLOG-programme is supported and supplemented at the Länder level with regional support teams in all provinces. During the last five years, 150 schools with about 40.00 students joined the ÖKOLOG-school network.

Hochschule für Agrar- und Umweltpädagogik Wien (University-level training institute for educational professions in agricultural and ecological affairs)

On March 1 2006 the Hochschulgesetz 2005 was passed by the Austrian parliament. This is the legal basis for the future University-level training institute for educational professions in agricultural and ecological affairs. This institute will essentially support the development and dissemination of appropriate methods and practices of teaching, training and creation of awareness in ecological matters.

College of Agriculture “Ursprung” focuses on environmental technologies

This agricultural College is a pioneer school in teaching organic farming, environmental protection and sustainable development. Its curriculum combines agricultural and ecological topics, its facilities and activities are also focused on these areas.

9.1.3 Regional programmes

Various programmes supporting environmental education do exist on the regional level. Some examples should be mentioned here:

- The regional initiative in Tyrol “Schule mit Zukunft” focuses on building school teams responsible for the management, reflection and documentation of environmental projects and for stabilising them in a school profile. Schools get support by an advisor and are offered financial support and in-service training.
- The ”Local Agenda 21”-Schools initiative in Styria is organised by the NGO ”Umweltbildungszentrum Steiermark UBZ” (”Environmental Education Centre of Styria”) on behalf of and financed by the Styrian Provincial Government. Agenda 21-schools should follow the ”Ecologisation of Schools” concept with a stronger focus on collaboration with their community and on school development processes. Support for schools is provided by an advisory team of UBZ and central public relation support is offered.
- Every year Upper Austria offers various possibilities of education in the field of climate protection under the official further training programme for teachers (e.g. every year solar day and excursion of the Upper Austrian Academy for Nature and the Environment). In addition to theoretical training also implementation-focused energy, mobility, and development-policy projects are offered - especially within the framework of the Upper Austrian initiative “Klimarettung” (“saving global climate”) and the Climate Alliance “Klimabündnis”. Apart from the above-mentioned organisations, the OÖ Energiesparverband, Upper Austria’s “energy-saving agency”, provides material and offers support for energy projects. The Wels power station advertises renewable sources of energy at schools by means of an “energy bus” equipped with models. Other energy providers (e.g. Energie AG, Linz AG, erdgas oö) and organisations (e.g. IFAU Steyr, Naturfreunde) offer relevant initiatives for schools.
- Within the framework of the so-called “Mitwelt- und Solarpreis”, a prize which is awarded annually in Vorarlberg for outstanding projects in the fields of nature, environment and solar energy, there is also a category “Young People”, where prizes are awarded for excellent school projects.

9.1.4 NGO Participation

Valuable work is done by several NGOs such as the Climate Alliance Austria, WWF, Naturschutzbund, and Umweltberatung. Some of these NGOs, interest groups and communication agencies organised project competitions, provided teaching materials, organised workshops for teachers or acted as consultants. Expert lessons in schools or outdoors were provided. By doing so, these groups offer valuable

additional support to interested teachers and schools, which cannot be provided by school authorities alone.

Common issues of climate change are especially looked after by the Climate Alliance Austria (see also Section 9.3.):

- More than 100 schools have "joined" the Climate Alliance and take part in activities within their municipalities.
- Climate alliance Austria offers different workshops for schools with the focus to traffic, energy and partnership.
- The "*Green feet campaign*" invites primary schools and kindergartens in Austria to carry out an activity week dedicated to sustainable mobility and climate change, focusing on the fun of movement and independent mobility. For each journey they make - using a sustainable means of transport - , they receive one Green Footprint. It is the aim of the campaign that the children altogether will collect as many Green Footprints (each representing one kilometre) as necessary, to make a symbolic journey to the moon. Until 2005 about 900 schools have participated in the project which has been supported by the Federal Ministry of Agriculture, Forestry, Environment and Water Management.
- 2004/2005 a "*quiz for the climate*" has been launched. Pupils and students are invited to create questions and answers about climate issues.
- *Energy bonus for schools*: This joint initiative of the Ministry of Agriculture, Forestry, Environment and Water Management and the Ministry of Education, Science and Culture, the Austrian federal provinces, and Climate Alliance Austria aims at creating an attractive, project-oriented and competitive framework for the implementation of energy-saving measures in schools. The bonus model for schools allows schools to get a share of cost savings from reduced energy consumption in school buildings.

9.1.5 International Networks

International decentralised Network "Environment and School Initiatives/ENSI"

ENSI is an international government based network focused on innovation and research in Environmental Education (EE) and Education for Sustainable Development (ESD) (http://www.ensi.org). ENSI was set up under the auspices of OECD's Centre for Educational Research and Innovation almost 20 years ago. It has developed an official partnership with UNESCO in the framework of the UN Decade on Education for Sustainable Development (UN DESD) and the United Nations Economic Commission for Europe (UNECE) in relation to the UNECE strategy on Education for Sustainable Development.

ENSI brings together school initiatives, school authorities, teacher training, educational research institutions and other stakeholders from more than twenty countries worldwide and its membership is growing. ENSI supports educational developments that promote environmental understanding, dynamic qualities and active approaches to teaching and learning as well as citizenship education. This is achieved mainly through research and the international exchange of experiences. The current international secretariat is based in Solothurn, Switzerland, with Austria having the ENSI presidency.

EU COMENIUS III Net work project "School Development through Environmental Education" (SEED)

SEED is a group of educational authorities and institutes promoting Environmental Education as a driving force for School Development. Within the 14 European SEED partner countries and 6 SEED member countries, Environmental Education fosters an innovative culture of teaching and learning that promotes Education for Sustainability (http://www.seed-eu.net).

9.2 Training and Advising

The need for information on topics related to climate protection, especially on energy, energy-saving measures and technology, has increased during recent decades.
The reasons for this development are the population's awareness of environmental problems and a general interest in a rational use of energy on the one hand, and certain administrative measures on the other hand.

9.2.1 Training Programmes relating to energy saving

Special "training programmes" have been established by the Länder governments themselves, by regional energy agencies and by the national government as well, partly in co-operation with other institutions.

An important step is the *training of energy advisers*, which consists of a basic course of 50 hours and an advanced course of 150 hours. The courses comprise basic principles of constructional and energy engineering, energy and climate policy as well as practical training

In the year 2000 the Austrian Biomass Association (Österreichischer Biomasse-verband), supported by the Federal Ministry of Agriculture and Forestry, Environment and Water Management, introduced a *certification-system for plumbers* specialized in installing biomass-heating systems. To obtain the certification, plumbers must participate in a theoretical and practical training programme, which is organised by the Biomass Association. In 2005 65 plumbers received the certification "Biowärme-Installateur", so up to now nearly 700 plumbers in Austria are certified "bio heat-plumbers".

Furthermore, seminars and workshops for different target groups, for example teachers, civil servants from municipalities and architects, are organized by Länder and energy agencies on energy related topics.

Independent advising services on energy issues, which are offered free of charge by energy agencies and several non-profit environmental consulting organizations and partly by the Länder authorities themselves, have received enormous interest from the population in recent years. In most of the Länder, regional energy agencies

provide energy consulting services (Oberösterreichischer Energiesparverband, Energieinstitut Vorarlberg, Steiermärkischer Landesenergieverein, Energie Tirol).

Related programmes for enterprises exist in many Länder, e. g. ”ÖkoBusinessPlan Wien”, “ÖkoProfit Niederösterreich”, “Umwelt.Service.Salzburg” or “WIN Steiermarkt”. Advice, support and partial grants for measures related to environmental protection and energy efficiency are offered especially to small and medium enterprises. For several branches of commerce and industry, energy efficiency strategies were developed at Länder level and are now being implemented together with the professional associations. In Vorarlberg e.g. a tailor-made extension service for enterprises (focusing on the hotel and catering industry and office buildings) is offered. Recently there have been two training facilities in Upper Austria in the field of eco-energy, the course “ÖKO.ENERGY” offered at the Technical College in Wels and the eco-energy engineer craft which has been introduced on trial in Upper Austria. Contents and shape of the relevant programmes differ among the Länder.

The Austrian Chamber of Commerce, together with experts from science and from the Federal Ministry of Agriculture, Forestry, Environment and Water Management and supported by management consultants, carried out training programmes related to climate change, emission reduction and carbon trading. The programmes aimed at supporting Austrian enterprises in developing strategies for greenhouse gas management.

Furthermore, the “Arbeitsgemeinschaft Erneuerbare Energie – AEE” (Society for Renewable Energy) needs to be mentioned. It was founded in 1988 as an independent association to promote the practical use of renewable sources as well as the rational use of energy. Fields of activities are the dissemination of thermal solar systems, translucent insulation, low-energy housing, municipal energy concepts, utilisation of biomass, and photovoltaic and biogas production. To an essential extent, AEE´s work consists of advising architects, mechanical engineers, building societies and municipalities in realizing definite projects.

9.2.2 klima:aktiv – a comprehensive Austrian initiative for climate protection

In 2004 the Federal Ministry of Agriculture and Forestry, Environment and Water Management (“Lebensministerium”) launched an eight-year initiative program for active climate protection. klima:aktiv is an innovative add-on to common instruments of the Austrian Climate Strategy, introducing target-group oriented program in the areas construction and energy efficiency, transport and mobility, communities and renewable energy sources. Within these fields 19 thematic programmes have already been launched by the end of 2005.

The klima:aktiv program combines various market-constituent measures and effectuates target-oriented implementation, by providing easier access to target groups and resources for attaining the commonly set targets, by enhanced know-how-transfer with support in vocational training and networking of important actors, by the organisation and development of quality assurance and standards as well as by target group-specific information and marketing.

The overall objective is to reduce energy consumption and to enforce CO_2-neutral usage of energy. klima:aktiv is determined to affect a breakthrough in the use of climate-friendly technologies and services for increased energy-efficiency and of renewable energy sources, as well as to accrue their market shares in different fields. The initiative is aimed at enhancing quality and accelerate introduction of climate-friendly technologies and services, which shall become the self-evident alternatives for companies and for private end-users as soon as possible. By activating all relevant actors through networking the business location of Austria will be strengthened in a sustainable and innovative way.

klima:aktiv programmes develop technological and organisational solutions able to compete on the market, take care of innovative quality standards and promote training of all relevant groups. This is achieved by appropriate information of those investing in climate-relevant areas (i.e. pro-motors of residential housing projects, companies, home builders), by developing expert know-how of the providers of the respective services (master builders, architects) and by improvement of the offer on the market.

Implementation of the klima:aktiv programmes must be accomplished within set time limits and results in concrete measurable targets. Under the aegis of the Austrian "Lebensministerium", the Austrian Energy Agency (AEA.) is responsible for the whole programme management of the klima:aktiv initiative. klima:aktiv pursues an open discussion process and invites all relevant economic branches and important actors to actively participate in designing klima:aktiv thematic programmes. The main benefit of this open process is that the klima:aktiv partners involved allow for easier access to the target groups and an increase of the resources available for attaining the common target. Thus it might have powerful impact in terms of market transformation and energy savings.

The government provides about 5 million Euro per year. In addition, relevant branches of business are invited to contribute.

Next to investment subsidy programmes and legal and fiscal instruments, klima:aktiv provides targeted support for e.g. further education and vocational training of key-players, for quality management or for target-group specific information, motivation and marketing. The single klima:aktiv thematic programmes set targeted impulses and therewith help to transform the market in the fields of construction and living, transport and mobility, company policies, electricity saving and renewable energy sources.

The energy- relevant programmes in detail:

- solarwärme (solar heat): saves costs through increased use of solar energy in single-family houses, residential buildings and tourist enterprises;
- ecofacility (eco facility): reduces heating costs and CO2 emission through the reconstruction and modernisation of tourist enterprises, office buildings, business centres;
- e5-gemeinden (e5-communities): helps communities to use energy more efficiently;
- energieholz (energy wood): encourages the development of so far unused wood resources;

- wohnmodern (live modern): provides for a higher quality of life through the modernisation of large residential buildings;
- qmheizwerke (quality management for biomass district heating plant): makes biomass district heating plants even more efficient;
- biogas (biogas): promotes electricity, heat and fuels from renewable resources;
- energieeffiziente betriebe (energy-efficient companies): helps companies to optimise their energy use;
- klima:aktiv haus (klima:aktiv house): stands for ecologically friendly new buildings in passive-house technology;
- holzwärme (heat from wood): motivates house owners to install biomass-based heating systems;
- wärmepumpe (heat pump): promotes the right application of heat pump;
- klima:aktiv leben (modernisation of private homes): helps to make homes more comfortable, to reduce heating costs of households and to sensitize people for the theme of CO2 reduction;
- klima:aktiv vor ort (klima:aktiv in communities): promotes klima:aktiv services for communities;
- topprodukte (top products): is a net-based platform about the most energy-efficient appliances and equipment;
- energieeffiziente geräte (energy-saving appliances): supports wholesale buyers in purchasing energy-efficient appliances and equipment.

The transport relevant programmes in detail:
- spritsparinitiative (fuel saving initiative): improves road safety, fuel efficiency and combats climate change;
- betriebliches mobilitätsmanagement (mobility management in companies): helps companies to develop intelligent solutions for trips to work, motor-vehicle pool and logistics;
- mobilitätsmanagement kommunal-regional (communal mobility management): Supports communities with respect to mobility management;
- mobilitätsmanagement raumplanung (mobility management for land use planning);
- mobilitätsmanagement schule (mobility management for schools);
- mobilitätsmanagement verwaltung (mobility management public administration);
- mobilitätsmanagement freizeit (mobility management for leisure): aims at an increased share of public transport for leisure and tourism activities;

The advantage of combining the various topics in the fields of construction and energy efficiency, transport and mobility, communities and renewable energy sources in one umbrella programme mainly results from the fact that the instruments used (subsidies, coaching, training, quality management etc.) might differ in content but not so much in form. Thus, the single thematic programmes profit from each other (cross-fertilisation). Success stories will quickly work a circuit and all other programmes can profit.

Furthermore, the sheer number of programmes gives the whole initiative quite some awareness and makes “the whole more then the sum of its parts”. klima:aktiv stands as a “brand“, a corporate design. Its aim is to abolish the apparent contradiction between economy and ecology.

9.2.3 Training and extension programmes relating to farming

Training programmes and extension services concerning organic farming, soil protecting farming and biomass production are offered to the farmers mainly by the Chambers of Agriculture, the Institute of Further Training in Rural Areas LFI, the organic farm association BIO AUSTRIA and the provincial governments. These programmes and services receive grants from the Federal Ministry of Agriculture and Forestry, Environment and Water Management. Because of the increasing interest in organic production and biomass the demand for these services has been rising over the last decades.

9.3 Public Awareness

Austria lays great emphasise on educating the public on the significance of the climate change issue and therefore improving public awareness in this field. Some key initiatives are described below.

9.3.1 General aspects

In order to increase the effectiveness of climate change communication activities, a distinct project titled “How to comprehensibly communicate climate change” was carried out in 2004/2005. The project was based on psychological methods; its aim was to examine the awareness of people concerning matters of climate change and to find out, in how far personal consequences – as changes in the personal lifestyle – can be deducted from a certain degree of awareness. The results of this study show that people are concerned about the environment. It also seems that people in Austria are quite well informed about the ongoing climate change and the dangers resulting from this. They have astonishingly detailed knowledge on certain global perspectives of climate change such as the IPCC-scenarios.

97 % of the people in the sample feel obliged to contribute to the reduction of GHG-emissions, themselves. Asked, what kind of contribution they would personally favour in this respect, waste separation, waste abatement and saving of energy are mentioned first hand. Cutting down on using the car or turning toward a more modest lifestyle are ranking far behind.

The authors of the study give the following resume: People in Austria maybe have sufficient information on the facts of climate change, so they need not be “shaken up”. But there is quite a deficit/gap between the perception of the problem as such and definite personal consequences. People could most likely be motivated to a more “climate-friendly” behaviour by being offered more concrete recommendations for actions and by getting certain incentives.

The leaflet “klima:aktiv handeln”, edited by the Federal Ministry of Agriculture and Forestry, Environment and Water Management aims just at that. The key message of this brochure is that we all can take action to reduce our impact on the environment and every individual action – no matter how small – really does count. Focus is laid on recommendations of actions that people can take at home and at work to reduce

the release of greenhouse gases. The brochure makes clear, that looking after the environment will not only improve our quality of life but it can help to save money as well.

9.3.2 Activities for climate change awareness in general

Climate protection requires more than a contribution towards sustainable development from political, economic and administrative players. Every individual can support climate protection objectives, although many people are unaware of how much individual behaviour can contribute towards climate change. In honour of the World Environment Day, the Lebensministerium therefore created Eco-Check (http://ecocheck.lebensministerium.at), a new online service that allows any Austrian to check his or her personal energy scorecard and to find out about ways to save energy and cut CO_2.

"ZeroCarbonCity – Reacting to Climate Change" is a global campaign of the British Council to raise public awareness about climate change and energy challenges faced by the world. It is targeted to visit a great number of countries around the world with a wide variety of interactive events including debates, model making, lectures on climate change issues and the NorthSouthEastWest (NSEW) Photo Exhibition. The exhibition touches upon the broad themes of physical environment, development, technology, food, health, urban life, etc. The Federal Ministries of Science as well as of Agriculture, Forest Management, Environment and Water Management supported the campaign in Austria and organised an action day of zero carbon city in September 2005.

With its umbrella programme "Klimarettung" ("Saving global climate") the Province of Upper Austria has comprehensively organised its public relations work in the field of climate protection. In this network most different stakeholders can contribute in the form of voluntary commitments and supports. Improved framework conditions in the form of project road maps or subsidies are offered. Every year households can win prizes by completing a climate balance-sheet (first prize € 10,000 in cash for climate protection measures). Networking with the Climate Alliance and the federal programme klima:aktiv is working very well.

There is a wide variety of public-awareness activities in Vienna in the course of the implementation of the climate protection programme of the city (KLIP). Periodic electronic KliP news are sent to the members of the expert network and to relevant public relation workers. In headlines they provide valuable information about climate protection and KliP Wien. An internet presentation (www.wien.at/umwelt/klimaschutz) provides information about climate protection, the respective programme and success gained in the implementation, as well as tips how each of us can help to safeguard our climate.

Special focus of Lower Austria is strong cooperation and support of the Austrian Climate Alliance, setting out special priority regions: In a priority region of the Climate Alliance (approx. 15-25 communities, for two years) the Federal Province of Lower Austria supports climate-relevant projects in communities and schools to encourage citizens to reflect on the issue of climate protection. The Climate Alliance Working Group Development Policy supports the climate-protection activities with targeted

education efforts and public relations work. Enhancing fair trade is given top priority in this context.

Landjugend Österreich is an association of about 90,000 rural young people and young farmers in Austria. It offers general and agricultural training for its members and therefore receives grants from the Federal Ministry of Agriculture and Forestry, Environment and Water Management. In 2006 climate protection has been chosen as the main topic of the training programme to raise awareness in the young rural population.

9.3.3 Energy

The "Energiesparmesse", an exhibition about energy efficiency, thermal insulation and renewable energy and related products, which is held annually in Wels (Upper Austria), is an event with a widespread effect. In 2006, nearly 100.000 visitors attended the event, and the exhibition received excellent coverage in Austrian media. Also the Austria climate protection initiative klima:aktiv was one main theme in Wels.

In connection with the exhibition, the international conference "World Sustainable Energy Day" is organised by the OÖ Energiesparverband; the conference highlights sustainable energy solutions from all over the world and aims at fostering initiatives and projects involving energy efficiency and renewable energy sources. In 2006, more than 930 delegates from 56 countries attended the conference and the related seminars.

In a competition for initiatives in the fields of energy efficiency and renewable energy sources from all over the world, the Energy Globe Award honours outstanding projects. In 2005, more than 800 entries from all over the world participated in 5 categories. The Energy Globe Award is presented during an international TV gala ceremony. (www.energyglobe.at)

In 2005 the solar initiative "Sonne für Wien" (Sun for Vienna) was launched. During the whole year events, presentations at fairs, and press conferences were organised.

9.3.4 Transport

In summer 2004, the Mobility Department in the Austrian Federal Ministry of Agriculture, Forestry, Environment and Water Management ("Lebensministerium"), in co-operation with the Austrian Energy Agency (AEA) and the Federal Branch Association of Driving Schools started *Eco-Driving Austria* ("Spritspar-Initiative"). The programme is part of the "klima:aktiv->mobil" initiative of the government (see above) with the aim to reduce greenhouse gas emissions from all sectors. Its elements are:

- Eco-Driving Championship for drivers: Drivers, who obtained their driving licence not longer than one year ago, have been invited in 2004 to take part in this championship in fuel-saving driving style. The competition aims at spreading the idea of ECO-DRIVING among young drivers and also among driving schools. In 2005 the competition was extended to all drivers (owners

of a driving licence for passenger cars) again with an extra category/valuation for novice drivers. From 3500 applicants 520 drivers were picked for several rounds of the competition. The final saw 25 competitors. The winner picked 5000 Euros. Along with the competition leaflets, radio-spots, print media coverage etc. have been organised.

- Eco-Driving certificate for driver trainers: In pilot seminars driving teachers have been educated and certified to ECO-DRVIVING-trainers (”Spritspar-Trainer”) with a certain quality standard.
- Co-operation with fleet operators
- Awareness raising, marketing and public relations: The project is accompanied by elements of PR works such as radio spots, print media coverage, leaflets with tips to save fuel etc. The main focus of this campaign has been the target groups as mentioned above, but some focus is also put on the general public (car drivers).

In the context of the *European Carfree Day* (September, 22) Austria has organised this action day yearly since the year 2000. A goal of this European initiative is it to sensitize and motivate the citizens for pollution free mobility and to offer sustainable solutions. Walking, cycling and use of public transport take over the leading part, at least for one day. The population can experience the advantages of a carfree environment. The European Carfree Day is not to be understood as a single action, but shall bring a long-term change of behaviour. With a peak participation of 323 cities and municipalities altogether (cooperation with the Austrian Climate Alliance!) in 2005, the Carfree Day was one of Austria’s most successful public awareness campaigns regarding transport.

The project “traffic-saving municipalities” has reduced the rate of transportation by car has been from 63 % to 54 % in the pilot community Langenlois through awareness raising measures. The project has therefore been extended to 26 communities in the Wienerwald (Lower Austria). The initiative “ZweiRad FreiRad” (“BiCycle FreeCycle”) is to make cycling more attractive in communities. The offer of leasing bicycles free of charge is to give the people living in the relevant communities a new interest in cycling.

9.3.5 Agriculture – Organic Farming

Informing the public is important for the Federal Ministry of Agriculture and Forestry, Environment and Water Management. Only well-informed consumers will appreciate the advantages of organic farming and its products and are thus prepared to pay a higher price. Partly, the information is published by the Federal Ministry of Agriculture and Forestry, Environment and Water Management itself (e.g. the brochure on organic farming), and partly orders are placed with firms specialised in public relation.

So relevant brochures can be downloaded from the homepage of the Federal Ministry of Agriculture and Forestry, Environment and Water Management or may be ordered by mail. Web sites (www.lebensministerium.at, www.landnet.at) present information on important issues regarding organic farming.

The Federal Ministry of Agriculture, Forestry, Environment and Water Management also grants a considerable amount of financial support to Agrarmarkt Austria (AMA) and associations for organic farmers so that they can fulfil the task of informing the consumers at the best. For example, within the framework of the services, subsidies for public relations amounting to approx. 700,000 EUR are granted to the associations for organic farmers.

Farmers, processors and persons or organisations pay contributions for marketing to AMA, which, in turn, uses them for various activities; they are co-financed by the Federal Ministry of Agriculture, Forestry, Environment and Water Management and the EU (for instance, the so-called „Bio-Aktionstage“ catch the eyes of the consumers with sampling demonstrations, disseminating information on organic farming within the „I love Bio“-activities). Internet pages (www.bio-erleben.at, www.bio4kids.at) were created for children and parents, who would like to know more about organic farming. Moreover, the advantages of organic products are presented in newspapers, on posters, in folders etc. The joint platform of the associations for organic farmers, “BIO AUSTRIA”, publishes a magazine for sustainable lifestyle in co-operation with „die umweltberatung“

During Austria’s Presidency of the EU a lot of events will take place where organic products are served and where this fact is explicitly pointed out. Public relations for organic products is going to continue to be important within the promotional activities of the Federal Ministry of Agriculture and Forestry, Environment and Water Management and of the EU as it enables the consumers to make their responsible choice.

9.3.6 NGO-Participation – Climate Alliance Austria

The Climate Alliance is a partnership between more than 1500 European local authorities and indigenous rainforest peoples with the goal of protecting the earth’s atmosphere. In Austria, more than 600 municipalities and all federal provinces, 275 private companies and more than 100 schools have joined the Alliance. As a very successful non-profit organisation – with respect to raising public awareness for climate change issues as well as stimulating counter measures at the local level – it is supported by the members as well as by the Federal Ministry for Agriculture and Forestry, Environment and Water Management. The members have committed themselves to:

- Reducing their carbon dioxide emissions by 50%, by 2010;
- Supporting the indigenous partners to preserve tropical rainforests.

In almost all member municipalities, working groups dealing with the implementation of measures in different areas (energy, transport, procurement, etc.) have been established. The success of these working groups is usually based on the involvement of committed citizens and local NGOs.

Many and diverse activities were undertaken by Climate Alliance Austria in the last years. These range from nation-wide competitions to regional seminars:

- Every year a competition among the member municipalities is organised, focusing on a special topic. The topics in recent years were “life-style”, “municipal carbon dioxide balance” and “climate protection in agriculture”.
- A nation-wide climate alliance meeting every year allows for intensive discussion and exchange of opinions among the member municipalities. The meetings consist of presentations and excursions; several hundred municipalities have taken part in recent years.
- Information on different subjects of climate protection was offered at about 150 local seminars and regional meetings.
- A periodical paper, issued five times a year, informs the public about current activities and serves as project exchange for the members.
- Information campaigns have been conducted on special topics such as the advantages of organic farming, the ban of HCFCs and HFCs in municipal procurement, and on fair trade.
- The campaign for climate protection includes the business sector, too. After initial analysis and advice by the climate alliance, companies commit themselves to energy saving measures and to a CO_2-reduction target. The performance with respect to the targets is evaluated regularly. To date, 275 companies have joined the climate alliance

An important part of the activities of the Climate Alliance is the *partnership with indigenous rainforest people* and raising of awareness for these issues in Austria. Representatives of indigenous people have visited Austrian municipalities and vice versa. Austria has contributed to the protection of the global climate system with a programme for sustainable development in the “Rio Alto Negro” region since 1993. Rio Alto Negro is a tributary of the Amazon in the north-west of Brazil. In this region, which is somewhat larger than Austria, 23 indigenous peoples have joined together in the umbrella organisation FOIRN. Climate alliance Austria supports FOIRN in their struggle for economic and cultural autonomy and for preserving the tropical rainforests, these being the very basis of their existence, by granting them title of ownership and ensuring the sustainable use of their territories. The main principle is the integration of native people in measures for the protection of their environment.

Appendix A

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Appendix B

Greenhouse Gas Inventory Information – Tables

Table B.1 Summary report for CO_2 equivalent emissions 2003 (CRF Summary 2)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 (1)	CH_4	N_2O	HFCs	PFCs	SF_6	Total
	CO_2 equivalent (Gg)						
Total (Net Emissions) (1)	**63.440,70**	**7.806,62**	**5.542,26**	**1.308,22**	**102,54**	**593,52**	**78.793,87**
1. Energy	**67.857,30**	**653,33**	**820,00**				**69.330,63**
A. Fuel Combustion (Sectoral Approach)	67.624,26	332,14	820,00				68.776,41
1. Energy Industries	16.030,35	6,50	68,38				16.105,23
2. Manufacturing Industries and Construction	14.163,39	9,96	164,77				14.338,12
3. Transport	22.692,33	22,50	280,75				22.995,58
4. Other Sectors	14.702,00	293,15	305,15				15.300,30
5. Other	36,19	0,03	0,96				37,17
B. Fugitive Emissions from Fuels	233,04	321,19	0,00				554,22
1. Solid Fuels	0,00	8,14	0,00				8,14
2. Oil and Natural Gas	233,04	313,04	0,00				546,08
2. Industrial Processes	**8.151,09**	**7,30**	**883,38**	**1.308,22**	**102,54**	**593,52**	**11.046,05**
A. Mineral Products	3.060,20	0,00	0,00				3.060,20
B. Chemical Industry	558,88	7,23	883,38	0,00	0,00	0,00	1.449,49
C. Metal Production	4.532,01	0,07	0,00		0,00	0,00	4.532,08
D. Other Production	NA						0,00
E. Production of Halocarbons and SF_6				NO	NO	NO	0,00
F. Consumption of Halocarbons and SF_6				1.308,22	102,54	593,52	2.004,28
G. Other	NO	NO	NO	NO	NO	NO	0,00
3. Solvent and Other Product Use	**193,60**		**232,50**				**426,10**
4. Agriculture	**0,00**	**3.989,38**	**3.359,68**				**7.349,06**
A. Enteric Fermentation		3.093,65					3.093,65
B. Manure Management		885,35	703,64				1.589,00
C. Rice Cultivation		0,00					0,00
D. Agricultural Soils(2)	NA	9,09	2.655,72				2.664,80
E. Prescribed Burning of Savannas		0,00	0,00				0,00
F. Field Burning of Agricultural Residues		1,29	0,32				1,61
G. Other		0,00	0,00				0,00
5. Land-Use Change and Forestry(1)	**-12.772,55**	**0,00**	**0,00**				**-12.772,55**
6. Waste	**11,27**	**3.156,61**	**246,70**				3.414,59
A. Solid Waste Disposal on Land	0,00	2.828,85					2.828,85
B. Wastewater Handling		302,76	192,43				495,19
C. Waste Incineration	11,27	0,00	0,02				11,29
D. Other	0,00	25,00	54,25				79,25
7. Other *(pl[redacted]specify)*	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**

Memo Items:							
International Bunkers	**1.451,90**	**0,52**	**16,47**				**1.468,89**
Aviation	1.451,90	0,52	16,47				1.468,89
Marine	NO	NO	NO				0,00
Multilateral Operations	**IE**	**IE**	**IE**				**0,00**
CO_2 Emissions from Biomass	**14.665,91**						**14.665,91**

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 emissions	CO_2 removals	Net CO_2 emissions / removals	CH_4	N_2O	Total emissions
Land-Use Change and Forestry	CO_2 equivalent (Gg)					
A. Changes in Forest and Other Woody Biomass Stocks	0,00	0,00	0,00			0,00
B. Forest and Grassland Conversion	0,00		0,00	0,00	0,00	0,00
C. Abandonment of Managed Lands	0,00	0,00	0,00			0,00
D. CO_2 Emissions and Removals from Soil	0,00	0,00	0,00			0,00
E. Other	0,00	0,00	0,00	0,00	0,00	0,00
Total CO_2 Equivalent Emissions from Land-Use Change and Forestry	0,00	0,00	**-12.772,55**	0,00	0,00	**-12.772,55**

Total CO_2 Equivalent Emissions without Land-Use Change and Forestry (a)	91.566,42
Total CO_2 Equivalent Emissions with Land-Use Change and Forestry (a)	78.793,87

Table B.2 Summary report for national emissions in 2003 (CRF Summary 1.A)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 emissions	CO_2 removals	CH_4	N_2O	HFCs		PFCs		SF_6		NO_x	CO	NMVOC	SO_2
					P	A	P	A	P	A				
	(Gg)				CO_2 equivalent (Gg)				(Gg)					
Total National Emissions and Removals	**76.213,26**	**-12.772,55**	**371,74**	**17,88**	**2.311,71**	**1.308,22**	**380,59**	**102,54**	**0,03**	**0,02**	**229,03**	**801,78**	**182,30**	**34,14**
1. Energy	**67.857,30**		**31,11**	**2,65**							**222,58**	**767,35**	**82,08**	**32,87**
A. Fuel Combustion — Reference Approach	72.162,78													
Sectoral Approach	67.624,26		15,82	2,65							222,58	767,35	78,63	32,72
1. Energy Industries	16.030,35		0,31	0,22							15,64	4,35	0,74	8,43
2. Manufacturing Industries and Construction	14.163,39		0,47	0,53							33,49	168,82	3,69	11,90
3. Transport	22.692,33		1,07	0,91							135,69	186,73	23,64	2,24
4. Other Sectors	14.702,00		13,96	0,98							37,70	407,23	50,54	10,14
5. Other	36,19		0,00	0,00							0,08	0,21	0,01	0,01
B. Fugitive Emissions from Fuels	233,04		15,29	0,00							0,00	0,00	3,45	0,15
1. Solid Fuels	0,00		0,39	0,00							0,00	0,00	0,00	0,00
2. Oil and Natural Gas	233,04		14,91	0,00							0,00	0,00	3,45	0,15
2. Industrial Processes	**8.151,09**		**0,35**	**2,85**	**2.311,71**	**1.308,22**	**380,59**	**102,54**	**0,03**	**0,02**	**1,66**	**23,82**	**15,71**	**1,21**
A. Mineral Products	3.060,20		0,00	0,00							0,00	9,78	0,00	0,00
B. Chemical Industry	558,88		0,34	2,85	0,00	0,00	0,00	0,00	0,00	0,00	0,69	11,09	12,34	0,77
C. Metal Production	4.532,01		0,00	0,00				0,00		0,00	0,09	2,30	0,41	0,45
D. Other Production	NA										0,88	0,64	2,96	0,00
E. Production of Halocarbons and SF_6						NO		NO		NO				
F. Consumption of Halocarbons and SF_6					2.311,71	1.308,22	380,59	102,54	0,03	0,02				
G. Other	NO		NO	NO	NO	NO	NO	NO	NO	NO	0,00	0,00	0,00	0,00
3. Solvent and Other Product Use	**193,60**			**0,75**							**0,00**	**0,00**	**82,63**	0,00
4. Agriculture	**0,00**	**0,00**	**189,97**	**10,84**							4,76	1,12	1,76	0,00
A. Enteric Fermentation			147,32											
B. Manure Management			42,16	2,27									NE	
C. Rice Cultivation			NO										NO	
D. Agricultural Soils	NA	NA	0,43	8,57							4,73		1,63	
E. Prescribed Burning of Savannas			NO	NO							NO	NO	NO	
F. Field Burning of Agricultural Residues			0,06	0,00							0,03	1,12	0,13	0,00
G. Other			NO	NO							NO	NO	NO	0,00

Table B.2 continued

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 emissions	CO_2 removals	CH_4	N_2O	HFCs		PFCs		SF_6		NO_x	CO	NMVOC	SO_2
					P	A	P	A	P	A				
	(Gg)				CO_2 equivalent (Gg)				(Gg)					
5. Land-Use Change and Forestry	**0,00**	**-12.772,55**	**0,00**	**0,00**							**0,00**	**0,00**	**0,00**	**0,00**
A. Changes in Forest and Other Woody Biomass Stocks	0,00	0,00												
B. Forest and Grassland Conversion	0,00		0,00	0,00							0,00	0,00	NO	
C. Abandonment of Managed Lands	0,00	IE												
D. CO_2 Emissions and Removals from Soil	0,00	NE												
E. Other	0,00	NO	0,00	0,00							0,00	0,00	NO	NO
6. Waste	**11,27**		**150,31**	**0,80**							**0,03**	**9,49**	**0,13**	**0,05**
A. Solid Waste Disposal on Land	0,00		134,71									9,48	0,13	
B. Wastewater Handling			14,42	0,62							0,00	0,00	0,00	
C. Waste Incineration	11,27		0,00	0,00							0,03	0,01	0,00	0,05
D. Other	0,00		1,19	0,18							0,00	0,00	0,00	0,00
7. Other ***(please specify)***	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO

Memo Items:														
International Bunkers	**1.451,90**		**0,02**	**0,05**							**4,64**	**1,43**	**0,61**	**0,46**
Aviation	1.451,90		0,02	0,05							4,64	1,43	0,61	0,46
Marine	NO		NO	NO							NO	NO	NO	NO
Multilateral Operations	**IE**		**IE**	**IE**							**IE**	**IE**	**IE**	**IE**
CO_2 Emissions from Biomass	**14.665,91**													

Table B.3 Emission trends summary

GREENHOUSE GAS EMISSIONS	Base year[1]	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
	CO_2 equivalent (Gg)														
Net CO_2 emissions/removals	52.249,29	52.249,29	52.979,04	50.913,32	51.138,93	52.563,31	56.069,09	61.370,87	54.836,85	53.510,71	51.976,69	51.808,21	55.934,87	59.683,51	63.440,70
CO_2 emissions (without LUCF) [6]	61.262,62	61.262,62	64.752,08	59.348,14	59.899,64	60.203,24	63.115,45	66.562,46	66.527,30	66.217,81	64.614,14	65.454,12	69.279,64	70.994,47	76.213,26
CH_4	9.797,69	9.797,69	9.759,88	9.460,60	9.425,66	9.257,72	9.142,84	8.958,72	8.681,40	8.557,07	8.365,73	8.146,25	8.020,50	7.856,28	7.806,62
N_2O	5.711,76	5.711,76	6.060,03	5.706,80	5.561,46	6.034,88	6.137,65	5.794,74	5.890,80	5.973,57	5.807,59	5.758,53	5.730,53	5.636,41	5.542,26
HFCs	555,26	219,16	334,57	386,59	444,24	505,20	555,26	637,15	729,62	812,53	866,99	1.019,00	1.122,34	1.218,92	1.308,22
PFCs	68,74	1.079,24	1.087,08	462,67	52,92	58,65	68,74	66,27	96,83	44,75	64,54	72,33	82,15	86,87	102,54
SF_6	1.139,16	502,58	653,36	697,85	793,71	985,70	1.139,16	1.218,05	1.120,15	907,99	683,96	633,31	636,62	640,83	593,52
Total (with net CO_2 emissions/removals)	**69.521,89**	**69.559,72**	**70.873,96**	**67.627,81**	**67.416,92**	**69.405,45**	**73.112,74**	**78.045,80**	**71.355,65**	**69.806,62**	**67.765,51**	**67.437,64**	**71.527,01**	**75.122,83**	**78.793,87**
Total (without CO_2 from LUCF) [6]	**78.535,22**	**78.573,05**	**82.647,00**	**76.062,64**	**76.177,63**	**77.045,38**	**80.159,10**	**83.237,39**	**83.046,10**	**82.513,72**	**80.402,96**	**81.083,55**	**84.871,78**	**86.433,79**	**91.566,42**

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year[1]	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
	CO_2 equivalent (Gg)														
1. Energy	54.945,90	54.945,90	58.769,48	53.932,46	54.573,05	54.536,96	57.200,73	61.019,19	60.283,20	60.287,29	58.865,23	59.014,77	62.927,72	64.026,01	69.330,63
2. Industrial Processes	10.114,82	10.152,65	10.269,45	9.118,31	8.842,87	9.376,47	9.875,84	9.751,84	10.345,24	9.897,07	9.590,82	10.328,82	10.234,05	10.963,93	11.046,05
3. Solvent and Other Product Use	515,17	515,17	469,27	420,24	419,85	404,04	422,38	405,31	422,59	404,74	390,87	413,52	426,10	426,10	426,10
4. Agriculture	8.456,23	8.456,23	8.643,69	8.187,31	7.970,20	8.492,49	8.557,75	8.089,34	8.144,83	8.146,26	7.860,19	7.724,46	7.753,92	7.552,64	7.349,06
5. Land-Use Change and Forestry [7]	-9.013,33	-9.013,33	-11.773,04	-8.434,82	-8.760,71	-7.639,93	-7.046,36	-5.191,59	-11.690,45	-12.707,10	-12.637,45	-13.645,91	-13.344,77	-11.310,96	-12.772,55
6. Waste	4.503,10	4.503,10	4.495,12	4.404,33	4.371,66	4.235,43	4.102,39	3.971,72	3.850,23	3.778,36	3.695,85	3.601,98	3.529,99	3.465,11	3.414,59
7. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO

Table B.4 CO_2 emissions 1990–2003

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year[1]	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
	(Gg)														
1. Energy	**53.527,09**	**53.527,09**	**57.236,98**	**52.425,77**	**53.037,84**	**53.027,87**	**55.667,06**	**59.430,39**	**58.797,95**	**58.807,61**	**57.399,85**	**57.616,58**	**61.475,09**	**62.586,99**	**67.857,30**
A. Fuel Combustion (Sectoral Approach)	53.425,06	53.425,06	57.125,96	52.305,74	52.925,81	52.900,34	55.540,03	59.359,36	58.677,44	58.665,78	57.229,31	57.452,05	61.292,36	62.419,95	67.624,26
1. Energy Industries	13.622,41	13.622,41	14.416,96	11.346,25	11.384,60	11.644,66	12.677,57	13.762,22	13.371,32	12.897,76	12.258,63	12.275,76	13.423,01	13.347,79	16.030,35
2. Manufacturing Industries and Construction	12.970,71	12.970,71	13.379,09	12.274,18	12.813,11	13.817,64	13.904,54	13.777,76	16.121,87	14.589,73	13.556,77	14.298,68	14.064,14	14.394,72	14.163,39
3. Transport	12.404,87	12.404,87	13.997,14	13.941,35	14.119,23	14.081,96	14.466,30	16.042,44	14.977,02	17.182,90	16.596,33	17.735,29	18.886,06	20.973,52	22.692,33
4. Other Sectors	14.392,05	14.392,05	15.295,67	14.710,26	14.569,45	13.314,49	14.459,03	15.738,00	14.170,10	13.952,94	14.775,96	13.097,37	14.882,92	13.662,92	14.702,00
5. Other	35,02	35,02	37,11	33,70	39,43	41,60	32,59	38,94	37,13	42,45	41,62	44,95	36,23	41,00	36,19
B. Fugitive Emissions from Fuels	102,03	102,03	111,03	120,03	112,03	127,53	127,03	71,03	120,51	141,83	170,53	164,53	182,73	167,03	233,04
1. Solid Fuels	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2. Oil and Natural Gas	102,03	102,03	111,03	120,03	112,03	127,53	127,03	71,03	120,51	141,83	170,53	164,53	182,73	167,03	233,04
2. Industrial Processes	**7.432,16**	**7.432,16**	**7.259,88**	**6.727,09**	**6.665,95**	**6.994,08**	**7.248,43**	**6.948,86**	**7.528,56**	**7.226,96**	**7.044,61**	**7.645,23**	**7.599,70**	**8.202,61**	**8.151,09**
A. Mineral Products	3.242,73	3.242,73	3.100,60	3.118,54	3.052,83	3.166,86	2.825,81	2.738,24	2.938,01	2.784,78	2.770,53	2.928,28	2.946,53	3.055,39	3.060,20
B. Chemical Industry	464,46	464,46	471,67	450,80	469,98	429,52	514,86	516,90	507,83	555,63	524,86	532,29	509,05	510,25	558,88
C. Metal Production	3.724,97	3.724,97	3.687,60	3.157,75	3.143,14	3.397,69	3.907,75	3.693,72	4.082,72	3.886,54	3.749,22	4.184,65	4.144,13	4.636,97	4.532,01
D. Other Production	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
E. Production of Halocarbons and SF_6															
F. Consumption of Halocarbons and SF_6															
G. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**282,67**	**282,67**	**236,77**	**187,74**	**187,35**	**171,54**	**189,88**	**172,81**	**190,09**	**172,24**	**158,37**	**181,02**	**193,60**	**193,60**	**193,60**
4. Agriculture	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**
A. Enteric Fermentation	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
B. Manure Management	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
C. Rice Cultivation	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Agricultural Soils [2]	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
E. Prescribed Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
F. Field Burning of Agricultural Residues	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
G. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
5. Land-Use Change and Forestry [3]	**-9.013,33**	**-9.013,33**	**-11.773,04**	**-8.434,82**	**-8.760,71**	**-7.639,93**	**-7.046,36**	**-5.191,59**	**-11.690,45**	**-12.707,10**	**-12.637,45**	**-13.645,91**	**-13.344,77**	**-11.310,96**	**-12.772,55**
A. Changes in Forest and Other Woody Biomass Stocks	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
B. Forest and Grassland Conversion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
C. Abandonment of Managed Lands	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
D. CO_2 Emissions and Removals from Soil	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
E. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
6. Waste	**20,70**	**20,70**	**18,45**	**7,55**	**8,50**	**9,75**	**10,09**	**10,40**	**10,70**	**10,99**	**11,31**	**11,28**	**11,24**	**11,27**	**11,27**
A. Solid Waste Disposal on Land	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
B. Waste-water Handling	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
C. Waste Incineration	20,70	20,70	18,45	7,55	8,50	9,75	10,09	10,40	10,70	10,99	11,31	11,28	11,24	11,27	11,27
D. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
7. Other ***(please specify)***	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**

Total Emissions/Removals with LUCF [4]	**52.249,29**	**52.249,29**	**52.979,04**	**50.913,32**	**51.138,93**	**52.563,31**	**56.069,09**	**61.370,87**	**54.836,85**	**53.510,71**	**51.976,69**	**51.808,21**	**55.934,87**	**59.683,51**	**63.440,70**
Total Emissions without LUCF[4]	**61.262,62**	**61.262,62**	**64.752,08**	**59.348,14**	**59.899,64**	**60.203,24**	**63.115,45**	**66.562,46**	**66.527,30**	**66.217,81**	**64.614,14**	**65.454,12**	**69.279,64**	**70.994,47**	**76.213,26**

Memo Items:															
International Bunkers	**885,97**	**885,97**	**993,88**	**1.077,44**	**1.139,98**	**1.185,65**	**1.327,42**	**1.466,42**	**1.525,57**	**1.578,21**	**1.541,67**	**1.674,93**	**1.647,45**	**1.526,14**	**1.451,90**
Aviation	885,97	885,97	993,88	1.077,44	1.139,98	1.185,65	1.327,42	1.466,42	1.525,57	1.578,21	1.541,67	1.674,93	1.647,45	1.526,14	1.451,90
Marine	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Multilateral Operations	**IE**	**IE**	**IE**	**IE**	**IE**	**IE**	**IE**	**IE**	**IE**	**IE**	**IE**	**IE**	**IE**	**IE**	**IE**
CO_2 Emissions from Biomass	**9.750,10**	**9.750,10**	**10.612,24**	**10.367,55**	**10.923,44**	**10.553,40**	**11.217,02**	**11.940,19**	**12.022,34**	**11.436,51**	**12.734,05**	**12.017,13**	**13.410,61**	**13.296,77**	**14.665,91**

Table B.5 CH_4 emissions 1990–2003

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year[1]	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
	(Gg)														
Total Emissions	**466,56**	**466,56**	**464,76**	**450,50**	**448,84**	**440,84**	**435,37**	**426,61**	**413,40**	**407,48**	**398,37**	**387,92**	**381,93**	**374,11**	**371,74**
1. Energy	**35,56**	**35,56**	**37,09**	**34,97**	**34,65**	**32,43**	**33,46**	**35,35**	**30,76**	**30,15**	**30,32**	**28,89**	**30,27**	**29,70**	**31,11**
A. Fuel Combustion (Sectoral Approach)	22,34	22,34	23,70	21,65	20,98	19,01	19,51	20,43	15,94	15,36	15,32	14,31	15,53	14,82	15,82
1. Energy Industries	0,15	0,15	0,17	0,16	0,16	0,16	0,16	0,19	0,19	0,19	0,16	0,17	0,19	0,21	0,31
2. Manufacturing Industries and Construction	0,39	0,39	0,43	0,43	0,43	0,45	0,45	0,46	0,50	0,47	0,46	0,47	0,47	0,49	0,47
3. Transport	2,91	2,91	2,88	2,61	2,40	2,19	1,99	1,82	1,63	1,56	1,40	1,29	1,19	1,14	1,07
4. Other Sectors	18,88	18,88	20,21	18,45	18,00	16,21	16,90	17,96	13,63	13,13	13,30	12,38	13,68	12,98	13,96
5. Other	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
B. Fugitive Emissions from Fuels	13,22	13,22	13,40	13,31	13,67	13,42	13,96	14,92	14,82	14,80	15,01	14,58	14,74	14,88	15,29
1. Solid Fuels	0,52	0,52	0,45	0,37	0,36	0,29	0,28	0,24	0,24	0,24	0,24	0,27	0,26	0,39	0,39
2. Oil and Natural Gas	12,70	12,70	12,95	12,94	13,31	13,13	13,68	14,68	14,58	14,55	14,76	14,31	14,49	14,49	14,91
2. Industrial Processes	**0,36**	**0,36**	**0,35**	**0,32**	**0,35**	**0,36**	**0,34**	**0,35**	**0,36**	**0,39**	**0,35**	**0,35**	**0,32**	**0,36**	**0,35**
A. Mineral Products	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
B. Chemical Industry	0,35	0,35	0,35	0,31	0,35	0,36	0,33	0,34	0,35	0,38	0,34	0,35	0,32	0,35	0,34
C. Metal Production	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
D. Other Production	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
E. Production of Halocarbons and SF_6															
F. Consumption of Halocarbons and SF_6															
G. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
4. Agriculture	**219,15**	**219,15**	**216,17**	**208,14**	**208,72**	**210,63**	**211,77**	**208,45**	**206,11**	**205,52**	**201,19**	**197,73**	**195,49**	**191,25**	**189,97**
A. Enteric Fermentation	170,15	170,15	167,85	160,53	160,56	162,74	164,02	161,60	159,25	158,15	156,28	154,15	151,58	148,74	147,32
B. Manure Management	48,60	48,60	47,93	47,23	47,63	47,42	47,25	46,34	46,35	46,86	44,39	43,06	43,41	42,02	42,16
C. Rice Cultivation	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Agricultural Soils	0,33	0,33	0,33	0,31	0,47	0,40	0,44	0,45	0,45	0,45	0,45	0,45	0,43	0,43	0,43
E. Prescribed Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
F. Field Burning of Agricultural Residues	0,07	0,07	0,07	0,06	0,06	0,06	0,07	0,06	0,07	0,07	0,07	0,06	0,07	0,07	0,06
G. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
5. Land-Use Change and Forestry	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
A. Changes in Forest and Other Woody Biomass Stocks	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
B. Forest and Grassland Conversion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
C. Abandonment of Managed Lands	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
D. CO_2 Emissions and Removals from Soil	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
E. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
6. Waste	**211,49**	**211,49**	**211,14**	**207,08**	**205,12**	**197,42**	**189,80**	**182,46**	**176,17**	**171,42**	**166,51**	**160,94**	**155,84**	**152,80**	**150,31**
A. Solid Waste Disposal on Land	197,34	197,34	196,82	192,51	190,26	182,35	174,64	167,23	160,94	156,13	151,14	145,55	140,39	137,27	134,71
B. Waste-water Handling	13,64	13,64	13,77	13,93	14,04	14,09	14,12	14,14	14,15	14,17	14,19	14,23	14,28	14,36	14,42
C. Waste Incineration	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
D. Other	0,52	0,52	0,54	0,65	0,82	0,98	1,04	1,09	1,08	1,12	1,18	1,16	1,17	1,17	1,19
7. Other *(please specify)*	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Memo Items:															
International Bunkers	**0,01**	**0,01**	**0,02**	**0,02**	**0,02**	**0,02**	**0,02**	**0,02**	**0,03**	**0,03**	**0,03**	**0,03**	**0,03**	**0,03**	**0,02**
Aviation	0,01	0,01	0,02	0,02	0,02	0,02	0,02	0,02	0,03	0,03	0,03	0,03	0,03	0,03	0,02
Marine	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Multilateral Operations	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE
CO_2 Emissions from Biomass															

Table B.6 N_2O emissions 1990–2003

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year[1]	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
	(Gg)														
Total Emissions	**18,43**	**18,43**	**19,55**	**18,41**	**17,94**	**19,47**	**19,80**	**18,69**	**19,00**	**19,27**	**18,73**	**18,58**	**18,49**	**18,18**	**17,88**
1. Energy	**2,17**	**2,17**	**2,43**	**2,49**	**2,60**	**2,67**	**2,68**	**2,73**	**2,71**	**2,73**	**2,67**	**2,55**	**2,64**	**2,63**	**2,65**
A. Fuel Combustion (Sectoral Approach)	2,17	2,17	2,43	2,49	2,60	2,67	2,68	2,73	2,71	2,73	2,67	2,55	2,64	2,63	2,65
1. Energy Industries	0,15	0,15	0,17	0,14	0,14	0,15	0,16	0,16	0,15	0,17	0,17	0,18	0,20	0,20	0,22
2. Manufacturing Industries and Construction	0,51	0,51	0,54	0,53	0,53	0,56	0,55	0,54	0,59	0,57	0,58	0,55	0,55	0,55	0,53
3. Transport	0,55	0,55	0,76	0,88	0,98	1,03	1,02	1,00	0,94	0,99	0,91	0,89	0,88	0,91	0,91
4. Other Sectors	0,95	0,95	0,95	0,94	0,94	0,93	0,94	1,03	1,03	0,99	1,01	0,93	1,00	0,96	0,98
5. Other	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
B. Fugitive Emissions from Fuels	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
1. Solid Fuels	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2. Oil and Natural Gas	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE
2. Industrial Processes	**2,94**	**2,94**	**2,99**	**2,70**	**2,83**	**2,66**	**2,77**	**2,82**	**2,78**	**2,89**	**2,98**	**3,07**	**2,54**	**2,60**	**2,85**
A. Mineral Products	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
B. Chemical Industry	2,94	2,94	2,99	2,70	2,83	2,66	2,77	2,82	2,78	2,89	2,98	3,07	2,54	2,60	2,85
C. Metal Production	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE
D. Other Production	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
E. Production of Halocarbons and SF_6															
F. Consumption of Halocarbons and SF_6															
G. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**0,75**	**0,75**	**0,75**	**0,75**	**0,75**	**0,75**	**0,75**	**0,75**	**0,75**	**0,75**	**0,75**	**0,75**	**0,75**	**0,75**	**0,75**
4. Agriculture	**12,43**	**12,43**	**13,24**	**12,31**	**11,57**	**13,13**	**13,26**	**11,97**	**12,31**	**12,36**	**11,73**	**11,52**	**11,77**	**11,41**	**10,84**
A. Enteric Fermentation	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
B. Manure Management	2,54	2,54	2,51	2,41	2,43	2,46	2,50	2,45	2,43	2,42	2,38	2,34	2,32	2,28	2,27
C. Rice Cultivation	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Agricultural Soils	9,90	9,90	10,73	9,89	9,14	10,66	10,76	9,52	9,88	9,93	9,34	9,18	9,44	9,13	8,57
E. Prescribed Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
F. Field Burning of Agricultural Residues	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
G. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
5. Land-Use Change and Forestry	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
A. Changes in Forest and Other Woody Biomass Stocks	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
B. Forest and Grassland Conversion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
C. Abandonment of Managed Lands	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
D. CO_2 Emissions and Removals from Soil	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
E. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
6. Waste	**0,13**	**0,13**	**0,14**	**0,16**	**0,18**	**0,26**	**0,34**	**0,42**	**0,45**	**0,54**	**0,61**	**0,68**	**0,79**	**0,79**	**0,80**
A. Solid Waste Disposal on Land	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
B. Waste-water Handling	0,05	0,05	0,06	0,06	0,06	0,12	0,19	0,26	0,30	0,38	0,44	0,51	0,62	0,62	0,62
C. Waste Incineration	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
D. Other	0,08	0,08	0,08	0,10	0,12	0,14	0,15	0,16	0,15	0,16	0,17	0,17	0,17	0,17	0,18
7. Other *(please specify)*	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**

Memo Items:															
International Bunkers	**0,03**	**0,03**	**0,03**	**0,04**	**0,04**	**0,04**	**0,05**	**0,05**	**0,05**	**0,06**	**0,05**	**0,06**	**0,06**	**0,05**	**0,05**
Aviation	0,03	0,03	0,03	0,04	0,04	0,04	0,05	0,05	0,05	0,06	0,05	0,06	0,06	0,05	0,05
Marine	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Multilateral Operations	**IE**	**IE**	**IE**	**IE**	**IE**	**IE**	**IE**	**IE**	**IE**	**IE**	**IE**	**IE**	**IE**	**IE**	**IE**
CO_2 Emissions from Biomass															

Table B.7 HFC, PFC and SF_6 emissions 1990–2003

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year[1]	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
	(Gg)														
Emissions of HFCs[5] - CO_2 equivalent (Gg)	**555,26**	**219,16**	**334,57**	**386,59**	**444,24**	**505,20**	**555,26**	**637,15**	**729,62**	**812,53**	**866,99**	**1.019,00**	**1.122,34**	**1.218,92**	**1.308,22**
HFC-23	0,0011	0,0002	0,0003	0,0004	0,0006	0,0009	0,0011	0,0014	0,0015	0,0012	0,0014	0,0017	0,0019	0,0021	0,0022
HFC-32	0,0001	0,0000	0,0000	0,0000	0,0000	0,0000	0,0001	0,0002	0,0004	0,0007	0,0010	0,0019	0,0026	0,0034	0,0041
HFC-41	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000
HFC-43-10mee	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000
HFC-125	0,0015	0,0000	0,0000	0,0000	0,0000	0,0000	0,0015	0,0057	0,0110	0,0143	0,0151	0,0198	0,0276	0,0349	0,0415
HFC-134	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000
HFC-134a	0,4128	0,1671	0,2550	0,2940	0,3363	0,3808	0,4128	0,4576	0,5068	0,5594	0,5941	0,6348	0,6720	0,7065	0,7386
HFC-152a	0,0001	0,0000	0,0000	0,0000	0,0000	0,0000	0,0001	0,0003	0,0006	0,0007	0,0006	0,4897	0,4991	0,5085	0,5191
HFC-143	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000
HFC-143a	0,0004	0,0000	0,0000	0,0000	0,0000	0,0000	0,0004	0,0025	0,0056	0,0079	0,0089	0,0125	0,0200	0,0269	0,0332
HFC-227ea	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0001	0,0001	0,0002	0,0004	0,0005	0,0008	0,0011	0,0014
HFC-236fa	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000
HFC-245ca	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000
Emissions of PFCs[5] - CO_2 equivalent (Gg)	**68,74**	**1.079,24**	**1.087,08**	**462,67**	**52,92**	**58,65**	**68,74**	**66,27**	**96,83**	**44,75**	**64,54**	**72,33**	**82,15**	**86,87**	**102,54**
CF_4	0,0060	0,1410	0,1414	0,0592	0,0050	0,0052	0,0060	0,0058	0,0085	0,0027	0,0048	0,0063	0,0063	0,0064	0,0069
C_2F_6	0,0032	0,0177	0,0182	0,0084	0,0022	0,0027	0,0032	0,0031	0,0045	0,0029	0,0036	0,0033	0,0044	0,0041	0,0051
C_3F_8	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0011	0,0014
C_4F_{10}	0,0001	0,0000	0,0000	0,0001	0,0001	0,0001	0,0001	0,0001	0,0001	0,0001	0,0001	0,0001	0,0001	0,0001	0,0001
$c\text{-}C_4F_8$	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000
C_5F_{12}	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000
C_6F_{14}	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000
Emissions of SF_6[5] - CO_2 equivalent (Gg)	**1.139,16**	**502,58**	**653,36**	**697,85**	**793,71**	**985,70**	**1.139,16**	**1.218,05**	**1.120,15**	**907,99**	**683,96**	**633,31**	**636,62**	**640,83**	**593,52**
SF_6	0,05	0,02	0,03	0,03	0,03	0,04	0,05	0,05	0,05	0,04	0,03	0,03	0,03	0,03	0,02

Appendix C

Examples of Research Projects

Table C.1 Interdisciplinary programmes

FloodRisk http://www.umweltbundesamt.at/umwelt/floodrisk/	FloodRisk: The Umweltbundesamt coordinates jointly with BOKU the flood analyses 2002. After successful completion of the first phase of FloodRisk (to-be analyses), the second phase is on the way which shall implement real measures in real places.
reclip http://systemsresearch.ac.at/wwwsys/LUC/reclip/	reclip:more:Model Run Evaluation – mesoscale climate modelling. A reliable assessment of future climate impacts in Austria makes necessary to provide regional climate model (RCM) runs, and additional tasks to deliver high resolution downscaled datasets for past and future climate targeting the entire eastern alps covering Austria. reclip:tom: Technology orientated options for the mitigation of greenhouse gas emissions reclip:strat: Strategic project observation, controlling and evaluation
StartClim2003: First analyses of extreme weather events and their impacts on Austria www.austroclim.at/startclim/ ingeborg.schwarzl@boku.ac.at	Interdisciplinary research programme, 16 subprojects, about 20 different Austrian research institutions worked on the analysis of extreme weather events of the past, their impacts and economic dimensions, along with elements of future scenarios for Austria and synopsis of the factors that triggered the 2002 flood event and their economic repercussions
StartClim2004: Heat and drought and their impacts in Austria www.austroclim.at/startclim/ ingeborg.schwarzl@boku.ac.at	Interdisciplinary research programme, 5 subprojects, 8 different Austrian research institutions worked on first analysis of the extremely hot summer 2003 and its impact especially on agriculture.

Table C.2 Examples of climate process and climate system studies, including modelling.

ALP-IMP – Multi-centennial climate variability in the Alps based in Instrumental data, Model simulations and Proxy data. http://www.zamg.ac.at/ALP-IMP/ Reinhard.Boehm@zamg.ac.at	ALP-IMP is an integrated research attempt on the unique Alpine instrumental and proxy data potential. It will extend the instrumental period in terms of length and spatial density, introduce new climate elements under strict quality requirements in terms of homogeneity and combine them with the typical Alpine proxy information from tree-ring records, isotopic ice core records and glacier variability records to a consistent picture of at least 1000 years of natural climate variability in the Alpine realm. High resolution regional climate model runs combined with sophisticated statistical analyses is going to study meso-scale internal climate variability patterns in the region as well as the Alpine climate as a whole versus European to global scale variability

	and change.
Climate change and heavy-precipitation weather patterns in Austria petra.seibert@boku.ac.at	Heavy-precipitation weather patterns relevant for Austria are diagnosed from back trajectories using a clustering algorithm. Then, the change in the frequency and seasonal distribution of these patterns shall be studied.
Climatographies	Sonnblick and surrounding glaciers, ingeborg.auer@zamg.ac.at. Vorarlberg, http://www.vorarlberg.at/vorarlberg/umwelt_zukunft/umwelt/umweltinstitut/weitereinformationen/klima/uebersicht.htm Salzburg, 1961 – 1990. www.salzburg.gv.at/klima_inhalt.pdf Steiermark. http://www.infrastruktur.steiermark.at/cms/beitrag/10028372/248280/DE/, http://www.gis.steiermark.at/
CLIVALP – Climate Variability Studies in the Alpine Region ingeborg.auer@zamg.ac.at	This project aims to describe climate variability as an inter-connected system of historical climate time series, to analyse outstanding periods and the sensitivity of climate elements in respect to temperature change.
Comparative analysis of the net ecosystem CO2, H2O and energy exchange of mountain meadows http://www.fwf.ac.at/de/abstracts/abstract.asp?L=D&PROJ=P17560 Georg.Wohlfahrt@uibk.ac.at	The objective of this project is to compare the net ecosystem CO2, H2O and energy exchange of several mountain meadows in Tyrol using a combination of eddy covariance and soil/plant/ecophysiological measurements, remote sensing and modelling.
COST 719: "The Use of Geographical Information Systems in Climatology and Meteorology" hartwig.dobesch@zamg.ac.at	The main objective of COST719 is to broaden and enhance the potential of Geographical Information Systems (GIS) in the fields of climatology and meteorology by developing applications in those fields, with emphasis on the procedures and capabilities for integrating and adding value to data from various sources and on quality control and presentation of climate and other related data.
COST 730 - Towards a Universal Thermal Climate Index UTCI for Assessing the Thermal Environment of the Human Being	Analysis of existing procedure to determine from routine meteorological measurements the ambient meteorological parameters, temperature, humidity, radiation, and wind in the micro scale which is relevant for the human people’s thermal environment.

weihs@mail.boku.ac.at	
FORALPS – High Resolution Meteorological Forecasting and Observations for Management of Natural Risks in the Alps http://www.unitn.it/foralps/project/ ingeborg.auer@zamg.ac.at	Assessment of climatic trends at regional scale. Precipitation, snow melting, dearth of precipitation are climatic factors affecting the alpine hydrological cycle. Quantitative estimates of these factors on a climatological time scale are a key basis for realistic planning and management, as well as an appreciable support for weather forecasters. An accurate assessment of past and ongoing variations requires many and, as far as possible, complete time series of hydro-meteorological variables. In FORALPS, series of daily precipitation, snow and temperature measurements available from national and regional services will be digitised, integrated with historical metadata, validated and homogenised, in order to create a rich and homogeneous climatological database.
FWF-Projekt Homogenization of the global radiosonde temperature dataset http://homepage.univie.ac.at/leopold.haimberger/P18120.htm leopold.haimberger@univie.ac.at	Purpose: Improvement of homogenization methods for radiosonde temperatures, especially utilization of wind data for homogenization. The wind data themselves are also homogenized.
High Resolution Temperature Climatology in Complex Terrain (HRT-GAR) ingeborg.auer@zamg.ac.at	Preparation of a High Resolution Temperature Climatology for the Greater Alpine Region (4-19°E and 43-50°N) in monthly resolution for the 30years climate normal. The study region comprises 12 countries, the available data bases consists of more than 1700 stations from more than 15 data providers. Project within ECSN (European Climate Support Net; ECSN is a sub-programme in the framework of the Network of European Meteorological Services EUMETNET).
Holocene climate reconstruction from multi-proxy lake sediment core data (Ob. Landschitzsee, Niedere Tauern) roland.schmidt@oeaw.ac.at	Transfer functions between algal bioindicators and climate-driven environmental variables were applied to a high alpine lake sediment core and used together with other proxies to reconstruct Holocene climate at the southern slopes of the Niedere Tauern. Snow-cover variation showed the strongest lake impact. Climate oscillations coincided with cold and wet periods on European scale. The 8,200 cold event was clearly indicated. From 4000 onward the Mediterranean influence increased. Mid-Holocene as well as Roman and Medieval warm periods approximated present temperatures.
Homogenization of the global radiosonde temperature and wind dataset ECMWF special project, Duration 2005-2007	Purpose: Development of a homogenized radiosonde dataset suitable for climate change studies as well as input for future reanalyses. The homogenization method works with innovation statistics from both ERA-40 and operational ECMWF data.

http://www.ecmwf.int/publications/library/ecpublications/_pdf/era40/ERA40_PRS23.pdf leopold.haimberger@univie.ac.at	
Mesoscale Alpine Climatology with VERA (VERACLIM) http://www.univie.ac.at/IMG-Wien/vera http://www.ecmwf.int/about/special_projects/steinacker_mesoscale-alpine-climatology/ Reinhold.Steinacker@univie.ac.at	The project focuses on a mesoscale climatology over the complex topography of the Alpine region on a high resolution grid (10 and 20 km horizontal). One important aim is to answer the question, if and how during the last decades mesoscale meteorological phenomena have changed their frequency and/or intensity in the Alpine region. The high spatial and temporal resolution of the analysis provides the opportunity for a climatology of weather-features not only on the scale of storms, but also on a very small spatial scale.
MOMBASA wolfgang.schoener@zamg.ac.at	Glacier mass balance, glacial discharge and snow chemistry are monitored for three selected glaciers in the region of Hoher Sonnblick (Hohe Tauern). Glacier mass balanced is measured for both winter and summer balance. Recording of glacial discharge is limited to summer season for two sites and is available all year round for one site. The monitoring program is the basis for several projects of climate-glacier and climate-hydrology relation in the Alps as well as a contribution to international glacier monitoring programs.
OBSERVED GLOBAL CLIMATE , new volume of Landolt-Börnstein michael.hantel@univie.ac.at	This edition is a one-volume book, including a DVD, edited by Michael Hantel (University of Vienna). The book comprises the theoretical and observational background of how to quantitatively represent the global climate. This topic is reviewed in Chapters 1--16 by a total of 25 international authors (each article between 7 and 43 pages) and is illustrated in Chapter 17 with global maps of selected key climate quantities (187 pages). On the DVD, observed data for the present global climate, focussed on the period 1991-1995, are stored electronically in form of: complete data sets 1 degree resolution globally), coloured figures, extended tables, detailed formulae, lengthy derivations, etc. (including videos of selected fields of particular climatological relevance).
Zukunftsprognose Pasterze wolfgang.schoener@zamg.ac.	Measurements of mass balance of Pasterze glacier (Großglockner, Hohe Tauern) and long-term climate data from Sonnblick Observatory are used for calibration of mass balance model (degree-day model). The model as well as measurements of ice volume and climate scenario data are used to estimate future volume and area extent of the glacier. Moreover effects of glacier retreat on water power production as well as the possibility to transfer of methods to other glaciers will be investigated.

Table C.3 Examples of research on the impacts of climate change.

ACTIVE – Austrian Climate and Health Tourism Initiative 2002 Ernest.Rudel@zamg.ac.at	Austria has a high potential of climate resources for health-tourism that are not used in an adequate way. With the help of the bioclimatological analyses of Austria (products are bioclimatic maps for Austria as a whole as well as bioclimatic diagrams for small scale climate health resorts, both based on a human energy balance model with meteorological and physiological input parameters) the medical partners of the project make recommendations for medical indications and therapies using the healing potential of the specific climate conditions.
ALARM - Biodiversity assessment and analysis of pressures on biodiversity http://www.alarmproject.net/alarm/ http://www.seri.at/alarm/ ines.omann@seri.at	ALARM is essentially a project to improve the instruments for assessing the threat to and the loss of biodiversity in Europe, and on this basis to derive suggestions how to stop the negative trends. Climate is one of the four issues under investigation, each representing a main challenge to biodiversity. The specific work on climate change is done by scenario technique and consists of (1) identifying the dramatic socio-economic change that happened throughout the last decades all over Europe and which accompanied the climate change and thus of linking both patterns of changes and detecting the causes for these changes; (2) developing recommendations for political and socio-economic measures to reduce the negative impacts of climate change on biodiversity.
Assessing uncertainty in bottom-up full carbon accounting for Russia: Towards closing the accounting gab with top-down atmospheric inversion jonas@iiasa.ac.at	This research study is motivated by the need to close the gap between bottom-up and top-down accounting of net atmospheric carbon emissions. Its focus is on the consistent and spatiotemporal assessment of existing data in terms of uncertainty. The aim is to overcome the bottom-up/top-down 'accounting gap'. The geographical focus is on Russia (1) because of the important role of Russia's terrestrial biosphere in the global carbon cycle and (2) to complement similar ongoing work focusing on other regions in the northern extratropical belt, with the consequence that a truly consistent and complete bottom-up/top-down coverage of the northern extratropical belt can be achieved in terms of carbon.
Auswirkungen von Klimaänderung und Gletscheränderung auf den Alpintourismus in den Hohen Tauern wolfgang.schoener@zamg.ac.at	Effects of climate change and related glacier variability on alpine mountaineering tourism is summarized for the example of Großglockner-Sonnblick region (Hohe Tauern). An opinion poll send out to local actors (mountain guides, alpine hut renters and owners, organisations in charge of alpine mountaineering trails) in the region is used for investigation of perception of climate change and climate change related impact on high alpine landscape.
Auswirkungen von Klimaänderungen auf die Tierwelt - derzeitiger Wissenstand, fokusiert auf den Alpenraum und Österreich thomas.gerersdorfer@boku.ac.at	Aim of this study was to assess the potential impact of climate change on the Austrian fauna. Beside an analysis of the effect of the observed climate change within the last decades, regional climate change scenarios were used, to investigate the possible developments in the future.

helga.kromp-kolb@boku.ac.at	
Beurteilung der Auswirkungen möglicher Klimaänderungen auf die Fischfauna anhand ausgewählter Fließgewässer herbert.formayer@boku.ac.at, stefan.schmutz@boku.ac.at	Assessment of effects of potential climate changes on the fish fauna of selected running waters in Austria.
CarboEurope Integrated Project www.carboeurope.org bernhard.schlamadinger@joanneum.at	CarboEurope-IP aims to understand and quantify the present terrestrial carbon balance of Europe and the associated uncertainty at local, regional and continental scale. This means to - determine the European carbon balance with its spatial and temporal patterns - understand the controlling processes and mechanisms of carbon cycling in European ecosystems and how these are affected by climate change and variability and human management - develop an observation system to detect changes in atmospheric CO2 concentrations and ecosystem carbon stocks related to the European commitments under the Kyoto Protocol.
Carbo-Invent: Multi-Source Inventory Methods For Quantifying Carbon Stocks And Stock Changes In European Forests www.joanneum.at/carboinvent bernhard.schlamadinger@joanneum.at	Carbo-Invent is an EU FP5 project coordinated by Joanneum Research with contributions of the Umweltbundesamt and the Federal Research and Training Centre for Forests, Natural Hazards and Landscape (BFW). The objective is to identify/develop/test methods for assessing forest carbon (C) stock changes at national and EU levels, for the purpose of reporting under the UNFCCC and the Kyoto Protocol (KP), using multi-source inventory methods: biomass expansion factors, soil C assessments combined with forest inventories; remote sensing techniques to enhance accuracy and reduce cost. This will aid the design of "national systems" as called for in the KP. Methods/integration techniques are be applied in boreal, continental, oceanic, alpine, mediterranean test sites. Upscaling to national level is tested for both "full C accounting" and selective accounting under the KP. Separate national and EU stock-change estimates will result from integrating multi-source data with a European Forest Resource Database. C monitoring/verification procedures are suggested to translate KP decisions into inventorying requirements at national/project levels.
Carbon Storage in Soils martin.gerzabek@boku.ac.at	The institute of soil research investigates intensively carbon sequestration in soil. The impact of land use (arable land, grassland, forest) and land management (tillage, fertilizer application) is especially in the focus of these research efforts. Recently a paper of C-sequestration in Austrian agriculturally used soils was published. Future activities will focus on the impact of climate change on C-sequestration potential.

CLIMPHEN - Climate impact on plant and insect phenology in Austria Helfried.Scheifinger@zamg.ac.at	Phenology has become an important source of information of climate change impacts on plants and animals. Based plant and animal phenological observations collected during the last 50 years in Austria the spatial distribution of long term mean phenological entry dates are studied. The temporal variability and trends of phenological observations and temperature time series are compared. It is to be investigated, if the length of the spring season and the length of the vegetation period has changed in terms of phenology and temperature. Via statistical downscaling methods changes in phenological occurrence dates in potential future climate scenarios are to be assessed.
COST Action 856: Denitrification in agriculture, air and water pollution Contact Sophie Zechmeister-Boltenstern; sophie.zechmeister@bfw.gv.at http://www.cost856.de/	The objective of the Action is to understand factors governing denitrification at the molecular, cellular and environmental level. Most of the processes involved in nitrogen turnover in the environment are exclusively the result of microbial activities. Loss of nitrogen compounds such as nitrate or ammonia via denitrification or its interaction with other nitrogen turnover processes limits the growth of crops. Gaseous side products of these processes emitted from soils contribute to the destruction of the ozone layer and to global warming. To minimise the negative effects of nitrogen turnover in the environment in the long run and to make use of denitrification to enhance environmental quality it is crucial to understand denitrification and other nitrogen transforming environmental processes.
Cost Action E52: Evaluation of beech genetic resources for sustainable forestry Thomas Geburek, thomas.geburek@bfw.gv.at	European beech (*Fagus sylvatica* L.) is a widely spread economically important tree species that is well suitable to study the impacts of global change due to its functional flexibility and genetic plasticity. The objective of E52 is to make predictions about the future distribution range of beech forest ecosystems under certain scenarios of climate change. The basis of the action is the analysis of the reaction pattern of European beech populations from defined origins that are planted in a large set of field trials distributed all over Europe.
Crop drought stress monitoring by remote sensing werner.schneider@boku.ac.at	The overall goal of the project is to adapt and to advance remote sensing based methods of drought stress detection and monitoring on agricultural crops exploiting the potentials of present-day satellite-based optical sensors. Different sensors are being combined, making synergistic use of high spectral resolution, high spatial resolution and high temporal resolution. The methods are developed and tested for selected cultivars of wheat and maize.
Effects of different soil tillage practices on carbon sequestration and CO2 emissions andreas.klik@boku.ac.at	Field experiments are performed on an agricultural field in Lower Austria where different tillage practices are carried out. These practices consist of 1) conventional tillage, 2) conservation tillage and 3) direct seeding. For both reduced tillage practices cover crops are planted during the winter period. Objective of these measurements are to investigate the effects of the soil management systems

	on soil carbon sequestration and soil respiration (CO2 emissions).
Effect of experimental warming of mountain forest soils Contact Robert Jandl; Robert.jandl@bfw.gv.at http://bfw.ac.at/rz/bfwcms.web?dok=4175	Information on the effect of soil warming in mountain forest ecosystems is scarce. Under the harsh environmental conditions in mountain regions especially the forest floor tends to accumulate soil organic matter. Soil warming, an elongation of the growing season and high rates of N deposition can accelerate microbial turnover processes and thereby increase decomposition of recently fixed carbon from unstabilised soil organic matter. The experiment quantifies the effects of a 3°C increase in soil temperature on greenhouse gas emissions. The pathway of carbon through soil water is examined in order to provide a complete C budget. In addition to changes in soil carbon, changes in soil nitrogen are expected as well. Nitrogen oxides are highly effective greenhouse gases. Therefore additional measurements of nitrous oxide will be carried out on all treatment plots.
Estimating the effects of dry spells in grassland using plant growth models and climatological analysis of Austrian data Herbert.formayer@boku.ac.at, josef.eitzinger@boku.ac.at	Different methods were adapted and developed to simulate the effects of droughts on grassland yields in Austria, including GIS incorporation.
forest parameters and laserscanner data Roland.wack@joanneum.at	- Extraction of terrain and forest parameters for avalanche modelling based on airborne laserscanner BMLFUW - Austria - Extraction of forest parameters for alpine protection forest from laserscanner data and optical satellite data, within GEOLAND, EC FP 6 GMES IP Landcover & Vegetation - Services for Protection Forests and Nature 2000 Sites based on the Combined use of Very High Resolution Satellite and Airborne Laser Scanner Data, Austrian Settlement and AlPine Environments (ASAPII)
Holocene Climate Change Reflected in a Remote High Alpine Lake FWF Projekt R29 N10 karin.koinig@uibk.ac.at	Signatures of climate change in the biotic and abiotic remains of the sediment will be investigated in a remote high alpine lake (Schwarzsee ob Sölden). High alpine lake ecosystems are remarkably sensitive to climate change as even a small increase in temperature shortens the duration of the snow and ice cover of the lake and its catchment. Based on the climate signals we observe in the sediment records, we will assess the impact of climate change on the lake over the last 10000 years. It is of special interest how recent warming compares to historic warm periods.
IFORCAM Integrated Forest Carbon Management	The project studies the effect of 4 selected forest management strategies under climate change on timber production and carbon sequestration at management unit level. The ecosystem model PICUS v1.41 is employed to simulate forest development, ecosystem services and economic

Manfred J. Lexer, mj.lexer@boku.ac.at	performance of alternative management concepts for a case study FMU situated in Austrian secondary Norway spruce forests. Particular emphasis is placed on the effect of explicitly considering natural disturbances by bark beetles. Possible consequences with regard to Art. 3.4 of the Kyoto Protocol are exemplified and discussed.
Impact of Climate Extremes on the Tree Growth within the Alpine timberline ecotone and inner alpine valleys Walter.Oberhuber@uibk.ac.at	At the upper and drought-caused timberlines tree growth responds very sensitive to climate variability. The analysis is focused on the impact of extreme climate conditions on growth of tree species which form widespread forest ecosystems in the Eastern Alps, by applying methods of tree ring analysis and assessing dynamics of cambial activity.
Impact of climatic change on crop production. josef.eitziniger@boku.ac.at	Impacts of climate change on crop production are simulated using crop models.
Impact of climatic change on the water balance of lake Neusiedl josef.eitzinger@boku.ac.at	The water balance of lake Neusiedl is investigated using regionalized climate change scenarios of the 2020´s and 2050´s.
Level I and Level II Assessments with Forest Focus Ferdinand Kristöfel; Ferdinand.kristoefel@bfw.gv.at	Forest Focus is a Community scheme for harmonised, broad-based, comprehensive and long-term monitoring of European forest ecosystems. It concentrates in particular on protecting forests against air pollution and fire. To supplement the monitoring system, new instruments relating to soil monitoring, carbon sequestration, biodiversity, climate change and protective functions of forests are pursued.
Long-term growth trends of forests Markus Neumann and Günter Rössler; markus.neumann@bfw.gv.at; guenter.roessler@bfw.gv.at	The response of forest stands to changing site conditions reveal how forest productivity is affected by changing climate conditions. The experiments are continuously monitored since more than 40 years and serve as benchmark systems for the quantification of the climate effect on trees.
Monitoring reproduction and flowering phenology of forest trees in Austria and the adjacent alpine regions Rudolf Litschauer, rudolf.litschauer@bfw.gv.at	The survival of forest trees under changing environmental conditions depends not only on the physiological reaction of the trees. Rather, the integrity of the reproductive processes must be seen as prerequisite for the sustainability of the forest ecosystem under changing climate. Monitoring the reproduction and flowering phenology of forest tree species enables to identify tree species, forest ecosystems and regions, which suffer from climate changes. The actual reproduction monitoring is based on pollen samples from stations all over Austria with collections

	going back up to 20 years. Moreover, data from adjacent regions in Bavaria, Italy, and Switzerland are being incorporated into the monitoring.
NEW ICETOOLS (EU Project No. NNE5-2001-00259); 2002 - 2004 hartwig.dobesch@zamg.ac.at	Modelling the risk of icing at different sites (duration of icing), resulting in a Potential Icing Map of Europe. On-site cold climate problems and their effect on power production; Modelling the loss of production due to icing
NitroEurope (6th Framework Programme) Contact Sophie Zechmeister-Boltenstern; sophie.zechmeister@bfw.gv.at http://www.neu.ceh.ac.uk/about.html	NitroEurope focuses on (i) Multiple components of the nitrogen cycle and its interactions with the carbon cycle: treating inputs and outputs via air and water and changes in stocks for terrestrial ecosystems (forests, shrublands, grasslands and croplands);(ii) Experimental manipulation of terrestrial ecosystems in relation to the key drivers of change in the nitrogen and carbon cycles: climate change, atmospheric composition change, land management and land use change; (iii) Modelling the process interactions and scaling up to consider fluxes at the plot, landscape, region and European level.
Nitrogen dynamics in forest ecosystems under different nitrogen deposition and climate conditions. Friederike Strebl friederike.strebl@arcs.ac.at	Based on geochemical nitrogen transport models, different nitrogen deposition scenarios are coupled to present and future climate scenarios. Nitrogen pool sizes and dynamics in above-ground vegetation, soil, migration towards groundwater and gaseous nitrogen losses are assessed.
Objective topoclimatic assessment of winegrowing areas in Austria in view of their influence on wine quality herbert.formayer@boku.ac.at	Aim of this project is to determine objective climatological criteria concerning the quality of wine in different vine growing regions in Austria. For this purpose the thermal and radiative differences, topographic effects of the terrain, as well as risk for water stress and frost are considered.
Pesticide degradation under climatic change conditions. bernhard.wimmer@arcs.ac.at	In lysimeter experiments the transport and degradation characteristics of a model pesticide (S-Metolachlor) under different temperature and humidity conditions are studied. Soil temperature is decreased by 3 °C, precipitation patterns are changed with respect to rain intensity (with unchanged sum of precipitation). The pesticide is analysed in vegetation, soil and seepage water samples
SilviStrat, Silvicultural response strategies to climatic change in management of European forests http://www.efi.fi/projects/silvistrat/	The project studies adaptive management strategies to enhance carbon sequestration in the European forests without constraining timber production and to mitigate adverse impacts of the global climate change on them. The basic strategy of the Project is to analyse possibilities to adjust current forest management strategies to improve the carbon sink capacity and the adaptation of the forests to the expected changing environmental conditions.

Tree-ring research at BOKU michael.grabner@boku.ac.at	The tree-ring research group of the University of Natural Resources and Applied Life Sciences – BOKU, Vienna, is working in the field of dendroclimatology. We are setting up long-time tree-ring chronologies (multi millennial) using sub-fossil stems in lakes and bogs. Additionally a network of precipitation limited sites in eastern Austria was set up. In cooperation with Prof. Keith Briffa, (Climatic Research Unit, University of East Anglia, UK) the analysis of climatic variation in the past was started.

Table C.4 Examples of socio-economic analysis, including both of the impacts of climate change and response options.

Carbon management—Uncertainty and verification: A systems-analytical vade mecum for reporting and comparing carbon management policies http://www.iiasa.ac.at/Research/FOR/index.html jonas@iiasa.ac.at	The final report compiles scientific manuscripts, reports and other documents (Excel files etc.), which evolved from this study and that fulfill one of the following criteria: 1) they have been submitted, or are prior to their submittal, to a scientific journal; 2) they have been published as an IIASA Interim Report that can be downloaded; or 3) they have been made available to the public via the Internet.
CIRCLE http://www.umweltbundesamt.at/umwelt/circle/	Umweltbundesamt coordinates the EU ERA-Net project CIRCLE which aims at networking 20 national research programmes in the field of climate impacts and adaptation in 18 European countries (plus Israel). Major tasks of CIRCLE will be to align research agendas of participating national research programmes and the design and execution of transnational activities like e.g. joint calls and project clustering.
ECOCHECK – internet platform for individual eco-assessment www.umweltnet.at/ecocheck www.umweltbildung.at/cgi-bin/cms/af.pl?contentid=1499 www.akaryon.com/ecocheck busswald@akaryon.com	To date, environmental projects have tended to focus on the role that industry and big business plays with regards to pollution, leaving a dearth of accessible information on the impact that the individual citizen has on the environment as a global system. While many people are conscious of environmental issues, they have no means by which to judge their overall impact on the environment. To this end, ECOCHECK offers an internet platform that enables individuals to assess the impact of their lifestyle on the environment by calculating CO2 emissions and energy consumption.
futuro – calculation of "sustainable prices“ for products www.futuro-preise.at	Individuals get more and more concerned about quality of goods (especially food) and services, but they have little means by which to judge the ecological and social impact of production, transport, use and disposal of goods and services. The sustainable prices of project futuro reflect the scope of sustainability (So far the algorithm includes the criteria: "fair wages“, "social

www.akaryon.com/futuro busswald@akaryon.com	standards“, "CO2 emissions“, "usage of agricultural land“, "toxicity“ and "usage of material“) and allow for price-like comparisons between different types of products (where eco-labels only provide a sort of ranking of products of the same type from different producers). In this sense the sustainable prices are meant to build an orientation guide for consumers.
STRATEGE http://www.klimawandel-wintersport.at/index_en.html. ulrike.proebstl@boku.ac.at herbert.formayer@boku.ac.at	In this project regionally adapted climate change models will be used to investigate the impact of climate change on winter tourism. Such issues as security of investment, uncertainty of planning decisions, and the potential for compensation with snow making in an applied research context will be addressed in an inter- and transdisciplinary approach.

Table C.5 Examples of research and development on mitigation and adaptation technologies

Abatement of landfill methane emissions by microbial oxidation in biocovers made of compost http://www.wau.boku.ac.at/H813_projekt.html?project_id=3073&lang=de&L=0 http://www.wau.boku.ac.at/H813_projekt.html?project_id=3057&lang=de&L=0 http://dissdb.bibvb.ac.at/opus-search/frontdoor.php?source_opus=1632 marion.huber-humer@boku.ac.at	Despite of modern landfill technology, forced gas extraction and utilisation, landfills are still a paramount global anthropogenic source of the greenhouse gas methane. One inexpensive way to reduce methane emissions from landfills is to exploit the natural process of microbial methane oxidation through improved landfill cover design and maintenance. Two research projects including comprehensive field studies with variously designed cover layers on Austrian landfills were carried out between 1998 and 2002 in order to find an optimal design of a biocover for enhancing methane oxidation and to assess the efficiency of this technology. Findings from these field trials as well as results from detailed laboratory tests and specific lysimeter investigations on the interaction between microbial methane oxidation, the vegetation and the water balance of such covers were integrated in a PhD-Thesis.
Activities within IPCC bernhard.schlamadinger@joanneum.at	- Coordinating Lead Author: IPCC Good Practice Guidance for Land Use, Land-Use Change and Forestry - Lead Author: IPCC Fourth Assessment Report, Working Group II, "Energy Supply" (in Preparation) - Review Editor: 2006 IPCC Guidelines for National Greenhouse Gas Inventories Member of the US-DOE Center for Carbon Sequestration in Terrestrial Ecosystems (CSITE)
AGRIDEMA - Introducing tools for agricultural decision-making under climate change conditions by connecting users and tool-providers.	Training for users of different climate models and crop models by model developers including pilot projects.

josef.eitziniger@boku.ac.at thomas.gerersdorfer@boku.ac.at	
Aktiver Gletscherschutz – Development of methods for the reduction of ice and snow melt in glacier ski resorts http://imgi.uibk.ac.at/IceClim/alpS/ Andrea.Fischer@uibk.ac.at	The effect of snow compaction, water injection and covering with geotextiles on the melt rate in glacier ski resort is measured by the Institutes for Meteorology and Geophysics, Zoology and Limnology and Microbiology in cooperation with 4 glacier ski resorts. In a second step, the methods are improved and computational models are developed.
Aktualisierung Kyoto-Optionenbericht Salzburg	The project aims at a status report, looking at the realisation of the measures worked out and described in the first Kyoto-Options-Report of Salzburg 2001. Based on the results a revision and actualisation of the Kyoto-Options-Report will be worked out.
Animal husbandry and manure management systems in Austria barbara.amon@boku.ac.at; martina.froehlich@boku.ac.at	Emission inventories require activity data to be known. The project carries out a detailed survey on animal husbandry and manure management systems in Austria. The aim is to improve inventory quality and show mitigation options and potentials for ammonia and greenhouse gases from Austrian agriculture.
ARTEMIS - ASSESSMENT OF RENEWABLE ENERGY TECHNOLOGIES ON MULTIPLE SCALES - A PARTICIPATORY MULTI-CRITERIA APPROACH http://www.project-artemis.net/ ines.omann@seri.at	The aim of ARTEMIS is to further develop and apply a participatory tool for the multi-criteria evaluation (MCE - PROMETHEE) of alternative renewable energy scenarios for Austria. The evaluation is performed at different levels (national, local) and involves the compilation of a detailed criteria list for renewable energy technologies (RETs) to assess their socio-economic, environmental and institutional impacts and the social preferences revealed. Both case studies involve representatives from different interest groups.
Assessment and mitigation of ammonia, nitrous oxide and methane emissions from a straw flow system for fattening pigs barbara.amon@boku.ac.at	Animal welfare and environmental protection are increasingly important. Housing systems must be found that offer animal welfare and emit little ammonia and greenhouse gases. The project measures N_2O, CH_4, and NH_3 from a commercial straw flow system and during the subsequent manure storage. Emission levels and mitigation options are worked out.
Biogas usage in Fuel Cells http://www.energyagency/projekte/biogas_fuelcell.htm	The 5RP-project "Advanced prediction, monitoring and controlling of anaerobic digestion processes behaviour towards biogas usage in Fuel Cells" aims to enable the cost-effective utilisation of Biogas from Anaerobic Digestion in Fuel Cells for the most efficient production of energy from a renewable resource. The role of the Austrian Energy Agency is in particular the

guenter.simader@energyagency.at	dissemination of the achieved FTE Results ("dissemination manager").
CO2 Capture and Sequestration (CCS) in Future National and International R&D Programmes guenter.simader@energyagency.at	Carbon capture and sequestration (CCS) received in the last years major attention as future green house gas mitigation technology in several international R&D positions, programmes, and projects. Within this project an analysis and evaluation of national and international programmes, activities and policies were carried out. Furthermore a discussion process with national companies resulting in a position paper was initialised.
ENCOFOR: ENvironment and COmmunity based framework for designing afFORestation, reforestation and revegetation projects in the CDM: methodology development and case studies. www.joanneum.at/encofor hannes.schwaiger@joanneum.at	The aim of ENCOFOR is to promote the implementation of sustainable afforestation and reforestation projects in the Clean Development Mechanism. ENCOFOR is developing an operational framework for the planning and evaluation of CDM-AR projects in (sub)tropical developing countries.
Environmental impacts of decentralised composting of organic wastes: greenhouse gas emissions, nutrient leaching, sanitation of organic wastes. barbara.amon@boku.ac.at	Sustainable management of organic wastes aims at guaranteeing a constant and high product quality as well as low emissions during the composting and recycling process. The research project investigated the environmental impacts of decentralised composting of organic wastes in households. Greenhouse gas and NH3 emissions and nutrient leaching during the composting process were measured under field conditions. Sanitation of the organic wastes during the composting process was monitored. The quality of the produced compost was assessed. Economics and environmental impacts of decentralised composting were quantified.
Evaluierungssystem für die Maßnahmen im NÖ-Klimaprogramm	The project is focused on the creation of monitoring model for the measures of the Climate Programme of Lower Austria. Herewith the measures shall be checked for visible effects in national and regional surveys (Österreischische Luftschadtstoffinventur und Bundesländer-inventur) to interpret the trends in the surveys in connection to the Climate Programme.
Fuel cell technology and hydrogen as energy carrier of the future Austrian energy system guenter.simader@energyagency.at	The political interest in hydrogen based energy systems increased considerably worldwide in the past few years. Following activities were carried-out: (i) analysis of the state of the art of hydrogen based energy systems (ii) analysis of national and international programmes and activities (iii) initiation of a discussion process about the future strategical role of hydrogen based energy systems in Austria involving national and international experts and stake holders. (iv) proposal of recommendations for future RTD activities in Austria.
Greenhouse gas and ammonia emissions after	Slurry application to arable land is followed by NH3, N2O and CH4 emissions. The research

slurry spreading and influence of slurry treatment barbara.amon@boku.ac.at; gerhard.moitzi@boku.ac.at	project quantified emissions after surface application of slurry in dependency on the slurry treatment. The following treatments were included in the investigations: untreated slurry, anaerobically digested slurry, slurry after mechanical separation of solids, aerated slurry and slurry with addition of chopped straw.
Greenhouse Gas Mitigation for Organic and Conventional Dairy Production (MIDAIR) barbara.amon@boku.ac.at; vitaliy.kryvoruchko@boku.ac.at	MIDAIR aimed to identify region and system specific, cost-effective GHG mitigation measures and strategies for organic and conventional dairy production in Europe. The GHG mitigation potential for all dairy regions in Europe was quantified. Agronomic, environmental and socio-economic consequences of complete and partial adoption were assessed and recommendations are presented. The MIDAIR consortium consisted of 17 partners from 11 European countries.
IEA Bioenergy Task38: Greenhouse Gas Balances of Biomass and Bioenergy Systems www.joanneum.at/iea-bioenergy-task38 bernhard.schlamadinger@joanneum.at	Task 38 is an international research network comprising 12 countries (8 European countries, US, Canada, Australia, New Zealand), and coordinated by Joanneum Research in Austria. The objective is to analyse and integrate information on bioenergy, land use, and greenhouse-gas (GHG) mitigation; thereby covering all components that constitute a biomass or bioenergy system, i.e. from biomass production to bioenergy conversion and end use. The ultimate goal is to aid policy and industry decision makers in selecting mitigation strategies that optimise GHG benefits while being practical and cost effective.
Influence of the slurry additive "effective micro-organisms" on ammonia, methane, nitrous oxide and odour emissions during storage of dairy cattle and pig slurry barbara.amon@boku.ac.at	The research project investigated the influence of the slurry additive "effective micro-organisms" (EM) on NH3, CH4, N2O and odour emissions during storage of dairy cattle and pig slurry under field conditions.
INSEA: Integrated Sink Enhancement Assessment (coordinated by IIASA) www.insea-eu.info/ Manfred J. Lexer, mj.lexer@boku.ac.at bernhard.schlamadinger@joanneum.at	The project's objective is to develop an analytical tool to assess economic and environmental effects for enhancing carbon sinks and greenhouse gas abatement measures on agricultural and forest lands.
Introduction of broadleaf species for sustainable forest management (Sustman); 5th Framework Programme Ernst Leitgeb; Ernst.leitgeb@bfw.gv.at	The objective of the project is to provide for the conversion of spruce monocultures through the introduction of broadleaf species. Conversion of potentially unstable spruce monocultures into broadleaf species forests will enhance biodiversity as a prerequisite for coping with climate change effects. Changing the species composition will reduce the economical vulnerability when calamities occur in spruce forests. The project implements Community measures on the protection

http://www.sustman.de/	and on sustainable management of forests.
Maintenance and exploitation of the genetic variability of tree species Silvio Schüler, silvio.schueler@bfw.gv.at	In order to cope with climatic change, the natural genetic variability of tree species is of prime importance. To analyse the genetic variability of tree populations provenance trials from various tree species are being monitored on field trials all over Austria. These data help to estimate the adaptability of a given tree species according to stand and climate conditions, to the susceptibility to biotic stressors (insects, fungi) and the economical performance. On basis of this data, selection and breeding programme can be established for different purposes, e.g. fast-growing trees for energy-plantations or to increase the adaptability of the species.
Methane, nitrous oxide and ammonia emissions from management of liquid manures barbara.amon@boku.ac.at; gerhard.moitzi@boku.ac.at	Large uncertainties are associated with the estimation of CH4, NH3, and N2O emissions from manure management. Abatement measures have not been intensively investigated under field conditions. The research project aimed at quantifying emissions from liquid manure stores and after manure application under field conditions. Several manure treatment options were investigated and evaluated.
More agricultural Austrian products - better for the climate, the environment and the economy www.hagel.at simak@hagel.at	The Johannes-Kepler-University in Linz carried out an investigation commissioned by the Austrian Hail Insurance (Österreichische Hagelversicherung) which for the first time quantified the positive effects on the environment and the Austrian economy with an increase of the demand for regional products. According to the survey, the import of eatables leads to expenses in environmental and climate protection programs amounting to 100 million euro. If, instead of that, ten percent more domestic eatables were consumed, 17.000 new jobs could be provided and - as a result of shorter itineraries - the environment could be protected substantially.
Preventive spatial planning against the consequential damages of natural disasters stanzer@oir.at	Based on the legal provisions of the spatial planning legislation of the Länder, the Austrian Institute for Regional Studies and Spatial Planning - ÖIR - and Regional Consulting make recommendations how to reduce potential damages and enforce preventive planning with respect to the optimal use of living space. The focus of the investigation was on the options available to avoid future flooding damages in built-up areas or areas zoned as building land.
Renewable raw materials in chemical industries herbert.boechzelt@joanneum.a	The study was carried out by JOANNEUM RESEARCH, surveying the chemical industry to give their opinion on the development status of new chemicals based on renewable raw materials. It shows perspectives for the orientation and development of research and possible ways of how to promotion them. The study was focused on Europe, especially Austria. Contracted by the Austrian ministry of transportation, innovation and technology
Risk assessment for European larch	European larch in high elevation forests is exposed to multiple stress exerted by ozone and changing climatic conditions. Criteria and indicators for larch will be developed and the

Friedl Herman; friedl.herman@bfw.gv.at	vulnerability of larch stands in mountain forests is investigated.
SHEMOS - Shell mobility scenarios 2035 gerd.sammer@boku.ac.at	The project was funded by Shell Austria and carried out by Institute for Transport Studies, University Bodenkultur, Vienna, Austria. Applying scenario techniques the objective of the study was to investigate possible routes towards a sustainable transport system in the area of Vienna by 2035.
Sustainable energy systems and Renewable Energy Technologies,	arsenal research develops innovative concepts for the integration of sustainable technologies into the energy supply of buildings, municipalities and regions. R & D activities concentrate on the use of solar radiation for the generation of heat and power. The safe integration of decentralised electric generators into public electricity-networks is crucial in order to guarantee high quality and safety of electricity supply also in the future.
The carbon sink strength of beech in a changing environment: Experimental risk assessment of mitigation by chronic ozone impact (Casiroz) 5th Framework Programme Gerhard Wieser; Gerhard.wieser@bfw.gv.at http://www.casiroz.de/	The carbon budget of beech forests is highly relevant for the assessment of the C sequestration in forest ecosystems. So far, the impact of ozone stress on C dynamics has been widely ignored. The project partners provide a mechanistic model for the interaction of C and ozone and will provide scenarios for the carbon storage which are valid for different levels of ambient ozone concentrations.
The European Hydrogen based Society http://www.hysociety.net Günter Simader, guenter.simader@energyagency.at	The main aim of this project is to provide European decision and policy makers how hydrogen technology should be implemented and improved within the Europe, in order to assess the energetic and environmental impact of such technology and making hydrogen a cost-effective energy carrier for utility, buildings and transportation applications on these countries.
Waste management relevant to Climate III – co-incineration of waste kanzlei.dr.hackl@aon.at	The Climate Strategy of the Austrian government contains an assumption that co-incineration of waste in industrial furnaces and boilers could mitigate about 500,000 t CO_2 per year. This assumption was checked with respect to the existing capacity of installations for combustion reflecting especially the technical possibilities to incinerate waste in these installations.

Appendix D

Systematic Observation and GCOS

Table D.1: Atmospheric observing systems for climate at the land surface ("Table S1"†)

Systems	*Climate Parameters** *(e.g. Temp. Precip.other)*	*Total # Stations*	*Appropriate for Characterizing National Climate? (tick one box)* Fully	Partly	No	*Time Series #stations/platforms (#Data Digitized)* 30-50y	50-100y	>100y	*Adequate Quality Control Procedures? (tick one box)* Fully	Partly	No	*Metadata available Total # Stations (% Digitized)*	*Continuity # expected operational in 2010*
Stations Useful for National	***[1)]Standard****	***68***	***X***			***42 (42)***	***20 (20)***	**6 (6)**	***X***			***68 (100)***	***68***
Climate Monitoring	***[2)]Temperature***	***590***	***X***			***60 (0)***	***115 (0)***	***235 (0)***	***X***			***559 (100)***	***590***
Purposes (Specify	***[2)]Precipitation***	***1090***	***X***			***95 (0)***	***185 (0)***	***325(0)***	***X***			***1090 (100)***	***1090***
parameters observed)*	***[2)]Potential Evaporation***	***50***	***X***						***X***			***50 (100)***	***50***
Stations Reporting Internationally	***[1)]Standard****	**80**				**8 (8)**				**X**			**80**
CLIMAT Reporting Stations	***[1)]Standard****	**10**					**4**	**6**	**X**				**10**
Reference Climate Stations	***[1)]Standard****	**2**						**2**	**X**			**2 (100)**	**2**

[1]) Responsible Institute: Central Institute for Meteorology and Geodynamics (ZAMG)
[2]) Responsible Institute: Hydrographic central office (HZB)
*Standard means, that at this stations at least the parameters temperature, humidity and precipitation are measured.

All stations are installed and maintained according to the WMO-recommendations. (WMO,1996)

† Table numbers S1–S10 relate to the *Supplementary Guidance to Parties on the Preparation of Detailed National Reports on Global Climate Observing Systems* prepared at an informal meeting of national GCOS co-ordinators in August 2000.

Table D.2: Available homogeneous data sets for meteorological land surface observations ("Table S2")

Data Set Name	*Climate Parameters*	*# Stations of Grid Resolution and Region covered*	Time Period	*References*
ALOCLIM	***Mean Temperature*** ***Min. Temperature*** ***Max. Temperature*** ***Precipitation*** ***Cloudiness*** ***Sunshine duration*** ***Relative Humidity*** ***Vapour pressure*** ***Pressure***	***43 Eastern Alps*** ***20 Eastern Alps*** ***20 Eastern Alps*** ***37 Eastern Alps*** ***18 Eastern Alps*** ***15 Eastern Alps*** ***19 Eastern Alps*** ***21 Eastern Alps*** ***17 Eastern Alps***	***≥1930 – 1998*** ***≥ 1930 – 1998*** ***≥1930 – 1998*** ***≥1927 – 1998*** ***≥1901 – 1998*** ***≥1934 – 1998*** ***≥1931 – 1998*** ***≥1931 – 1998*** ***≥1901 - 1998***	***Austrian Long-Term Climate – Multiple Instrumental Climate Series from Central Europe. 2001: I.Auer, R.Böhm, W.Schöner: Österreichische Beiträge zu Meteorologie und Geophysik 25: 1-147. Publ.Nr. 397. Zentralanstalt für Meteorologie und Geodynamik, Wien.***
ALPCLIM	***Temperature*** ***Precipitation (in preparation)***	***1 deg. (43 – 49 deg. north; 4 – 18 deg. east)*** ***1 deg. (43 – 49 deg. north; 4 – 18 deg. east)***	***≥1899 – 1998 (earliest 1760)*** ***≥1899 – 1998 (earliest 1837***	***Regional Temperature Variability in the European alps 1760 – 1998 from homogenized instrumental time series. 2001: R. Böhm, I. Auer,M Brunetti, M. Maugeri, T. Nanni, W. Schöner: International Journal of Climatology: 21: 1779-1801.***
HISTALP	***Temperature:*** ***low elev. grid01*** ***high elev. grid01***	***1 deg(4-19 degE , 43-49 deg N)***	*low elevation >= 1880 (earliest 1760),* *high elevation >=1901, earliest 1818*	***Auer I, Böhm R, Jurkovic A, Lipa W, Orlik A, Potzmann R, Schöner W, Ungersböck M, Matulla C, Briffa K, Jones PD, Efthymiadis D, Brunetti M, Nanni T, Maugeri M, Mercalli L, Mestre O, Moisselin J-M, Begert M, Müller-Westermeier G, Kveton V, Bochnicek O, Stastny P, Lapin M, Szalai S, Szentimrey T, Cegnar T, Dolinar M, Gajic-Capka M, Zaninovic K, Majstorovic Z, Nieplova E, (2005). HISTALP – Historical instrumental climatological surface time series of the greater Alpine region 1760-2003. International Journal of Climatology, submitted***
HISTALP	*CRSM: (Coarse Resolution Subregional Means)*	***4-19E, 43-49N*** ***NE (northeast)*** ***NW (northwest)*** ***SE (southeast)*** ***SW (southwest)*** ***H (high)*** ***L (low: NE,NW,SE,SW)*** ***N (north: NE,NW)*** ***S (south: SE, SW)*** ***W (west: NW, SW)*** ***E (east: NE,SE)***	***1767*** ***1760*** ***1767*** ***1760*** ***1818*** ***1767*** ***1767*** ***1767*** ***1760*** ***1767***	
	----------	**----------**	**----------**	
HISTALP	***air pressure:*** *CRSM:*	**4-19E, 43-49N)** **NE** **NW**	**1775** **1760**	

		SE	**1766**	
		SW	**1763**	
		H	**1864**	
		L	**1775**	
		N	**1775**	
		S	**1766**	
		W	**1763**	
		E	**1775**	
	----------	**----------**	**----------**	
HISTALP	**precipitation: low level grid01**	**1 deg(4-19E , 43-49 N)**	**>= 1880, earliest 1800**	***Auer I, Böhm R, Jurkovic A, Orlik A, Potzmann R, Schöner W, Ungersböck M, , Brunetti M, Nanni T, Maugeri M, Briffa K, Jones P, Efthymiadis D, Mestre O, Moisselin JM, Begert M, Brazdil R, Bochnicek O, Cegnar T, Gajic-Capka M, Zaninoviv K, Majstrrovic Z, Szalai S, Szentimrey T, Mercalli L, 2005: A new instrumental precipitation dataset for the Greater Alpine Region for the period 1800-2002. International Journal of Climatology. 25: 139-166***
HISTALP	CRSM:	**4-19E, 43-49N**		
		NE	**1800**	
		NW	**1800**	
		SE	**1800**	
		SW	**1800**	
		L	**1800**	
		N	**1800**	
		S	**1800**	
		W	**1800**	
		E	**1800**	
HISTALP	**HRSM mode:(High Resolution Subregional Means):**	**1/6 deg(4-19E, 43-49N)**	**earliest 1800**	***Efthymiadis D, Jones PD, Briffa K, Auer I, Böhm R, Schöner W, Frei C, Schmidli J. 2005.. Construction of a 10-min-gridded precipitation dataset for the Greater Alpine Region 1800-2003. Journal of Geophysical Research, accepted.***
	----------	**----------**	**----------**	
HISTALP	**bright sunshine, CRSM**	**4-19E, 43-49N**		
		NE	**1880**	
		NW	**1881**	
		SE	**1884**	
		SW	**1886**	
		H	**1884**	
		L	**1886**	
		N	**1881**	
		S	**1886**	
		W	**1886**	
		E	**1884**	
	----------	**----------**	**----------**	
HISTALP	**cloudiness CRSM**	**4-19E, 43-49N**		
		NE	**1842**	
		NW	**1864**	

		SE	1858	
		SW	1858	
		H	1878	
		L	1864	
		N	1864	
		S	1858	
			1864	
		W	1858	
	----------	E	----------	
HISTALP	relative humidity CRSM	----------		
		4-19E, 43-49N	1860	
		NE	1874	
		NW	1860*	
		SE	1887	
		H	1874	
	----------	N	----------	
HISTALP	vapour pressure, CRSM	----------		
		4-19E, 43-49N	1837	
		NE	1874	
		NW	1845	
			1881	
		SE	1874	
		H		
		N		

Table D.3: Atmospheric observing systems for climate above the surface ("Table S3")

Systems Useful for National Climate Monitoring Purposes	*Total # Stations or platforms*	*Appropriate for Characterizing National Climate? (tick one box)* Fully	Partly	No	*Time Series #stations/platforms (#Data Digitized)* 5-10y	10-30y	30-50y	>50y	*Adequate Quality Control Procedures? (tick one box)* Fully	Partly	No	*Metadata available Total # Stations (% Digitized)*	*Continuity # expected operational in 2010*
Radiosonde stations	**4**	**x**				**3**	**1**		**x**			**x**	**x**
Stations reporting Internationally	**4**												
CLIMAT TEMP reporting stations	**1**												
*Profilers**	**3**								**x**			**3**	**3**

Table D.4 Available homogeneous data sets for meteorological upper air observations ("Table S4")

Climate Parameter	*# Stations or Grid Resolution and Region covered*	*Time Period*	*References*
Temperature, Relative humidity and wind at pressure level	**1 (Vienna)**	**1951-2002**	**http://homepage.univie.ac.at/christian.haeberli/techdocu.htm**

Table D.5 Atmospheric constituent observing systems for climate ("Table S5")

Constituent	*Total # Stations or platforms*	*Appropriate for Characterizing National Climate? (tick one box)*			*Time Series #stations/platforms (#Data Digitized)*				*Adequate Quality Control Procedures? (tick one box)*			*Metadata available Total # Stations (% Digitized)*	*Continuity # expected operational in 2010*
		Fully	*Partly*	*No*	*10-20y*	*20-30y*	*30-50y*	*>50y*	*Fully*	*Partly*	*No*		
Carbon dioxide	***1***	***X***							***X***			***1(100)***	***1***
Ozone (surface)	***115***	***X***			***115***				***X***			***115(100)***	***115***
*Ozone (column)**	***1***	***X***			***1***				***X***			***1(100)***	***1***
*Ozone (profile)**	***1***	***X***			***1***				***X***			***1(100)***	***1***
Atmospheric Water Vapor =Relative Humidity	***156***	***X***			***156***				***X***			***156(100)***	***156***
SO2	***122***	**x**			**3**							**122(100)**	**122**
SO4 particulate	***1***		**X**			**1**			**X**			**1 (1)**	**1**
NO3, NH4 particulate	**1**		**X**						**X**			**1 (1)**	**1**

The measurements of atmospheric constituents are in the responsibility of the nine province governments and are gathered and published by the Federal Environment Agency. * measured by University.

Table D.6 Available homogeneous data sets for atmospheric constituents ("Table S6")

Data Set Name	*Constituent*	*# Stations of Grid Resolution and Region covered*	*Time Period*	*References*
-	*Carbon dioxide*	*1 station Austria*	*1999-*	*http://www.umweltbundesamt.at/umweltschutz/luft/luftguete_aktuell/jahresberichte/*
-	*Ozone*	*8 stations Austria*	*1990-*	*http://www.umweltbundesamt.at/umweltschutz/luft/luftguete_aktuell/jahresberichte/*
-	*Water Vapor*	*7 station Austria*	*1990-*	*http://www.umweltbundesamt.at/umweltschutz/luft/luftguete_aktuell/jahresberichte/*
-	*Other Greenhouse Gases*	*1 station Austria*	*2003-*	*http://www.umweltbundesamt.at/umweltschutz/luft/luftguete_aktuell/jahresberichte/*

Table D.7 Terrestrial observing systems for climate ("Table S9")

Systems Useful for National Climate Monitoring	*Total # Stations*	*Appropriate for Characterizing National Climate? (tick one box)*			*Time Series #stations/platforms (#Data Digitized)*			*Adequate Quality Control Procedures? (tick one box)*			*Metadata available Total # Stations (% Digitized)*	*Continuity # expected operational in 2010*
		Fully	*Partly*	*No*	*30-50y*	*50-100y*	*>100y*	*Fully*	*Partly*	*No*		
River Discharge[2] *(Streamflow Gauges)*	**554**	**X**			**100 (100)**	**130 (100)**	**70 (0)**	**X**			**600 (100)**	**560**
Ground Water Storage[2] *(e.g. Boreholes)*	**2793**	**X**			**753 (0)**	**175 (0)**	**4 (0)**	**X**			**2800 (100)**	**2800**
Snow [1)2)] Snow depth	**939**	**X**			**146 (75)**	**180 (2)**	**310 (0))**	**X**			**825(100)**	**825**
Glaciers [3] Lenght variation	**~ 100**	**X**					**All(100)**	**X**			**All (100)**	**~ 100**
Glaciers [3] *mass balance*	**9**		**X**					**X**			**9(100)**	**9**
Permafrost [3] Ground temperature	**4**		**X**						**X**		**4(100)**	**4**
FluxNet3[3] CO2 and H2O	**4**		**X**						**X**		**4(100)**	**4**
Radiation [1] *Global radiation*	**100**	**X**				**1(1)**			**X**		**100(100)**	**100**
Soil [1] Soil temperature	**100**		**X**			**1(1)**			**X**		**100(100)**	**100**

Measurements performed by the 1) Central Institute for Meteorology and Geodynamics, the 2) Hydrographic Central Office and 3) several universities and associations.

Table D.8: Ecological observing systems for climate ("Table S10")

Systems useful for national climate monitoring	*Total # stations*	*Appropriate for Characterizing National Climate? (tick one box)*			*Time Series #stations/platforms (#Data Digitized)*				*Adequate Quality Control procedures? (tick one box)*			*Metadata available Total # Stations (% Digitized)*	*Continuity # expected operational in 2010*
		Fully	*Partly*	*No*	*30-50y*	*50-100y*	*100-300y*	*>300y*	*Fully*	*Partly*	*No*		
Phenological [1)2)]	**282**		**X**		**282**					**X**		**2**	**90**
Biomass Change[1)2)]	***82***		***X***		***75***				***X***			***80***	**15**
Vegetation Type [1)2)]	**82**		**X**		**75**				**X**			**80**	**15**
Land Cover [1)2)]	**27**		**X**		**20**				**X**			**20**	**10**
Land Use Change [1)2)]	**20**		**X**		**20**				**X**			**25**	**15**
PaleoClimate [1)]	**5**		**X**				**1**	**4**	**X**			**1(100**	**5**

Measurements performed by the 1) Central Institute for Meteorology and Geodynamics and the 2) Umweltbundesamt.

Tab. D.9 Examples of data collection, monitoring and systematic observation, including data banks.

Austrian Glacier Inventory http://www2.uibk.ac.at/meteo/ Michael.Kuhn@uibk.ac.at	From aerial photography in 1997 and 98 digital elevation models and ortho-photo maps of all Austrian glaciers have been produced. A new photogrammetric evaluation of the 1969 inventory serves as base for an analysis of climate changes.
Austrian Forest Inventory Klemens Schadauer; klemens.schadauer@bfw.gv.at http://bfw.ac.at/rz/bfwcms.web?dok=35	Reporting the carbon stocks and stock changes in terrestrial ecosystems relies on the provision of accurate data on forest biomass, because forest ecosystems are the largest carbon pool in terrestrial ecosystems.
Austrian Network for Isotopes in Precipitation (ANIP). Wolfgang Papesch, wolfgang.papesch@arcs.ac.at	The aim of the Austrian Network for Isotopes in Precipitation (ANIP) is to provide input data for hydrological and hydrogeological investigations and to serve as a data-base for climatological changes and trends in sensitive Alpine areas. 71 stations are presently sampled all over Austria with some preference given to the Karst areas north and south of the Alpine mountain range. The network is jointly run by the Austrian Research Centers Seibersdorf and the Austrian Environment Agency. The precipitation is collected on a daily basis in ombrometers (500 cm2) and mixed to monthly samples at stations ranging from 120 to 2250 m in altitude.
Development of Operational Monitoring Systems for European Glacial Areas (OMEGA) http://www.omega.utu.fi Michael.Kuhn@uibk.ac.at	A complete set of records and observations, annual ice velocities and length of Hintereisferner since 1894, mass balance records since 1952, climate records, maps and photographic documentation. Annual laser scans of the glacier surface are being processed.
DisAlp Johannes.huebl@boku.ac.at	In the course of the DisAlp project (www.dis-alp.org) an improved field-documentation tool for natural hazards is developed in order to harmonise the information basis and make it more easily accessible. Detection of possible changes and trends of magnitude and frequency of occurrence of extreme events in the context of climate change on a European level is eased
Emission Inventory for the Agricultural Sector in Austria (Manure Management) barbara.amon@boku.ac.at; katharina.hopfner-sixt@boku.ac.at	An improved emission inventory for the Agricultural sector in Austria was compiled by the Division of Agricultural Engineering and by ARC Seibersdorf research GmbH for the years 1980 - 2001. Emission estimates followed the IPCC and CORINAIR guidelines. Uncertainties were quantified. The inventory quantifies emissions and shows key driving factors. Where ever possible, emissions were estimated with Austrian specific emission factors and activity data. Possibilities for future

	inventory improvements are described.
Glacier Mass Balance Measurements on Hintereisferner, Kesselwandferner and Jamtalferner http://www2.uibk.ac.at/meteo/ Michael.Kuhn@uibk.ac.at	Long term glacier mass balance measurements are carried out by the Institute for Meteorology and Geophysics in cooperation with Hydrographischer Dienst des Landes Tirol. On Hintereisferner, a glacier monitoring system consisting of two energy balance stations and a webcam is operating since August 2003.
GMES products & services, integrating EO monitoring capacities to support the implementation of European directives and policies related to “land cover and vegetation” (GEOLAND) Wolfgang Wagner, ww@ipf.tuwien.ac.at	GEOLAND aims to provide geo-information products and services to support the European Global Monitoring for Environment and Security (GMES) programme. GEOLAND utilises available Earth Observation resources, and integrates them with existing models into pre-operational end-user applications. The tasks of TU Wien within this European project to provide global remotely sensed soil moisture products to support yield and drought monitoring activities.
Historical information on natural hazards Johannes.huebl@boku.ac.at	Especially in the field of natural hazards in alpine region, insufficient database (i.e. short term data rows) complicates identification of long term trends and assessment of possible consequences. The data of a chronicle of natural disasters in Vorarlberg and Tyrol / South Tyrol, containing information from early mediaeval time until 1891, as well as other local sources are gathered, edited and analysed regarding frequency, return interval, and event magnitude. By qualitative climate reconstruction the data can be interpreted in a long term context.
Ice Flow Velocity Measurements on Hintereisferner and Kesselwandferner http://www2.uibk.ac.at/meteo/ Michael.Kuhn@uibk.ac.at	On Hintereisferner, the surface profile and ice flow velocity is measured every year in a cross profile on the glacier tongue. On Kesselwandferner, surface elevation, ice flow velocity and ablation are measured every year in several cross profiles and along the central flow line.

INTEGRAL - Interferometric Evaluation of Glacier Rheology and Alterations http://dib.joanneum.at/ aleksey.sharov@joanneum.at	The general objective of the INTEGRAL initiative is to promote an advanced observation technology for the unsupervised detection, precise measurement and variation analysis of ice motion / deformation on large European glaciers under currently changing climatic conditions. The technology will be based on the complementary use of radar interferometry and interferometric altimetry, and will support natural exploration, social-economic activities and subsequent surveys in the nival environment with equivalent rheological models and appropriate information on the glacier regime in the form of new value-added INSAR products. Our polar idea is to enhance the detailedness, accuracy, integrity and versatility of glacier interferometric models yet without involving complex process artifices and to demonstrate new utilities of differential radar interferometry to operational users working with SAR data from post-operational, operational and upcoming systems such as E-SAR, ERS-1/2, SRTM, ENVISAT, RADARSAT-1, 2, 3, ALOS and CRYOSAT.
Integrating Techniques, Scenarios and Strategies to Mitigate Global Change Impact on the Hydrological Cycle (GLOWA Danube) http://www.glowa-danube.de Michael.Kuhn@uibk.ac.at	The subproject Glaciology treats storage and runoff from snow and ice in a 1 km^2 grid of Danube and Inn at Passau.
Long term changes and climatology of UV radiation over Europe weihs@mail.boku.ac.at	Reconstruction of the UV intensity of the last 50 years, detection of UV trends.
MEDEA http://www.umweltbundesamt.at/umwelt/medea/	The Umweltbundesamt is establishing a data information system for meteorological extreme events which aims at providing a central access for researchers and stakeholders in the field of climate change and meteorology and planning.
METEORISK – Mitigation of Meteorological Risks in the Alps http://www.meteorisk.info m.staudinger@zamg.ac.at	Optimisation of the collaboration of weather services in the Alps by creating online access to data from automatic weather stations for the participating services, direct exchange of forecaster know how in cases of extreme weather situations with the help of GIS tools and creating a data bank of more than 2000 stations for statistical evaluation of extreme events of parameters like snow height, new snow, precipitation etc..
Monitoring stratospheric ozone and UV radiation on the mountain Hoher Sonnblick (3106 m)	The investigation of effects of the change of the stratospheric ozone layer on the incident UV radiation

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Multi-Sensor Concepts for Greenhouse Gas Accounting of Northern Eurasia (SIBERIA II) Wolfgang Wagner, ww@ipf.tuwien.ac.at	The overall objective of SIBERIA-II is to demonstrate the viability of full carbon accounting over a 200 million ha large region in Siberia. The tools and systems to be employed include a selected yet spectrally and temporally diverse set of multi-sensor Earth Observation instruments, detailed existing databases of field information and some of the worlds most advanced climate models to account for fluxes between land and atmosphere. The tasks of TU Wien within this European project are to provide indicators of thawing dates and maps of open water bodies, respectively wetland classifications.
Preparatory signal detection for the EU Member States under EU burden sharing—Advanced monitoring including uncertainty (1990–2001; 1990–2002; …) http://www.iiasa.ac.at/Publications/Documents/IR-04-029.pdf; http://www.iiasa.ac.at/Publications/Documents/IR-04-024.pdf. jonas@iiasa.ac.at	Annual IIASA Interim Reports that advance the reporting of the annual greenhouse gas emission inventories of the European Union. The emission changes (termed emission signals) of the EU Member states and of the EU as a whole are confronted with their underlying uncertainties and are re-evaluated in terms of signal detectability and the risk of not complying with agreed-upon emission limitations and reductions.
QualiMET Austria http://www.ebp.de/geschaeftsbereiche/information/projekte/165/ http://www.cosis.net/abstracts/EMS04/00129/EMS04-J-00129.pdf wolfgang.lipa@zamg.ac.at roland.potzmann@zamg.ac.at	Multi-functional data monitoring and data quality control system, based on the software development of the German Weather Service (DWD) and the software company Ernst Basler and Partners
Reconstruction of water level fluctuations of the river Lech using tree rings Walter.Oberhuber@uibk.ac.at	Ring width chronologies of Pinus sylvestris growing on alluvial terraces of the river Lech will be developed to reconstruct water level fluctuations for the last c. 200 years. Furthermore, the agreement between radial growth and the North Atlantic oscillation (NAO) will be evaluated. This study will contribute to a better understanding of the natural hydrological variability within an inner alpine valley.
SNOW TRANS Transformation of observed and computed ice- and snowmelt data to ungauged basins	High quality glaciological and hydrological measurements in the Sonnblick region (Hohe Tauern) are used for calibration and improvement of a distributed precipitation-discharge model (PREVAH from ETH-Zürich). Validation of model results is done by both ground truth as well as satellite

wolfgang.scheoner@zamg.ac.at	data. The experiences from model experiments are transformed to ungauged basins for better modelling of snow- and ice melt processes.
Terrestrial 3D laser scanning for terrain monitoring www.joanneum.at/en/elektronik_sensorik/projekte_detail.php?p_iid=DIB&p_pid=350 www.joanneum.at/en/elektronik_sensorik/projekte_detail.php?p_iid=DIB&p_pid=352 DI Arnold Bauer, arnold.bauer@joanneum.at	Long range terrestrial 3D laser scanners (TLS) have developed into an essential component of terrain monitoring in the past few years. TLS systems are well qualified for the survey of terrain to be at risk (e.g. instable slopes, landslides, rockslides, or areas exposed to avalanches) and (rock) glacier surfaces. The measurement system is able to automatically monitor slope changes and movements incorporating accurate 3D terrain models. Several measurement campaigns (Pasterze glacier, Gößnitzkees, Langtal rock glacier, Arlberg snow cover monitoring, Eiblschrofen and Gries rock fall) show that TLS is a valuable sensing method for evaluation of short and long-term changes.
Testing of Novel Earth Observation Systems for Supporting Quality Control Activities required by the Kyoto Protocol (NEOS-QUICK) Wolfgang Wagner, ww@ipf.tuwien.ac.at	The project investigated how remote sensing can be utilised to support the reporting and verification of Land Use, Land Use Change and Forestry (LULUCF) activities in Austria within the framework of the Kyoto Protocol. It was shown that airborne photography and high-resolution satellite imagery can be used for mapping forest areas according to specifications as required by the Kyoto Protocol. For mapping biomass airborne laser scanning has been found to be the most promising remote sensing technique.
The relationship between air temperature and stable isotopes of Antarctic snow and ice http://www2.uibk.ac.at/meteo/research/polarmeteorology/index.html Elisabeth.Schlosser@uibk.ac.at	The relationship between air temperature and stable isotopes of snow and ice is investigated using meteorological and glaciological data from the German Antarctic wintering base Neumayer. The study aims at a better understanding of the involved processes, especially the meteorological conditions during precipitation formation and moisture transport, and thus a more reliable interpretation of ice core data for paleoclimatological purposes.
The response of Arctic Ice Masses to Climate Change Modelling, Remote Sensing and Field Measurements (ICEMASS) http://meteo9.uibk.ac.at/IceClim/finprojects.html friedrich.obleitner@uibk.ac.at	Long-term monitoring of Kongsvegen glacier (Spitzbergen), aiming on investigation of the mass- and energy budget of the glacier with special emphasis on internal accumulation (super imposed ice), starting 2000
UV-B monitoring at Sonnblick as a part of UV-B monitoring network of Austria mariao.blumthaler@uibk.ac.at stana.simic@boku.ac.at	The Austrian UV-B monitoring network provides public information of UV-B irradiance.

weihs@mail.boku.ac.at	
WURTEN wolfgang.scheoner@zamg.ac.at	Glacier mass balance monitoring (ongoing since 1982) of Wurtenkees in the Hohe Tauern region. Mass balances derived according to the “glaciological method” through field measuring campaigns twice a year for winter-balance (Oct-Apr) and summer balance (May to Sep).

Appendix E

Abbreviations, Terms and Units of Measurement

Abbreviations and Terms

ACCC	Austrian Council on Climate Change
CDM	Clean Development Mechanism
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
CRF	Common Reporting Format
ECE (UN)	Economic Commission for Europe
ETS	Emissions Trading Scheme
EU	European Union
EUR	Euro
FCCC (UN)	Framework Convention on Climate Change
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
HFCs	hydrogenated fluorocarbons
ICAO	International Civil Aviation Organisation
IEA	International Energy Agency
IER	Austrian Institute of Economic Research (WIFO)
IGBP	International Geosphere-Biosphere Program
IHDP	International Human Dimensions Program (of Global Env. Change)
IIASA	International Institute for Applied Systems Analyses
IPCC	Intergovernmental Panel on Climate Change
JI	Joint Implementation
Land	Federal Province of Austria
Länder	Federal Provinces of Austria
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
PFCs	perflourocarbons
UNEP	United Nations Environment Program
US $	United States Dollar
VAT	value added tax
VOC	volatile organic compounds
WCRP	World Climate Research Program
WIFO	see IER
WMO	World Meteorological Organisation
WWW	World Weather Watch / World Wide Web

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