FIFTH NATIONAL COMMUNICATION
of the Austrian Federal Government

in Compliance with the Obligations under the
United Nations Framework Convention on Climate Change,
according to Decisions 10/CP.13 and 4/CP.5
of the Conference of the Parties,
and in Compliance with the Obligations under the Kyoto Protocol,
according to Decisions 8/CMP.3 and 15/CMP.1
of the Conference of the Parties
serving as the meeting of the Parties to the Kyoto Protocol

The Fifth 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, Christopher Lamport and Angela Friedrich). The *Umweltbundesamt* (Melanie Sporer, Barbara Muik and Manfred Ritter) has elaborated the chapter on policies and measures and emission projections. 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). Further contributions have been provided by units of the Federal Ministry of Agriculture, Forestry, Environment and Water Management, by the Federal Ministry of Education, Science and Culture, by several Länder 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 autumn 2009 and in the meeting of the IMC Climate on 26 November 2009.

The Austrian Council of Ministers took official notice of this report on 16 February 2010.

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Chapter 1

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, its Third National Communication in November 2001 and its Fourth National Communication in October 2006. This document is Austria's Fifth 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 after the ratification of the Convention 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. An increase of more than 1 °C in average temperature has been observed during the last century. 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 (*Länder*), 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 8.32 million inhabitants in 2007; after stagnation in the early 1980ies this represents an increase of more than

700,000 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 € 271 billion in the year 2007 with a growth of 5.3 % in that year; per capita GDP was € 32,570. The largest contribution to Austria's GDP with almost two third comes from the tertiary production, the rest is contributed mainly by secondary production. Gross value added of manufacturing industries (at constant prices) showed an increase of 51 % from 1995 to 2007. The Austrian energy profile shows a high share of renewable energy with about one quarter of total gross energy consumption, contributed mainly by biomass and hydropower. With a gross domestic consumption per capita of 171 MJ and a final energy consumption per capita of 130 MJ respectively in 2007 Austria belongs to the countries with low energy consumption among industrialised countries. Regarding the development of final energy consumption since 1990 the transport sector exhibits by far the strongest increase; however, the amount of road fuel that is sold in Austria but consumed abroad ("fuel export in the vehicle tank", the so called "fuel tourism") has become a significant reason for that increase in the last years.

1.3 Greenhouse Gas Inventory Information

The Fifth National Communication lists Austria's greenhouse gas emissions as reported in the annual inventory submission from April 2009. 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 1990–2007. 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 87.96 Tg (i. e. million tons) CO_2 equivalent in the year 2007. The emissions of CO_2 clearly dominate the GHG emissions in Austria with 74.18 Tg or 84 % compared to 8 % 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 (28 %)
- 1A2: Manufacturing Industries and Construction (18 %)
- 1A1: Energy Industries (17 %)
- 1A4: Other Sectors (13 %)
- 2: Industrial Processes (11 %)
- 4: Agriculture (9 %).
- 6: Waste (2 %)

CO_2 emissions per capita amounted to 8.9 t in 2007 and total greenhouse gas emissions per capita to 10.6 t CO_2 equivalent.

Total greenhouse gas emissions in 2007 were about 9 Tg or 11 % above the 1990 base year emissions. The increase in emissions is caused mainly by the 19 % increase in the sector “Energy”, which could not be compensated by the steady decline in the sectors “Waste“ and “Agriculture” (cf. Fig. 1.1). The most important single contributions to emissions growth from 1990 to 2007 came from road transport and steel production. Road fuel export in the vehicle tank resulted in a more than 6 Tg increase and further 3.6 Tg were caused by the growing inland road transport demand. Emissions from iron and steel production (fuel combustion and processes) rose by 3.2 Tg (or less than 40 %) due to a production increase of about 80 %.

Table 1.1: Austrian GHG emissions 1990 and 2007, in Tg CO_2 equivalent

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	1990					2007				
	CO_2	CH_4	N_2O	F-Gases	Total	CO_2	CH_4	N_2O	F-Gases	Total
Total without LULUCF	**62.08**	**9.18**	**6.17**	**1.60**	**79.04**	**74.18**	**6.96**	**5.37**	**1.45**	**87.96**
Total with LULUCF	**48.65**	**9.18**	**6.42**	**1.60**	**65.86**	**56.78**	**6.96**	**5.65**	**1.45**	**70.84**
1. Energy	**54.20**	**0.85**	**0.55**		**55.59**	**64.38**	**1.02**	**0.75**		**66.15**
A. Fuel Combustion (Sectoral Approach)	54.09	0.46	0.55		55.11	64.14	0.31	0.75		65.20
1. Energy Industries	13.79	0.00	0.05		13.84	13.93	0.01	0.08		14.01
2. Manufacturing Industries and Construct.	12.69	0.01	0.08		12.77	15.67	0.01	0.14		15.82
3. Transport	13.77	0.06	0.19		14.02	23.92	0.02	0.28		24.22
4. Other Sectors	13.81	0.39	0.23		14.43	10.58	0.27	0.25		11.10
5. Other	0.04	0.00	0.00		0.04	0.04	0.00	0.00		0.05
B. Fugitive Emissions from Fuels	0.10	0.38	IE,NA		0.49	0.24	0.71	IE,NA		0.94
2. Industrial Processes	**7.58**	**0.01**	**0.91**	**1.60**	**10.11**	**9.54**	**0.02**	**0.27**	**1.45**	**11.28**
3. Solvent and Other Product Use	**0.28**		**0.23**		**0.51**	**0.25**		**0.16**		**0.41**
4. Agriculture		**4.83**	**4.34**		**9.17**		**4.11**	**3.84**		**7.95**
5. Land Use, Land-Use Change and Forestry	**-13.43**	**0.00**	**0.25**		**-13.18**	**-17.40**	**0.00**	**0.27**		**-17.12**
6. Waste	**0.03**	**3.49**	**0.13**		**3.65**	**0.01**	**1.81**	**0.35**		**2.18**

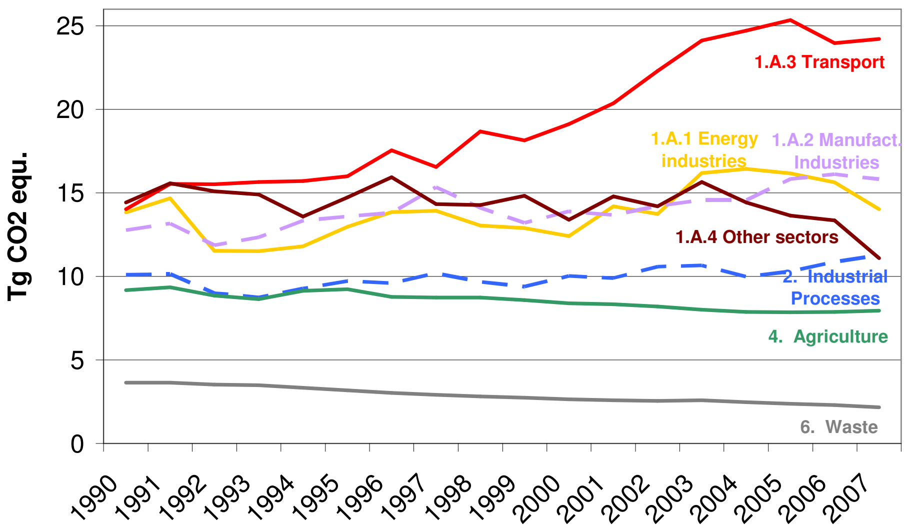


Figure 1.1: GHG emission, split by sector

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 mitigation programme – the Climate Strategy – was adopted in 2002 and, after a comprehensive evaluation process, amended in 2007. Most *Länder* have adopted their own regional climate change programmes, taking into account specific regional circumstances and areas of competence. The legislative arrangements for the implementation of the national Climate Strategy are quite different for the individual elements of the strategy; some important elements are laws relating to the European Emissions Trading Scheme and to JI/CDM.

A series of important measures has been implemented over the past years. With respect to residential energy demand, policies and measures aim at increased energy efficiency in space heating and hot water preparation and lower electricity demand as well as the use of energy sources that are less carbon-intensive, for example by improving technical minimum standards and support schemes for energy efficient construction of buildings as well as by providing subsidies for biomass and solar space heating systems and for the thermal rehabilitation of building. In the energy supply sector, measures to increase the share of renewable energy sources in electricity production (Green Electricity Act) and to promote district heating from renewable energy sources have been implemented. Emission trading is the stimulus with highest relevance for emission reduction in conventional power plants. Emissions in the waste sector have been significantly reduced by the reduced total organic carbon content of waste fractions disposed to landfills and by the collection of landfill gas.

Measures in the transport sector range from CO_2 related tax incentives and increased use of bio fuels to awareness-raising and support of programmes for sustainable mobility. Subsidies are provided for energy efficiency measures and use of renewable energy sources in industry. About 200 energy intensive installations from manufacturing and energy industries are covered by the EU emissions trading scheme, which entered into effect in 2005. The use of fluorinated gases has been restricted by law. Support for sustainable agriculture and organic farming is granted.

1.5 Projections and the Total Effect of Policies and Measures

Up to date national greenhouse gas (GHG) emission projections have been developed in 2008/2009. The ‘with measures’ scenario comprises climate change mitigation measures that were implemented and adopted under the Austrian Climate Strategy and its amendment before August 2008. The ‘with additional measures’ scenario also takes into account planned policies and measures with a realistic chance of being adopted and implemented in the near future.

The emission calculations have been performed by the Umweltbundesamt. The underlying sectoral forecasts of activities are based on the use of various models and methods and have been carried out in close collaboration with several institutions. The calculations show an increase of GHG emissions in the 'with measures' scenario from 2006 to 2020 of about 7 %. Additional measures will lead to a 2 % decrease from 2006 to 2020. Table 1.2 and Figure 1.2 give an overview of the expected development.

Table 1.2: Projected greenhouse gas emissions 2005–2020 in Tg (million tons) CO_2 equ.

	Emissions					With Measures			With Additional Measures		
	1990	1995	2000	2006	2007	2010	2015	2020	2010	2015	2020
Total	79.04	80.51	81.08	92.83	87.96	93.87	95.47	98.11	92.87	91.58	89.61

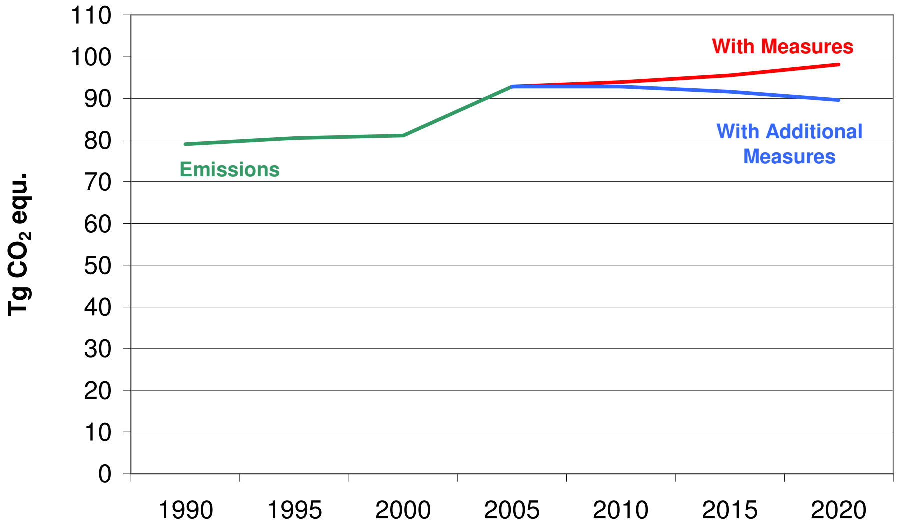


Figure 1.2: Projected greenhouse gas emissions in Austria

The impact of the current economic crisis is not reflected in the presented emission projections and therefore the projections are systematically biased towards an overestimation. When comparing the current emission scenarios for certain years with the Kyoto Protocol target and the Austrian target of -13 % under the EU burden sharing agreement, the use of carbon sinks (estimated to equal -0.7 Tg CO_2 equivalents), the Kyoto mechanisms JI/CDM (currently intended annual government use -9 Tg CO_2 equivalents) and the allocated emissions according to the national allocation plan in the European Emissions Trading Scheme (purchases by the government for the flexible reserve for new entrants and by the companies in the commitment period, estimated to equal -3.1 Tg CO_2 equivalents) have to be taken into account. Altogether 12.8 Tg CO_2 equivalents have to be subtracted from the actual projections. The resulting gap is meant to be closed by the forceful implementation of additional measures.

The aggregate effect of *implemented and adopted* policies and measures, which are listed in Chapter 4 of this report, is estimated at about 18 Tg CO_2 equivalent for the year 2010 and 35 Tg for 2020. The effect of planned measures is about 1 Tg for the year 2010 and more than 8 Tg for 2020. Austria's efforts to make use of the Kyoto Protocol flexible instruments are supplemental to domestic efforts.

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.

Model results let expect 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, but a decrease of annual amount of rainfall only in the flat basins of southern and eastern Austria. 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. Changes in intensity and frequency of precipitation, temperature increase, glacier retreat and degradation of mountain permafrost can 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.

In the past adaptation measures were either motivated by impacts of observed climate change, like artificial snow making facilities in skiing resorts or construction of irrigation channels or they have climate change adaptation as a co-benefit, as the measures for the reduction of natural hazards (avalanche, erosion and torrent control).

The development of a comprehensive national adaptation strategy has been initiated in 2007. Based on a study describing existing adaptation measures, climate projections, vulnerability assessments and a portfolio of first recommendations for additional adaptation actions, a participatory process has been started together with the relevant stakeholders. Currently the sectors agriculture, forestry, water management, tourism and electricity industry are covered. An expansion to further vulnerable sectors will be considered in the near future.

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 2005 to 2008, Austria provided about US$ 30 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. 2008 total ODA of Austria amounted to US$ 1,714 million. Roughly 70% qualified as bilateral ODA, LDCs received about 10 % thereof. 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.

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 and energy efficiency.

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.

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 3,106 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. A national *Strategy for Education for Sustainable Development* passed the Austrian Council of Ministers in 2008. Awareness of climate issues in schools is strengthened by various initiatives at Federation and *Länder* level, e. g. by competitions and workshops. Austria also plays an active role in the OECD/CERI network "Environment and School Initiatives" and participates in network projects at EU level.

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 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. Related programmes directed especially at small and medium enterprises exist in many *Länder*. The Federal Ministry of Agriculture and Forestry, Environment and Water Management has 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 and further institutions.

There is substantial public awareness on climate change issues in Austria. Campaigns and initiatives are organised and funded by the Federal Government 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 about 1,500 European local authorities and indigenous rain-forest peoples with the goal of protecting the earth's atmosphere. In Austria more than 700 municipalities and all *Länder* as well as a considerable number of companies and schools 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 D1

Zusammenfassung

CONTENTS

D1.1 Einleitung

Im Rahmen der Konferenz der Vereinten Nationen über Umwelt und Entwicklung (UNCED), die im Juni 1992 in Rio abgehalten wurde, haben 158 Staaten, darunter Österreich, das Rahmenübereinkommen über Klimaänderungen (UNFCCC) unterzeichnet. Österreich hat das UN Rahmenübereinkommen über Klimaänderungen am 28. Februar 1994 als 58. Staat ratifiziert.

Die Vertragsparteien sind verpflichtet, ihre Aktivitäten, die sie hinsichtlich der Einhaltung der Verpflichtungen aus dem Rahmenübereinkommen durchführen, in Form von nationalen Berichten darzustellen. Die Berichtspflicht umfasst unter anderem folgende Themen: Information über Treibhausgasinventuren, Maßnahmen zur Verringerung der Treibhausgasemissionen und zur Bekämpfung von nachteiligen Auswirkungen von Klimaänderungen; Maßnahmen zur Förderung von Forschung und systematischer Beobachtung, die finanzielle Unterstützung von Entwicklungsländern und Initiativen zur Verstärkung des Technologietransfers zwischen Vertragsstaaten, sowie Maßnahmen zur Förderung von Bildung und öffentlichem Bewusstsein im Hinblick auf den Klimawandel.

Österreich hat die erste Nationale Mitteilung im September 1994 übermittelt, die zweite im Juli 1997, die dritte im November 2001 und die vierte im Oktober 2006. Das vorliegende Dokumente ist Österreichs fünfte Nationale Mitteilung, mit der Österreich seiner Verpflichtung zur Informationsübermittlung an das Sekretariat der UNFCCC gemäß Art. 12 des Übereinkommens nachkommt.

Die wohl bedeutendste Entwicklung nach der Ratifikation des Übereinkommens war das Protokoll von Kyoto zum Rahmenübereinkommen über Klimaänderungen, das konkrete Ziele zur Reduktion der Treibhausgasemissionen für die im Annex I enthaltenen Vertragsparteien enthält. Österreich hat das Kyoto-Protokoll im April 1998 unterzeichnet and am 31 May 2002 als einer der 15 EU-Mitgliedsstaaten ratifiziert. Die Mitgliedstaaten der Europäischen Union sind übereingekommen, ihre Verpflichtungen unter dem Kyoto-Protokoll gemäß Art. 4 des Protokolls gemeinsam zu erfüllen. Die vorliegende Mitteilung dient auch zur Erfüllung der Berichtspflichten nach Artikel 7.2 des Kyoto-Protokolls.

D1.2 Nationale Rahmenbedingungen

Österreich ist ein Binnenland inmitten Europas. Seine Fläche beträgt 83.858 km^2, ein großer Teil davon wird von den Ostalpen eingenommen: Rund 40 % der Gesamtfläche liegen höher als 1000 m über dem Meeresspiegel. Im letzten Jahrhundert ist die durchschnittliche Temperatur um mehr als 1°C angestiegen. Wälder bedecken mehr als 40 % des Gebiets; die landwirtschaftliche Nutzfläche, einschließlich Almen, hat einen vergleichbaren Anteil an der Gesamtfläche. Österreich ist ein Bundesstaat mit 9 Bundesländern, von denen jedes eine Landesregierung und einen Landtag besitzt. Die Regierungsaufgaben werden zwischen Bund, Ländern und Gemeinden geteilt. Österreich hat mit seinem Beitritt zur Europäischen Union im Jahr 1995 einen Teil seiner nationalstaatlichen Kompetenzen an die Union abgetreten.

Im Jahr 2007 belief sich die ständige Bevölkerung Österreichs auf 8,32 Millionen Einwohner. Nach einer Stagnation in den 80er-Jahren des 20. Jahrhunderts ist die Bevölkerung damit seit 1985 um mehr als 700.000 gewachsen. Weniger als ein Drittel der Bevölkerung lebt in fünf Städten mit jeweils über 100.000 Einwohnern, etwa die Hälfte in Gemeinden mit einer Größe zwischen 1.000 und 10.000 Einwohnern.

Das Bruttoinlandsprodukt (BIP) zu aktuellen Preisen lag im Jahr 2007 bei 271 Milliarden €. Das BIP-Wachstum in diesem Jahr lag bei 5,3 % und das BIP pro Kopf bei 32.570 €. Der größte Beitrag zum BIP (annähernd zwei Drittel) stammt aus dem tertiären Sektor, der Rest hauptsächlich aus dem sekundären. Die Industrieproduktion (zu konstanten Preisen) verzeichnete zwischen 1995 und 2007 einen Anstieg um 51 %. Die Energieaufbringung in Österreich weist einen hohen Anteil an erneuerbaren Energieträgern von rund einem Viertel des Bruttoinlandsverbrauchs auf, insbesondere Wasserkraft und Biomasse tragen dazu bei. Mit einem Gesamtenergieverbrauch von 171 MJ pro Kopf bzw. einem Endenergieverbrauch von 130 MJ pro Kopf im Jahr 2007 gehört Österreich zu den Ländern mit einem vergleichsweise geringen Energieverbrauch unter den Industriestaaten. Bei der Entwicklung des Endenergieverbrauchs seit 1990 weist der Verkehrssektor bei weitem den höchsten Zuwachs aus; allerdings ist festzuhalten, dass der Anteil des Kraftstoffs, der in Österreich gekauft und im Ausland verfahren wird ("Kraftstoffexport im Fahrzeugtank", der so genannte "Tanktourismus"), in den letzten Jahren ein wesentlicher Grund für diesen Anstieg geworden ist.

D1.3 Treibhausgas-Inventur

Die Information über die österreichischen Treibhausgasemissionen in der fünften Nationalen Mitteilung entspricht jener aus der jährlichen Inventurberichterstattung an die UNFCCC vom April 2009. Sie enthält Daten über Kohlenstoffdioxid (CO_2), Methan (CH_4), Distickstoffmonoxid (N_2O), teilhalogenierte Fluorkohlenwasserstoffe (H-FKW), vollhalogenierte Fluorkohlenwasserstoffe (FKW) and Schwefelhexafluorid (SF_6) für die Jahre 1990–2007. Weiters werden die Emissionen der indirekten Treibhausgase Stickstoffoxide (NO_x), flüchtige organische Verbindungen außer Methan (NMVOC), Kohlenstoffmonoxid (CO) und Schwefeldioxid (SO_2) angegeben. Zusammenfassende Tabellen gemäß dem "gemeinsamen Berichtsformat" sind im Anhang B des Berichts enthalten, einschließlich der Angaben von CO_2-Äquivalenten und Emissionstrends.

Die Emissionen der Treibhausgase sind nach den folgenden Sektoren gegliedert angegeben: Energie, industrielle Prozesse, Lösungsmittel und andere Produktverwendung, Landwirtschaft, Landnutzungsänderungen und Forstwirtschaft, Abfall und sonstige Emittenten (siehe Tabelle 1.1)

Die Gesamtemissionen der Treibhausgase CO_2, N_2O, CH_4, H-FKW, FKW und SF_6 betrugen 87,96 Millionen Tonnen CO_2-Äquivalent im Jahr 2007 (ohne Einrechung der Senken aus dem Sektor „Landnutzungsänderung und Forstwirtschaft"). Anteilsmäßig klar dominierend waren die CO_2-Emissionen mit 74,18 Millionen Tonnen bzw. 84 %

im Vergleich zu 8 % für CH_4, 6 % für N_2O und 2 % für die fluorierten Treibhausgase. Die Reihenfolge der Subsektoren bzw. Sektoren entsprechend ihrem Beitrag zu den Gesamtemissionen ist folgende:

- 1A3: Verkehr (28 %)
- 1A2: Produzierende Industrie (18 %)
- 1A1: Stromerzeugung und Energieumwandlung (17 %)
- 1A4: Haushalte, Gewerbe, Verwaltung etc. (13 %)
- 2: Industrielle Prozesse (11 %)
- 4: Landwirtschaft (9 %).
- 6: Abfall (2 %)

Die CO_2-Emissionen pro Kopf betrugen 8,9 t im Jahr 2007 und die gesamten Treibhausgasemissionen pro Kopf 10,6 t CO_2-Äquivalent.

Die gesamten Treibhausgasemissionen im Jahr 2007 lagen 9 Mio. t oder 11 % über den Emissionen des Basisjahrs 1990. Die Zunahme der Emissionen beruht hauptsächlich auf dem 19%-igen Anstieg im Sektor „Verbrennung fossiler Energieträger", der nicht durch Emissionsrückgänge in anderen Sektoren wie „Abfall" und „Landwirtschaft" kompensiert werden konnte. Die größten Einzelbeiträge zum Emissionsanstieg zwischen 1990 und 2007 stammten aus dem Straßenverkehr und der Stahlerzeugung. Der Kraftstoffexport im Fahrzeugtank führte zu einem Anstieg um mehr als 6 Mio. t, weitere 3,6 Mio. t wurden durch die Straßenverkehrsleistung im Inland verursacht. Emissionen aus der Erzeugung von Eisen und Stahl stiegen um 3,2 Mio. t (bzw. weniger als 40 %) in Folge einer Produktionssteigerung um rund 80 %.

Tab. 1.1: Treibhausgasemissionen in Österreich 1990 und 2007, in Mio. t CO_2-Äquivalenten

QUELLEN UND SENKEN DER TREIBHAUSGASE	1990					2007				
	CO_2	CH_4	N_2O	F-Gase	Summe	CO_2	CH_4	N_2O	F-Gase	Summe
Gesamt ohne LULUCF	**62.08**	**9.18**	**6.17**	**1.60**	**79.04**	**74.18**	**6.96**	**5.37**	**1.45**	**87.96**
Gesamt mit LULUCF	**48.65**	**9.18**	**6.42**	**1.60**	**65.86**	**56.78**	**6.96**	**5.65**	**1.45**	**70.84**
1. Energie	**54.20**	**0.85**	**0.55**		**55.59**	**64.38**	**1.02**	**0.75**		**66.15**
A. Verbrennung	54.09	0.46	0.55		55.11	64.14	0.31	0.75		65.20
1. Energieumwandlung	13.79	0.00	0.05		13.84	13.93	0.01	0.08		14.01
2. Produzierende Industrie und Bauwirtsch.	12.69	0.01	0.08		12.77	15.67	0.01	0.14		15.82
3. Verkehr	13.77	0.06	0.19		14.02	23.92	0.02	0.28		24.22
4. Andere Sektoren (Kleinverbraucher)	13.81	0.39	0.23		14.43	10.58	0.27	0.25		11.10
5. Andere	0.04	0.00	0.00		0.04	0.04	0.00	0.00		0.05
B. Flüchtige Emissionen aus Brennstoffen	0.10	0.38	IE,NA		0.49	0.24	0.71	IE,NA		0.94
2. Industrielle Prozesse	**7.58**	**0.01**	**0.91**	**1.60**	**10.11**	**9.54**	**0.02**	**0.27**	**1.45**	**11.28**
3. Lösungsmittel und Produktverwendung	**0.28**		**0.23**		**0.51**	**0.25**		**0.16**		**0.41**
4. Landwirtschaft		**4.83**	**4.34**		**9.17**		**4.11**	**3.84**		**7.95**
5. Landnutzungsänder., Forstws. (LULUCF)	**-13.43**	**0.00**	**0.25**		**-13.18**	**-17.40**	**0.00**	**0.27**		**-17.12**
6. Abfall	**0.03**	**3.49**	**0.13**		**3.65**	**0.01**	**1.81**	**0.35**		**2.18**
7. Andere	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**

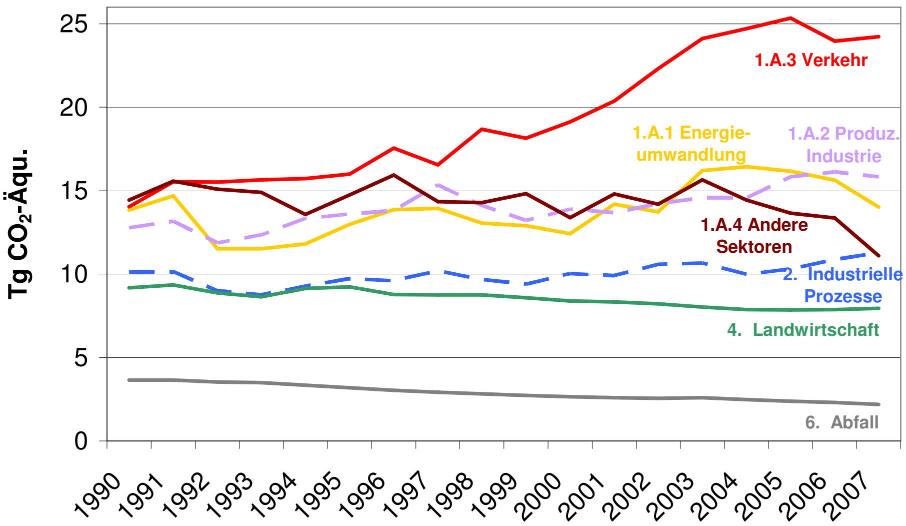


Abbildung 1.1: Emissionstrends nach Sektoren

D1.4 Nationale Maßnahmen

Das Bundesministerium für Land- und Forstwirtschaft, Umwelt und Wasserwirtschaft ist für die Koordination der österreichische Klimapolitik zuständig. Kompetenzen hinsichtlich der konkreten Maßnahmen zur Reduktion der Treibhausgasemissionen sind allerdings auf verschiedene Bundesministerien, auf Länder und Gemeinden verteilt. Als Unterstützung für den Bereich Klimaforschung und für die Koordinierung von Maßnahmen wurden mehrere Gremien eingerichtet. Dazu zählen das *Interministerielle Komitee zur Koordinierung von Maßnahmen betreffend den Schutz des globalen Klimas* (IMK Klima) und das *Kyoto-Forum*, zuständig für die Koordinierung von Maßnahmen zwischen Bund, Ländern und Gemeinden,

Auf Basis dieser institutionellen Struktur wurde ein nationales Programm – die nationale Klimastrategie – ausgearbeitet und 2002 beschlossen. Sie wurde nach einer umfassenden Evaluierung im Jahr 2007 überarbeitet. Die meisten Länder haben ihre eigenen regionalen Klimaschutzprogramme beschlossen, in denen spezifische regionale Umstände, Bedürfnisse und Kompetenzen berücksichtigt sind. Die legislativen Maßnahmen zur Umsetzung der nationalen Klimastrategie sind für die einzelnen Elemente sehr unterschiedlich; einige wichtige Elemente sind die rechtlichen Bestimmungen für die EU-Emissionshandel und das JI/CDM-Programm.

Eine Reihe von wichtigen Maßnahmen ist in den letzten Jahren umgesetzt worden. Hinsichtlich Energiebedarf der Haushalte zielen die Maßnahmen auf erhöhte Effizienz bei Heizungen und Warmwasserbereitung und geringeren Strombedarf sowie auf die Nutzung von Energieträgern mit geringerer Kohlenstoffintensität. Beispielsweise wurden energierelevante Anforderungen in den Bauordnungen verbessert und Fördermaßnahmen zur Unterstützung von energiesparenden Neubauten, thermischer Sanierung von Altbauten und zur Nutzung von Biomasse und Solarwärme gesetzt. Im Bereich Energieversorgung wurden Maßnahmen zur Erhöhung des Anteils erneuerbarer Energieträger bei der Elektrizitätsproduktion (Ökostromgesetz) und Fördermaßnahmen für die Fern- und Nahwärmeversorgung aus erneuerbaren Energieträgern gesetzt. Der Emissionshandel ist bei konventionellen Kraftwerken der relevanteste Anreiz zur Emissionsreduktion. Emissionen im Abfallbereich sind durch die Reduktion des Kohlenstoffanteils beim deponierten Abfall und durch Deponiegaserfassung deutlich zurückgegangen.

Maßnahmen im Verkehr reichen von CO_2-bezogenen steuerlichen Anreizen und dem verstärkten Einsatz von Biokraftstoffen bis hin zu Bewusstseinsbildung und Programmen für nachhaltige Mobilität. Förderungen werden für Energiesparmaßnahmen und die Nutzung erneuerbarer Energieträger im Industriebereich zur Verfügung gestellt. Rund 200 Anlagen aus Industrie und Energieerzeugung werden vom EU-Emissionshandel erfasst, der 2005 eingeführt worden ist. Die Nutzung von fluorierten Treibhausgasen wurde gesetzlich eingeschränkt. In der Landwirtschaft werden nachhaltige Bewirtschaftung und biologischen Landbau unterstützt.

D1.5 Emissionsprojektionen und Gesamteffekt nationaler Maßnahmen

Aktuelle Emissionsprojektionen wurden in den Jahren 2008/2009 berechnet. Das Szenario ‘mit Maßnahmen’ unfasst jene Maßnahmen zur Treibhausgasreduktion, die im Rahmen der nationalen Klimastrategie vor August 2008 umgesetzt worden sind. Das Szenario ‘mit zusätzlichen Maßnahmen’ bezieht auch geplante Maßnahmen ein, die eine realistische Chance auf Umsetzung in der nahen Zukunft haben.

Die Emissionsberechnungen wurden vom Umweltbundesamt durchgeführt. Die zugrundliegenden sektoralen Aktivitätsprognosen basieren auf verschiedenen Modellen und Methoden und wurden in enger Zusammenarbeit von verschiedenen Institutionen erstellt. Die Berechnungen zeigen einen Anstieg der Treibhausgasemissionen im Szenario ‘mit Maßnahmen’ von 2006 bis 2020 von rund 7 %. Zusätzliche Maßnahmen werden zu einem Rückgang von 2 % zwischen 2006 und 2020 führen. Tabelle 1.2 and Abbildung 1.2 geben einen Überblick über die erwartete Entwicklung.

Tab. 1.2: Treibhausgasemissionen in Österreich – Projektionen bis 2020 (in Millionen Tonnen CO_2-Äquivalent)

	Emissionen					Mit Maßnahmen			Mit zusätzlichen Maßn.		
	1990	1995	2000	2006	2007	2010	2015	2020	2010	2015	2020
Total	79.04	80.51	81.08	92.83	87.96	93.87	95.47	98.11	92.87	91.58	89.61

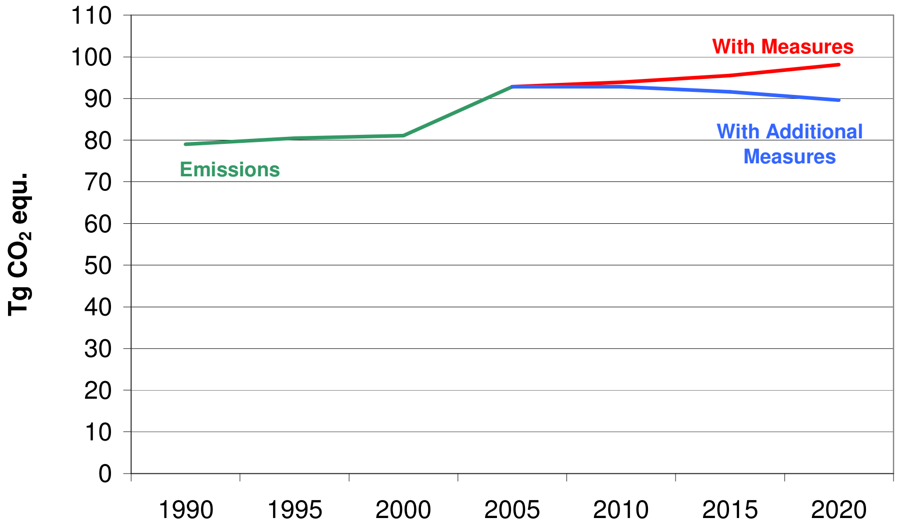


Abbildung 1.2: Treibhausgasemissionen in Österreich – Projektionen bis 2020

Die Auswirkungen der gegenwärtigen Wirtschaftskrise konnten in den Projektionen noch nicht berücksichtigt werden; die Ergebnisse sind daher als Überschätzung der zu erwartenden Entwicklung zu betrachten. Außerdem müssen beim Vergleich einzelner Jahresergebnisse der Projektionen mit dem österreichischen Kyoto-Ziel von -13 % die Nutzung von Kohlenstoffsenken (geschätzt -0,7 Mio. t CO_2), die Kyoto-Mechanismen JI/CDM (derzeit geplante -9 Tg CO_2 equivalents) und die Zuteilung gemäß nationalem Zuteilungsplan im EU-Emissionshandel (Ankäufe im Rahmen der flexiblen Reserve für neue Marktteilnehmer durch die Bundesregierung und durch die Unternehmen in der Kyotoperiode, insgesamt -3,1 Tg CO_2-Äquivalente)berücksichtigt werden. Insgesamt müssen daher 12,8 Mio. t CO_2-Äquivalente von den Szenarioergebnissen abgezogen werden. Die resultierende Lücke soll durch verstärkte Maßnahmensetzung geschlossen werden.

Der Gesamteffekt der umgesetzten und beschlossenen Maßnahmen, die in Kapitel 4 des Berichts beschrieben werden, wird mit 18 Mio. t CO_2-Äquivalent für das Jahr 2010 und mit 35 Mio. t für 2020 abgeschätzt. Der Effekt geplanter Maßnahmen liegt bei 1 Mio. t im Jahr 2010 und bei mehr als 8 Mio. t im Jahr 2020. Die Nutzung der flexiblen Mechanismen des Kyoto-Protokolls durch Österreich erfolgt zusätzlich zu den Anstrengungen im Inland.

D1.6 Gefahrenabschätzung, Auswirkungen des Klimawandels und Anpassungsmaßnahmen

Es ist anzunehmen, dass Österreich angesichts der äußerst empfindlichen Ökosysteme der Bergregionen durch Klimaänderungen sehr verwundbar ist. 70 % der Oberfläche Österreichs liegen über 500 m Seehöhe und 40% über 1.000 m bei einer zugleich sehr ausgeprägten kleinräumigen orographischen Struktur. Signifikante Anzeichen eines Klimawandels können bereits beobachtet werden, zum Beispiel ist die mittlere Temperatur ist in den letzten 50 Jahren in der Größenordnung von 1–2 °C angestiegen und Gletscherinventuren zeigen Rückgänge in Fläche und Volumen. Obwohl Klimamodellierung für Berggebiete aufgrund der Einschränkungen aktueller Modelle schwierig ist und die Resultate unsicher sind, können einige Schlussfolgerungen aus dem bestehenden Wissen abgeleitet werden.

Modellergebnisse lassen eine Verschiebung im jahreszeitlichen Niederschlagszyklus in den alpinen Regionen hin zu erhöhtem Niederschlag im Winter und Rückgängen in Sommer erwarten, einen Rückgang des Gesamtniederschlags aber nur für die flachen Becken Süd- und Ostösterreichs. Eine verkürzte Dauer der Schneebedeckung aufgrund geänderter Niederschlagsmuster muss angenommen werden. Dies führt zu einer Änderung von Zeitpunkt und Ausmaß der Schneeschmelze, zu erhöhter Verdunstung sowie zu Verminderung der Bodenfeuchtigkeit und des Grundwasserzuflusses. Änderungen in der Intensität und Häufigkeit von Niederschlägen, steigende Temperaturen, Gletscherrückgänge und das Auftauen des alpinen Permafrosts könnten die Häufigkeit von Naturkatastrophen wie Rutschungen, Muren und Lawinen erhöhen.

Gebirge begünstigen eine relativ breitgefächerte Klimaverteilung und eine große Vielfalt von Lebensräumen auf kleinem Raum. Änderungen von Temperatur und Niederschlag können eine Vegetationsmigration und teilweise das Aussterben von Arten hervorrufen. Ergebnisse laufender Feldstudien in Österreich lassen für den Zeitraum der vergangenen 70–90 Jahre für einige typisch in Schneeregionen angesiedelte Pflanzenarten Migrationsgeschwindigkeiten erkennen, die im Durchschnitt weniger als 1,5 m pro Jahrzehnt betragen, aber auf bis zu 4 m pro Jahrzehnt steigen können. Diese Ergebnisse weisen darauf hin, dass die Erwärmung der Erdatmosphäre bereits messbare Auswirkungen auf die alpine Pflanzenwelt zeigt.

Eine verkürzte Schneebedeckung wird auch den österreichischen Wintertourismus beeinträchtigen, der rund 4 % zum österreichischen Bruttonationalprodukt beiträgt. Da die Länge der Schisaison bereits von relativ geringen Klimaschwankungen beeinflusst werden kann, sind deutliche sozialwirtschaftliche Auswirkungen in jenen Gemeinden zu erwarten, die große Investitionen in den Schitourismus getätigt haben. Der Konkurrenzkampf zwischen alternativen Nutzungen von Berggebieten wird in Zukunft voraussichtlich zunehmen. Die Landwirtschaft in Bergregionen wird wahrscheinlich besonders von Änderungen im Gleichgewicht von Ökosystemen betroffen sein, die durch den Klimawandel hervorgerufen werden.

In der Vergangenheit wurden Maßnahmen zur Anpassung an den Klimawandel einerseits durch bereits stattfindenden Klimaänderungen bewirkt, beispielsweise Beschneiungsanlagen in Schigebieten oder Bewässerungskanäle, oder sie traten als Nebennutzen auf wie bei den Maßnahmen zum Schutz vor Naturgefahren (Lawinen, Erosion und Wildbächen).

Die Entwicklung einer umfassenden nationalen Anpassungsstrategie wurde 2007 begonnen. Basierend auf einer Studie, in der bestehende Maßnahmen, Klimaszenarien, Gefährdungsabschätzungen und erste Handlungsempfehlungen dargestellt wurden, wurde ein partizipatorischer Prozess unter Einbindung der betroffenen Stakeholder gestartet. Derzeit werden die Sektoren Land-, Forst- und Wasserwirtschaft, Tourismus und Elektrizitätswirtschaft betrachtet. Eine Ausweitung auf weitere gefährdete Sektoren wird in naher Zukunft geprüft.

D1.7 Finanzielle Unterstützung und Technologietransfer

Die Globale Umweltfazilität (GEF) wurde 1991 eingerichtet, um die Entwicklungsländer und, in einem gewissen Maß, die Länder, deren Wirtschaft sich im Übergang zur Marktwirtschaft befindet, bei der Bewältigung der vier größten Umweltprobleme von grundlegender und globaler Bedeutung – darunter die Erwärmung der Erdatmosphäre – zu unterstützen. Österreich hat seit 1991 Beiträge zur GEF geleistet; die österreichischen Zahlungen an die GEF wurden zusätzlich zu bestehenden Verpflichtungen und Zahlungen an andere internationale Finanzinstitutionen geleistet. Von 2005 bis 2008 hat Österreich Beiträge in der Höhe von rund 30 Mio. US$ geleistet.

Im Hinblick auf die bilaterale finanzielle Unterstützung ist grundsätzlich festzuhalten, dass Projekte der österreichischen öffentlichen Entwicklungshilfe (ODA) dem Ziel der umweltgerechten nachhaltigen Entwicklung entsprechen müssen; ein beträchtlicher Teil der Projekte hat Umweltschutz als ein wesentliches Ziel. Die gesamte von Österreich geleistete öffentliche Entwicklungshilfe betrug 2008 1.681 Mio. US$. Rund 70 % davon sind als bilaterale ODA einzustufen, 10 % davon gingen an am wenigsten entwickelte Länder (LDCs). Einige Schwerpunktregionen in Afrika, im Himalaja und in Zentralamerika mit einem erheblichen Anteil an am wenigsten entwickelten Ländern werden in langfristigen Partnerschaften unterstützt. Darüber hinaus wurden durch andere Bundesministerien, Länder, Gemeinden und nichtstaatlichen Organisationen weitere projektorientierte Mittel zur Verfügung gestellt.

Bilaterale Projekte von spezieller Bedeutung für die Verhinderung eines Klimawandels wurden konzentrieren sich auf die technische Unterstützung der nachhaltigen Nutzung von natürlichen Ressourcen und Know-How in den Bereichen erneuerbare Energieträger und Energieeffizienz.

Österreich ist Mitglied von Institutionen und Initiativen, zu deren Hauptzielen der Austausch von Forschungsergebnissen und der Technologietransfer zählt, beispielsweise der Internationalen Energieagentur (IEA) und der *Climate Technology Initiative*. Österreich ist an mehreren *Implementing Agreements* der IEA beteiligt, die sich "klimafreundlichen" Technologien und Maßnahmen beschäftigen, z. B. in den Bereichen Solarenergie, Biomasse und Windenergie. Weiters erleichtern und fördern viele Projekte, die aus den Mitteln der Öffentlichen Entwicklungshilfe und durch NGOs und Industrie unterstützt finanziert werden, den Transfer von umweltfreundlichen Technologien und entsprechendem Know-how in Entwicklungsländer. Selbst wenn Technologietransfer nicht das Hauptziel eines solchen Projektes ist, erleichtert der Einsatz von umweltfreundlichen Technologien im Rahmen des Projekts den Zugang zu und das Verständnis von solchen Technologien für die betroffenen Personen in den Entwicklungsländern.

D1.8 Forschung und systematische Beobachtung

Österreich engagiert sich bei der Förderung von Forschungsvorhaben und der systematischen Beobachtung des Klimasystems und unterstützt zahlreiche Forschungsprojekte und –programme sowohl auf nationaler als auch auf internationaler Ebene. Klima- und Klimafolgenforschung werden durch die Alpen geprägt, die annähernd zwei Drittel der Fläche Österreichs einnehmen.

Forschungsprogramme zum Thema nachhaltige Entwicklung wurden von den verschiedenen sachlich betroffenen Ministerien eingerichtet. Auf den Klimawandel bezogene Projekte (Folgen, Anpassung, Minderungsmaßnahmen) werden von einer beträchtlichen Zahl von Universitätsinstituten wie auch von außeruniversitären Einrichtungen wie der Zentralanstalt für Meteorologie und Geodynamik, dem Umweltbundesamt und Forschungseinrichtungen des Bundesministeriums für Land- und Forstwirtschaft, Umwelt und Wasserwirtschaft durchgeführt. Ein besonderer Schwerpunkt wird auf den Klimawandel im Forschungsprogramm “StartClim” gelegt, das 2002 initiiert wurde und mit öffentlichen und privaten Mitteln finanziert wird.

Die sehr heterogenen Wetterverhältnisse in den Gebirgsregionen haben zu einem engmaschigen Netzwerk an Beobachtungsstationen für meteorologische und hydrologische Parameter geführt. Die in Österreich bestehenden instrumentellen Zeitreihen gehören zu den längsten Europas und reichen bis in das 18. Jahrhundert zurück. Das Höhenobservatorium am Hohen Sonnblick, auf 3.106 m Seehöhe gelegen, ist seit 1886 in Betrieb und verfügt über die längste kontinuierliche meteorologische Zeitreihe einer hoch gelegenen Messstelle weltweit. Österreichische Messdaten werden internationalen Netzwerken wie *World Weather Watch*, GCOS *surface network*, *Global Atmosphere Watch*, CLIMAT und *Global Terrestrial Network – Glaciers* zur Verfügung gestellt. In den letzten Jahren hat sich Österreich auch verstärkt im Bereich der satellitengestützten Beobachtungsprogramme engagiert.

D1.9 Bildung, Ausbildung und Öffentlichkeitsarbeit

Umwelterziehung ist an Österreichs Schulen ein interdisziplinäres Unterrichtsprinzip und Themen im Zusammenhang mit Klimaschutz, wie Energieeinsparung und erneuerbare Energieträger, wurde in den letzten Jahrzehnten erhöhte Aufmerksamkeit gewidmet. Eine nationale Strategie für die Bildung über nachhaltige Entwicklung passierte im Jahr 2008 den Ministerrat. Das Bewusstsein zur Klimaproblematik wird durch verschiedene Initiativen auf Bundes- und Länderebene gestärkt, beispielsweise durch Schulwettbewerbe und Workshops. Österreich nimmt außerdem aktiv am OECD/CERI-Netzwerk "Environment and School Initiatives" teil.

Ausbildungprogramme und Seminare für verschiedene Zielgruppen wurden von öffentlichen Einrichtungen und regionalen Energieagenturen eingerichtet. Unabhängige Beratung zum Thema Energie wird den Haushalten kostenlos von Energieagenturen, Umweltberatungen und teilweise von den Ländern direkt angeboten. Vergleichbare Programme bestehen auch für Klein- und Mittelbetriebe. Das Bundesministerium für Land- und Forstwirtschaft, Umwelt und Wasserwirtschaft hat die für 8 Jahre angesetzte Initiative „klima:aktiv“ gestartet mit einer Reihe von zielgruppenorientierten Programmen zu den Themen energieeffizientes Bauen, Verkehr und Mobilität, Gemeinden und erneuerbare Energieträger. Die Landwirtschaftskammern und weitere Einrichtungen bieten ihren Mitgliedern Beratung und Weiterbildung zum Thema nachhaltige Land- und Forstwirtschaft an.

Das Thema Klimaschutz besitzt im öffentlichen Bewusstsein in Österreich einen besonderen Stellenwert. Kampagnen und Initiativen zur Bewusstseinsbildung werden von Bund und Ländern organisiert. Sie zielen i. a. auf auf konkrete Empfehlungen für Klimaschutzmaßnahmen ab, beispielsweise in den Bereichen Energie, Verkehr und Landwirtschaft. Besonders erwähnenswert ist auch das "Klimabündnis", das eine Partnerschaft zwischen mehr als 1500 Gemeinden und Städten in Europa und den indigenen Einwohnern der Regenwälder zum Schutz der Atmosphäre darstellt. In Österreich haben sich mehr als 700 Gemeinden und alle Bundesländer sowie eine beträchtliche Zahl von Betrieben und Schulen dem Klimabündnis angeschlossen. Das Klimabündnis Österreich trägt nicht nur zum öffentlichen Bewusstsein über die globale Dimension von Klimaänderungen bei, sondern hat auch eine Vielzahl erfolgreicher und beeindruckender Klimaschutzmaßnahmen auf Gemeindeebene initiiert.

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 comprising 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 8.32 million inhabitants in 2007. After declines in the late 1970ies and stagnation in the early 1980ies this represents an increase of more than 700,000 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 99 inhabitants per square kilometre total area or 257 per square kilometre settlement area.

In 2007, 15 % of the Austrian population was younger than 15 years of age, about one fifth between the ages of 15 and 29 and between 45 and 59 respectively, 23 % between 30 and 44, 14 % between 60 and 74, and 8 % was 75 years old or older. The Austrian population is aging; in 2030 31 % of all Austrians are expected to be 60 years or older and only 30 % younger than 30 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 1.38. The balance of births has decreased in the 1990ies and shows a small birth-surplus in 2007. Life expectancy at birth is 77 years for male and 83 years for female persons. (Source: Statistik Austria)

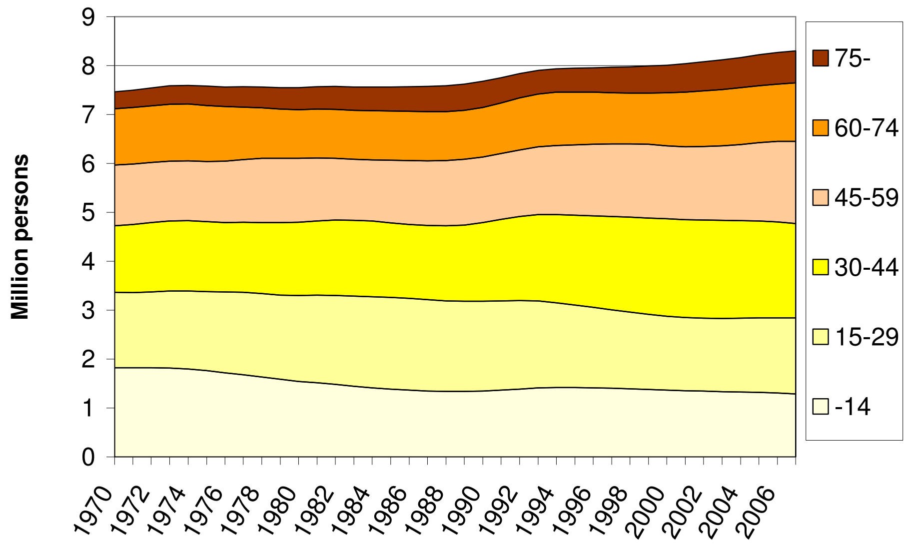


Fig. 2.1: Austrian Population 1970–2007 by age groups

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℃, 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℃, 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℃ (July: 20.2℃), the number of days per year with minimum temperature below 0℃ 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℃ (July: 13.2℃), the number of days per year with minimum temperature below 0℃ 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℃ 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, 2007, 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)

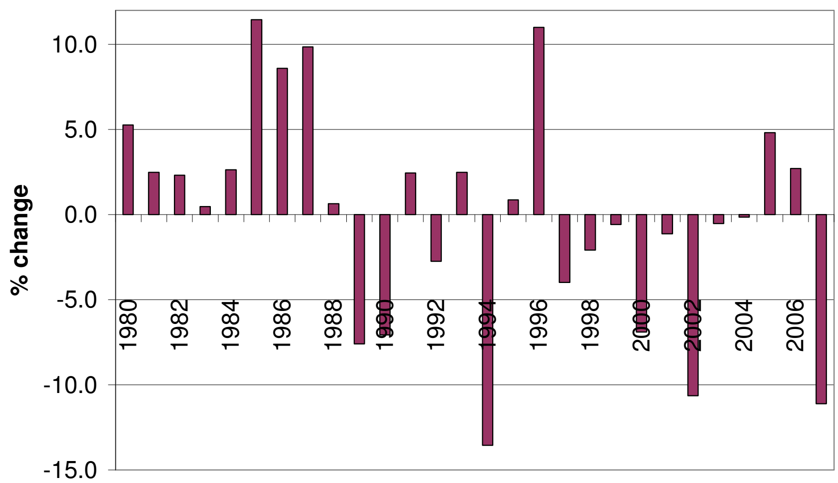


Fig. 2.2: Heating degree days in winter (Jan–Mar and Nov–Dec), deviation from mean value for 1980–2007 (Source: Statistik Austria)

2.5 Economic Profile

In 2007 Austria's GDP at current prices was € 271 billion. With a per capita GDP of € 32,570 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; the balance of trade in goods in 2007 showed a slight surplus (exports 43.7 %, imports 43.1 % of GDP), the balance of trade in services a high surplus (exports 15.9 %, imports 10.6 % of GDP).

Export and import quotas for goods have considerably increased from the beginning of the 1990ies, when they had been at a level of about 20 % and 25 % respectively. The largest share of exports is related to final goods (72 % of total goods exports), smaller shares to intermediate products (16 %), raw materials and energy (6 %) and food (6 %). Austria's main trading partner is its neighbour Germany with a 30 % share of total exports and 42 % share of total imports. Trade with the new EU member states and economies in transition of Central and Eastern Europe has considerably increased throughout the last years. Exports of services are dominated by travel (34 % of total service exports, but the share of travel services has decreased in the last decade), followed by transport (21 %, more than 2/3 of which is freight transport). The share of knowledge-intensive business services has grown from 9 % in 1997 to 18 % in 2007.

Table 2.1: Development of GDP in the period 1980-2007 (Source: Statistik Austria)

	GDP at Current Prices		GDP Price Index		GDP/capita
	Bio €	% Change	Index	% Change	€
1980	76,60	+ 7,4	62,9	+ 1,8	10.150
1985	103,42	+ 5,5	67,6	+ 2,5	13.670
1990	136,21	+ 7,4	77,9	+ 4,2	17.740
1991	146,08	+ 7,2	80,5	+ 3,3	18.840
1992	154,21	+ 5,6	82,1	+ 1,9	19.670
1993	159,16	+ 3,2	82,4	+ 0,4	20.130
1994	167,01	+ 4,9	84,2	+ 2,2	21.040
1995	174,61	+ 4,6	86,3	+ 2,5	21.970
1996	180,15	+ 3,2	88,2	+ 2,2	22.630
1997	183,48	+ 1,8	90,1	+ 2,1	23.030
1998	190,85	+ 4,0	93,4	+ 3,6	23.930
1999	197,98	+ 3,7	96,5	+ 3,3	24.770
2000	207,53	+ 4,8	**100,0**	+ 3,7	25.900
2001	212,50	+ 2,4	100,5	+ 0,5	26.420
2002	218,85	+ 3,0	102,2	+ 1,6	27.070
2003	223,30	+ 2,0	103,0	+ 0,8	27.510
2004	232,78	+ 4,2	105,6	+ 2,5	28.480
2005	244,45	+ 5,0	108,7	+ 2,9	29.690
2006	257,29	+ 5,3	112,3	+ 3,4	31.070
2007	270,84	+ 5,3	115,8	+ 3,1	**32.570**

The largest contribution to Austria's GDP with almost two third comes from the tertiary production (67.7 %), the rest is contributed mainly by secondary production (30.6 %) and to a small extent by primary production (1.8 %). The sectoral composition has been remarkably stable in the last years, from 1993 to 2007 the share of tertiary production has increased by 1 percentage point, with a comparable reduction for the primary production. Greenhouse gas emissions per GDP unit were 366 tonnes per million € in 2007, which is in the bottom range of the EU and about one fifth below the OECD average. From 1990 to 2007 emissions per GDP have decreased by 25 %. CO_2 emission indicators can be found in Appendix B.

Austria is one of the few countries in the world where tourism contributes significantly to GDP with a share of 8.7 % in 2007. Obviously this sector is highly vulnerable to weather conditions. This is one way in which climate change might impact not only tourist regions, but also the economy as a whole. (Source: Statistik Austria, 2009; FIW, 2008)

2.6 Energy

Compared to other industrialized countries the Austrian energy sector has a rather high share of renewables that amounted to 9.3 % hydro power[1] and 16.4 % other renewables (mainly biomass) of total gross energy consumption in 2007. 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.

[1] Without net imports/exports for electricity

Nevertheless energy supply in Austria is still heavily dependent on fossil fuels, with shares of 12 % of coal products, 42 % of oil products, and 21 % of natural gas of total gross energy consumption in 2007. 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 and an increase of other renewables in the last years (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 2007, gross energy consumption per GDP (at 2000 prices) has decreased by about 25 % to 5,9 MJ/€ (see also Figure 2.5).

About two third of electricity was generated by hydro power on average in the last ten years; in 2007 the share was 59 %. The share relates to inland production; electricity net imports have reached a significant level after 2002 (2007: 10 %).

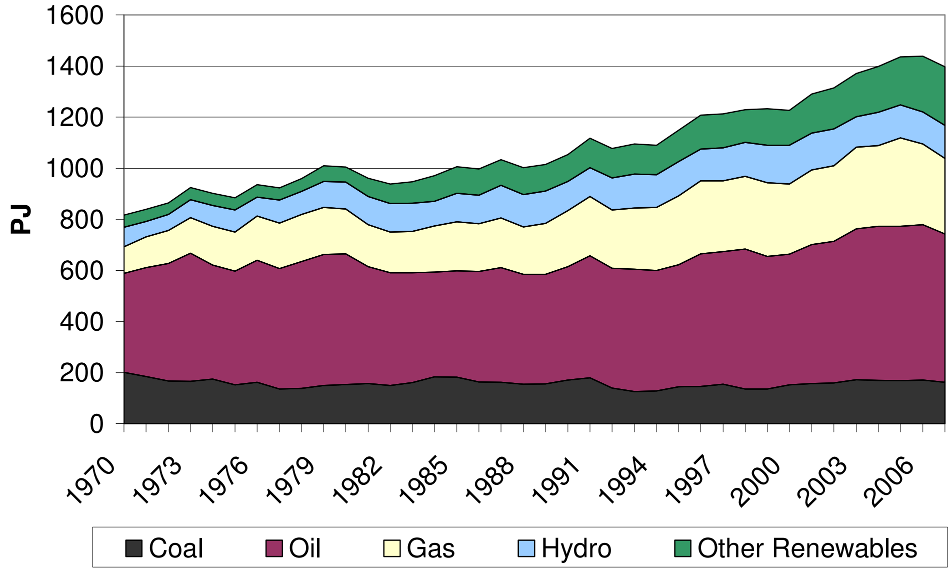


Fig. 2.3: Gross energy consumption 1970–2007 (Data: Statistik Austria)

Final energy consumption is characterized by increasing shares of gas (17 %) and district heating (5 %), see Figure 2.4. The share of coal has been continuously reduced to 2%; oil has held a constant share since the 1980ies (42 % in 2007). Renewables including waste now comprise about 14 %, electricity 19 %.

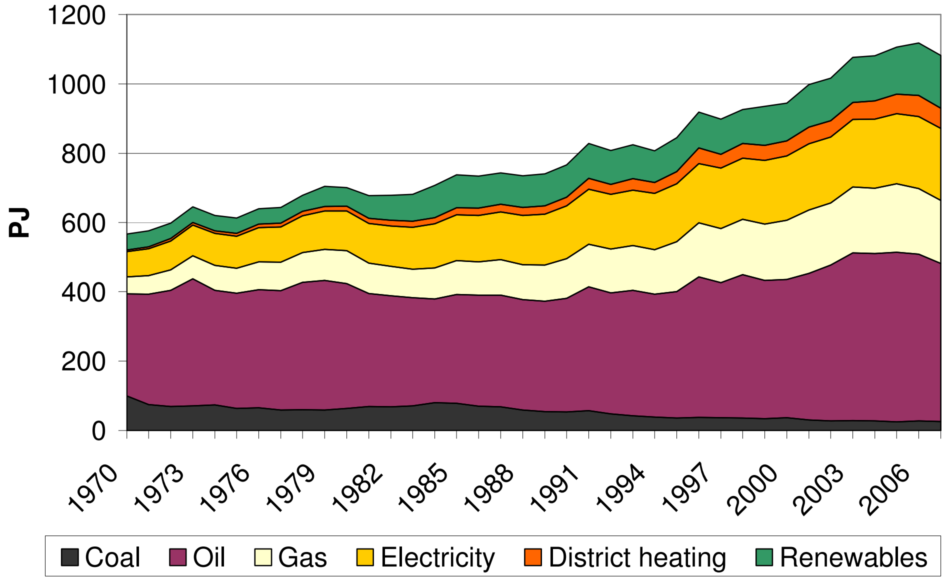


Fig. 2.4: Final energy consumption 1970–2007 (Data: Statistik Austria)

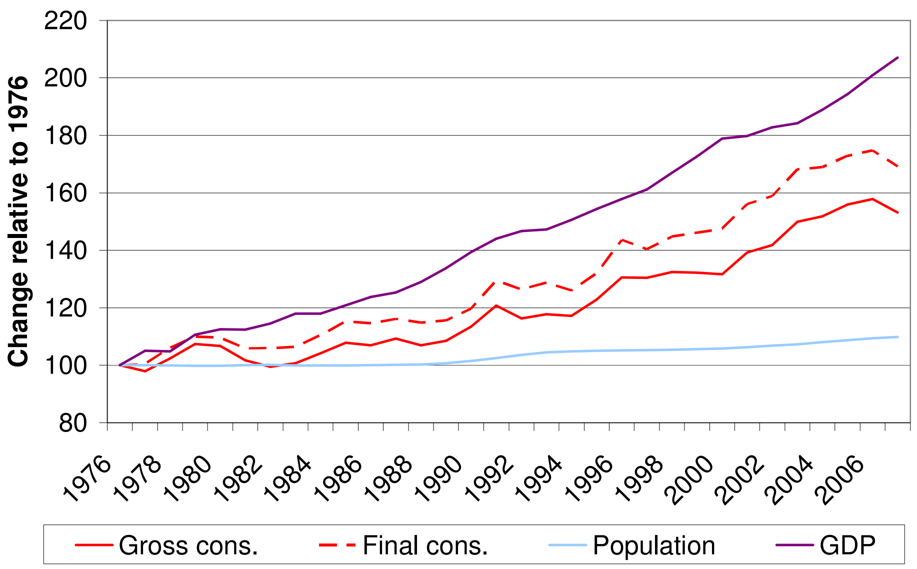


Fig. 2.5: Gross inland and final energy consumption, population und GDP at constant prices 2000; development relative to 1976 values (Data: Statistik Austria)

The share of private households in final energy consumption shows a falling tendency (1990: 32 %, 2007: 24%); the share of manufacturing industries and construction has stayed quite constant during the last two decades (2007: 29 %). The share of transport shows a continuously increasing tendency (1970: 20 %, 1990: 27 %, 2007: 35 %). It should be mentioned that the amount of road fuel, that is sold in Austria but consumed abroad, has become significant in the last years (see next section). CO_2 emission indicators can be found in Appendix B.

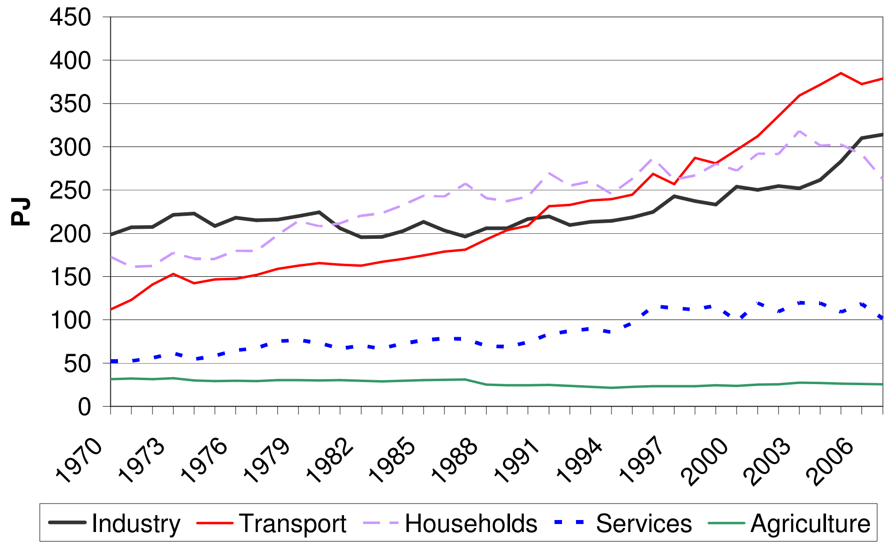


Fig. 2.6: Final energy consumption according to sectors1970–2007 (Energy consumption for transport based on total fuel sold in Austria. Data: Statistik Austria)

(Source: Statistik Austria, 2008c)

2.7 Transport

Economic and demographic development in the past decades, especially since the opening of the East European market, 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 4.2 million in 2007, the total number of motor vehicles from 2.2 million to 5.8 million. The share of diesel fuelled passenger cars has increased enormously from 14 % in 1990 to 54 % in 2007.

In 2007 Austria's passenger transport amounted to approx. 135 billion passenger kilometres. Since 1990 passenger transport rose by more than 30%. The biggest increase could be noticed in the aviation sector: +180 % from 1990 to 2007. 86 billion passenger kilometres were travelled by passenger cars, 30 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.

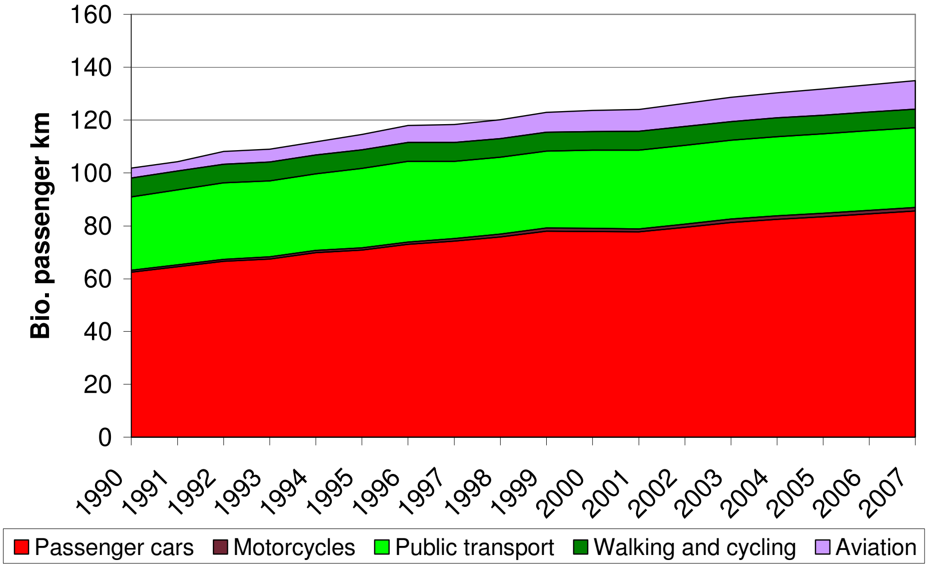


Fig. 2.7: Trend in inland passenger transport[2] 1990–2007 (Source: Umweltbundesamt)

The total performance in freight transport in Austria amounted to 65 billion ton kilometres in 2007, of which road transport counted for 44 billion, rail for 17 billion and ship for 3 billion ton kilometres. Therefore, freight transport is also predominated by the share of road transport. Since 1990 the amount of freight transport increased by 72 %. The share of road transport has slightly increased between 1990 and 2007 (from 65 % to 68 %), while the share of rail transport has decreased from 30 % to 26 %.

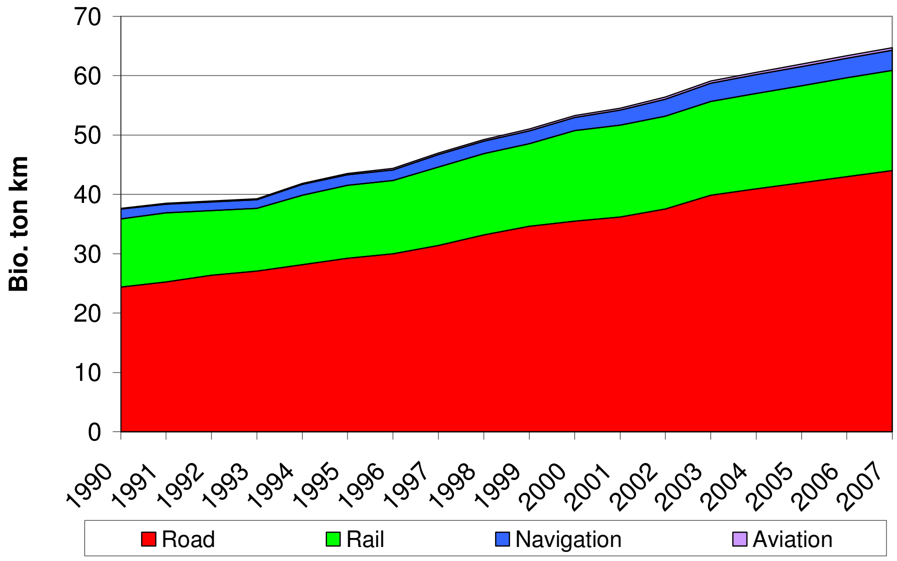


Fig. 2.8: Trend in inland freight transport 1990-2007 (Source: Umweltbundesamt)

According to the Austrian greenhouse gas inventory, 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 disproportionately high increase after the mid 1990ies. This is due to fuel export in the vehicle tank, which is caused by the fact that fuel prices have been slightly lower than in most neighbouring countries, that important routes for

[2] aviation transport demand contains national and international flights (pkm abroad: includes the whole distance to the abroad destination; only starts are considered)

long-distance freight traffic cross Austria and that the integration of eastern neighbour states into the European economic area led to additional transport demand. A recent study showed that about one third of the greenhouse gas emissions from transport are caused by this kind of fuel export in the vehicle tank, the main reason being long-distance freight transport. As the calculation of emissions has to be based on the fuel sold in Austria, this part of the fuel and the related emissions are also allocated to the Austrian inventory. The emission figures of 2005 to 2007 indicate that this kind of fuel export in the vehicle tank has been stabilised at a high level (see Figure 2.9).

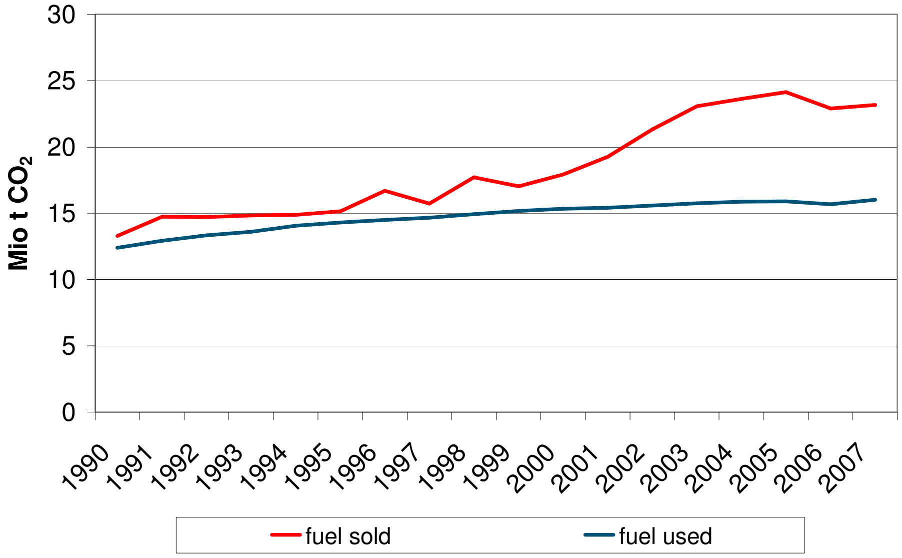


Fig 2.9: Carbon dioxide emissions of road transportation – calculation based on fuel sales in Austria (“fuel sold”) and on inland fuel use (“fuel used”). (Source: Umweltbundesamt)

(Source: Umweltbundesamt)

2.8 Industry

With regard to the growth of its industrial sector, Austria ranks among the leaders within the EU countries. Gross value added of manufacturing industries (at constant prices) showed an increase of 51 % from 1995 to 2007. Compared to other industrialized countries basic materials industries still play a decisive role in Austria.

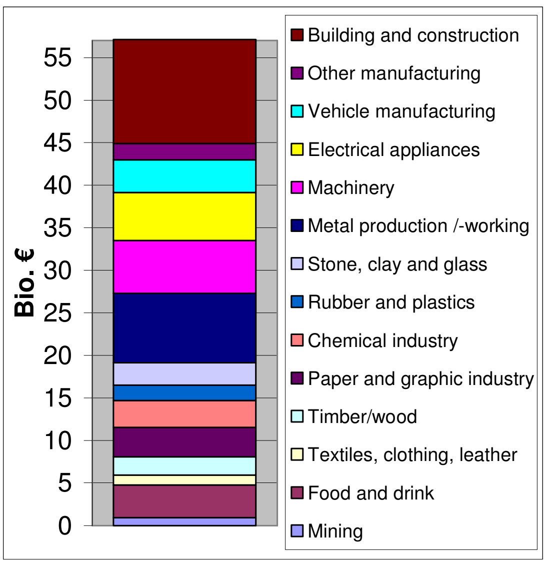


Fig. 2.10: Gross value added 2006 (Data: Statistik Austria)

20 % of Austria’s economic productivity is derived directly from manufacturing industries, 7 % from construction. The most important branches of the production of goods are machines and steel construction, electrical and electronic appliances, chemicals, iron and metal

goods, food and vehicles (cf. Fig. 2.10). Turnover per employee in manufacturing industries was € 230,000 in 2007; gross value added per employee was about € 72,000.

€ 6.95 billion, that is 2.55 % of GDP, were spent for research and technology development in 2007, compared to a share of 1.36 % in 1990. About half of that sum was spent by enterprises, about one third by the public sector. 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. Energy consumption in manufacturing industries and construction did not exceed the 1976 level until the mid 1990ies and showed a considerable increase after 2003 (cf. Figure 2.11). In 2007, consumption was 44 % above the 1990 level. CO_2 emissions, however, increased only about half as much as consumption, which is mainly due to fuel switch and increased used of biogenous fuels. CO_2 emission indicators can be found in Appendix B.

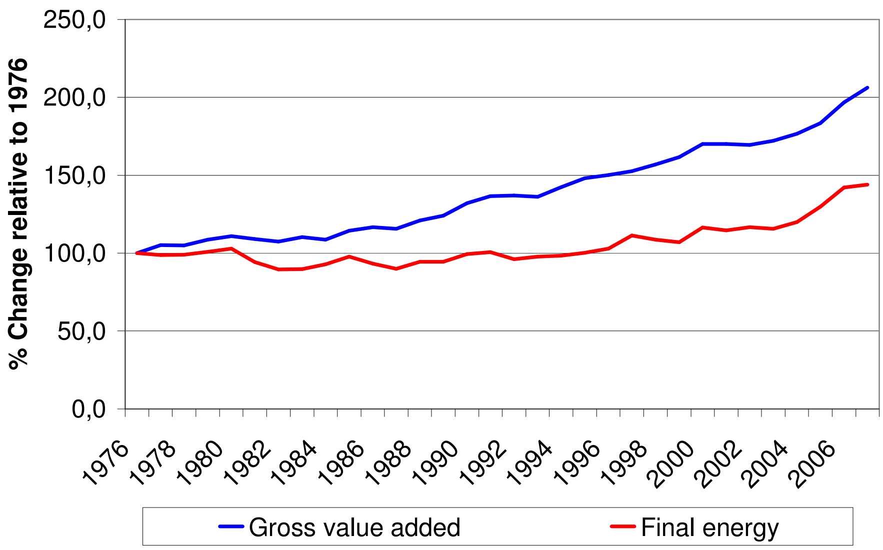


Fig. 2.11: Gross value added at 2000 prices and final energy consumption in manufacturing industries and construction (Data: Statistik Austria)

(Source: Statistik Austria, 2008; BMWA, 2008)

2.9 Waste

The total estimated amount of waste generated in Austria in 2007 was about 58 million tons. Excavation material accounted for 25 million tons, while hazardous waste is estimated at 1.1 million tons/a or 2 % of total waste. The change in total mass compared 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; 67 % is collected for conditioning, recycling and recovery; 23 % undergo other treatments.

Waste from households and similar sources rose by about one fifth between 1999 and 2007 to 3.7 million tons (448 kg waste per capita). In 2007, 3 % went directly without pre-treatment to sanitary landfills, compared to 28.5 % in 1999 and 63.1 % in 1989. Including residues from treatment, 19 % of household waste was disposed of in landfills (1999: 43.1 %, 1989: 74.8 %). As a result of separate collection, 1.4 million tons of secondary material (glass, paper, metal, …) and 0.7 million tons of organic waste were collected in 2007. The share of secondary material collected separately for recovery/recycling has increased from 13 % in 1989 to 36 % in 2007, the share of organic waste collected separately for composting from 1 % to 18 %. (See also Figure 2.12)

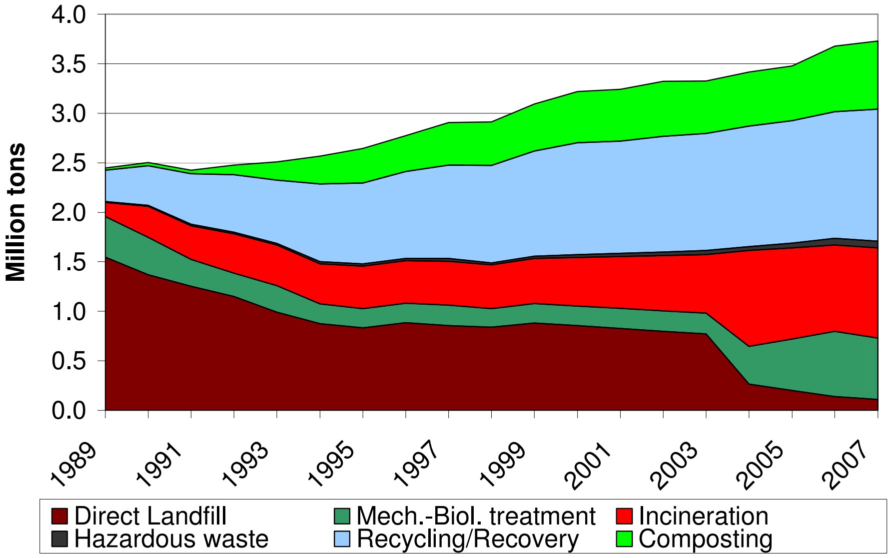


Figure 2.12: Household waste, treatment and recycling 1989–2007 (Source: Umweltbundesamt)

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 was exceptionally allowed under certain circumstances until 31 December 2008 at the latest. Since 1991, methane emissions caused by waste management have decreased by about 50 %. (Source: Umweltbundesamt, 2008b)

2.10 Building stock and urban structure

About 39 % 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 257 persons/km^2. One fifth of all Austrians (1.7 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 half of all Austrians live in communes with more than 1,000 up to 10,000 inhabitants, and 16 % in communes with more than 10,000 up to 100,000 inhabitants (cf. Figure 2.13). Two thirds live in municipal communes, one third in rural communes.

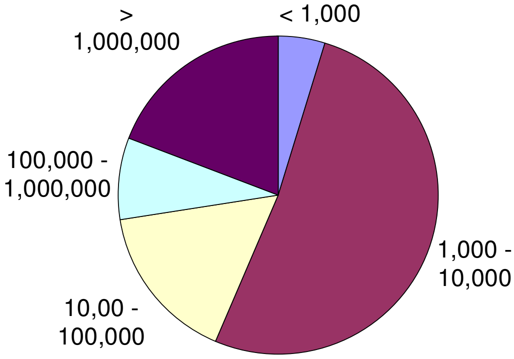


Figure 2.13: Population distribution according to size of communes (Data: Statistik Austria)

In recent decades, the number of households and dwellings increased to a much higher extent than population did. While in 2007 the number of households (3.54 million) was 38 % higher than in 1971, population growth was 11 % during the same time. The percentage of single households has grown from about 25 % in 1971 to 35 in 2007; the tendency towards single households is projected to continue. On average, 2.3 people lived in a household in 2007. The total stock of dwellings (3.86 million in 2001) has increased by 45 % since 1971.

The number of main residences has increased from 2.93 million in 1990 to 3.54 million in 2007, and average useful floor space has increased from 85 m² per dwelling in 1990 to 98 m² in 2007. The share of dwellings with central heating (including single storey heating and district heating) has increased from less than 60 % in 1990 to almost 80 % in 2007.

In 2007 almost half of these dwellings (main residences) were located in buildings with only one or two dwellings, less than one third in buildings with more than 11 dwellings. 15 % of the dwellings were built before 1919; 22 % between 1919 and 1960; 31 % between 1961 and 1980; 26 % between 1981 and 2000 and 5 % after 2000. 8 % of dwellings had a useful floor space less than 45 m^2, 43 % 45 m^2 up to less than 90 m^2, 25 % 90 m^2 up to less than 130 m^2, and 23 % 130 m^2 and more. (Source: Statistik Austria, 2008)

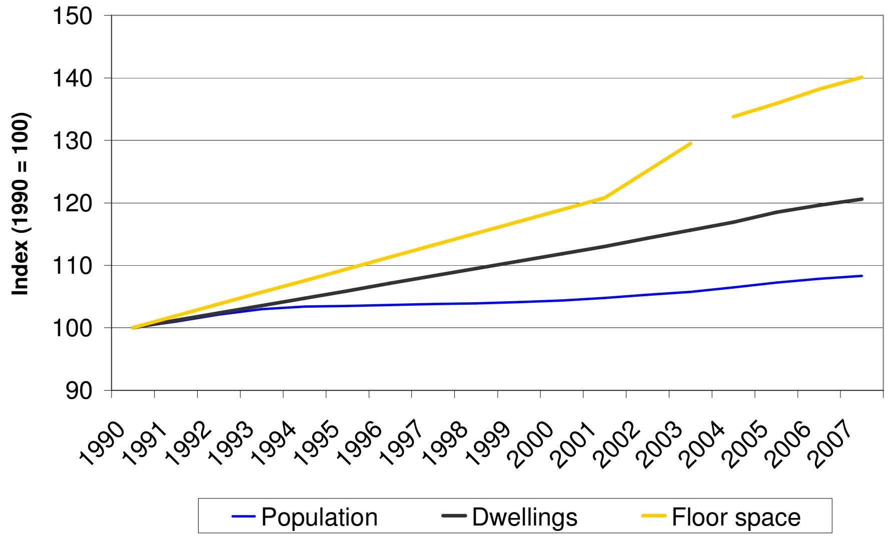


Fig. 2.14: Development of population, number of dwellings (main residences) and floor space (Data: Statistik Austria, Umweltbundesamt)

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 2007 the share of agriculture and forestry in GDP was 1.8 %. The agricultural quota of the working population amounts to 6 %.

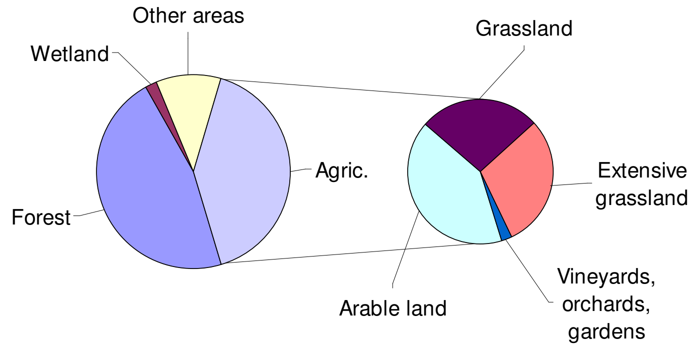


Figure 2.15: Land cover / land use in Austria 2005

According to the 2005 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 2007 amounts to 6.4 billion €; the share of plant production is 47 %, of animal products 45 % and of other agricultural activities and services 8 %. 2.0 million heads of cattle were counted in 2007, which is 23 % less than in 1990. The number of pigs decreased by 11 % to 3.3 million. For meat domestic production was 8 % higher than domestic consumption in 2007, for cereals 5 % lower.

The number of organic farms increased from 200 in 1980 and 1,539 in 1990 to 19,829 in 2007; more than 10 % of arable land are managed according to organic criteria. Three quarters 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. Coniferous trees have a high share in species with 67 %, most of them spruce; 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 more than one billion cubic metres of solid timber.

Because of their protective functions, mountain forests are of great importance to Austria. About one fifth of forest area in Austria is classified as protection forest, which protects its own site, settlements, agricultural areas or other objects against natural hazards. Austrian forests represent the largest carbon reservoir and have been a net carbon sink during recent decades. (Source: BMLFUW, 2008a; BMLFUW, 2008b)

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 87.96 million tons CO_2 equivalent in the year 2007 and were dominated by CO_2 with a share of 84 %. 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. Summary CRF tables are shown in Appendix C.

3.1 Inventory Methodology

The Austrian greenhouse gas inventory for the period 1990 to 2007 (NIR 2009 submitted to the UNFCCC secretariat in April 2009; Umweltbundesamt, 2009) 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 as well as the IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories and the IPCC Good Practice Guidance for Land Use, Land-Use Change and Forestry.

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.

3.2 Emissions in 2007

Austria's CO_2 emissions amounted to 74.18 Tg in 2007. Total emissions of the greenhouse gases CO_2, N_2O, CH_4, HFCs, PFCs and SF_6 were 87.96 Tg in the year 2007 (excluding Land Use, Land-Use Change and Forestry), with the transport sector contributing more than one quarter of total emissions, followed by energy use in manufacturing industries and energy industries with about one sixth each, and energy other sectors[1] with a slightly lower share.

3.2.1 Total emissions of direct greenhouse gases

The total emissions[2] of the greenhouse gases CO_2, N_2O, CH_4, HFCs, PFCs and SF_6 (excluding Land Use, Land-Use Change and Forestry) amounted to 87.96 Tg in the year 2007 (see Table 3.1). The ranking of the (sub)sectors according to their relative contribution is as follows (cf. Figure 3.1):

- **1A3:** Transport (28 %)
- **1A2:** Manufacturing Industries and Construction (18 %)
- **1A1:** Energy Industries (17 %)
- **1A4:** Other Sectors (13 %)
- **2:** Industrial Processes (11 %)
- **4:** Agriculture (9.0 %)
- **6:** Waste (2 %)

Table 3.1: GHG emissions 1990 and 2007, in Gg CO_2 equivalent

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	1990					2007				
	CO_2	CH_4	N_2O	F-Gases	Total	CO_2	CH_4	N_2O	F-Gases	Total
Total without LULUCF	**62.08**	**9.18**	**6.17**	**1.60**	**79.04**	**74.18**	**6.96**	**5.37**	**1.45**	**87.96**
Total with LULUCF	**48.65**	**9.18**	**6.42**	**1.60**	**65.86**	**56.78**	**6.96**	**5.65**	**1.45**	**70.84**
1. Energy	**54.20**	**0.85**	**0.55**		**55.59**	**64.38**	**1.02**	**0.75**		**66.15**
A. Fuel Combustion (Sectoral Approach)	54.09	0.46	0.55		55.11	64.14	0.31	0.75		65.20
1. Energy Industries	13.79	0.00	0.05		13.84	13.93	0.01	0.08		14.01
2. Manufacturing Industries and Construct.	12.69	0.01	0.08		12.77	15.67	0.01	0.14		15.82
3. Transport	13.77	0.06	0.19		14.02	23.92	0.02	0.28		24.22
4. Other Sectors	13.81	0.39	0.23		14.43	10.58	0.27	0.25		11.10
5. Other	0.04	0.00	0.00		0.04	0.04	0.00	0.00		0.05
B. Fugitive Emissions from Fuels	0.10	0.38	IE,NA		0.49	0.24	0.71	IE,NA		0.94
2. Industrial Processes	**7.58**	**0.01**	**0.91**	**1.60**	**10.11**	**9.54**	**0.02**	**0.27**	**1.45**	**11.28**
3. Solvent and Other Product Use	**0.28**		**0.23**		**0.51**	**0.25**		**0.16**		**0.41**
4. Agriculture		**4.83**	**4.34**		**9.17**		**4.11**	**3.84**		**7.95**
5. Land Use, Land-Use Change and Forestry	**-13.43**	**0.00**	**0.25**		**-13.18**	**-17.40**	**0.00**	**0.27**		**-17.12**
6. Waste	**0.03**	**3.49**	**0.13**		**3.65**	**0.01**	**1.81**	**0.35**		**2.18**

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 (29 % versus 28 %).

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

[2] 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

The emissions of CO_2 clearly dominate the GHG emissions in Austria with 74.18 Tg or 84 % compared to 8 % for CH_4, 6 % for N_2O and 2 % for F-Gases. (HFCs account for almost two thirds of F-Gases.)

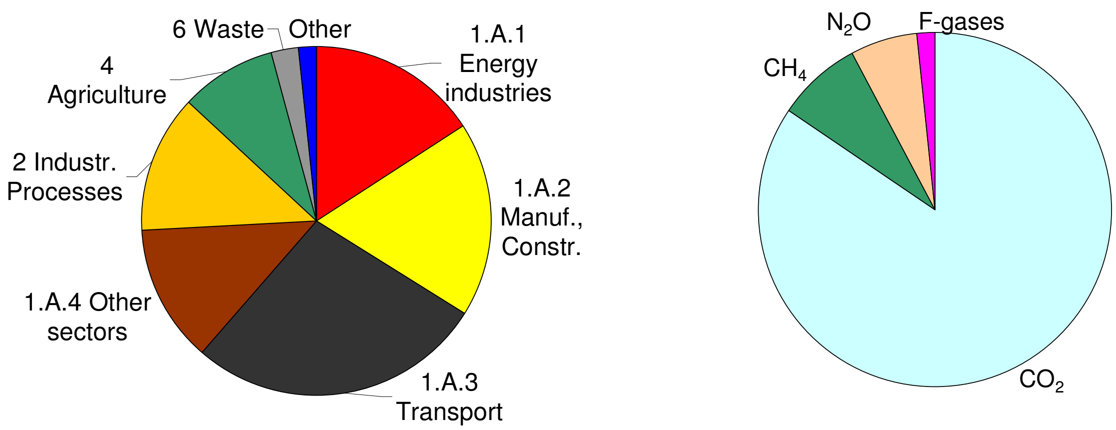


Figure 3.1: GHG emissions 2007 (excluding land-use change and forestry), split into sectors and gases

3.2.2 CO_2

CO_2 had the largest share of all greenhouse gases with emissions of 74.18 Tg in 2007 (see Table C.2). This amounted to 84 % of all greenhouse gas emissions in Austria.

The sector 'Fuel Combustion' (1A) accounted for 64.14 Tg or 86 % of CO_2 emissions with the subsector 'Transport' (1A3) showing the largest contribution to sector 1A with 23.92 Tg or 32 % of total CO_2 emissions. The next largest subsectors were 'Manufacturing Industries and Construction' (1A2) with 15.67 Tg (21 %) and 'Energy Industries' (1A1) with 13.93 Tg (19 %) and 'Other Sectors' (1A4) with 10.58 Tg (14 %). The sector with the second largest contribution was 'Industrial Processes' with 9.54 Tg or 13 %.

3.2.3 CH_4

In 2007 the CH_4 emissions of Austria were estimated to be 331.22 Gg (see Table C.2). The sector 'Agriculture' (4) shows the largest contribution with 195.73 Gg (59 %), with the subsector 'Enteric Fermentation' (4A) showing a contribution of 153.09 Gg (46 %). The sector 'Waste' (6) accounted for 86.22 Gg or 26 % and 'Solid Waste Disposal on Land' (6A) is the most important subsector with emissions as high as 83.06 Gg (25 %).

3.2.4 N_2O

In 2007 the Austrian N_2O emissions without Land Use, Land-Use Change and Forestry were estimated to be 17.33 Gg (see Table C.2). The sector 'Agriculture' (4) showed the largest contribution with 12.38 Gg (71 %), with the subsector 'Agricultural Soils' (4D) showing a contribution of 9.55 Gg (55 %). The next largest sectors were 'Fuel Combustion' (1A) with 2.42 Gg (14 %) and 'Waste' (6) with 1.14 Gg (7 %) respectively.

3.2.5 HFCs, PFCs, SF_6

In 2007 the actual and potential emissions of HFCs, PFCs and SF_6 were estimated to be 1.45 Tg and 2.26 Tg CO_2 equivalent, respectively (see Table C.2). The main contributions of the total actual HFC emissions of 0.86 Tg originated from the use of HFCs in mobile/stationary refrigeration (48 % of total emissions of HFCs, PFCs and SF_6) and in the foam blowing industry (8 % of total emissions of HFCs, PFCs and SF_6) and.

Estimation of total PFC emissions resulted in 0.18 Tg CO_2 equivalent originating mainly from the semiconductor industry. Estimation of total SF_6 emissions resulted in 0.41 Tg CO_2 equivalent, caused to a large extent by the production and disposal of noise insulate windows.

3.2.6 Indirect greenhouse gases

NMVOC: The main contributions to the total of 179.38 Gg of NMVOC emissions in Austria (see Table C.2) originated from the following sectors (subsectors):

- **3:** Solvent and Other Product Use (58 %)
- **1A4:** Other Sectors (24 %)
- **1A3:** Transport (12 %)

NOx: The main contributions to the total of 219.22 Gg of NO_x emissions in Austria (see Table C.2) originated from the following sectors (subsectors):

- **1A3:** Transport (64 %)
- **1A2:** Manufacturing Industries and Construction (15 %)
- **1A4:** Other Sectors (11 %)

CO: The main contributions to the total of 767.56 Gg of CO emissions in Austria (see Table C.2) originated from the following sectors (subsectors):

- **1A4:** Other Sectors (45 %)
- **1A3:** Transport (29 %)
- **1A2:** Manufacturing Industries and Construction (22 %)

SO2: The main contributions to the total of 25.52 Gg of SO_2 emissions in Austria (see Table C.2) originated from the following sectors (subsectors):

- **1A2:** Manufacturing Industries and Construction (44 %)
- **1A4:** Other Sectors (26 %)

1A1: Energy Industries (23 %)

3.2.7 Land-use, land-use change and forestry

The sector 'Land Use Change & Forestry' (5) was a sink for CO_2 in 2007 amounting to minus 17.40 Tg CO_2 due to the increase in Biomass Stock Change. The main CO_2 sink is subsector 'Forest Land' (5A) with net removals of 19.54 Tg CO_2 in 2007. Another sink is subsector 'Grassland' with net removals of 1.27 Tg CO_2. Emissions arise from the other subsectors (in total 3.41 Tg CO_2 in 2007).

Sector 5 is a source for emissions of N_2O, emissions amounted to 0.89 Tg. The emissions arise from subsector 'Cropland' (5B). There are no significant emissions of CH_4 from sector 5.

3.3 Trend of emissions from 1990 to 2007

Austria's total greenhouse gases showed an increase of 11 % from the base year to 2007 (CO_2: +19 %). 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 Fourth Austrian National Communication, have been recalculated to obtain consistent numbers.

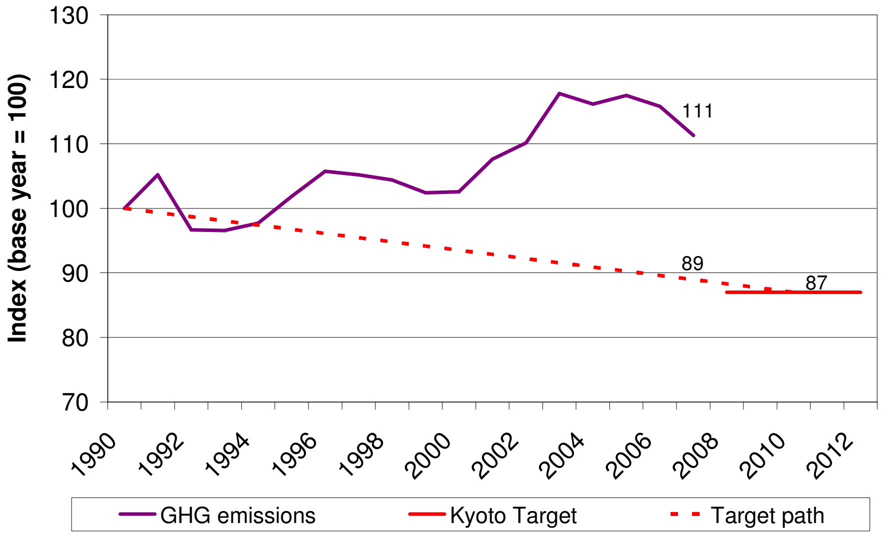


Figure 3.2: Trend in total GHG emissions 1990-2007 (excluding land-use change and forestry) and Kyoto Target

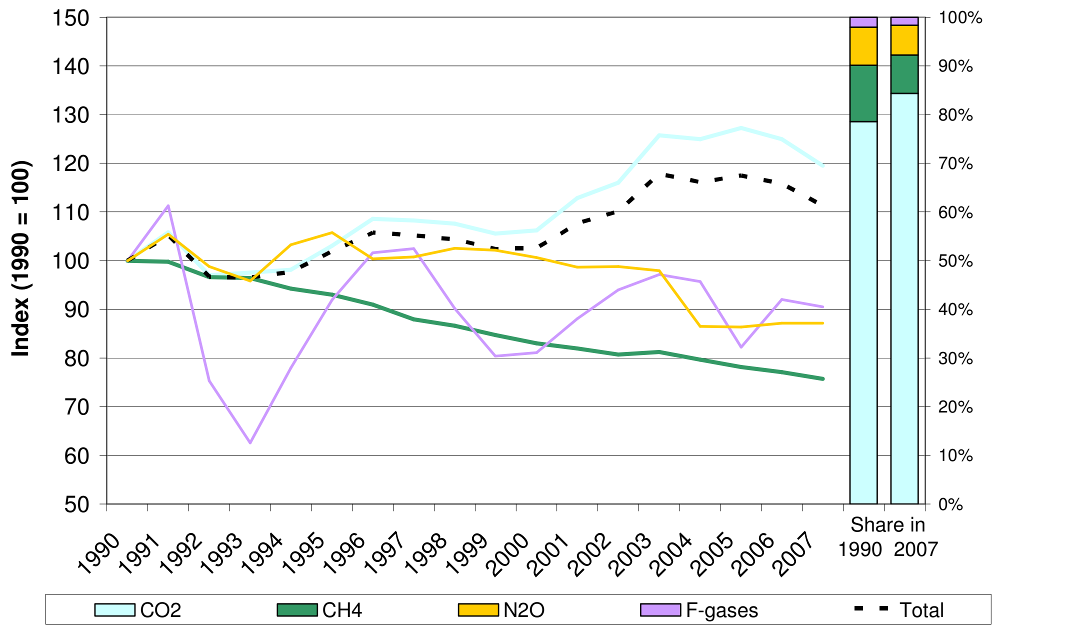


Figure 3.3: GHG emission trend (excluding land-use change and forestry), split into gases

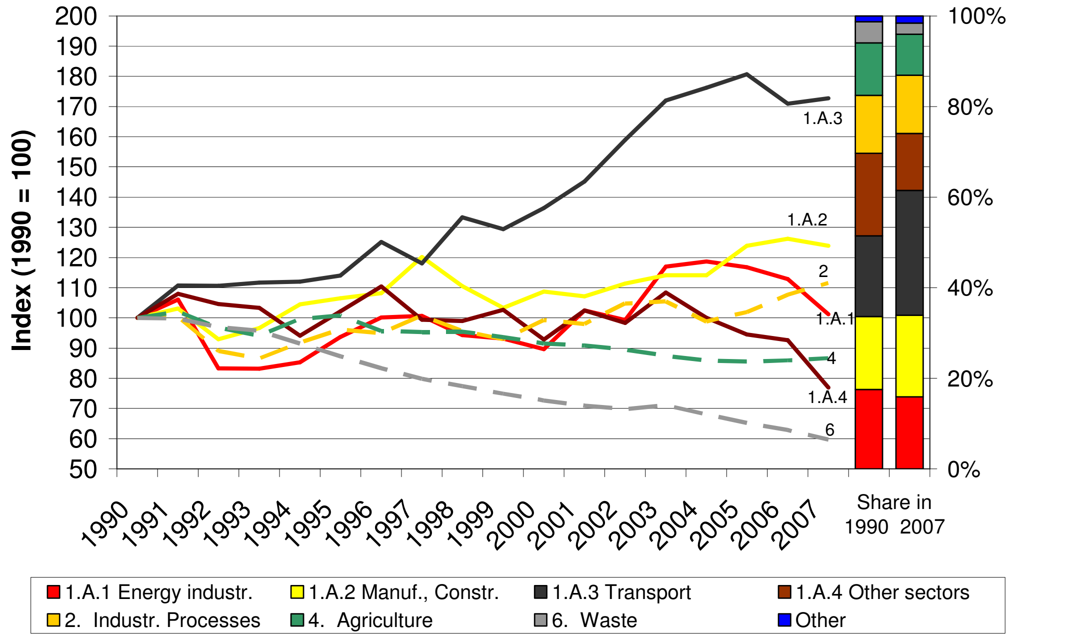


Figure 3.4: GHG emission trend, split by sectors

3.3.1 CO_2

CO_2 emissions have been fluctuating at the beginning of the decade in the range of 60 to 65 Tg, and after an increase until 1996 followed by a decrease, emissions seemed to have stabilized on a level of about 66 Tg. However, since 2000 emissions have strongly increased, from 2000 to 2005 by 13 Tg (+20 %). From 2005 to 2007 emissions have decreased again by 3 Tg. Quoting in absolute figures, CO_2 emissions increased from 62.08 Tg in 1990 to 74.18 Tg in 2007, that is an increase of 19 %. This is mainly due to emissions from transport, which increased by 73 % (cf. Fig. 3.5).

Emissions calculated according to fuel used in Austria show a different picture. Starting from a comparable level in 1990 (61.2 Tg) emissions increased less pronounced from 2000 to 2005 (from 63.4 Tg to 70.8 Tg), and by only 10 % from 1990 to 2007.

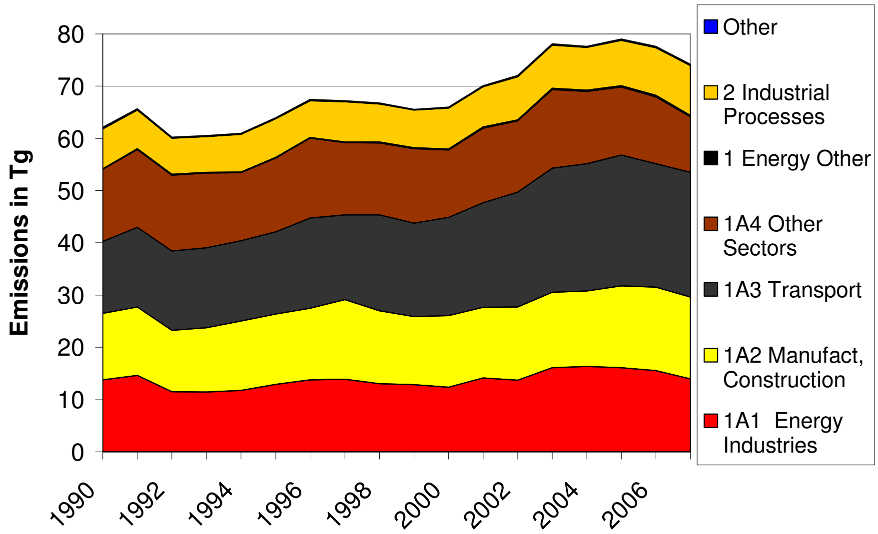


Figure 3.5: CO_2 emission trend

According to the 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.

The increase of CO_2 emissions in the sector 'Transport' (1A3) is mainly due to the increase of road fuel export in the vehicle tank and to the increase of transport demand. In addition there is a comparatively small effect of the increased share of road transport. Use of biofuels and improved energy efficiency due to technical improvements could only marginally slow down the increase. This description is valid for passenger and freight transport, the magnitude of net increase, however, is less than 50 % for passenger transport and considerably more than 100 % for freight transport.

Almost half of the manufacturing industries' emissions (1A2 and 2) are caused by the iron and steel industry. The increased steel production would have caused a CO_2 emission increase of almost 80 %, which could be halved by reduced energy intensity and to a smaller extent by reduced carbon intensity of fossil fuel and more electricity purchase. Driving force for the increase in energy related emissions of the other subsectors of 1A2 was the increase in value added, which would have led to an emission increase of about 60 %; factors like reduced energy intensity of production, more biomass use and reduced carbon intensity of fossil fuel, however, could compensate the increase by about two third.

CO_2 emissions from energy industries (1A1) are dominated by public electricity and heat production. Emissions of this subsector would have increased by more than half due to higher electricity consumption as most important factor as well as due to increased production in thermal plants and more district heating demand. The emission reducing effects of reduced fuel intensity, increased share of biomass, reduced carbon intensity of fossil fuel and increased electricity imports, however, led to a slight decrease of emissions all in all.

Space heating in private households, the most important source of CO_2 emissions in sector 1A4, is a subsector with a substantial emissions decrease of about 20 %. Improved energy efficiency of buildings and, to a smaller extent, a reduced share of fuels in final energy consumption, increased biomass and reduced carbon intensity of fossil fuel would have led to an even higher emission decrease, if the increase in number and size of dwellings would not have more than halved that effect.

The trend analysis shown above is described in more detail in Umweltbundesamt, 2009c. See also Figure 3.9 at the end of this chapter.

3.3.2 CH_4

CH_4 emissions decreased steadily during the period from 1990 to 2007, from 437.3 to 331.2 Gg. In 2007 CH_4 emissions were 24 % below the level of the base year. The decrease was dominated by the emission trends in the sectors waste management and agriculture (see Figure 3.6).

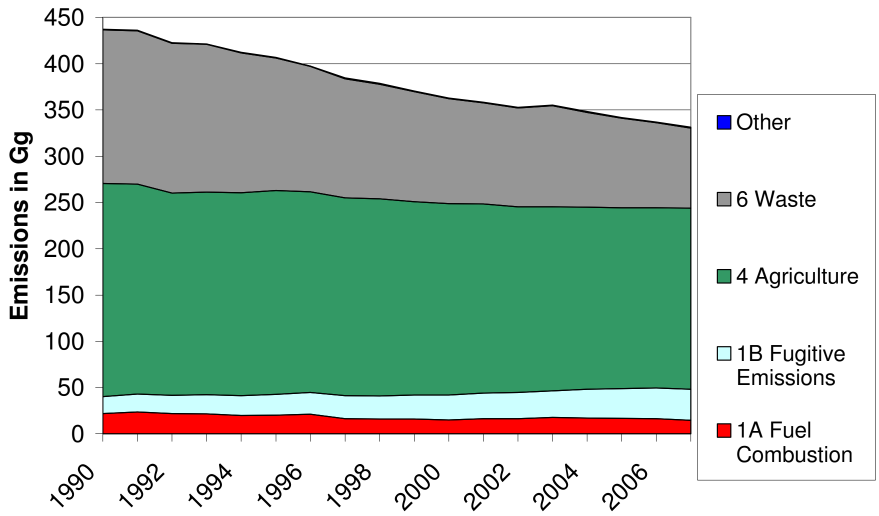


Figure 3.6: CH_4 emission trend

Emissions from solid waste disposal sites are the most important source of CH_4 emissions in sector 6. The amount of waste deposited has increased and would have led to an emission increase of about one third. Reduced carbon content of the waste deposited and, to a smaller extent, the reduced share of degradable carbon in landfills and improved landfill gas recovery have reduced emissions. As net effect emissions from this subsector have been almost halved.

Emissions from enteric fermentation dominate sector 4. The decrease in this subsector is mainly caused by increasing milk yield per cow and reduced numbers of livestock.

3.3.3 N_2O

N_2O emissions in Austria fluctuated in the 1990ies, but were at the same level in 2000 as in 1990. After 2000 emissions showed a decreasing trend, resulting in 17.3 Gg in 2007 compared to 19.9 Gg in the base year (-13 %). The decrease is mainly due to lower N_2O emissions from agricultural soils and emission reduction measures in the chemical industry (cf. Fig. 3.7).

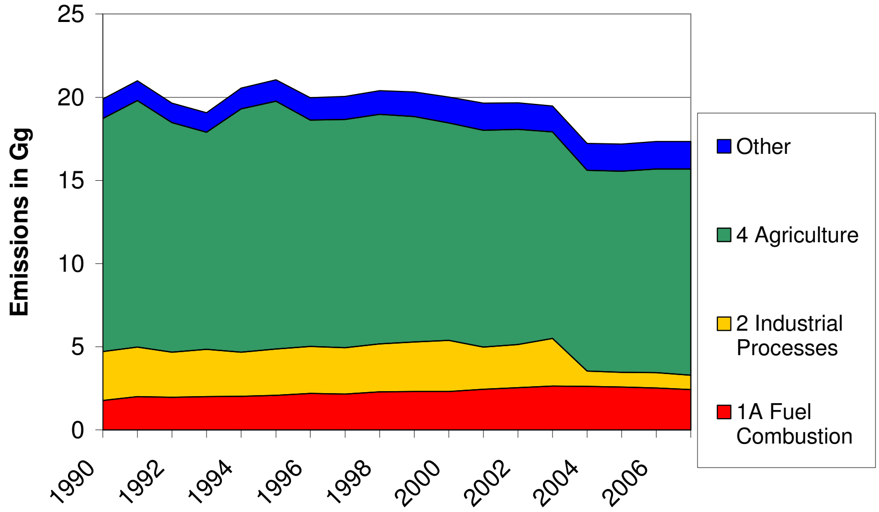


Figure 3.7: N_2O emission trend

3.3.4 HFCs, PFCs and SF_6

Emissions of F-gases showed considerable fluctuations after 1990 and were 9 % below the 1990 level in 2007. The share of the gases has changed greatly (cf. Fig. 3.8).

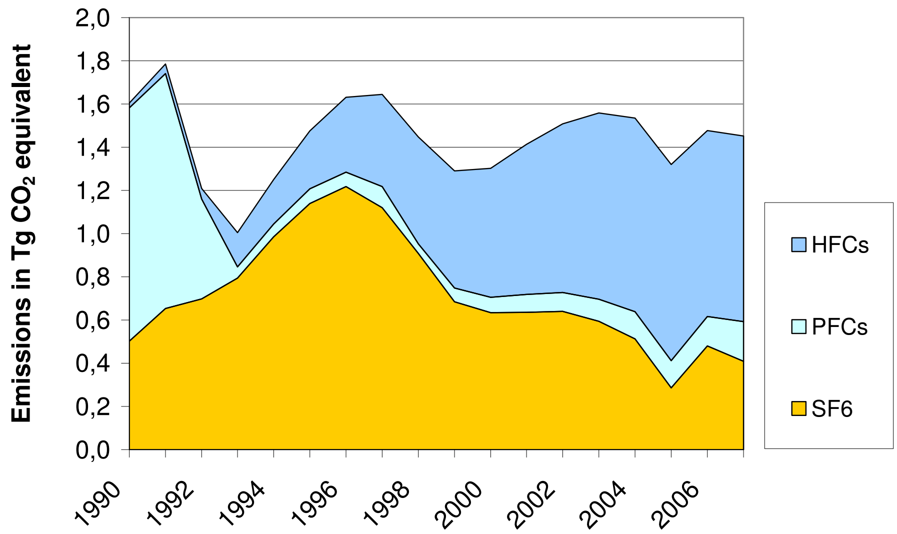


Figure 3.8: Emission trend of F-gases

HFC emissions increased remarkably during the period from 1990 to 2007: From 0.02 to 0.86 Tg CO_2 equivalent. HFCs habe been increasingly used as substitutes for HCFCs (Hydrochlorofluorocarbons; these are ozone depleting substances), the use of which has been banned for most applications. The increase is mainly due to their use in refrigeration and air conditioning equipment.

PFC emissions decreased by more than 80 %, from 1.08 to 0.18 Tg CO_2 equivalent. 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.

Starting with 0.50 Tg CO_2 equivalent, emissions of SF_6 reached am maximum of 1.22 Tg in 1996 and dropped to 0.41 Tg in 2007, which is almost 20 % below the level of 1990. The decrease starting in the late 1990ies is due to technological improvements in light metal foundries, reduced consumption in semiconductor manufacture and the ban of certain uses of SF_6.

3.3.5 Indirect greenhouse gases

NMVOC: Emissions decreased from 273.5 to 179.4 Gg during the period from 1990 to 2007. In 2007 NMVOC emissions were 34 % 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 192.2 to 219.2 Gg during the period from 1990 to 2007. In 2007 the NO_x emissions were 14 % 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 1,432.2 to 767.6 Gg during the period from 1990 to 2007. In 2007 CO emissions were 46% below the level of 1990. The trend in CO emissions is decreasing in all sectors, with an especially large reduction in the sector 'Transport' and considerable reductions in 'Other Sectors' and 'Manufacturing Industries and Construction'.

SO_2: Emissions decreased from 74.3 to 25.5 Gg during the period from 1990 to 2007. In 2007 SO_2 emissions were 66 % below the level of 1990. The largest reductions since 1990 were achieved in the sectors 'Other Sectors', 'Energy Industries' and 'Manufacturing Industries and Construction'.

3.3.6 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 13.43 Tg CO_2 in the base year and 17.40 Tg in 2007, which is an increase of 30 %. N_2O emissions increased from 0.25 Tg CO_2 equivalent in 1990 to 0.27 Tg in 2007.

3.4 Fuel split of CO_2 emissions

In 2007 the sector 'Fuel Combustion' (1A) accounted for 64.14 Tg emissions of CO_2. Liquid fuels contributed 56% or 35.61 Tg, gaseous fuels 25% or 15.81 Tg and solid fuels 17% or 10.97 Tg. The remaining 1.7 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 2007 shows that the CO_2 emissions from the sector 'Fuel Combustion' increased by 10.05 Tg. The liquid and gaseous fuels show an increase of 7.47 and 5.51 Tg CO_2, respectively, whereas the solid fuels decreased by 2.95 Tg.

3.5 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*, an inspection body accredited according to the International Standard ISO 17020 *General Criteria for the operation of various types of bodies performing inspections*. 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. 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.

The Austrian national system was reviewed during the in-country review of the initial report of Austria (February 2007). Para 10 of the review report (FCCC/IRR/2007/

AUT) states that the national system has been developed in line with the relevant guidelines and can fulfil the requirements of the Kyoto Protocol as well as other obligations regarding its air emissions inventory that Austria has to comply with.

Detailed information on the national inventory system has been reported and can be found in Austria's Initial Report[3] according to Decision 13/CMP.1.

The inventory preparation at *Umweltbundesamt* is supported by a quality management system that embeds an inventory improvement plan. This centralized improvement management guarantees the cost-effective allocation of resources to programmes specific for inventory improvement. Improvement programmes are formulated in a continuous process in all inventory sectors and cover the quality of country-specific emission factors, activity data and models.

Examples for these programmes in the latest years are: The cooperation with other European countries in developing the "handbook of emission factor" for road transport; the close cooperation with research institutes for the continuous improvement of emission factors and models for Agriculture; the cooperation with Statistics Austria that allows feedback from *Umweltbundesamt* to the energy statistics improving consistency and transparency; and the continuous improvement of assessing sources and sinks in land use and land-use changes to fully comply with the reporting under Article 3.3 of the Kyoto protocol.

3.6 National Registry

The registry administrator designated by Austria to maintain the national registry is Umweltbundesamt GmbH. The registry is operational since June 2005.

Detailed information about the national registry has been reported and can be found in Austria's Initial Report[3] and in the National Inventory Reports 2008[4] and 2009[5].

[3] http://unfccc.int/files/national_reports/initial_reports_under_the_kyoto_protocol/application/pdf/at-initial-report-200611-corr.pdf
[4] http://unfccc.int/files/national_reports/annex_i_ghg_inventories/national_inventories_submissions/application/x-zip-compressed/aut_2008_nir_15apr.zip
[5] http://unfccc.int/files/national_reports/annex_i_ghg_inventories/national_inventories_submissions/application/zip/aut_2009_nir_15apr.zip

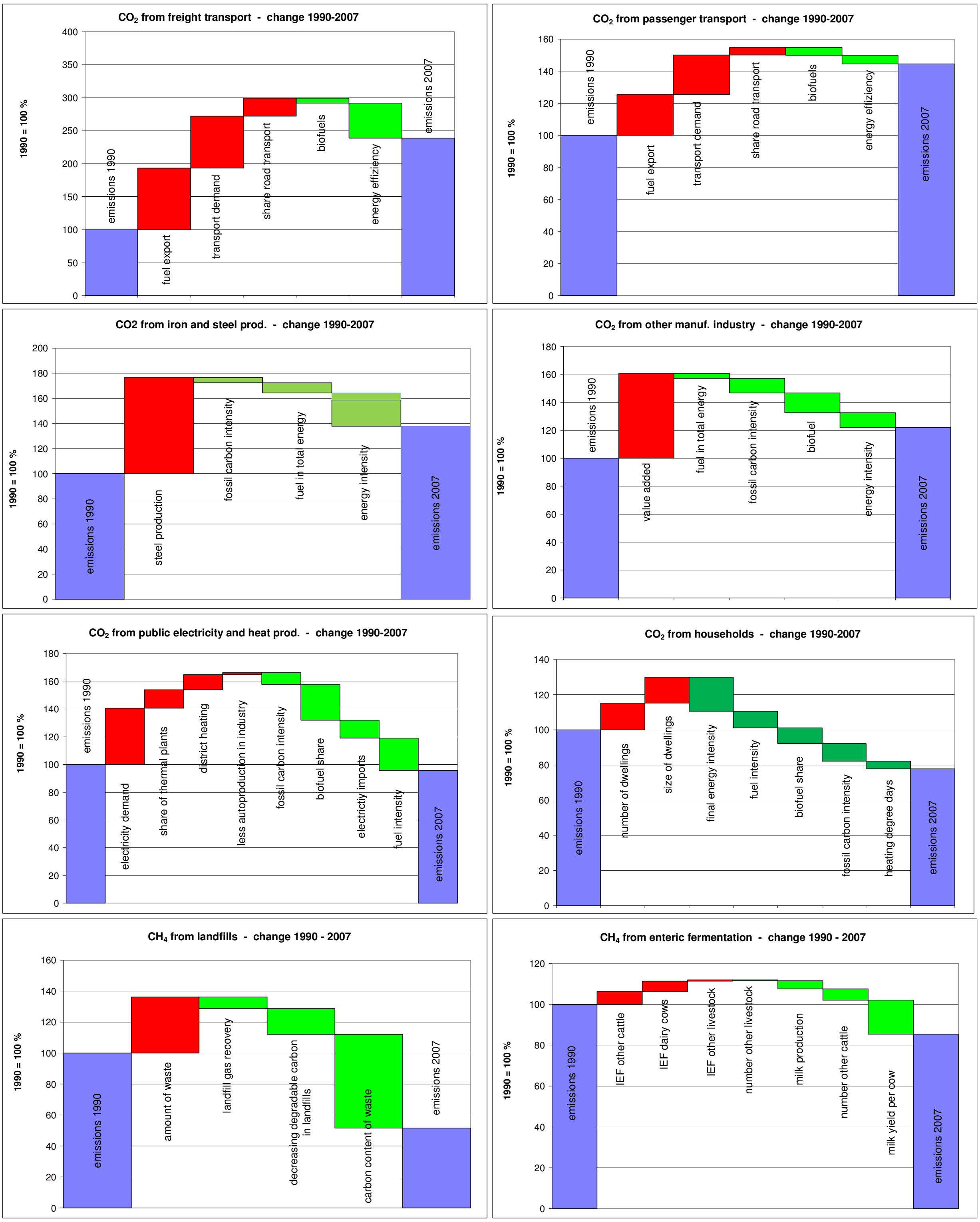


Figure 3.9: Decomposition analysis of sectoral GHG emissions (Source: Umweltbundesamt, 2009c)

Chapter 4

Policies and Measures

CONTENTS

An overview of the policy-making process and of domestic programmes and arrangements, as well as details on policies and measures for climate change mitigation, as requested by the Convention and the Kyoto Protocol, are presented in this chapter. 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.

4.2 Domestic and regional Programmes, legislative Arrangements, enforcement and administrative Procedures

4.2.1 Administrative Procedures

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 and the Kyoto Protocol 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*. The IMC serves to exchange information on national and international climate change issues and to discuss and agree on proposals that are intended for adoption by the council of ministers of the federal government. On an ad hoc basis the IMC is supplemented by expert groups for certain issues, for example for the preparation of the climate strategy.

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.

4.2.2 Programmes

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, describing domestic measures with the aim to reach the national Kyoto target. After three years of implementation, the effects of the *Climate Strategy* have been evaluated and in 2007 the *Climate Strategy II* has been adopted by the Austrian Federal Government.

Most *Länder* (e.g. Vienna, Upper Austria, Lower Austria, Salzburg) have 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.

4.2.3 Legislative arrangements and enforcement

The 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 and made available to the public.

Some important elements of legislation concerning climate change mitigation are mentioned below.

Climate Protection Act ("Klimaschutzgesetz", KSG)

The Klimaschutzgesetz (Climate Protection Act), which will define the responsibilities of the public authorities for reaching the emission reduction target, is currently under development.

The Domestic Environmental Support Scheme

The Austrian Environmental Support Act was enacted in 1993 (Umweltförderungsgesetz, BGBl. Nr. 185/1993 as amended). The main objective of this subsidy is to provide economic incentives for companies to implement measures in the field of energy efficiency, climate and environment protection. In general, the subsidy covers 30 % of the environment related investment costs – higher or lower subsidy rates are intended in certain circumstances. Kommunalkredit Public Consulting is in charge of the management of the environmental support schemes of the Federal Government. Information on the effects of the environmental support scheme can be found in Section 4.3 (cross-cutting policies).

EU Emission Trading Scheme

The basis of the EU Emissions Trading Scheme (EU ETS) is the Emissions Trading Directive 2003/87/EC, which entered into effect by 1 January 2005. This Directive has been transposed into Austrian law by the Emissionszertifikategesetz (EZG, Emissions Allowance Trading Act, BGBl. I Nr 46/2004 as amended). In order to link the EU ETS to international emissions trading, the EU passed Directive 2004/101/EC, the so-called Linking Directive. This directive specifies how the EU ETS is linked to the Kyoto flexible mechanisms Joint Implementation and Clean Development Mechanism. The Linking Directive has been transposed into Austrian law by an amendment to the EZG. Another piece of legislation in this context is Decision 2006/780/EC on avoiding double counting of greenhouse gas emission reductions for project activities under the Kyoto Protocol.

At national level the Emissions Allowance Trading Act is the core of Austrian legislation on emissions trading. The number of allowances to be allocated in the relevant trading period is first of all determined in the National Allocation Plan (NAP). After having finalised the National Allocation Plan for the respective trading period, Austria submits the NAP to the European Commission for approval. After approval, emission allowances are granted to the individual installations by permit.

In Austria, around 200 energy intensive installations from industry and energy production sectors are covered by the scheme. Information on the effects of the ETS can be found in Section 4.3 (energy supply, industry, cross-cutting policies).

JI/CDM Programme

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.

The Programme is based on an amendment of the Umweltförderungsgesetz (UFG, Environmental Support Act, BGBl. Nr. 185/1993 as amended). Kommunalkredit Public Consulting (KPC) was appointed for the Programme Management. The programme was launched in August 2003. A purchase budget of 89 million € annually from 2009 to 2012 is guaranteed by law (purchase budget started with 1 million € in 2003 and increased to 56 million € in 2008). The total budget available for purchase of emissions reductions will amount to 531 million €. Information on the effects of the JI/CDM programme can be found in Section 4.3 (cross-cutting policies). (http://www.ji-cdm-austria.at/en/portal/theaustrianjicdmprogramme/)

4.2.4 Sustainability and Biodiversity

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 of environmentally friendly modes of transport.

Nature conservation has a long tradition in Austria. The management of forest is characterised by a long-term forestry policy that takes issues of biodiversity conservation into account. The principle of sustainable management of forests is laid down in § 1 of the Austrian Forest Act, the need for re-afforestation in § 13. Laws on nature conservation and landscape protection and on national parks have been enacted at *Länder* level. Forest biodiversity is also supported by the Natural Forest Reserves Programme.

In order to balance the various interests in forest utilisation and to assure the many benefits of the Austrian forest in the long term, the Federal Minister of Agriculture, Forestry, Environment and Water Management initiated the Austrian Forest Dialogue. It is a structured participative, transparent and on-going public dialogue on the forests. As an important result of the Austrian Forest Dialogue, the Austrian

Forest Programme identifies all the fundamental issues, targets and actions for the Austrian forest for the future. It contains specific political proposals for action with regard to all the major forest issues, with the aim of assuring and continuously optimising sustainable management, preservation and development of the Austrian forests. The programme's fields of action include "biological diversity of the Austrian forests" and "Austria's international responsibility for sustainable forest management".

4.3 Policies and Measures and their Effects

This section provides information on implemented, adopted and planned policies and measures, which contribute to achieving the greenhouse gas mitigation goals of the Convention and Austria's quantified emission limitation and reduction commitment under the Kyoto Protocol.

The current national climate strategy (Climate Strategy II, BMLFUW 2007) is based upon a comprehensive evaluation conducted by the Austrian Energy Agency (EEA) and the Environment Agency Austria (Umweltbundesamt) in 2005/2006 (Österreichische Energieagentur & Umweltbundesamt 2006) and amends the Climate Strategy of 2002 (Climate Strategy I, BMLFUW 2002). The project contained an evaluation of past impacts (ex-post) and an appraisal of future impacts (ex-ante) of policies and measures (PaMs) proposed in the national Climate Strategy I as well as a monitoring of progress made by 2003. Meanwhile, a detailed examination of ex-post emission trends through indicators, a sectoral decomposition analysis, and an evaluation of the status of implementation of policies and measures specified in the national Climate Strategy I and its amendment is carried out annually by the Environment Agency Austria (Umweltbundesamt 2008, Umweltbundesamt 2009c). 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 order to improve monitoring and evaluation of PaMs in an integrated approach, the *Länder* are invited to report on the status of implementation of PaMs on the basis of a set of performance indicators that have been elaborated by an ad-hoc working group on monitoring.

In the years 2005/2006 emission projections have been elaborated by the Environment Agency Austria within the framework of the project EMIPRO (Umweltbundesamt 2006). The emission projections presented in this report have been updated in 2008/2009 (Umweltbundesamt 2009c). However, the experience has shown that due to methodological constraints it was not always possible to link all policies and measures of the projections to the PaMs outlined in the climate mitigation programmes of the national authorities. In view of that, the latest report on projections under Decision 280/2004/EC (Umweltbundesamt 2009c) aimed at a closer link between PaMs and assumptions made for emission projections. Hence the structure of the policies and measures chapter in the present NC5 has been slightly changed in order to (i) harmonise reporting on PaMs and projections under the EU and the UNFCCC and (ii) gain a better overall view on progress made. Being aware that this will impair continuity to previous national communications we have tried to refer to the 4th National Communication (NC4) to the extent feasible and thus bridge the current and the previous national communications.

The descriptions by sector in the following paragraphs need to be read in conjunction with the PaMs summary table at the end of this chapter. The PaMs summary table provides quantifiable reduction effects for the years 2010, 2015 and 2020 and other information requested and outlined in the UNFCCC reporting guidelines. In addition, ex-post data on reduction effects or on relevant indicators are provided in the textual description, where available. To this end, it has to be noted that the level of sophistication for both – ex-post and ex-ante assessment of PaMs – varies between different sectors and between different types of measures (e.g. voluntary, fiscal, economic, education, research, etc.).

With few exceptions, reduction effects are given for groups of policies and measures and not for all PaMs individually. Even if effects could be specified for individual policies and measures, those cannot be simply summed up in order to express the total effect of PaMs within a sector. There are major strengthening and weakening impacts between policies and measures. This should be taken into account when comparing reduction effects.

This chapter fully complies with the UNFCCC reporting guidelines. It follows their proposed structure, i.e. energy, transport, industry, agriculture, forestry and waste management. Further subdivision was introduced for the energy sector (energy supply and energy demand) and the industry sector (F-gases). Consistency with the projections chapter is given through the transparent declaration of CRF source categories.

All emissions are reported in carbon dioxide equivalent values and have been converted from each gas on the basis of global warming potentials (GWP) as agreed upon by the Conference of the Parties.

The current economic crisis

The current economic crisis has an impact on greenhouse gas emissions from 2008 onwards, e.g. through reductions in production and freight transport. For reasons of data availability, this is however not reflected in the emission scenarios and the effects of policies and measures presented in this report.

Differences to the fourth national communication (NC4):

- The notation, the denomination and partly the definitions of policies and measures have been adapted to the updated projections (Umweltbundesamt 2009c) in order to increase consistency and transparency within this NC5. Reference to PaMs in previous NCs is provided to the extent possible.
- In an attempt to avoid over-lengthy textual descriptions, priority has been given to the most effective PaMs in terms of their emission abatement effect and to PaMs that are considered to be innovative or possibly replicable by other countries.
- A list of all policies and measures included in the emission projections is given in the PaMs summary table at the end of this chapter.

4.3.1 Energy

Source Categories of the Common Reporting Format affected[1]: 1.A.1 (energy industries), 1.A.4 (other sectors)

Austria's energy policy was laid down in the Energy Report 2003 of the Federal Government to the Parliament (BMWA 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 I (BMLFUW 2002), just as the results of the Climate Strategy II (BMLFUW 2007) will be taken into account in the next Energy Report.

It should be mentioned that the Minister for the Environment and the Minister for Economic Affairs initiated a stakeholder process to establish a new Energy Strategy for Austria in April 2009, in response to the legally binding European commitments on renewable energy and climate change (2020 targets). Since then, numerous working groups, incorporating government institutions, social partners and other interest groups (including environment NGOs) were set up for elaboration of policies and measures, which shall ensure to improve energy efficiency, to increase the share of renewable energy sources to 34% by 2020 and to bring down greenhouse gas emissions to levels compatible with the European legal framework in the period 2013-2020. It is envisaged to conclude the Energy Strategy in the first half of 2010, on time to deliver an National Renewable Energy Action Plan (NREAP) to the European Commission by end of June 2010, according to Directive 2009/28/EC. Results are not yet available and are therefore not described in this National Communication.

For reasons of consistency with the national Climate Strategy (BMLFUW 2002, 2007) and with the national emission scenarios as reported in the projections chapter of this report the energy sector has been split into the energy supply subsector (1.A.1) and the energy demand subsector (residential and commercial, 1.A.4). 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).

4.3.1.1 Energy Demand (residential and commercial)

Source Categories of the Common Reporting Format affected: 1.A.4. (other sectors)
GHG affected: CO_2 (almost exclusively)

The subsector energy demand (residential and commercial) mainly represents emissions from individual heating and hot water preparation in buildings (dwellings, commercial and public services), being responsible for around 90 % of total emissions covered under 'other sectors' (1.A.4). Single- and two-storey houses for

[1] According to the projections chapter emissions from the categories 1.B Fugitive Emissions from fuels and 1.A.5 Other are also attributed to the energy sector, but there are no measures designated for these subsectors and therefore no further description is provided.

one or two families are responsible for about two third of the emissions of the residential sector due to specific construction and heating systems as well as due to the floor space, which is in average higher than in flats.

Emissions from this sector have been lower by 23 % in 2007 compared to 1990. Climate adjusted data (with balance for heating degree days) show quite stable emissions over the whole period between 1990 an 2007 with a slight decrease since 2004, even though the number of dwellings increased substantially from 2.9 million permanently occupied dwellings to 3.5 million between 1990 and 2007, mainly due to population growth. At the same time, average numbers of persons per dwelling fell because of the trend to single households while net square meters per dwelling increased. Also trade and public service sectors had a rising demand for building net square meters. The final energy consumption per square meters fell from 0.8 GJ/m^2 in 1990 to 0.7 GJ/m^2 in 2007 (Umweltbundesamt 2009c). The decreasing trend can partly be attributed to PaMs (especially energy efficiency gains), but there are a lot more factors influencing the development of emissions such as mild winters (e.g. in 2007) or disproportionately low heating oil sales caused by fuel price fluctuations and purchase decisions taken by consumers.
Policies and measures relating to this subsector generally aim at reducing the energy consumption through increases in energy efficiency in space heating, hot water preparation and electricity demand and through the use of energy sources that are less carbon-intensive or even carbon-neutral. Hence, the strategy to reduce GHG emissions is based on the following pillars:

- Thermal improvement of existing building stock
- Enhanced technical standards for new buildings
- Increasing share of renewable energy sources such as biomass and solar or ambient heat
- Increased use of district heating
- Increasing boiler efficiency
- Increased use of heat pumps and solar heat
- Switching to fuels with lower (fossil) carbon content
- Raising consumer awareness of energy saving

Efficiency of heating systems and buildings have been improved, due to technical progress, strengthened legal standards and extended public support schemes for energy efficient buildings and heating systems. Public funding programmes and the establishment of a legal basis to encourage the use of renewable energy sources are also substantial prerequisites to promote the implementation of existing measures. To this end action has been taken and is mainly referenced in the PaMs paragraphs. With respect to public awareness, numerous campaigns concerning domestic energy saving have been performed at national, regional and municipal level and also by Non-Governmental Organisations (NGOs); advising services by publicly funded energy agencies and training programmes for specific target groups have been established and have become increasingly popular throughout the last decade. In 2004 the climate change initiative klima:aktiv has been initiated by the Ministry of Environment. The programme is planned to last until 2012. Several thematic programmes have been launched in the framework of klima:aktiv (e.g. 'klima:aktiv ecofacility', 'klima:aktiv wohnmodern', 'Bundescontracting.at', 'Bildungskoordination', etc.), which cover inter alia the areas construction, energy efficiency and renewable energy sources. The initiative combines various market-based measures and effectuates target-oriented implementation, e.g. by providing easier access to target groups and resources, by enhanced transfer of know-how 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. Programmes such as klima:aktiv push the implementation of more than one measure. These programmes are only implicitly included in the assumptions for the emission scenarios. A 100 million programme to stimulate thermal insulation of both private and commercial buildings has been launched in April 2009 as part of the Austrian economic stimulus package. Depending on the number and type of measures, a certain reduction of heating demand had to be achieved in order to qualify for financial support, which may be up to 20% (private buildings) or 40% (commercial buildings) of investment costs.

The following PaMs[2] are included in the 'with measures' (wm) and 'with additional measures' (wam) scenarios. The emission reductions outlined have been quantified through an energy demand model for residential and commercial buildings in the scope of the development of emission projections in Austria. A detailed description of assumptions made for the assessment can be found in the underlying report on emission scenarios (Umweltbundesamt 2009c).

01_ED Increased use of renewable energy in the sector residential and commercial ('Erneuerbare')

This group of measures comprises a great number of policies and measures defined in the Climate Strategy (BMLFUW 2002) and its amendment (BMLFUW 2007). The overall objective is to increase the use of biomass (log wood, wood chips, wood pellets and wood briquettes), solar heat and ambient energy (heat pumps) through specific subsidies for renewable energy sources.

Significant policy instruments that promote the implementation of this measure group are the Housing Support Scheme of regional authorities ('Wohnbauförderung' – WBF), Technical Construction Regulations by the *Länder*, the Austrian Climate and Energy Fund ('Klima- und Energiefonds'-KLI.EN), the Domestic Environmental Support Scheme ('Umweltförderung im Inland'- UFI), and the programme klima:aktiv – the last three are funded by the national government (BMLFUW). For further information related to the UFI see chapter cross-cutting policies, related to the KLI.EN see measure 05_EN in the subsector energy supply.

The Housing Support Scheme (WBF) promotes inter alia the use of renewable energy and building renovation. Most *Länder* in Austria support the replacement of old fossil fuelled heating systems by highly efficient systems based on renewable energy (solar, biomass) or natural gas (with condensing boiler technology). In addition, the *Länder* continue to promote the connection with existing or new (often biomass-fired) district heating. Thermal minimum standards for new buildings are defined in the Technical Construction Regulations of the *Länder*. A majority of dwellings is constructed or renovated with public support in Austria.

A constitutional treaty between the *Länder* and the Federation came into effect in 2006 (BGBl. II Nr. 19/2006) and provided for further improved standards as a prerequisite for receiving subsidies and for a shift of subsidies in favour of the

[2] The denotation for policies and measures in the sub-sector energy demand was changed from RES used in the underlying report on PaMs and projections (Umweltbundesamt 2009c) to ED in the report at hand.

thermal renovation of existing dwellings. This agreement according to Article 15a of the Federal Constitution Act has been amended (BGBl. II Nr. 251/2009) and came into force in August 2009. Additional areas covered by the amended agreement are building law, commercial buildings and additional measures to be implemented by the Federation. The extensions are implicitly included in the 'with additional measures' scenario but not in the current 'with measures' scenario and relate to all aspects of greenhouse gas mitigation in the sector energy demand.

A common reporting format including performance indicators in terms of CO_2 emission reductions and associated costs is already implemented. A detailed description of the Housing Support Scheme has been given in the 4th National Communication (M2 *Housing Support Schemes – Constitutional Treaty between Federation and Länder*, M2.3 *Housing support for use of renewable energy* and also M1 *Minimum thermal standards for buildings*).

The main objective of the domestic environmental support scheme (UFI) (BGBl. Nr. 185/1993 as amended) is to provide economic incentives to promote the implementation of measures in the field of energy efficiency, climate and environmental protection. The following table represents the project categories relevant for the energy demand subsector. The focus in the period of 2004 to 2007 was on biomass use and biomass powered combined heat and power plants (see Table 4.1). Further information on the UFI is given in the chapters on energy supply (4.2.1.2), industry (4.2.4) and cross-cutting policies and measures (4.2.7).

Table 4.1: The domestic environmental support scheme 2004-2007: subsector energy demand (Umweltbundesamt 2009c)

2004-2007	Number of projects	Environment related investment costs [million €]	Subsidy [million €]	CO_2reduction efficiency [t/a]
Biomass	1 813	91.03	23.42	102 506
Biomass – CHP	15	66.47	11.67	83 038
Biomass district heating systems	455	12.49	3.22	29 092
(thermal) building renovation	393	50.40	10.60	14 096
Solar heat	1 998	55.33	15.31	14 724
Natural gas CHP	54	3.15	0.88	1 823
Energy efficiency	386	24.35	5.82	22 552
Total subsector energy demand (residential)	5 114	303.22	70.92	267 831
Total subsector energy demand (commercial and others)	328	57	13	29 333

Accordingly, there is a remarkable trend towards renewables, which is partly noticeable in an increase of wood chips and wood pellets consumption. Another indication for the development of emissions is the shrinking share of fossil fuels and the increasing share of district heating, electricity and ambient energy in total fuel used in the area of residential buildings (1.A.4.b) from 70 % in 1990 to 64 % in 2007. Decreasing CO_2 emissions per amount of fossil fuel from 74 t /TJ (1990) to 66 t/TJ (2007) indicate a shift to less carbon intensive fossil fuels in residential buildings (Umweltbundesamt 2009c). The implementation of this overall group of measures leads to a reduction of approximately 17 PJ of fossil fuels in 2020.

02_ED Forced renovation of buildings ('Sanierung')

This group of measures includes the effects of increased thermal renovation of buildings. The measures target the improvement of thermal building envelopes (house front, windows, top and bottom floor ceiling) and thus of the overall renovation rate. 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 still very low. Austria's Climate Strategies (BMLFUW 2002, 2007) therefore set an important priority on thermal renovation of buildings.

Specific schemes can give relevant incentives for more sophisticated energy solutions, optimised thermal insulation or even 'zero-energy-houses' by shifting and fine tuning of housing subsidies and improving thermal minimum standards. Thereto, some policy instruments and programmes are: the Housing Support Scheme (see 01_ED), the UFI (see 01_ED and chapter cross-cutting Policies and Measures), the Directive on Energy performance of buildings (Directive 2002/91/EC) and its transformation into national law (BGBl. I Nr. 137/2006) as well as the programme klima:aktiv. (Further information in the 4th National Communication, PaM No *M4 Improvement of technical building standards and energy codes for buildings* and *M3 Third Party Financing for public buildings*).

The Directive on Energy Performance of Buildings (2002/91/EC): The methodological basis for calculating the energy performance and the energy performance certificate, as requested under the EU Directive, are regulated in the national directive 'Energieeinsparung und Wärmeschutz' of the Austrian Institute for Construction Technique (OIB RL 6). The implementation of the Directive into national law was achieved through the 'Energieausweis-Vorlagegesetz' (EAVG; BGBl. I Nr.137/2006) and by amendments of the Technical Construction Regulations of the *Länder*. This kind of energy efficiency certificates is expected to give appropriate price signals on the real estate market since energy consumption of houses, apartments and offices becomes transparent for the consumer. In practice of the real estate market the actual use of this certificate is quite poor. The amendment of the European Building Directive envisages changing this.

Being aware that there are also autonomous developments that lead to emission reductions through building renovation, the contribution of this measures-group can partly be tracked by the renovation rate. The renovation rate indicates the proportion of buildings (or households), which accomplish refurbishment measures on the thermal building envelopes. It is therefore an indicator for the renewal of buildings, which usually reduces their heating demands. The objective stated in the Austrian Climate Strategy, i.e. to enhance the annual renovation rate[3] to 3 % in the period from 2008 to 2012 and to 5 % in the medium term, has not yet been met. The thermal renovation rate of single measures in residential buildings is below 2.5 % per year (mean 1994-2004) (Umweltbundesamt 2009c).

The total renovation rate for all buildings (residential and commercial) is assumed to increase from 0.5% in 2007 to 1.3 % in 2020. The individual rates for each type of

[3] Meaning, per definition (BMLFUW 2007) the renovation of the whole thermal shell of buildings, including walls, roofs, windows, doors and cellar ceiling.

building differ. Based on a comprehensive building model the thermal renovation related to commercial buildings shows an overall reduction potential of 25 % of the final energy input and of 50 % with respect to residential buildings (Umweltbundesamt 2009c). Anyway, the implementation of this group of measures entails a reduction of energy consumption of 16.5 PJ (9.2 PJ fossil fuels) in the year 2020.

Other related PaMs in the 4th National Communication: *M1 Minimum thermal standards for buildings*, *M2 Housing support schemes, M2.1 Thermal insulation of dwellings, M2.2 Support schemes for energy efficient construction, M2.3 Housing support for use of renewable energy*.

03_ED forced replacement of heating systems ('Heizkesseltausch')

The target is an increase in the boiler exchange rate via various measures (defined in the Austrian Climate Strategy). It will be achieved through financial support and raising awareness for changing old, inefficient heating systems. This measure also shows co-benefits in terms of emission reductions of air pollutions i.e. PM and NO_x. The instruments for promotion – both in terms of financial support and information campaigns – overlap with those given under 02_ED.

In Austria, the subsidy policy for heating systems aims to achieve the installation of high efficient und low emission (CO_2) boilers. Therefore, the regional authorities grant financial support for biomass, district heating, heat pumps and solar heat. The individual rates differ between each regional authority. Model-based results predict a rise of the boiler exchange rate from about 1 % in 2007 to 2.3 % in 2020. Fully implemented this measure group will result in savings of 11.2 PJ fossil fuels by 2020, but with an increase in biomass demand by 4.3 PJ.

The European Community is encouraged to bring boiler efficiency and emission standards forward by implementing measures for boilers and heating facilities according to the Ecodesign Directive (2005/32/EC and amended by 2008/28/EC).

Related PaMs in the 4th National Communication: *M2 Housing support schemes, M2.3 Housing support for use of renewable energy.*

04_ED public support for new buildings ('Neubau')

This group of measures represents the effects of subsidized heating systems (renewable) and compulsory building regulations for thermal building quality in new buildings. Policy instruments related to financial subsidies (credit and cash) for better thermal quality (insulation) of new buildings are: the Directive on Energy performance of buildings (Dir 2002/91/EC) and the Housing Support Scheme. For further information related to these policy instruments see also 01_ED, 02_ED above and *M1 Thermal standards for buildings, M2.2 Support schemes for energy efficient construction, M4 Improvement of technical building standards and energy codes for buildings* in the 4th National Communication.

The effect of reduction is expected to result in 7.9 PJ of fossil fuels.

05_ED additional measures to reduce energy consumption in the sectors residential and commercial (planned)

The following measures are included in this planned bundle of measures (considers in the WAM-scenario as presented in the projections chapter of this report):

- exchange of boilers older than 30 years;
- support of condensing boiler technology in new installations of fossil heating systems;
- increase of building renovation rate up to 2 % by the year 2020;
- ban on electric resistance heating systems as primary heating system (Directive 6 for energy saving and insulation at buildings, Österreichisches Institut für Bautechnik);
- central heating systems in new buildings with more than three apartments;
- Buildings with a floor space of more than 1 000 m² have to use an alternative heating system, if its technical, ecological and economical application is appropriate.

Based on these planned actions, a further reduction of approximately 26 PJ of fossil fuels can be reached until 2020, including 16 PJ savings of heating oil.

06_ED National Energy Efficiency Action Plan ('Energieeffizienzaktionsplan', EEAP) in the residential and commercial sector (excluding fuel for heating and hot water)

Information as regards the National Energy Efficiency Action Plan is also provided in the section energy supply (07_EN).

According to Directive 2006/32/EC on energy end-use efficiency and energy services each EU member state has to set measures for improving the energy efficiency by 9 % until 2016 based on the average values of final energy from 2001 to 2005 (see national energy efficiency action plan) (BMWA 2007). Thus, a reduction in electric energy consumption of 4 605 TJ in the sector residential and 4 239 TJ in the sector commercial can be achieved in the year 2016. GHG emissions were not estimated.

Related PaM in the 4th National Communication: *M8 Energy Efficiency Programme*.

07_ED additional measures to reduce electric power consumption in the residential and commercial sector (excluding fuel for heating and hot water) (planned)

This group of measures concerns reduction of electric energy consumption. Based on current EU regulations based on the Ecodesign Directive (2005/32/EC amended by 2008/28/EC) a reduction of electric energy consumption in the area of households can be achieved due to the use of efficient lighting technologies and a decrease of stand-by and quasi-off demands, as well as compulsory usage of efficient home appliances (incl. 'office and entertainment'). The calculated total electric energy reduction in households by 2020 is approximately 4 400 TJ.

In the area of commercial buildings the reduction potential was estimated with the 'ESP' database of the European Commission. Therefore, the energy demand for office equipment (computer, monitor, photocopiers and printers) and other engine-driven appliances (assembly line, lift, etc.) can be reduced by 8 500 TJ up to the year 2020 (see also 07_EN in the sector energy industries). There are also overlaps with measure 08_EN Eco Design Directive (see PaM summary table in Annex 1).

GHG emissions from this sector were around 11.1 Tg of CO_2 equivalents in 2007. This decline mainly follows thermal renovation measures, the increasing use of renewable energy sources, district heating supply, and other factors like mild winter and low heating oil sales. Further measures will be necessary, as well as stepping up of existing measures like raising thermal renovation rates as well as increasing the efficient use of renewable energy sources combined with the best available technologies and new approaches like micro CHP and local heating. The recent revision and extension of the constitutional treaty between the Federation and the Länder (see description under 01_ED) will promote these further measures.

4.3.1.2 Energy Supply

Source Categories of the Common Reporting Format affected: 1.A.1 (energy industries)
GHG affected: CO_2, CH_4, N_2O

The subsector energy supply includes emissions from electricity generation and district heating (including waste incineration for energy generation e.g. in Combined Heat and Power (CHP) plants), as well as from oil and gas exploitation and storage, emissions from refineries and consumption of the energy sector. Data exclude emissions from power plants in the manufacturing industry (autoproducers), which are covered in the sector industry. Plants included in the national allocation plan for the period 2008 - 2012 are responsible for more than 85 % of the emissions in the subsector energy supply.

CO_2 emissions from this subsector in Austria show a falling trend since 2004. It is remarkable that the development in the ETS-sector (ETS: Emission Trading Scheme) and the non-ETS-sector differ. While emissions in the ETS-sector show a decreasing trend between 2005 and 2007 (-17 %), the emissions in the non-ETS - sector have risen by 13 % (Umweltbundesamt, 2009b). Emission trading is the stimulus with highest relevance for emission reduction in this subsector and the Emission Trading Scheme (ETS) is the central policy thereto. Other important (and to some extent overlapping) measures are the promotion of the use of renewable energies and the increase of energy efficiency by various policy instruments.

The most important driving force for the activities in this subsector is electricity consumption with an increase of about 35 %[4] between 1990 and 2007 (Umweltbundesamt 2009c). The CO_2 emissions from energy supply depend considerably on annual climatic conditions. The amount and the share of electricity production from renewable hydropower vary annually with respective impacts on emissions from caloric electricity generation. In 2007 66.8 % of public electricity was produced by hydropower, whereas electricity production from fossil fuels made up

[4] Without electricity consumption of the subsector energy itself (Umweltbundesamt 2009c).

26.0 % and wind power contributed for about 3.9 % to electricity production in 2007 (see Figure 4.1).

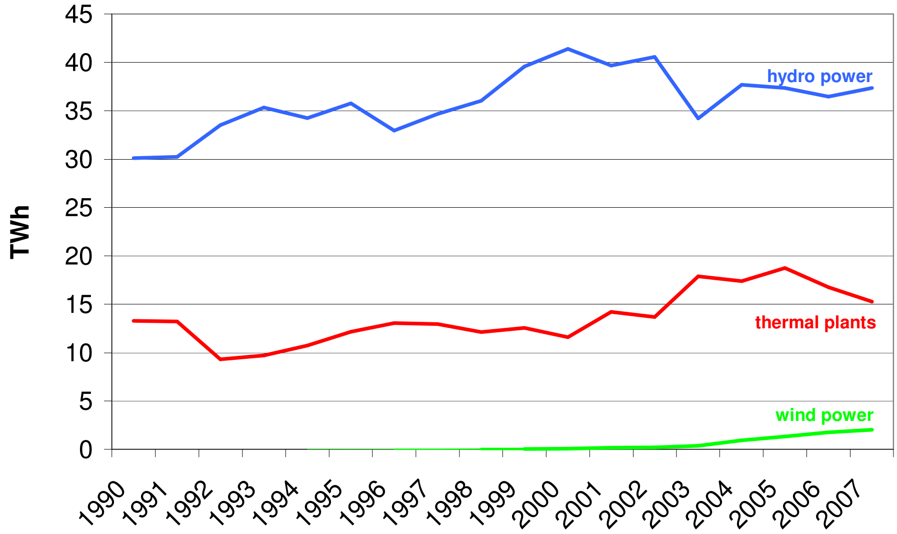


Figure 4.1: Public electricity production, 1990-2007 (Umweltbundesamt 2009c)

Losses in electricity production from hydropower are expected due to the implementation of the Water Framework Directive (Directive 2000/60/EC). However, losses are compensated by increased energy efficiency of existing plants and by the construction of small hydropower plants. In total it is expected that the production from hydropower will raise from 131 PJ (2007) to 135 PJ (2020) (Umweltbundesamt 2009e).

Electricity production from wind power shows an increasing trend since 2002 which came to a halt in 2007 due to changes in the legal framework as illustrated in Figures 4.1 and 4.2.

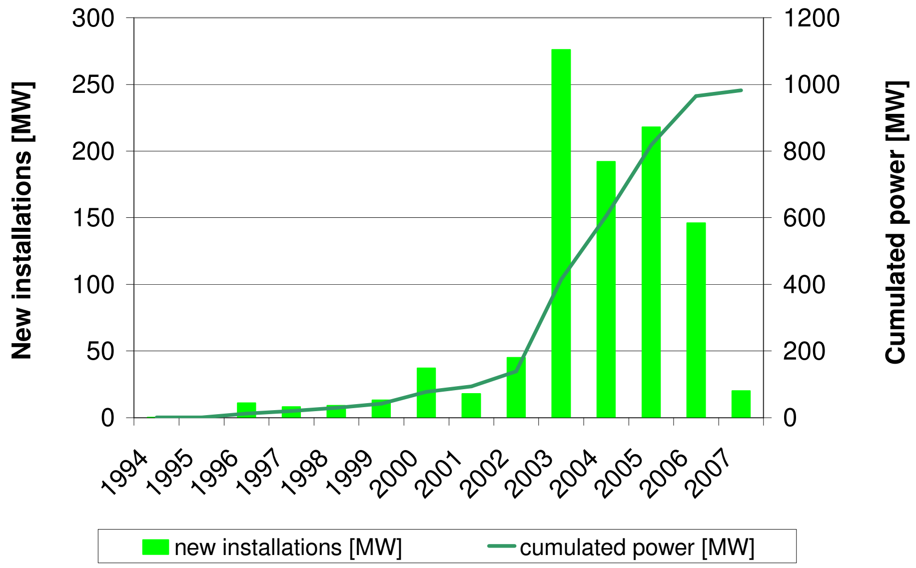


Figure 4.2: Development of wind energy (new installations per year and cumulated power). (Data: IG Windkraft, Austrian Wind Energy Association)

CO_2 emissions from district heating also depend on annual climatic conditions and correspond to temperature-induced heating energy demand during the winter season. The use of biomass in regional district heating systems has already gained a considerable share in Austria. In 1990 biomass (including the biogenic content share of waste) contributed 8 % to heat production in district heating systems, this share increased to 41 % in 2007. 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 (for further information to rural funding schemes see measure *M6 Rural funding schemes for energy from biomass* in the 4th National Communication and descriptions in sector Agriculture and Forestry of this report).

Representative instruments to promote renewable energies and energy efficiency in Austria's energy supply include direct financial support for transformation plants (see measure 01_EN), feed-in tariffs for electricity production from renewables (see measure 02_EN), funding for efficient (fossil fuel fired) CHP plants (see measure 06_EN) and public funding for research and development (R&D) projects and for demonstration plants (see measure 05_EN). The climate change initiative klima:aktiv, initiated by the Ministry of Environment, includes inter alia a programme on renewable energy. On the level of the federal provinces a variety of measures are in place to further promote the use of renewable energies (e.g. solid, liquid and gaseous biomass in the residential sector or in public power/heat generation, photovoltaic plants). Energy related taxes are a cross-sectoral promotive policy already described in detail in the 4th national communications (PaM No *M34 Energy related taxes and earmarking for climate change related measures*).

According to the emission scenarios in Chapter 5 the amount of wind power is assumed to further increase. The transformation input in Austrian power and heat plants of biomass and waste is also expected to rise in future years. The growth rates of wind power production and electricity from biomass and waste of biogenic origin will be significantly higher than the average growth rates of electricity and heat production (Umweltbundesamt 2009d).

The following PaMs are included in the 'with measures' and 'with additional measures' scenarios in the projections chapter of this report. The GHG emission reduction effect of individual policies and measures has been estimated to the extent possible. However, for various measures (e.g. emission trading, promotion of CHP) the reduction effect could not be estimated; for others it was only possible to estimate the reduction effect for the year 2010. A detailed description of assumptions made for the assessment can be found in the underlying report on emission scenarios (Umweltbundesamt 2009d). In general no grouping of policies and measures has been undertaken in this subsector.

01_EN Domestic environmental support scheme (UFI)

Information as regards the Domestic Environment Support Scheme (BGBl. Nr.185/1993 as amended) is also provided in the chapters energy demand, industry (01_IND) and cross-cutting measures.

The main objective of this subsidy is to provide economic incentives for companies to implement measures in the field of energy efficiency, climate and environment protection. The following categories are of relevance for the energy supply subsector: biomass district heating systems, biomass-powered combined heat and power plants, heat distribution, power production from biomass and waste of biogenic origin, and geothermal energy. The focus in the period 2004-2007 was in the area of biomass use and biomass powered combined heat and power plants (about 87 % of supported projects) (see Table 4.2).

Table 4.2: The domestic environmental support scheme 2004-2007: subsector energy supply (Umweltbundesamt 2009c)

2004-2007	Number of projects	Environment related investment costs [million €]	Subsidy [million €]	CO_2reduction efficiency [t/a]
Biomass district heating systems	179	223.84	36.60	202 851
Biomass – CHP	36	212.41	41.89	602 729
Power production from waste of biogenic origin	1	40.16	1.61	257 480
Other climate related measures	4	14.42	2.91	141 828
Others	70	45.30	10.02	133 187
Total	**290**	**536.13**	**93.04**	**1 338 075**

All in all the reduction effect accounted for 1.3 Tg CO_2 equivalents per year in that period. The total environment related investment costs for 290 projects amounted to € 536.13 million that have been subsidized by € 93.04 million. In general the projects affect both the ETS and the non-ETS sector.

The reduction effect for installations not affected by the ETS has been estimated on a combination of historic data and projections for the amount of future subsidies. It was not possible to provide estimates for 2015 and 2020 due to the fact that future amounts of subsidies are unknown.

(Related PaM in the 4th National Communication: *M6 Public Support for renewable energy projects and district heating: Federal Environment Fund*)

02_EN Green Electricity Act

The Directive 2001/77/EC on the promotion of electricity produced from renewable energy sources was implemented through the Green Electricity Act (BGBl. I Nr.149/2002 as amended). The Act does not only address the main issues raised by the Directive, but also unifies the system for promoting electricity production from renewable energy sources by granting fixed feed-in tariffs for various forms of biomass transformation and power production by wind, water, geothermal energy and photovoltaics. The objective of the Green Electricity Act currently in force is to raise the share of electricity from renewables in electricity consumption in public grids to 10 % by 2010, which will likely be missed. However, an amendment to the Green Electricity Act which has been adopted by the Austrian government (but not fully approved by the European Commission) intends to raise the share of renewables in electricity consumption in public grids to 15 % by 2015. Among other amendments, the guaranteed feed-in time was raised in general to 13 years and to 15 years for power plants based on biomass, respectively.

Table 4.3 shows the evolution of Austrian green power output (in GWh) supported by fixed feed-in tariffs from 2002-2007.

Table 4.3: Subsidised renewable electricity [GWh] from 2002-2007 (E-Control 2008)

Energy Source	2002	2003	2004	2005	2006	2007
Wind	203	366	924	1 328	1 738	2 019
Solid Biomass	95	99	313	553	1 096	1 631
Biogas	20	42	102	220	358	440
Liquid biomass	3	2	18	33	54	71
PV	3	11	12	13	13	15
Other supported green power	88	78				
Total other green power	412	598	1 445	2 212	3 304	4 230
Small hydro	4 243	3 386	3 995	3 561	1 806	1 527
Total supported renewable energy	4 655	3 984	5 440	5 773	5 110	5 757

The assumption for the ex-ante assessment (see projections chapter) is that the objective for the year 2015 according to the Green Electricity Act 2008 (see 02_EN) (BGBl. I Nr.44/2008) will be reached and that the promotion of green electricity will continue thereafter. The Green Electricity Act has no specific goals beyond the year 2015. However, the projections are based on the assumption that the growth rates for individual renewable energy sources remain at the same level until 2020. It is estimated that a vast part of the reductions will concern installations that take part in the emission trading scheme, mainly in the energy supply subsector.

(Related PaMs in the 4th National Communication: *M5 Promotion for electricity from renewable energy sources, M7 Further development of targets for renewable energy sources and implementation of EU directive on renewables* in the 4th National Communication)

05_EN Austrian Climate and Energy Fund (KLI.EN)

According to the 'Klima- und Energiefondsgesetz' (BGBl. I Nr. 40/2007) the objective of the KLI.EN is to contribute to meeting Austria's Kyoto Protocol target through funding of climate and energy related projects. Funds are provided (2007: € 50 million, 2008: € 150 million) for a number of projects and programmes targeting the increased use of renewable energies such as projects related to research on renewable energy, replacement of heating systems, photovoltaic, building renovation of buildings (tourism and commercial), energy efficiency, etc. Support for companies, research institutions or municipalities as well as for individuals, depending on the respective programme.

(Related to *M6 Public Support for renewable energy projects and district heating: Federal Environment Fund* in the 4th National Communication and to measure groups of the subsector energy demand (residential and commercial))

03_EN European Emission Trading Scheme (ETS)

Information as regards the Emission Trading Scheme according to the Emission Trading Directive (2003/87/EC) is also provided in chapter industry (03_IND) and in chapter cross-cutting policies and measures. The objective of emission trading is to limit the CO_2 emissions from large power plants through a trading mechanism for emission certificates.

In 2007, verified emissions from the subsector energy supply declined by 1.3 Tg CO_2 equivalents compared to 2006 and resulted in 12.0 Tg CO_2 equivalents as illustrated in Figure 4.3. Hence, 85.4 % of CO_2 emissions from this subsector were covered by emission trading in 2007. Figure 3.3 shows the comparison between allocated (NAP 1) and verified emissions for the pilot-phase 2005-2007, as well as the allocated emissions for 2008-2012 (NAP 2).

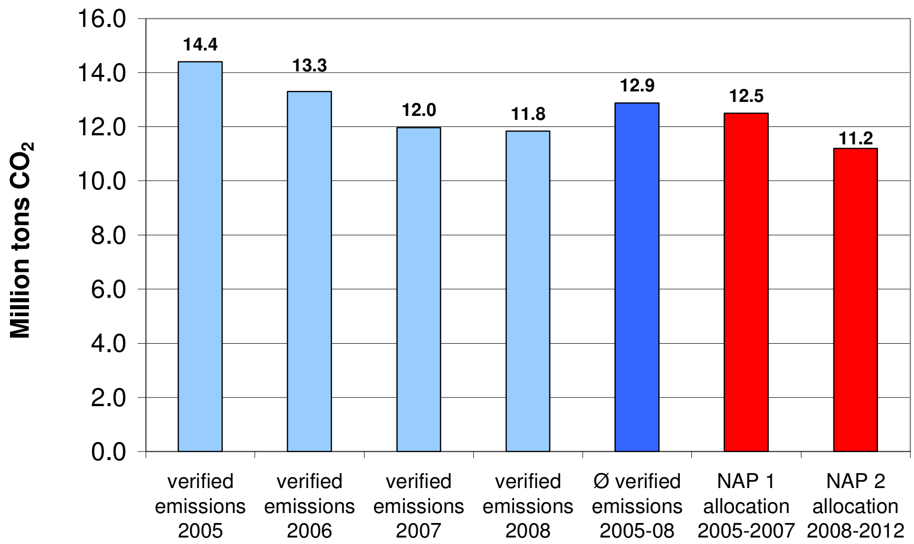


Figure 4.3: European Emission trading – sector energy supply – verified emission in comparison to national allocation

Due to interactions with other measures the specific reduction effect of emission trading in the energy sector could not be estimated.

06_EN Promotion of combined heat and power (CHP)

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 was transposed into national law by BGBl. I Nr. 111/2008. The main purpose 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.

The subsidies to expand Austrian CHP facilities accounted for 55 million € in 2007. The amounts of subsidies in the future cannot be estimated.

(Related to M5 Promotion for electricity from renewable energy sources, M7 Further development of targets for renewable energy sources and implementation of EU directive on renewables in the 4th National Communication)

In 2007, 12.0 Tg CO_2 equivalents were covered by emission trading, whereas 2.0 Tg CO_2 equivalents stem from non-ETS plants. While emissions from the ETS sector are capped, plants that do not participate in emission trading are required to cut down their emissions significantly. Legal obligations or financial support schemes usually do not differentiate between ETS and non-ETS sector in binding or eligibility concerns. Rather, most of the policy instruments tend to target the key sources of emissions and hence the plants which are covered by the ETS. This is also an important issue in the sector industry (see also 03_IND and chapter cross-cutting measures). Consequently, supplementary efforts will be made to slow down the growth in electricity demand. Measures to that end are described in the national climate strategy (i.e. contracting initiatives, energy consulting, 'green public purchasing' etc.).

4.3.2 Waste management

Source Categories of the Common Reporting Format affected: 6.
GHG affected: CH_4, CO_2 and N_2O

In the sector waste management mainly CH_4 emissions from solid waste disposal on land (6.A), but also CO_2 and N_2O and CH_4 emissions from wastewater handling (6.B), compost production and waste treatment (mechanical, biological, physical) (6.D), and waste incineration (without energy generation) (6.C) are considered. Waste incineration with energy generation is covered in the subsector energy supply in the energy section of this chapter.

In 1990, GHG emissions from waste management sources in Austria amounted to 3.6 Tg CO_2 equivalents. In 2007, emissions amounted to 2.2 Tg CO_2 equivalents and the trend analysis projects a further significant reduction (emissions decrease to 1.9 Tg CO_2 equivalents in 2010 and to 1.2 Tg in 2020). Emissions occurring from solid waste disposal on land are responsible for about 80 % of total emissions in this sector and were considerably reduced in recent years. Although N_2O emissions from waste water handling are expected to increase in future years, this will not change the declining trend according to emission scenarios in the report at hand. The share of emissions from compost production and waste incineration (without energy generation) is minor.

All measures in this sector aim at reducing the GHG emissions from landfills. Methane emissions from landfills are a consequence of Total Organic Carbon (TOC) of waste disposed on landfills. Therefore, the reduction of total organic compounds and the minimisation of the total volume of landfills are crucial elements when deciding on appropriate policy actions. Consequently, policies and measures follow as leading principles:

- prevention of waste
- decline of untreated solid waste
- waste recovery (recycling and incineration with energy recovery)

These principles are fully in line with the Austrian Waste Management Act (BGBl. I Nr. 102/2002 as amended) as well as with the Landfill Ordinance (see 01_WASTE, 02_WASTE). Other programmes to launch waste prevention and recovery have been described in the 4th National Communication (PaM No *M13 Other programmes to launch waste prevention and recovery*).

The following PaMs are included in the 'with measures' and 'with additional measures' scenarios in the projections chapter of this report. The single measures implemented could not be quantified. Nevertheless, the progress can be made visible by the indicator 'annually deposited biodegradable waste and CH_4 emissions' versus time in Figure 4.4.

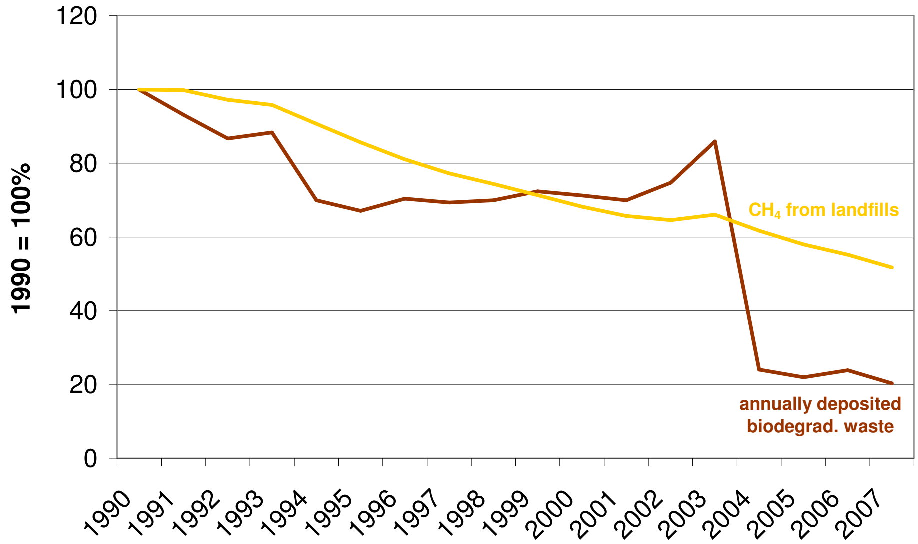


Figure 4.4: Methane emissions from landfills and annually deposited biodegradable waste.

01_WASTE Landfill Ordinance (deposition of untreated biodegradable waste)

The most important measure in this sector is the implementation of the Austrian Landfill Ordinance BGBl. Nr. 164/1996 of the year 1996 according to the Austrian Waste Management Act (BGBl. I Nr. 102/2002 as amended). A detailed description of the content of the Austrian Waste Management Act ('Abfallwirtschaftsgesetz') and the Landfill Ordinance was outlined in the 4th National Communication, PaMs *M9 Waste Management Act 1990, amended 2002* and *M10 Landfill Regulation 1996*.

According to this Ordinance the deposition of untreated biodegradable waste has been forbidden since 2004, with the possibility to grant exemptions (time extensions) until 2008. As a consequence, methane emissions from landfills have decreased constantly and the amount of waste incinerated and/or treated in mechanical-biological treatment plants increased.

02_WASTE Landfill Ordinance (collection and drainage of landfill gas)

A second important measure to reduce greenhouse gas emissions from landfills is the mandatory collection and drainage of landfill gas originating from mass-waste landfills according to § 22 of the Austrian Landfill Ordinance (BGBl. Nr. 164/1996 as amended). This measure has been mandatory for new landfills since 01.01.1997 and for existing landfills with a transition period until 01.01.2004. The landfill gas has to be used or subjected to treatment (a detailed description of the content of Austrian

Waste Management Act and the Landfill Ordinance was outlined in the 4th National Communication, PaMs *M9 Waste Management Act 1990, amended 2002* and *M10 Landfill Regulation 1996*).

03_WASTE Remediation of Contaminated Sites Act

Indirectly, the Remediation of Contaminated Sites Act (Federal Legal Gazette No 299/1989, as amended in 2004) contributes to a reduction of greenhouse gas emissions from landfills because it stipulates higher costs for the deposition of wastes on landfills without gas collection. The amendment 2000 of the Contaminated Sites Act provides for a significantly higher contribution from the deposition of untreated biodegradable waste from 2004 onwards (a detailed description of the content of Austrian Remediation of Contaminated Sites Act was outlined in the 4th National Communication, PaM No M11 Landfill Charge Act 1989 ('Clean-up of Contaminated Sites Act')).

04_WASTE Guideline for the Mechanical Biological Treatment of Waste

Mechanical biological treatment of biodegradable wastes prior to landfilling reduces the gas formation potential. The Guideline for the Mechanical Biological Treatment of Wastes was elaborated by the Ministry of Environment after expert consultations together with the Environment Agency Austria (BMLFUW 2002). With this guideline a consistent state of the art process for mechanical biological treatment is provided. (Related to *M14 Definition of technical state of art for mechanical-biological treatment of Waste* in the 4th National Communication)

The declining trend is projected to continue until 2020 with existing measures. No further policies and measures are planned at the time being.

4.3.3 Transport

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

The sector transport comprises emissions from road, rail, inland waterways, national aviation, emissions from pipeline compressors and emissions from military machines.

Since 1990, CO_2 emissions from transport have grown by 72.6 %. The major source of GHG emissions in this sector is road transport. In 2007, road transport was responsible for around 97 % of total transport emissions. 57 % of road transport emissions stem from passenger transport and 43 % from freight transport. Emissions trends in the transport sector depend on a variety of driving forces, among them increasing passenger transport, showing an increase from 83 billion passenger kilometres (pkm) in 1990 to 104 billion in 2007, and increasing freight transport with a rise from 32 billion tonne kilometres (tkm) in 1990 to 63 billion in 2007. These figures are based on fuel sold in Austria for the entire transport sector; inland transport has increased at a considerable lower rate (see Section 2.7). Important routes for long-distance freight transport cross Austria and the integration of eastern neighbouring states to the European economic area has led to additional transport demand especially on in- and outbound routes as well as transit routes. Also of particular importance for the extraordinary growth in the transport sector is 'fuel export'[5], which is particularly due to the lower fuel prices in Austria in comparison to the neighbouring countries (primarily Germany and Italy), but also caused by Austria's specific geographical location (i.e. as a midland) and other national circumstances (i.e. relatively high economic export share). About two thirds of fuel export is caused by freight transport. CO_2 emissions from fuels sold in Austria but used outside the country, both by lorries and by private cars, accounted for 7.2 Tg CO_2 equivalents in 2007.[6] Hence, 31 % of the total emissions in the sector transport can be attributed to 'fuel export'. Other factors influencing the emission trend are the economic development, changing living patterns, and technical progress e.g. in terms of energy efficiency improvements. It should be noted that an increased car usage – together with the present trend to fuel intensive cars (such as SUVs) – and the decreasing occupancy rate jeopardise the improvements in vehicle efficiency. An important step to counteract the current CO_2-emissions trend was taken by the enhanced introduction and use of biofuels (Umweltbundesamt 2009c).

Policies and measures to mitigate environmental impacts of the transport sector are mainly focusing on road transport. It is of relevance to identify and to assess the key influencing drivers in the sector. Those can be specified as follows:

- declining share of 'fuel export';
- decreasing transport performance on road transport both for passenger and freight transport;
- enhancing use of alternative fuels and propulsion systems;
- increasing energy and fuel efficiency of vehicles.

Policies and measures in the transport sector aim to stabilise and to reverse the current emission trend by introducing a mix of different instruments, such as regulatory (see 04_TRA), fiscal and awareness raising instruments, under participation of all levels of policy-making (Federation, *Länder*, municipalities). Especially in the field of transport there are a lot of supporting activities ranging from awareness raising programmes to R&D projects. For example new and alternative motor concepts like electric vehicles, fuel cells, biodiesel, 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) as presented in the 4th National Communication (*M23 Promotion of energy efficient and alternative motor concepts*). The promotion of walking and cycling is another measure that has been already described in the NC4 *(M24 Promotion of walking and cycling)* including the 'Master Plan Cycling' as a campaign. Combined transport is considered to be of central importance for solving present and future problems with regard to freight transport by road. Austria has introduced early measures for the support of environment friendly modes, such as combined transport. Those measures consist of financial support for investment and other support measures (e.g. liberalised initial and final combined transport hauls, exemption from driving bans on lorries) as well

5 also termed as so called ‚fuel tourism'

6 According to the IPCC reporting guidelines, emissions from transport fuel sold within Austria need to be captured by the national inventory on greenhouse gas emissions.

as measures concerning the infrastructure. (See *M19 Support of combined transport* in the NC4)

The selection of quantified PaMs described below is considered in the emission scenarios of this report. Measures focused on raising public awareness with regard to climate-friendly modes of mobility constitute an integral part of actions taken in the traffic and transport field. Nevertheless, it is not solved yet how to properly include behavioural measures in emission scenarios or how to separate autonomous development from the actual impact of such a measure.

10_TRA Fuel consumption based taxation ('Normverbrauchsabgabe' - NoVA)

This measure has been described already in the NC4 under PaM No *M16 Fuel consumption based taxation.*

Passenger car registration tax in Austria is based on standard fuel consumption, providing a clear incentive to buy energy efficient cars. The tax rates have changed since the NC4 was published. In July 2008 a bonus malus system has been implemented. On the one hand, all passenger cars that meet already the requirements under EURO 5 or EURO 6 get a bonus of € 200. In addition, if the CO_2 emissions of the passenger cars are less than 120 g/km, an additional bonus of € 300 is granted. On the other hand, there is a malus of 25 €/g CO_2 for passenger cars that emit more than 180 g/km. This requirement will be tightened to 160 g/km in January 2010. A bonus of € 500 is also granted for hybrid-vehicles and cars using fuels like natural gas, biogas, or ethanol. The incentives have already produced results insofar as the share of alternative and low-carbon vehicles has increased up to 20 % of all new cars.

04_TRA EU- Biofuels Directive & Development renewable energy carrier 1990 – 2020

According to Directive 2003/30/EC minimum shares for transport fuels from renewable energy sources should be implemented. In 2004, the Bio Fuel Directive was transposed into Austrian national law with an amendment (BGBl. II Nr. 417/2004) to the Fuel Ordinance. This amendment stipulates that all companies that put fuels on the market must, from 1 October 2005, replace 2.5 % of the total energy quantity by biofuels. From 2007, this percentage was increased to 4.3 %, and since October 2008 to 5.75 %. Together with the amendment to the Fuel Ordinance, the Mineral Oil Tax has been revised. Accordingly, tax concessions will be granted for fuels with a biofuel share of at least 4.4 % (and a sulphur content of less than 10 mg per kg of fuel). The use of pure biofuels as motor fuel is exempt from tax.

In 2007, 370 000 t of biodiesel, 20 400 t of bioethanol, and 18 000 t of straight vegetable oil (SVO) were distributed within the Austrian territory. Thus, the share of renewable energy used within the transport sector attained a level of 4.23 % (measured by the energy content). Biodiesel, bioethanol and straight vegetable oil (SVO) represent the set of renewable energy carriers which were mainly distributed by blending them with fossil fuels to an extent of 5 % (measured by volume). All together, 1.1 Tg CO_2 equivalents have been saved in 2007 (Umweltbundesamt 2009c).

The assessment for 2020 is based on present circumstances (initiatives, promotion, current infrastructure etc.) as well as foreseeable developments on national and international level. This means that about 820 000 tonnes of biodiesel, 216 000 tonnes of bioethanol and 31 000 tonnes of SVO would be distributed within the Austrian territory.The assumptions for the development of renewable energy carriers are valid for both scenarios - wm and wam in the projections chapter.

(Related to *M18 Promotion of 'bio fuels'* in the 4th National Communication)

07_TRA Action programme klima:aktiv mobil

The programme klima:aktiv mobil provides financial support and consultation for mobility management. Measures in the context of klima:aktiv mobil focus on five target groups and comprise:

- Upgrading of the national campaign for 'ecodriving' with the elements competition, certification of 'ecodriving trainer' and co-operation with fleet operators for fuel-efficient driving. The objective is increasing public awareness on a fuel saving driving style. Running the cars at lower engine power improves fuel efficiency; such a driving style is known as 'ecodrive'. The overall effects of such a driving style can be assessed roughly from training results (-15 % to -20 % of fuel for cars and -8 % to -10 % for heavy duty vehicles). To assess the overall effect of the public awareness campaign it is assumed that 10 % of all drivers will change their behaviour and switch to 'ecodriving' (constant level until 2020).
- mobility management for business and public administration (financial support and consulting)
- 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 (cities, communities and regions)
- mobility management for real-estate developers and investors
- programme for shaping of opinions to promote climate-friendly mobility with main messages 'ecodriving' and 'clean air – we do everything for our children'.

A reduction effect of 250 000 tonnes of CO_2 equivalents per year has been assumed for the years 2010, 2015 and 2020. This value is based on expert judgement of the Environment Agency Austria (Umweltbundesamt) and the Austrian Energy Agency. and includes the CO_2, CH_4 and N_2O emission reduction effect; providing a split per gas is not possible.

(Related to *M26 Model projects and programmes for environmentally sound mobility* in the 4th National Communication)

08_TRA Enhanced fuel efficiency of cars

The Community's strategy to reduce CO_2 emissions from passenger cars and improve fuel economy is based on three pillars: the self-commitments of the automobile industry on fuel economy improvements (ACEA – voluntary agreement (CO_2 emissions of newly registered vehicles) (Strategy [KOM (95) 689.]), the fuel-economy labelling of cars (Directive 1999/94/EC on compulsory labelling for new passenger cars) and the promotion of car fuel efficiency by fiscal measures.

As the first and foremost pillar of the strategy, the 'Commitments of the European (ACEA), Japanese (JAMA) and Korean (KAMA) automobile manufacturers associations' were designed to achieve a total of EU15 new passenger car fleet average CO_2 emissions of 140 g CO_2/km by 2008 (ACEA) and 2009 (JAMA and KAMA). The targets could not be met; the European Commission therefore introduced legislation to reduce emissions from vehicles.

On April 23rd 2009 an EU regulation was published to set emission standards for newly admitted passenger cars with the objective to reduce CO_2 emissions to 130 g/km in 2015. In addition to the EU regulation this measure projects the specific CO_2 emission reduction per kilometre in 2020 by an average car from 143 g CO_2 to 122 g CO_2. This equals to a 15 % reduction.

The expected effect of this measure can be seen in the summary table. The quantification is given in CO_2 equivalents and includes CO_2 and N_2O emission reduction effects. Providing a split per gas is not possible.

(Related to *M15 CO_2 labelling and other measures to reduce emissions from passenger cars* in the NC4 and to *01_TRA ACEA – voluntary agreement*, *02_TRA CO_2 labelling and other measures to reduce emissions from passenger cars* as included in the emission scenarios and listed in the summary table.)

09_TRA Control of speed limits, traffic control systems (planned)

Speed limits will be implemented area-wide: on highways, country roads, major roads in town, and secondary roads in town. Exceptions are permitted only apart from residential areas with low accidental risk. Further, the enforcement of the speed limit will be pushed.

The expected effects of these measures can be seen in the summary template in Annex 1. The quantification is given in CO_2 equivalents and includes CO_2 and N_2O emission reduction effects. Providing a split per gas was not possible.

01_TRA, 02_TRA, 03_TRA, 05_TRA, 06_TRA Group of measures

- 03_TRA Mileage based toll for lorries and trucks: 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 heavy duty vehicle with a total weight of more than 3.5 tonnes was introduced on 1st January 2004 (BGBl. I Nr. 109/2002) as a first step. (Related to *M17 Mileage-based toll for lorries*, *M25 Further internalisation of externalities from road transport* in the 4th National Communication.)
- 05_TRA EURO classification (EURO 4 for passenger cars and light duty vehicles, EURO 4 and 5 for heavy duty vehicles): for passenger cars Dir 70/220/EWG; for duty vehicles Dir 1999/96/EG, implemented within the 'Kraftfahrgesetz' (BGBl. Nr. 267/1967 as amended). Since 1.1.2005: EURO 4 for passenger cars; as from 1.1.2008: EURO 5 for heavy duty vehicles.

- 06_TRA Measures concerning infrastructure, public transport and mobility management: The objective of this group of measure is to increase the share of public transport in passenger transport by promoting and optimising transport and tariff associations. The individual measures can not be quantified because there is no data available to assess an emission reduction effect. A new study concerning transport related policy assessment will be carried out in 2009. (Related to *M20 Promotion of public transport systems, M21 Model projects and programmes for environmentally sound mobility, M22 Public awareness-raising measures, M24 Promotion of walking and cycling* in the 4th National Communication and 07_TRA Klima:aktiv –mobile programme)

The emission reductions achieved through use of biofuels have been, and still are, jeopardised by the continuous increase in transport volumes. Various measures from the Climate Strategy could not be implemented or only partly. Planned measures are expected to contribute 2.11 Tg CO_2 equivalents to a decrease in GHG emissions by 2020 according to the 'with additional measures' scenario (Umweltbundesamt 2009d).

4.3.4 Industry

Source Categories of the Common Reporting Format affected[7]: 1.A.2. (manufacturing industries and construction), 2 (industrial processes)
GHG affected: CO_2, N_2O

This sector covers emissions from combustion and industrial processes from manufacturing industries and construction. F-gas emissions are examined separately as a subsector of the sector industry. The plants included in the national allocation plan for the period 2008-2012 were responsible for around 77 % of the emissions in this sector in 2007.

Emissions continuously increased since 1990 due to considerable production growth of certain energy intensive activities. Policies and measures for the manufacturing industry, therefore, aim at decoupling emissions from production and come to absolute reductions. To this end, activities aim at:

- improvements in final energy efficiency, and
- a fuel shift from coal to gas or renewable sources.

A mix of promotional 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 Emissions Trading Scheme (ETS).

[7] Emissions from solvents and other product use are also considered in the sector industry. There are some enforced laws and regulations concerning the sector solvents and other product use (CRF 3) as can be seen in the PaM summary table (Annex 1) and in the chapter on projections. A detailed textual description is not provided here as (i) solvents are one of the minor sources with less than 1 % of total GHG emissions in Austria and (ii) there is no target set for this sector in the national climate strategy.

The following PaMs are included in the 'with measures' and 'with additional measures' scenarios in the projections chapter of this report. The single measures implemented could not be quantified.

02_IND Green Electricity Act

Additional information on the Green Electricity Act (BGBl. I 149/2002 as amended) is outlined in the chapter energy supply (2_EN).

The total reduction effect of all sectors concerned has been reported in the energy supply subsector, therefore no specific reduction effects have been given for the sector industry. It is assumed that the major reductions take effect in the energy supply subsector.

(Related to *M5 Promotion for electricity from renewable energy sources, M7 Further development of targets for renewable energy sources and implementation of EU directive on renewables* in the 4th National Communication)

01_IND Environmental support scheme for installations (UFI)

Information as regards the Domestic Environment Support Scheme (BGBl. Nr. 185/1993 as amended) is also provided in chapter energy demand, chapter energy supply (01_EN) and in chapter cross-cutting policies and measures.

The main objective of this subsidy is to provide fiscal incentives for companies to implement measures in the field of energy efficiency, climate and environment protection. The following categories are of relevance for the industry sector: biomass-powered combined heat and power plants, photovoltaic, small hydro power, power production from biomass and waste of biogenic origin, access to district heating, other measures targeting efficient energy use, and gas-powered combined heat and power plants.

Table 4.4: The domestic environmental support scheme 2004-2007: sector industry (Umweltbundesamt 2009c)

2004-2007	Number of projects	Environment related investment costs [million €]	Subsidy [million €]	CO_2reduction efficiency [t/a]
Renewables	1 125	251.73	51.52	565 297
Energy efficiency	415	73.95	14.09	126 291
Others	29	104.81	5.23	186 031
Total	**1 569**	**430.49**	**70.84**	**877 619**

Between 2004 and 2007 the reduction effect accounted for 0.878 Tg CO_2 per year. The total environment related investment costs for 1569 projects amounted to € 430.5 million whereof € 70.84 million were subsidies. An ex-ante estimate for the industry sector could not be given. The reduction effect includes both the installations affected and those not affected by the ETS.

(Related to *M26 Promotion of energy efficiency measures and renewable energy projects* in the 4th National Communication)

03_IND European Emission Trading Scheme (ETS)

Information as regards the Emission Trading Scheme (Directive 2003/87/EC) is also provided in chapter energy supply (03_EN) and in chapter cross-cutting measures. The objective of emission trading is to limit the CO_2 emissions from large industrial plants through a trading mechanism for emission certificates.

In 2007, verified emissions from the sector industry show a slight increase to 19.8 Tg CO_2 equivalents compared to 2006 as can be seen in Figure 4.5. Thus, industrial plants covered by the ETS accounted for 77 % of GHG emissions of the sector industry. Figure 4.5 shows the comparison between allocated (NAP 1) and verified emissions for the pilot-phase 2005-2007, as well as the allocated emissions for 2008-2012 (NAP 2).

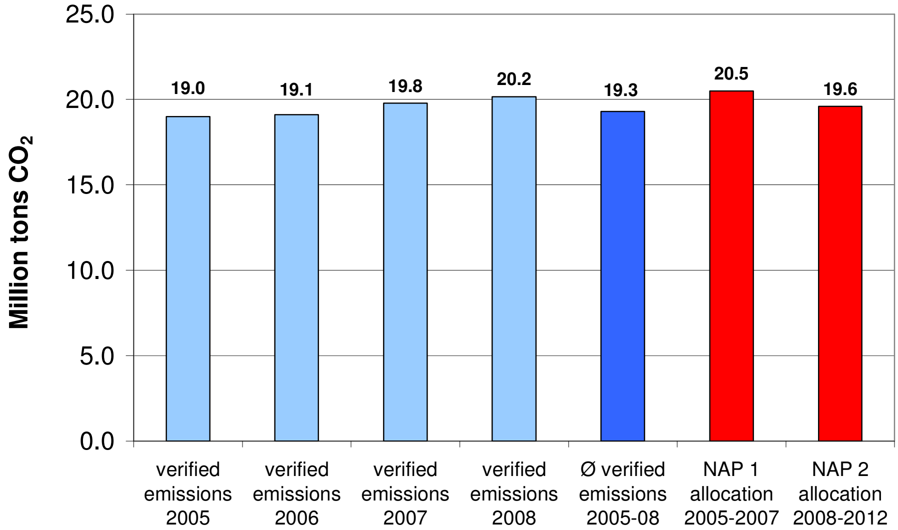


Figure 4.5: European Emission trading – sector industry – verified emission in comparison to national allocation

Due to interactions with other measures the specific reduction effect of emission trading in the industry sector has not been estimated.

In Summary, in 2007 19.8 Tg CO_2 equivalents were covered by emission trading, whereas 5.9 Tg CO_2 equivalents stem from non-ETS plants (sector industry excluding F-gases and Solvents). While emissions from the ETS-sector are capped, plants that do not participate in emission trading are required to further cut down their emissions.

4.3.5 Fluorinated Gases

Source Categories of the Common Reporting Format affected: 2.F (consumption of halocarbons and sulphur hexafluoride), 2.E (production of halocarbons and SF_6), 2.C (metal production)
GHG affected: HFC, PFC, SF_6

PFC emissions from aluminium production (2.C.3) and SF_6 used in aluminium and magnesium foundries (2.C.4) are covered in this subsector. There is no production of halocarbons and SF_6 (2.E) in Austria, but halocarbons and SF_6 have been used in Austria for a wide range of applications and are considered in this subsector. Among the applications is the use of HFC and PFC as refrigerants in refrigeration and air conditioning systems (2.F.1), the use of HFC as blowing agents in the production of foams (2.F.2), the use of HFC and PFC as fire extinguishing agents (2.F.3), the use of HFC as propellants in aerosols (2.F.4), the use of HFC as solvents (2.F.5), the use of HFC, PFC and SF6 as etching gases in semi-conductor manufacturing (2.F.7), the use of SF_6 as insulating gas in electrical equipment (2.F.8), and other uses of SF_6 (2.F.9) in soundproof windows, tyres and research.

Emissions of fluorinated gases showed an uneven trend during the past decade. Although fluorinated gases are not used in large amounts (1–1.8 kt per year) they contribute approximately 1.5 % of the total GHG emissions due to their high GWPs. In Austria's Third National Communication to the UNFCCC (2001) fluorinated gases were expected to reach 3 % of the total GHG emissions by 2010 and even 5 % by 2020 in the business-as-usual scenario. This forecast was based on the fact that HFCs are used in many applications as substitutes for ozone layer depleting 'Montreal gases' and thus, without reduction measures, their use would strongly increase. Because of this expected scenario, the Federal Environment Ministry started a consultation procedure in spring 2001 with the aim of drafting an ordinance on reducing and phasing-out the use of HFCs, PFCs and SF_6 in all relevant applications on the basis of the Federal Chemicals Act (BGBl. I Nr. 53/1997). The Austrian Ordinance on fluorinated gases was adopted in 2002 (BGBl. II Nr. 447/2002) and amended in 2007 (BGBl. II Nr. 139/2007) (a description of the content of the Austrian Ordinance has been provided in the NC4, PaM No *M31 Regulation on bans and restrictions of HFCs, PFCs, and SF6*). On European level the European Parliament and the Council of the European Union adopted the Regulation on certain fluorinated greenhouse gases (842/2006/EC) (this measure was already mentioned in the NC4 under *M33 Avoidance of leakage*) and the Directive relating to emissions from air-conditioning systems in motor vehicles (2006/40/EC).

In order to give incentives to the market for 'phase-out', even in applications not completely covered by the Austrian and EC legislation, 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. A description of this measure has been provided in the NC4, PaM No *M32 Public procurement and support measures*.

For a quantification of policies and measures affecting the sub-category halocarbons and SF_6 a without measures (wom) scenario was calculated. This scenario was based on the same assumptions as the wm-scenario but excluded assumptions on the effects of Austrian and EC policies. The average annual emission reduction was calculated by subtracting the wm-scenario emissions from the wom scenario. Some measures are included in both the Austrian Ordinance on fluorinated gases (BGBl. II Nr. 447/2002 as amended) and the European Regulation on certain fluorinated greenhouse gases (842/2006/EC). The Austrian Ordinance was adopted in 2002 and thus cannot be considered the implementation of the European Regulation. This is also the reason why most effects have been attributed to the Austrian Ordinance.

In summary, implemented and adopted policies and measures have prevented the strong increase that was predicted in previous business-as-usual scenarios (NC3). Nevertheless, the emissions of the subsector fluorinated gases (sector industry without manufacturing industry and construction) are expected to slightly increase in future years due to the forecast of SF_6 emissions from the disposal of sound-proof windows as outlined in the projections chapter. No further policies and measures are planned at the time being.

4.3.6 Agriculture

Source Categories of the Common Reporting Format affected: 4 (Agriculture)
GHG affected: CH_4, N_2O, (CO_2: indirect effect on energy demand)

The sector agriculture includes mainly CH_4 and N_2O emissions from enteric fermentation (4.A), manure management (4.B), agricultural soils (4.D), field burning of agricultural residues (4.F), but exclude 1.A.4.c agriculture and forestry.

Agricultural production contributes to climate change especially with methane and N_2O-emissions. Greenhouse gas emissions from agricultural activities show a decreasing trend since 1990, but the decline has slowed down since 2004. The main driving forces behind the decreasing trend were the steady decline of the number of animals (particularly cows) and the considerably reduced manure disposal until 2004. Due to the EU Rural Development Programme (RDP) and the included environmental programme, the use of mineral fertilizer declined considerable until 2006. The stabilization of the trend between 2005 and 2007 is due to the stabilization of animal numbers. The amount of mineral fertilizer sold shows a slight rise after 2006. Another aspect strengthening the recent developments is the raised production of biomass for biofuels and for energy generation purposes. Whereas changes in emissions owing to this are not yet reflected in statistical data, it is fact that fallow land has been shortened (Umweltbundesamt 2009c).

The main objective of agricultural policies is sustainable agriculture (reflected, inter alia, in the measure 09_AGR Organic farming). The high quality of agricultural products (food & feed) shall be maintained, while agriculture should minimise negative affects to the environment and be compatible with social and economic demands. An environmentally friendly agricultural production meets among others the claim of low gaseous emissions into the air (e.g. NH_3, CH_4, N_2O, CO_2). A lot of measures within the agricultural policy contribute directly or indirectly to GHG emission reduction (e.g. manure management and reduced use of mineral fertilisers, land use change). As accompanying measures, training programmes for farmers on ecologically sound production methods will be improved and intensified. In order to raise consumers' demand for food products from organic farming 'from the region', public institutions offer 'organic' meals and products in restaurants (e.g. in schools, hospitals etc.) (see also *M30 Further enforcement of measures to reduce methane and N_2O emissions* in the NC4 and 09_AGR).

Most of the policies and measures in the sector agriculture are strongly interconnected. A core element in this sector is the European Common Agriculture Policy (CAP). In an attempt to give an overview of the CAP and its climate related impact in Austria, a brief description of this policy is given together with references to Austrian policies and measures. The referred Austrian PaMs are summarized in the PaMs summary table. It was not possible to quantify individual PaMs in this sector. Further information on the inclusion of PaMs in the emission scenario is given in the report on emission scenarios (Umweltbundesamt 2009d).

01_AGR Common Agricultural Policy (CAP) 2003 reform

First Pillar: Council Regulation (EC) No 1782/2003 and – from 2009 – Council Regulation (EC) No 73/2009 establishes common rules for direct support schemes under the framework of the common agricultural policy (CAP) and further establishes certain support schemes for farmers.

As a result of the decoupling of granting premiums from production, farmers do not need to plant certain crops or raise bulls in order to obtain direct payments. Thus, future production decisions are expected to be more strongly based on market signals (i.e., crop and input prices). Until 2007 most of the farmers receiving direct payments had to set aside part of their land (organic farms and the use for non-food-production were exempted). All farmers are subject to compulsory cross-compliance and have to take measures for e.g. manure management.

Cross-compliance concerning 'good agricultural and environmental condition' is covered in measure 04_AGR as listed in the PaM summary table in Annex 2. Measure 07_AGR deals with grassland maintenance, which is also a requirement under 'cross-compliance'. Another general provision in the scope of the CAP is 'modulation and financial discipline' – this provision relates to measure 03_AGR.

Second Pillar: In Austria the modulation just mentioned would shift the transfer of direct payment to the second pillar of the CAP – the Rural Development Programme with agri-environment measures ('Österreichisches Programm zur Förderung einer umweltgerechten Landwirtschaft' - ÖPUL) (Council Regulation (EC) No 1698/2005). Measure 05_AGR deals with this second pillar of the CAP. The programme for rural development is of prime importance for the Austrian agricultural sector, because transfers from this source outweigh to some extent lower transfers from the market regime (which is the 'first pillar of the CAP'), i.e. commodity-related instruments. ÖPUL aims at preserving all environmental resources or at improving their status, respectively. A series of measures of this bundle of measures results in the reduction of emissions which are relevant for climate protection, a. o. by a reduction of the amount of nitrogen fertilizers, by improved manure management and spreading, and by improved humus contents of the soil. Measure 10_AGR is a planned option for payments for investments in emission reducing animal production technologies, also funded by the programme of rural development.

All these support schemes have to be considered as a building block in the decoupling process of the CAP – the Austrian subsidies for agri-environmental programmes (ÖPUL) (see measure 09_AGR, that represents one part of the agri-environmental programme and also *M27 Extension of organic farming* in the 4th National Communication), and the support programme for farms in less-favoured areas (LFA) are the most important elements under the umbrella of the current Rural Development Programme (2007-2013). EU member states co-finance farm subsidies in addition to EU funds.

06_AGR Implementation of the Biofuels Directive in Austria

In its energy policy, Austria has committed itself to the substitution of non-renewable energy sources by renewable ones. Raw materials produced by agriculture are a major alternative source. Two major legal sources are of interest in this context: the Austrian Federal Act on the provision of green electricity (see also 02_IND and 02_EN) and the European Biofuel Directive which was implemented in Austria in 2004 (see also 04_TRA). Austria follows an ambitious plan to implement the Biofuels Directive as already outlined in the sector transport. Most of the necessary agricultural products will be imported. There is some evidence that a shortage of agricultural products could lead to high price periods and stimulate domestic production.

The objective of this measure is to promote agricultural production for energy purposes. There is a financial support scheme within the rural development programme that meets the requirements under the Biofuels Directive and there is indeed a synergy between the two policy areas.

There happened to be an interaction between the Green Electricity act and the promotion of biogas production (see 12_AGR). Biogas production on the basis of slurry (i.e. fermentation of manure) would be the most effective procedure in terms of climate mitigation, because the anaerobic digestion of slurry and manure in biogas plants is a very effective measure to reduce methane emissions from manure management. Additionally, the reduction potential in the energy sector should be taken into account. But the funding under the Green Electricity Act does not differentiate if the biogas plants are based on slurry or on field crops such as maize for digestion (see 13_AGR). In contrary it stimulates the use of agricultural products by market price compensation. Consequently, a lot of the biogas plants are based on crops owing to this incentive and not only on slurry as initially intended. The flow back of nutrition and emissions of GHG in soil is not calculated yet.

(Related to *M6 Rural funding schemes for energy from biomass* in the NC4.)

In summary, implemented and adopted measures are expected to contribute to a slightly decreasing trend in the longer-term, compared to the year 2007. Main drivers are the declining trend in N_2O emissions from manure management and – to a lesser extent – from agricultural soils. According to the "with additional measures" scenario planned measures are expected to reduce emissions by 0.04 Tg CO_2 equivalents in 2020 (Umweltbundesamt 2009d).

4.3.7 Land use, Land-Use Change and Forestry

Source Categories of the Common Reporting Format affected: 5 (Land-Use Change and Forestry)
GHG affected: CO_2

Overall, forestry can play a future key role as supplier 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 woodchip heating or biomass-based district heating systems. Austria has a leading position in biomass utilization. For ecological and economic considerations, but also with a view to Austria's energy independence, a further increase is both necessary and possible. (BMLFUW 2008b)

01_FOR 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; AFI 2007/2009 is under progress) the forest as a characteristic element of the Austrian landscape has grown to cover a total area of 4 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.

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.

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 has developed an Austrian Forest Programme. This PaM was already described in the 4th National Communications *(M29 Maintenance and extension of vital forests).*

Concerning information on anthropogenic GHG emissions by source and removals by sinks from land use, land-use change and forestry activities according to Art. 3.3 of the Kyoto Protocol (afforestation/reforestation and deforestation) an average net-sink was estimated to be in the order of - 0.7 Tg CO_2 equivalents per year for the period 2008-2012 (BMLFUW 2007). Activities under Art. 3.4 of the Kyoto Protocol (forest management, cropland and grassland management) have not been elected by Austria.

4.3.8 Cross-cutting Policies and Measures

Sector transcending policies and measures are presented repeatedly in the PaMs chapter e.g. the Emission Trading Scheme is discussed in this chapter but sector related information is additionally given in the chapters energy supply and industry. Usually such PaMs have been quantified and discussed in detail in the section for which they are more relevant. In other cases the effect has been subdivided and quantification has been undertaken separately for the sectors affected. In any case the procedure is documented in the respective chapters. Table 4.5 shows an overview of all cross-cutting PaMs and the sectors affected, furthermore cross-reference to the PaMs sections is given:

Table 4.5: Cross-sectoral policies and measures

PaM	Sector affected					
	Energy supply	Energy demand	Waste	Transport	Industry	Agriculture and Forestry
National Energy Efficiency Action Plan (EEAP)	07_EN	06_ED				
Domestic Environmental Support Scheme (UFI)	01_EN	01,02,03,04_ ED			01_IND	
Green Electricity Act	02_EN	Linkage			02_IND	Linkage
Austrian Climate and energy Fund (KLI.EN)	05_EN	01_ED				
Emission Trading Scheme	03_EN				03_IND	
Water Framework Directive	04_EN				Linkage	
Promotion for combined heat and power (CHP)	06_EN				Linkage	
Eco-Design Directive	08_EN				Linkage	
Implementation of biofuels Directive	linkage			04_TRA		06_AGR

The Domestic Environmental Support Scheme

Funding according to the environmental support scheme in 2004–2007 has been provided for 7 616 projects whereof 95 % were related to climate change. These projects have brought about an emission reduction of some 2.7 Tg CO_2 equivalents. The environment related investment costs for the years 2004-2007 amount to € 1 464 million. Table 4.6 lists supported projects in the period between 2004 and 2007 by sectors:

Table 4.6: The domestic environmental support scheme 2004-2007: overview (Umweltbundesamt 2009c)

sector	**Number of projects**	Environment related investment costs (million €)	Subsidy (million €)	CO_2-reduction (t/a)
Waste management	27	44.5	6.6	163 042
Energy supply*	292	538.1	93.6	1 339 794
Industry*	1 620	506.3	86.0	898 765
Agriculture	155	9.4	2.3	9 701
Energy demand (residential and commercial)	5 442	360.6	84.3	297 163
Transport*	80	5.5	1.3	6 752
Total	7 616	1 464.4	274.1	2 715 217

*projects of the sectors energy and industry, have a reduction effect of 3 Tg in the sector transport

In 2008 2 609 projects have been supported by € 82.4 million, whereof € 79.2 million or 96.1 % were of importance for climate mitigation measures. More than 80 % of the emissions reduction can be attributed to the energy supply and industry sector. Two thirds of the projects, which are rather small due to structural conditions, have been supported within the subsector energy demand. Further information can be found on the webpage and in the annual reports of Kommunalkredit Public Consulting (http://www.public-consulting.at).

The Emission Trading Scheme

The emission trading scheme is based on the Austrian Emissions Allowance Trading Act (see Section 4.2.3). Emissions trading currently covers emitters of greenhouse gases which operate in specific sectors (energy intensive installations from industry and energy production sectors) as stipulated in the Austrian Emissions Allowance Trading Act. In 2007, these emitters were responsible for 36 % of the total emissions (based on verified emissions) in Austria. Within the affected sectors, about 80 % of emissions are covered.

The Allocation Plan for the pilot phase of the EU Emissions Trading Scheme from 2005-2007 was prepared and approved by the Commission in 2004. The total amount of emissions allowances to be allocated to about 200 Austrian companies was about 33 million allowances per year. Detailed figures of verified emissions for the pilot phase are depicted in Figure 4.6.

The Allocation Plan for 2008-2012 was submitted to the European Commission for approval in February 2007. On 2 April 2007 the Commission decided that the total amount of allowances had to be reduced from 32.8 to 30.7 million allowances per year. In addition, the Commission ruled that the refinery, integrated steel and district heating sectors may not be treated unduly favourable. In addition, the maximum percentage of Kyoto units from JI/CDM that operators may use was reduced from 20 % to 10 % of the total allocation to each individual installation. For further information the Austrian webpage on emissions trading may be consulted[8].

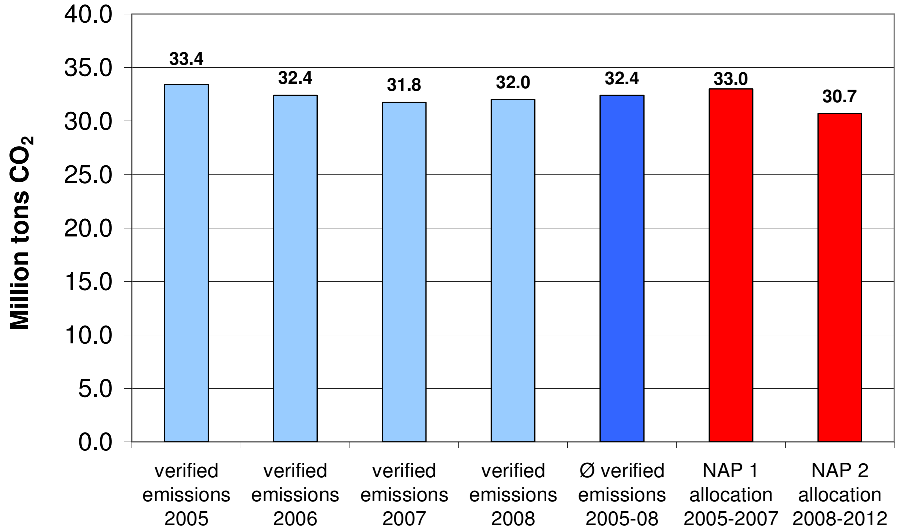


Figure 4.6: Emission trading – national allocation and total verified emissions (Umweltbundesamt2009b)

In the NC4 information on the ETS was given in measure *M35 Implementation of EU Emissions Trading Scheme.*

The Austrian JI/CDM Programme

Based on the amendment of the Environmental Support Act the Programme was launched in August 2003 (see Section 4.2.3). 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.

According to the national Climate Strategy (2007) the Austrian JI/CDM Programme will contribute 45 Tg CO_2 equivalents (i.e. 9 Tg CO_2 equivalents per year) to achieving the Austrian Kyoto target in the period 2008-2012. Of this contribution, KPC had already contracted around 41.8 Tg of CO_2 equivalents by the end of 2008. Out of this contracted amount 1.97 million emission reduction units corresponding to 1.97 Tg of CO2 equivalents were actually transferred to the Austrian national registry in 2008. (Umweltbundesamt 2009c)

8 http://en.emissionshandelsregister.at/emission_trading/emission_trading_basics/index.html

4.4 Further Information with Respect to the Kyoto Protocol

Austria is aware of the need to reduce *greenhouse gas emissions from aviation and shipping*. Austria supports EU work on that subject in ICAO and IMO. The EU, with active support from Austria, succeeded to include aviation CO2 emissions into the EU emissions trading scheme from 2012 onwards, resulting in a limitation of emissions below historic levels in 2004-2006. The EU scheme includes emissions from flights within the EU as well as between EU and third countries. Appropriate action is envisaged by the European Commission also for maritime transport.

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.

Austria also seeks to ensure that response measures are as diverse as possible. Most policies and measures, which Austria has implemented due to Climate Policy, will have no direct or indirect negative effects. In cases where adverse effects could occur, the following measures are/were undertaken:

- *Adverse effects of climate change*
  Emission Trading could lead to carbon leakage and higher emissions in countries which do not have comparable environmental standards. To minimise that risk, according to EU Directive 2003/87/EG emission allowances are granted for free to companies with specific characteristics. (http://www.eu-emissionshandel.at)
- *Social, environmental and economic impacts on developing countries*
  JI/CDM projects may in principle have negative side effects in the host countries. For example, projects for the production of biofuels might add to deforestation of forests and/or result in higher prices for food. The Austrian JI CDM Programme therefore has demanding social and environmental criteria to be eligible as an Austrian JI CDM project. The favoured project categories reflect the high priority that is given to technology transfer projects.
  (http://www.public-consulting.at/de/portal/sterreichischesjicdmprogramm/)

Table 4.7: Summary of policies and measures by sectors

No. of PaM[9]	Name of PaM	Objective and/or activity affected	GHG affected	Type of instrument[10]	Status[11]	Implem. entity or entities	Estimate of mitigation impact by gas [Tg CO2 equ.] [12] 2010	2015	2020	Policy instruments related
1.1 Energy Demand (residential and commercial)										
01_ED*	measure group: forced use of renewable energy	to reduce GHGs through increased use of renewables (biomass, solar heat, heat pumps) in the sector residential and commercial	CO2	Reg, Inf, Ed	impl.	Federation, *Länder*	-0.18	-0.72	-1.13	- BGBl. II Nr. 19/2006 as amended -Technical Construction Regulation by the 'Länder' - BGBl. I Nr. 40/2007 - BGBl. I Nr. 185/1993 as amended - Dir 2006/32/EC
02_ED*	measure group: forced building renovation	to improve thermal building envelopes (house front, windows, top and bottom floor ceiling) and the overall renovation rate	CO2	Ec, Reg, Inf, Ed	impl.	*Länder*	-0.09	-0.29	-0.60	-Dir 2002/91/EC - BGBl. I Nr. 137/2006
03_ED*	measure group: forced replacement of heating systems	to give financial support and raise awareness for changing old, inefficient heating systems	CO2	Ec, Reg, Inf	impl.	*Länder*	-0.09	-0.46	-0.78	- Dir 2002/91/EC -Dir 2005/32/EC -BGBl. Nr. 137/2006
04_ED*	measure group: public support for new building	to grant financial subsidies (credit, cash) for better thermal quality (insulation) of new buildings	CO2	Ec, Reg, Inf, Ed	impl.	Federation, *Länder*	-0.04	-0.28	-0.50	- Council Dir 92/42/EEC - Dir 2002/91/EC -BGBl. I 137/2006
05_ED	measure group: additional measures to reduce energy consumption in the sectors residential and commercial	- further reduction of GHGs by obligated exchange of heating systems older than 30 years - new heating systems with fossil fuels have to support the condensing boiler technology - further increase in renovations rates	CO2	Ec, Reg	planned	Federation, *Länder*	-0.02	-0.63	-1.80	

[9] An Asterisk (*) is used to indicate that a PaM is included in the with-measures scenario, (**) is used to indicate that a PaM is included in both – the with-measures and the with additional measures scenario and PaMs included in the with-additional measures scenario only are not marked. IP = Industrial processes, EN = Energy Supply, IND = Industry, TRA = Transport, ED = Residential, AGR = Agriculture

[10] Ec = Economic, Fi = Fiscal, Vo = Voluntary, Reg =regulatory, Inf = Information, Ed = Education, Res = Research, P = Planning, O = Other

[11] Impl. = implemented, adopt. = adopted, planned, expired

[12] There is not yet an ex post quantification available for the given measures. NE = not estimated

06_ED*	National energy efficiency action plan	- further improvement of energy efficiency - implementation of Dir 2006/32/EC in Austria	CO2	Reg, Inf	impl.	Federation	NE[5]	NE	NE	- Dir 2006/32/EC amended by 2008/28/EC
07_ED	measure group: additional measures to reduce electric power consumption in the sector residential and commercial without energy use for heating and hot water	reduction of electric energy consumption	CO2	Reg, Inf	planned	Federation, *Länder*	NE	NE	NE	- Dir 2005/32/EC
Aggregate effect of planned policies and measures in the energy demand sector:							-0.02	-0.63	-1.80	
1.2 Energy Supply										
01_EN*	Domestic environmental support schemes (UFI)	subsidy funding GHG relevant projects for energy efficiency and renewables	CO2, CH4, N2O	Fi	impl.	Federation	-0.039	NE	NE	- BGBl. No 185/1993 as amended -Dir 2003/87/EC (Green Electricity Plants result in a reduced production in large fossil fuel plants affected by the ETS)
02_EN**	Green Electricity Act	- subsidy promoting the power production from renewable energy sources, to raise the share of electricity from RES in electricity consumption in public grids to 10% by 2010	CO_2	Ec	impl.	Federation	-2.24	-3.29	-3.97	-Dir 2001/77/EC - BGBl. I Nr. 149/2002 as amended - Dir 2003/87/EC (Green Electricity Plants result in a reduced production in large fossil fuel plants affected by the ETS)
03_EN*	Emission Trading System (ETS)	limit the CO2 emissions from large power plants and industrial plants through a trading mechanism for emission certificates	CO_2	Ec, Reg	impl.	Federation	NE	NE	NE	- Dir 2003/87/EC - Dir 2004/101/EC
05_EN*	Austrian Climate and energy fund (KLI.EN)	- subsidy to meet the target specified within the Kyoto Protocol for Austria- energy-related measure involves subsidies for PV plants < 5 kW.	CO_2	Ec	impl.	Federation	-0.001	-0.003	-0.003	- Dir 2001/77/EC - BGBl. I Nr. 40/2007

06_EN*	Promotion for combined heat and power (CHP)	Subsidy to expand Austrian CHP facilities	CO_2	Ec	impl.	Federation	NE	NE	NE	- Dir 2004/8/EC - BGBl. I Nr. 111/2008
07_EN	Directive on energy end-use efficiency and energy services and the corresponding first Austrian energy efficiency action plan	energy savings target of 9% by 2016	CO_2	Ec, Reg, Inf, Res	planned	Federation	NE	NE	NE	- Dir 2006/32/EC amended by 2008/28/EC
08_EN	Eco Design Directive	minimum ecodesign requirements for specific energy-using products	CO_2	Reg	planned	Federation	NE	NE	NE	- Dir 2005/32/EC
Aggregate effect of planned policies and measures in the energy supply sector: (excl. effect from EU-ETS 03_EN)							-0.76	-1.96	-4.57	
2 Waste Management										
01_WASTE**	landfill ordinance (deposition of untreated biodegradable waste)	reduction of the deposition of untreated deposited waste	CH_4	Reg	impl.	*Länder*	NE	NE	NE	- Council Dir 1999/31/EC - BGBl. Nr. 164/1996 as amended - BGBl. I 102/2002 as amended
02_WASTE**	landfill ordinance (collection and drainage of landfill gas)	mandatory collection and drainage of landfill gas originating from mass-waste landfills	CH_4	Reg	impl.	*Länder*	NE	NE	NE	- Council Dir 1999/31/EC - BGBl. Nr. 164/1996 as amended
03_WASTE**	Remediation of Contaminated Sites Act	higher costs for the deposition of wastes on landfills without gas collection	CH_4	Fi	impl.	Federation	NE	NE	NE	- BGBl. Nr. 299/1989 as amended
04_WASTE**	Guideline for the Mechanical Biological Treatment of Waste	reduction of gas formation potential	CH_4	P	impl.	Federation	NE	NE	NE	- Council Dir 1999/31/EC
Aggregate effect of planned policies and measures in the waste management sector:							0	0	0	
3 Transport										

01_TRA*	ACEA – voluntary agreement	raising the market share of advanced engine technologies with low fuel consumption	CO_2, N_2O	Vo	adopt.	Federation	NE	NE	NE	- Voluntary agreement with car manufacturers to reduce specific CO_2 emissions (ACEA, KAMA, JAMA), [KOM (95) 689]
02_TRA**	CO_2 labelling and other measures to reduce emissions from passenger cars	raising the market share of advanced engine technologies with low fuel consumption	CO_2	Reg, Inf	impl.	Federation	NE	NE	NE	- Dir 1999/94/EC
03_TRA**	Mileage based toll for lorries	internalisation of external costs for road transport	CO_2	Fi	adopt.	Federation	NE	NE	NE	- BGBl. Nr. 109/2002
04_TRA**	Promotion of biofuels	minimum shares for transport fuels from renewable energy sources	CO_2	Fi, Reg	impl.	Federation	-1.65	-2.11	-2.77	- Dir 2003/30/EC - BGBl. II Nr. 418/1999
05_TRA**	Euro classification	drowtown of the emission limits	CO_2, CH_4, N_2O	Reg	adopt.	Federation	NE	NE	NE	- Council Dir 70/220/EEC - Dir 1999/96/EC - Dir 2004/26/EC - BGBl. I Nr. 267/1967 as amended
06_TRA**	Measures concerning infrastructure, public transport and mobility management	increase the share of public transport in passenger transport by promoting and optimising transport and tariff associations	CO_2, CH_4, N_2O	Ec, Inf	adopt.	Federation, *Länder*	NE	NE	NE	
07_TRA**	klima:aktiv-->mobil programme	mobility management in companies, in public adminitration, leisure- & tourism-traffic, in schools, for cities,-communities&regions, for developer&investors, individual consulting	CO_2, CH_4, N_2O	Ec, Inf, Ed	impl.	Federation, *Länder*	-0.25	-0.25	-0.25	
08_TRA	Enhanced fuel efficiency of cars	raising the market share of advanced engine technologies with low fuel consumption	CO_2, N_2O	Vo	planned	Federation	-0.16	-0.83	-1.72	- Voluntary agreement with car manufacturers to reduce specific CO_2 emissions (ACEA, KAMA, JAMA), [KOM (95) 689]
09_TRA	Control of speed limits, traffic control systems and supporting measures	indirect fuel efficiency of cars	CO_2, N_2O	Reg	planned	Federation, *Länder*	0.00	-0.43	-0.39	

10_TRA	Fuel consumption based taxation (NOVA)	tax giving a clear incentive to buy energy efficient cars	CO_2	Fi	impl	Federation	NE	NE	NE	
Aggregate effect of planned policies and measures in the transport sector:							-0.16	-1.27	-2.11	
4 Industry										
4.1 Industrial Processes										
4.1.1 F-Gases										
07_IP*	Austrian F-Gas Ordinance	reducing and phasing-out respectively the use of HFCs, PFCs and SF6 in all relevant applications on the basis of the Federal Chemicals Act	HFC, PFC, SF_6	Reg	impl.	Federation	-0.03	-0.02	-0.02	- Council Reg (EC) No 842/2006 - BGBl. II Nr. 447/2002 as amended
08_IP*	EU F-Gas Ordinance	aims to reduce emissions of fluorinated greenhouse gases (mainly) in stationary applications through application-specific requirements covering all stages of the life cycle of F-Gases.	HFC, PFC, SF_6	Reg	adopt.	Federation	-0.01	0.00	0.00	- Council Reg (EC) No 842/2006
09_IP*	Directive on HFC emissions from air conditioning in motor vehicles	Reduce emissions of fluorinated gases used in air conditioning systems	HFC	Reg	adopt.	Federation	-0.01	-0.02	-0.01	- Dir 2006/40/EC
Aggregate effect of planned policies and measures in the F-Gases sub- sector:							0	0	0	
4.2 Manufacturing Industries and Construction										
01_IND*	Environmental support schemes for installations (UFI)	subsidy funding GHG relevant projects for energy efficiency and renewables	CO_2, CH_4, N_2O	Fi	impl.	Federation	NE	NE	NE	- BGBl. No 185/1993 as amended
02_IND**	Green Electricity Act	- subsidy promoting the power production from renewable energy sources	CO_2	Ec	impl.	Federation	IE	IE	IE	BGBl. I No 149/2002 as amended

03_IND*	Emission Trading System (ETS):	limit the CO_2 emissions from large power plants and industrial plants through a trading mechanism for emission certificates	CO_2	Ec, Reg	impl.	Federation	NE	NE	NE	- Dir 2004/101/EC - Dir 2003/87/EC
Aggregate effect of planned policies and measures in the Manufacturing Industries and Construction sub- sector: (excl. effect from EU-ETS – 03_IND)							0	0	0	
4.3 Solvents and other product use										
01_IP*	Solvent Ordinance	limitation of emission of VOC due to the use of organic solvents in certain paints and varnishes and vehicle refinishing products in order to combat acidification and ground-level ozone	CO_2	Reg	impl.	Federation	NE	NE	NE	- Dir 2004/42/CE - Council Dir 1999/13/EC - BGBl. II No 81/2000 as amended - BGBl. I No 98/2004
02_IP*	Ordinance for paint finishing system	limitation of emission of VOC due to the use of organic solvents by activities such as surface coating, painting or varnishing of different materials and products along the entire chain in the painting process in order to combat acidification and ground-level ozone	CO_2	Reg	impl.	Federation	NE	NE	NE	
03_IP*	Federal Ozone Law	establishes through various measures a reduction in emissions of ozone precursors (NOx and NMVOC)	CO_2	Reg	impl.	Federation	NE	NE	NE	
04_IP*	Ordinance for industrial facilities and installations applying chlorinated hydrocarbon	limitation of emission of chlorinated organic solvents from industrial facilities and installations applying chlorinated hydrocarbon	CO_2	Reg	impl.	Federation	NE	NE	NE	

05_IP*	Ordinance for volatile organic compounds (VOC) due to the use of organic solvents in certain activities and installations	limitation of VOC	CO_2	Reg	impl.	Federation	NE	NE	NE	- Council Dir 1999/13/EC
06_IP*	Ordinance on the limitation of emission during the use of solvents containing lightly volatile halogenated hydrocarbons in industrial facilities and installations	limitation of VOC	CO_2	Reg	impl.	Federation	NE	NE	NE	
Aggregate effect of planned policies and measures in the Solvents and other product use sub- sector:							0	0	0	
5 Agriculture and Forestry										
5.1 Agriculture										
01_AGR**	Common Agricultural Policy (CAP) 2003 reform	reduction of environmental pollution from agricultural activity	CO_2, CH_4, N_2O	Ec	impl.	Federation	NE	NE	NE	- Council Reg.(EC) No 1782/2003 - Council Reg.(EC) No 73/2009
02_AGR**	Austrian implementation of the CAP	incentives to livestock holders in less favoured regions (succler cow units are a main target of support for farmers under disadvantaged conditions)	CH_4, N_2O	Ec	impl.	Federation	NE	NE	NE	- Council Reg. (EC) No 1782/2003 - BGBL I Nr. 55/2007
03_AGR**	Funds transfer from "modulation"	big farms losing support for the benefit of environmental program (modulation would shift transfer of direct payment to rural development program with agri-environment measures)	CO_2	Ec, Fi	impl.	Federation	NE	NE	NE	- Council Reg.(EC) No 1782/2003 - Council Reg.(EC) No 73/2009

04_AGR**	Land is maintained in good agricultural and ecological condition ('cross compliance')	maintenance of unproductive agricultural areas (direct payments, decoupled from production , lead to extensively managed agricultural land, but with the potential to return to production)	CO_2, N_2O	Ec	impl.	Federation, *Länder*	NE	NE	NE	- Council Reg.(EC) No 1782/2003 - Council Reg.(EC) No 73/2009
05_AGR**	The program for rural development (2nd pillar of CAP)	support of environmental measures in agriculture	CO_2, CH_4, N_2O	Ec	impl.	Federation, *Länder*	NE	NE	NE	- Council Reg. (EC) No 1783/2003 - Council Reg. (EC) No 1698/2005
06_AGR**	Implementation of the Biofuels Directive in Austria	promoting production of biomass for energy purpose	CO_2, N_2O	Ec	impl.	Federation	NE	NE	NE	- Council Reg. (EC) No 1782/2003
07_AGR**	Grassland maintenance	grassland will be saved as a sustainable resource for production of biomass on steep hills and mountains	CO_2, N_2O	Ec	impl.	Federation, *Länder*	NE	NE	NE	- Council Reg.(EC) No 1782/2003 - Council Reg.(EC) No 73/2009
09_AGR	Organic farming	increase share of farmland used for organic farming to 20 % (within the given budget of the programme for rural development)	CO_2, CH_4, N_2O	Ec	planned	Federation	NE	NE	NE	- Council Reg. (EC) No 1783/2003 - Council Reg. (EC) No 1698/2005
10_AGR	Payments for investments in emission reducing animal production technologies (funded by the programme for rural development)	new installations of livestock stables and manure storage	CH_4, N_2O	Ec	adopt.	Federation, *Länder*	NE	NE	NE	- Council Reg (EC) No 1783/2003
11_AGR**	Set aside additional land for short rotation forests	short rotation areas should have been increased, but inter alia due to demand on biomass, this CO_2 sequestration strategy has been revised	CO_2	Ec	expired	Federation, *Länder*	NE	NE	NE	- Council Reg (EC) No 1783/2003
12_AGR	Usage of 800 000 m3 slurry for biogas production	support of fermentation of manure	CH_4, N_2O	Ec	impl.	Federation	NE	NE	NE	- Dir 2003/54/EC

13_AGR	Usage of 13 500 hectares of set aside land for biogas production from silage-maize	support of agricultural crops	CO_2, CH_4, N_2O	Ec	impl.	Federation	NE	NE	NE	- Dir 2003/54/EC
14_AGR	Usage of 10 000 ha silage of grassland and alfalfa (from 2008 on)	support of agricultural crops	CH_4, N_2O	Ec	impl.	Federation	NE	NE	NE	- Dir 2003/54/EC
Aggregate effect of planned policies and measures in the Agriculture sector:							-0.07	-0.04	-0.04	
Aggregate effect of planned policies and measures (total excl. ETS, JI/CDM, and 5.2 Forestry and LULUCF)							-1.00	-3.89	-8.51	
5.2 Forestry and LULUCF										
01_For	Maintenance and extension of vital forests	Maintaining biodiversity, productivity, regeneration, capacity and vitality of forests	CO_2	Res, Reg, Inf	impl.	Federation, *Länder*	NE	NE	NE	
6 Cross-cutting Policies and Measures										
01_EN, 01_IND	The Domestic Environmental Supporting Scheme (UFI)	subsidy funding GHG relevant projects for energy efficiency and renewables	CO_2, CH_4, N_2O	Fi	impl.	Federation	IE	IE	IE	BGBl. Nr. 185/1993 as amended
03_EN, 03_IND	The Emission Trading Scheme (ETS)	To limit the CO_2 emissions from large power plants through a trading mechanism for emission certificates	CO_2	Ec, Reg, flexible mechanism	impl.	Federation, EU	NE	NE	NE	BGBl. I Nr. 135/2004 as amended
-	The Austrian JI/CDM Programme	Public purchase of ERUs and CERs	CO_2, CH_4, N_2O, F-gases	flexible mechanism	impl., planned	Federation	-9	-	-	BGBl. Nr. 185/1993 as amended

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 Projections

Up to date national greenhouse gas (GHG) emission projections have been developed in 2008/2009 which include results for a 'with measures' scenario (wm) and a 'with additional measures' scenario (wam) up to 2020. The former comprises climate change mitigation measures that were implemented and adopted under the Austrian Climate Strategy I (BMLFUW 2002) and its amendment Climate Strategy II (BMLFUW 2007) before 8th August 2008. The latter takes into account planned policies and measures (PaMs) with a realistic chance of being adopted and implemented in time to influence the emissions (see also Chapter 4). Both emission control scenarios presented in this report are in line with the projections reported in March 2009 under the EU Monitoring Mechanism (Decision 280/2004/EC). Hence, for a more detailed description of the methodology used that report should be consulted (Umweltbundesamt 2009d). The optional 'without measures' (wom) projection was not produced.

The impact of the current economic crisis is not reflected in the presented emission projections and therefore the projections are systematically biased towards an overestimation. This needs to be kept in mind for the interpretation of the scenario results. When comparing the results shown below for certain years with the Kyoto Protocol target and the Austrian target of -13 % under the EU burden sharing agreement, the use of carbon sinks (estimated to equal -0,7 Tg CO_2 equivalents) and Kyoto mechanisms JI/CDM (intended annual government use -9 Tg CO_2 equivalents) have to be taken into account. The projections also do not take into account the allocated emissions according to the national allocation plan but include the ETS in terms of a carbon price. Thus, the ETS has to be considered additionally in the way that purchases by the government for the flexible reserve for new entrants and by the companies in the commitment period (both estimated to equal 3.1 Tg CO_2 equivalents) have to be subtracted from the actual projections. The resulting gap is meant to be closed by the forceful implementation of additional measures.

5.1.1 Inventory based emission projections and underlying models

Emission projections for CO_2, CH_4, N_2O and F-gases are generally calculated by the Environment Agency Austria (Umweltbundesamt) within the framework of the project EMIPRO (Umweltbundesamt 2009d). Basically, the same methodologies as for the national GHG inventory are applied. These methodologies are reported in Austria´s National Inventory Report 2009 (Umweltbundesamt 2009). The projections are calculated on the basis of the historical emission data of the Austrian Emission Inventory, submission January 2008 (Umweltbundesamt 2008b), up to the data year 2006. Nevertheless, historical data of emissions presented in tables below (chapter 5.1.3) represent the actual emission data according to the Inventory submission January 2009 (Umweltbundesamt 2009) in order to ensure consistency with the inventory chapter of this report. Actual emissions are given for the years 1990, 1995, 2000, 2005, 2006 and 2007, projections are given for 2010, 2015 and 2020 for two scenarios (wm, wam) and are subdivided by sector and by gas. All emissions are reported in carbon dioxide equivalent values and have been converted from each gas on the basis of global warming potentials (GWP) as agreed upon by the Conference of the Parties.

The underlying sectoral forecasts of activities are based on the use of various models and methods and have been carried out in close collaboration with several institutions. The following list provides a brief overview; a detailed explanation will be given in the methodology section (chapter 5.4).

- The energy forecast is based on the National Energy Balance of Statistics Austria and on a macro-economic model of the Austrian Institute of Economic Research (IER) (Kratena and Meyer, 2007), supported by calculations with the bottom-up models BALMOREL, LEAP (AEA) and ERNSTL (EEG). 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 Wueger, 2005).
- The transport forecast is based on the bottom-up, national transport model GLOBEMI (Technical University of Graz).
- The forecast of emissions from industrial processes, of solvent emissions and emissions of fluorinated gases are based on expert judgements of the Environment Agency Austria (EAA).
- The agricultural forecast is based on the PASMA model of the Austrian Institute of Economical Research (Sinabell & Schmid 2005) and expert consultations with the Agricultural Research and Education Centre, Gumpenstein (Pöllinger 2005, 2008).
- The waste forecast is based on the Environment Agency Austria forecast of the quantity of waste deposited and wastewater handled.

The data structure of activities, input data, emission factors and emission calculations is based on SNAP categories (Selected Nomenclature for sources of Air Pollution). The structure of output data is presented and aggregated in the Common Reporting Format (CRF) of the UNFCCC. Sectoral definitions align fully with the IPCC. For the purpose of transparency CRF source categories are specified in the headings and tables, respectively.

Differences to the fourth national communication (NC4):

The approach adopted in the NC5 is an up-date and an extension to the model calculations that have been performed in 2005 for the NC4. The current results include the implemented and adopted policies and measures suggested in the Climate Strategy II (BMLFUW 2007), albeit policies and measures described in this report are not fully consistent with the notation of policies and measures in the national Climate Strategies (BMLFUW 2002, 2007). This is why the projections for the year 2010 according to the Climate Strategy II are not discussed anymore.

5.1.2 Total GHG emission projections

Scenarios have been developed for the sectors energy (CRF 1), industrial processes and solvents (CRF 2 and 3), agriculture (CRF 4), waste (CRF 6) and the subsectors energy industries and fugitive emissions (CRF 1.A.1 and 1.B), manufacturing industries and construction (CRF 1.A.2), transport (CRF 1.A.3), residential, commercial and other (CRF 1.A.4 and 1.A.5). The sector Land Use Change and Forestry (LULUCF) (CRF 5) is not considered in the total emissions.

The summary of all sectors (without Land Use Change and Forestry) shows that in the wm-scenario emissions are expected to increase between 2006[1] and 2010 by 3 % or 2.6 Tg CO2 equivalents and between 2006 and 2020 by 7 % or 6.6 Tg CO2 equivalents. This increase to 98.1 Tg CO2 equivalents by 2020 is mainly driven by the forecast rise of emissions from the energy sector.

The wam-scenario indicates a decrease of total GHG emissions to 89.6 Tg CO2 equivalents by 2020 but shows rising emissions until 2010. The decline in emissions is mainly driven by a fall of emissions in the energy sector by 1.8 Tg CO2 equivalents, followed by the forecast decrease of emissions in the waste sector by 46 % or 1.1Tg CO2 equivalents between 2006 and 2020.

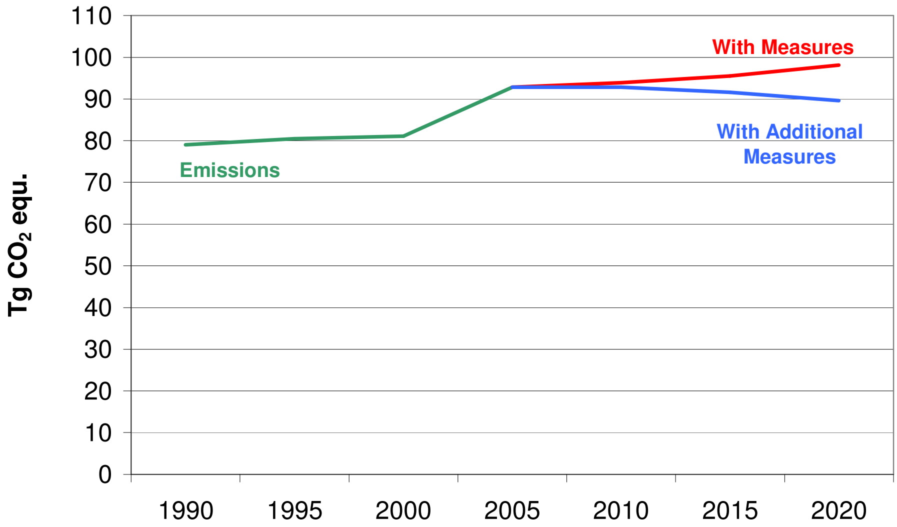


Figure 5.1: Actual and projected total GHG emissions in Austria (without LULUCF)

[1] Model calculations are actually based on data from Inventory Submission January 2008 using 2006 as starting point. Being aware of the importance of providing consistent projections and inventory data, it has been decided that the actual inventory data of the Inventory Submission January 2009 should be presented relative to the projections. This is why the trend is described relative to the year 2006, whereas tables present data for the year 2007 in addition.

Table 5.1: Actual and projected GHG emissions in Austria (without LULUCF) by sector

	Emissions						With Measures			With Additional Measures		
Sector or subsector (CRF)	1990	1995	2000	2005	2006	2007	2010	2015	2020	2010	2015	2020
in Tg CO_2 equivalent												
Energy (1)	55.59	57.93	59.58	71.91	70.05	66.15	72.74	74.29	76.69	71.81	70.43	68.22
Energy Industries (1.A.1, 1.B)	14.33	13.57	13.14	17.04	16.56	14.96	18.48	18.17	19.53	17.72	16.21	14.96
Manufacturing Industries & Construction (1.A.2)	12.77	13.59	13.89	15.83	16.12	15.82	15.77	17.01	18.04	15.77	17.01	18.04
Transport (1.A.3)	14.02	15.99	19.12	25.34	23.97	24.22	24.04	25.46	26.33	23.88	24.19	24.22
Residential, Commercial and Other (1.A.4, 1.A.5)	14.47	14.77	13.43	13.69	13.40	11.14	14.46	13.65	12.79	14.44	13.02	10.99
Industrial Processes (2) and Solvents (3)	10.62	10.15	10.46	10.70	11.29	11.69	11.42	11.88	12.29	11.42	11.88	12.29
Agriculture (4)	9.17	9.24	8.39	7.85	7.88	7.95	7.80	7.81	7.89	7.73	7.78	7.86
Waste (6)	3.65	3.18	2.65	2.38	2.29	2.18	1.91	1.50	1.24	1.91	1.50	1.24
Total	79.04	80.51	81.08	92.83	91.52	87.96	93.87	95.47	98.11	92.87	91.58	89.61

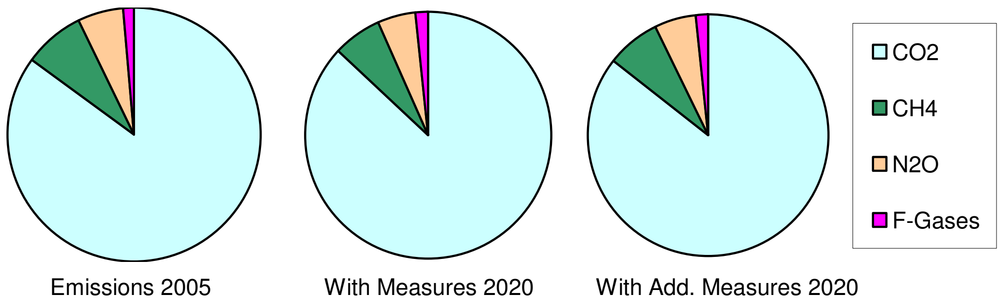


Figure 5.2: Actual 2005 and projected 2020 share of GHG emissions by gas

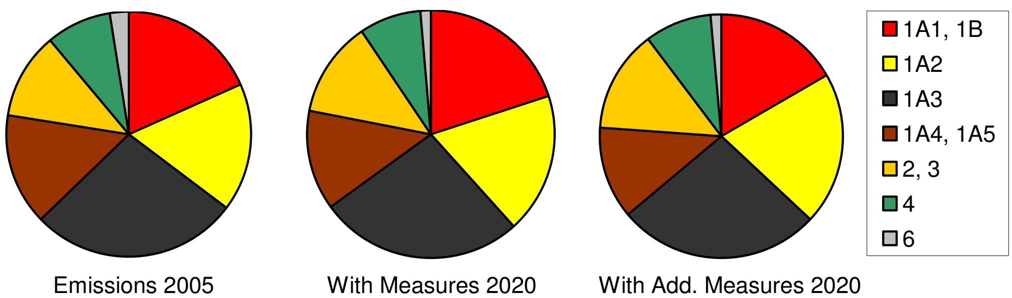


Figure 5.3: Actual 2005 and projected 2020 share of GHG emissions by sector

CO_2 and F-gas emissions are expected to increase until 2020, whereas N_2O and CH_4 show a continuously falling trend. The most important GHG in 2020 will be still CO_2 in both scenarios.

5.1.3 Key Underlying Variables

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. A summary of key variables used for both scenarios is given in the following table.

Table 5.2: Key input parameter of emission projections.

Year	2010	2015	2020
GDP [bio€ 2 000]	256.52	287.83	321.70
Population [1 000]	8 427	8 561	8 672
Stock of dwellings [1 000]	3 602	3 725	3 827
International coal prices [€/GJ]	6.59	7.36	7.44
International oil prices [€/GJ]	14.93	14.93	14.93
International gas prices [€/GJ]	9.62	9.62	9.62

Table 5.3: Historical trend of key parameter (Umweltbundesamt 2009)

Year	1990	1995	2000	2005	2006	2007
GDP [bio€ 2 000]	161.31	179.14	207.53	225.48	233.09	240.24
Population [1 000][(1)]	7678	7948	8012	8225	8268	8301
Stock of dwellings [1 000]	2947	3109	3261	3475	3508	3537

(1) STATISTIK AUSTRIA, Statistik des Bevölkerungsstandes.- Revidierte Ergebnisse für 2001 bis 2007. Erstellt am: 27.05.2009 – Jahresdurchschnittsbevölkerung

It should be noted that emission projections in this report are based on economic scenarios that have been developed before the current financial and economic crisis. Therefore, recent economic developments were not taken into account.

Differences to the fourth national communication:

In general emissions are expected to be higher in both current scenarios of the NC5 than in previous projections, mainly due to three main factors:

- Recalculations in the GHG inventory that are triggered by methodological changes. This led, consequently, also to recalculations of the emission projections, as the methods are applied consistently for the calculation of historical and forecast emissions.
- Assumptions for activity forecasts have changed. These changes might be triggered by revised economic or technical scenarios, additional policies and measures considered, and revisions of policies or measures e.g. due to amendments to legal texts.
- A change of the models used for activity or emission scenarios. (see also chapter 5.4)

5.1.4 Emission projections by sector and by gas

The sectoral definitions in this chapter are mostly but not fully in line with the sectoral breakdown in the policies and measures (PaMs) chapter of this report. The sectoral breakdown in the projections chapter builds upon the national inventory, whereas the sectoral categories in the PaMs chapter aim for consistency with official Austrian policy (i.e. the Climate Strategy) and follow quite closely the proposal as included in the UNFCCC reporting guidelines. However, comparability is assured as both classifications are in complete accordance with the IPCC and with the Austrian NC4. Lists of PaMs, which have been taken into account for the scenario calculations, are presented for each sector in Appendix D.

Sector Energy (CRF Source Category 1)

The sector energy (1) covers the subsectors energy industries and fugitive emissions (1.A.1 and 1.B), manufacturing industries and construction (1.A.2), transport (1.A.3) and residential, commercial and other (1.A.4 and 1.A.5).

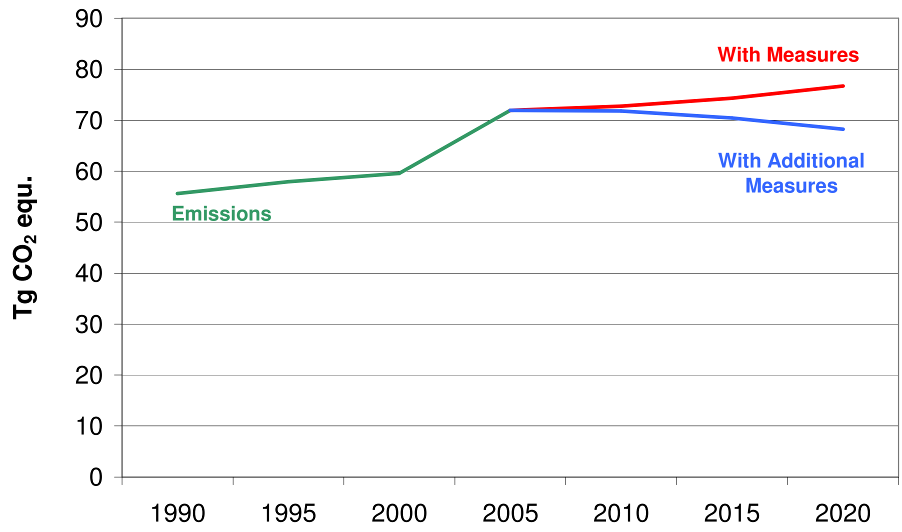


Figure 5.4: Actual and projected emissions from energy (1)

Table 5.4: Actual and projected emissions from energy (1) by gas

	Emissions						With Measures			With Additional Measures		
	1990	1995	2000	2005	2006	2007	2010	2015	2020	2010	2015	2020
	in Tg CO_2 equivalent											
CO_2	54.20	56.38	57.98	70.08	68.22	64.38	71.01	72.56	74.96	70.08	68.71	66.50
CH_4	0.85	0.90	0.88	1.03	1.04	1.02	1.02	1.07	1.10	1.02	1.07	1.11
N_2O	0.55	0.65	0.72	0.80	0.79	0.75	0.71	0.66	0.63	0.70	0.65	0.61
Total	55.59	57.93	59.58	71.91	70.05	66.15	72.74	74.29	76.69	71.81	70.43	68.22

For emissions from the energy sector the **wm-scenario** indicates that GHG emissions will rise by 4 % in the period 2006 to 2010 and by 9 percent between 2006 and 2020. GHG emissions are expected to result in 76.7 Tg CO_2 equivalents by 2020. The major contribution to this continuing rise in emissions is made by the subsectors energy industries and transport.

The **wam- scenario** shows emissions rising by 3 % until 2010 and decreasing afterwards to a level well below the 2006 emissions by 2020. The falling trend to 68.2 Tg CO_2 equivalents between 2010 an 2020 is dominated by the subsectors energy industries and residential and commercial whereas emissions from manufacturing industries and construction show an increase.

Subsector Energy Industries (CRF Source Category 1.A.1 and 1.B)

Table 5.5: Actual and projected emissions from energy industries (1.A.1 und 1.B) by gas

	Emissions						With Measures			With Additional Measures		
gas	1990	1995	2000	2005	2006	2007	2010	2015	2020	2010	2015	2020
	in Tg CO_2 equivalent											
CO_2	13.89	13.05	12.52	16.30	15.78	14.17	17.61	17.24	18.55	16.86	15.29	14.00
CH_4	0.39	0.48	0.57	0.68	0.71	0.71	0.74	0.78	0.80	0.74	0.78	0.80
N_2O	0.05	0.05	0.05	0.07	0.08	0.08	0.13	0.15	0.17	0.13	0.15	0.16
Total	14.33	13.57	13.14	17.04	16.56	14.96	18.48	18.17	19.53	17.72	16.21	14.96

The major driving force for the continuing rise in emissions in the **wm-scenario** in this subsector will be the growing electricity demand. However, it is assumed that the increase of emissions will be significantly slower than electricity production, mainly due to a shift of production technologies to new gas-fired combined cycle gas turbines with high electrical efficiencies. The growth rates of wind power production and electricity and heat production from biomass and waste of biogenic origin will be significantly higher than the average growth rates of electricity and heat production. However, the boost of these renewables will be compensated by a comparatively modest increase in hydropower, as hydropower is already well developed in Austria. Furthermore, it had been assumed in this scenario that the price of CO_2-tonne in Emission Trading will be at € 20/t till 2010, € 21/t till 2015 and € 22/t till 2020.

The driving forces for the decline in emissions in the **wam- scenario** are a significant shift in electricity and heat production to renewables (wind +142 % by 2020 compared to 2006, biomass +>100 %, waste of biogenic origin +52 %) and new, more efficient gas-fuelled power plants. The additional production of hydropower increases by 10 % due to more efficient usage of the Green Electricity Act 2008.The price of the CO_2-tonne in Emission Trading was assumed to be € 40/t in the wam-scenario..

Fugitive emissions (1.B) from the exploration, refining, transport, production and distribution of fossil fuels increased strongly between 1990 and 2007 (by nearly 100 %). The main driving force behind this increase is the extension of the natural gas distribution network and the increasing natural gas and oil extraction. A further increase is projected for 2010 and a stabilization of emissions by 2020. Although the gas distribution network and storage capacities are assumed to be further extended after 2010, this is assumed to be compensated by the substitution of valves (hydraulically controlled systems by electrical devices) and by a decrease in natural gas production.

Differences to the fourth national communication:

- Changes in the energy industries subsector have been caused by a switch to a new model for the energy projection. While a macroeconomic model was used for the previous calculations, an optimization model (Balmorel) has now been used for this projection. This has led to a completely new set of input data. Assumptions have been changed under the impact of the Water Framework Directive and the Austrian legislation (e.g. Green Electricity Act).
- The differences regarding fugitive emissions can be seen in historical and forecast data; they are linked to methodological improvements in the

inventory, especially the use of IPCC methodology for calculating emissions from the natural gas distribution system.

Subsector manufacturing industries and construction (CRF Source Category 1.A.2)

Table 5.6: Actual and projected emissions from manufacturing industries and construction (1.A.2) by gas

	Emissions						With Measures			With Additional Measures		
gas	1990	1995	2000	2005	2006	2007	2010	2015	2020	2010	2015	2020
in Tg CO_2 equivalent												
CO_2	12.69	13.49	13.74	15.68	15.97	15.67	15.62	16.86	17.89	15.62	16.86	17.89
CH_4	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.01	0.02	0.02
N_2O	0.08	0.10	0.13	0.14	0.14	0.14	0.13	0.13	0.14	0.13	0.13	0.14
Total	12.77	13.59	13.89	15.83	16.12	15.82	15.77	17.01	18.04	15.77	17.01	18.04

Major sub-groups contributing to the emissions of this subsector are the production of iron and steel, the production of non-metallic minerals, the paper industry and the chemical industry. For the period 2010–2020 a stable increase of CO_2 emissions, based on increased sectoral GDP projections (wm: +2.43 % until 2012 and then +2.25 % per year), is assumed. The oil price is assumed to be 120 US$ from the year 2008 onwards in the **wm-scenario**.

Differences to the fourth national communication

- The changes have resulted from the use of new activity data derived from a scenario run of the macroeconomic model.

Subsector Transport (CRF Source Category 1.A.3)

Table 5.7: Actual and projected emissions from transport (1.A.3) by gas

	Emissions						With Measures			With Additional Measures		
gas	1990	1995	2000	2005	2006	2007	2010	2015	2020	2010	2015	2020
in Tg CO_2 equivalent												
CO_2	13.77	15.67	18.79	25.00	23.65	23.92	23.82	25.30	26.21	23.67	24.04	24.11
CH_4	0.06	0.06	0.04	0.03	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01
N_2O	0.19	0.26	0.29	0.32	0.29	0.28	0.21	0.15	0.11	0.20	0.14	0.10
Total	14.02	15.99	19.12	25.34	23.97	24.22	24.04	25.46	26.33	23.88	24.19	24.22

While emissions from gasoline vehicles are declining steadily, emissions from diesel vehicles are increasing constantly. About a third of the GHG emissions are caused by fuel export due to persistent lower fuel prices in Austria compared to the neighbouring countries. The steep increase of recent years reached its peak in 2005. The implementation of the EU biofuels directive (Directive 2003/30/EC) changed the trend after 2005. Despite a higher fuel efficiency of the fleet, GHG emissions are beginning to increase once again. For the future it is assumed that the peak of the emissions of 2005 will be reached again. The implemented measures cannot reverse the trend of increasing road performance.

In the **wam-scenario** after 2010 the increase can be halted due to the implementation of further fuel efficiency measures for cars and the control of speed limits combined with traffic control systems.

Another source in this sector are emissions from pipeline compressors. These amounted to 2 % of the emissions in the transport sector in 2005 and are forecast to double until 2020, due to new compressor projects. Emissions of pipeline transport are forecast to rise sharply in the coming years; in the next decade emissions will continue to increase albeit at a reduced rate.

The projection of energy consumption in domestic aviation is an extrapolation of the trend of the latest years. Between 2010 and 2020 the annual growth rate of energy consumption is assumed to be 2.1 %.

There are no emission projections related to fuel sold to ships and aircraft engaged in international transport available at the time being.

Differences to the fourth national communication:

- The projection 2009 shows, for both scenarios (wm/wam), higher emissions than in the projection of 2006. This difference is basically due to a new transport demand model. Another reason for the divergence in the wm-scenario is an adapted plan for biofuels.
- The wam-scenario 2009 is not as optimistic as the wam-scenario in 2006. The reason is that instead of five assumed wam measures in the projection 2006, only two measures have now been quantified in the current year 2009. Measures aimed at transport demand were not quantifiable within the scope of underlying study.

Subsector Residential and Commercial (CRF Source Category 1.A.4 and 1.A.5)

Table 5.8: Actual and projected emissions from residential and commercial (1.A.4 and 1.A.5) by gas

	Emissions						With Measures			With Additional Measures		
gas	1990	1995	2000	2005	2006	2007	2010	2015	2020	2010	2015	2020
in Tg CO_2 equivalent												
CO_2	13.85	14.18	12.93	13.10	12.83	10.62	13.95	13.15	12.30	13.94	12.52	10.49
CH4	0.39	0.35	0.26	0.31	0.30	0.27	0.26	0.27	0.27	0.26	0.27	0.28
N2O	0.23	0.24	0.24	0.28	0.27	0.25	0.24	0.23	0.22	0.24	0.23	0.22
Total	14.47	14.77	13.43	13.69	13.40	11.14	14.46	13.65	12.79	14.44	13.02	10.99

Despite growing numbers of households and occupied living space, the total GHG emissions in this sector are slightly reduced by 2020 for the scenario with measures and significantly reduced for the scenario with additional measures. The driving force is the shift of fossil fuels to renewables such as biomass, solar heat und heating pumps as well as a slight transfer to other sectors (district heat). The only moderate increase of total energy consumption corresponds to the increased insulation of new buildings and during renovation measures, as well as to the improved efficiency of primary heating systems in buildings.

Differences to the fourth national communication:

- Even though a new top-down approach (model ERNSTL) has been applied for the forecast of stationary sources in the other sectors (1.A.5), the reductions in the wm-scenario are almost the same as in the last projection (2006). The difference of the old projection (2006) to the results of the inventory in the year 2005 shows the weakness of the old model in calculating the outputs for first years.
- The larger difference in the wam-scenario between the forecasts simply arises from a larger number of additional measures considered in the new projection.

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

The sector industrial processes and solvents covers emissions from industrial processes including F-gases (2) and solvents and other product gases (3).

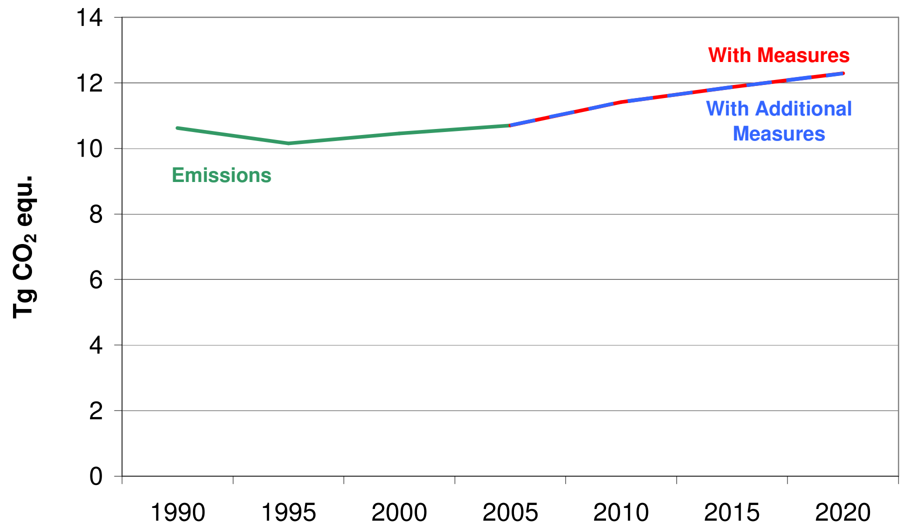


Figure 5.5: Actual and projected emissions from industrial processes (2) and solvent (3)

Table 5.9: Actual and projected emissions from industrial processes (2) and solvent (3) by gas

	Emissions						With Measures			With Additional Measures		
gas	1990	1995	2000	2005	2006	2007	2010	2015	2020	2010	2015	2020
	in Tg CO_2 equivalent											
CO_2	7.86	7.57	7.96	8.92	9.35	9.78	9.54	10.03	10.24	9.54	10.03	10.24
CH_4	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
N_2O	1.14	1.09	1.18	0.45	0.44	0.43	0.43	0.41	0.43	0.43	0.41	0.43
HFC	0.02	0.27	0.60	0.91	0.86	0.86	0.83	0.82	0.87	0.83	0.82	0.87
PFC	1.08	0.07	0.07	0.13	0.14	0.18	0.16	0.15	0.15	0.16	0.15	0.15
SF_6	0.50	1.14	0.63	0.29	0.48	0.41	0.44	0.44	0.58	0.44	0.44	0.58
Total	10.62	10.15	10.46	10.70	11.29	11.69	11.42	11.88	12.29	11.42	11.88	12.29

For the projection of N_2O emissions a major reduction measure implemented at a nitric acid plant at the end of 2003 has been taken into account. For the years 2006 to 2020 GHG emissions from industrial processes and solvents are assumed to rise to 12.3 Tg CO_2 equivalents due to a projected increase of production. This would be an increase of some 9 %. The main contributors are the CRF source categories metal production and mineral products. The rise between 2006 and 2010 is expected to account for 1 % (same assumptions for both scenarios).

Another source in this sector is fluorinated gas (HFC, PFC and SF_6) emissions. The main driving force behind this increase is the forecast increase of SF_6 emissions from the disposal of sound-proof windows. SF_6 emissions are expected to increase by 21 % or 0.1 Tg CO_2 equivalent by 2020 (same assumptions for both scenarios). The CRF Source Category 3 solvents and other product use is one of the minor sources with less than 1 % of total greenhouse gases in Austria. Greenhouse gas emissions decreased from 1990 to 2006 due to decreasing solvent and N_2O use and due to the positive impact of the enforced laws and regulations in Austria. Since 2006 a slight increase of GHG emissions has been observed due to increasing solvent use as a result of solvent use in households and thus growing population. This trend is forecast to continue up to 2020.

Differences to the fourth national communication:

- Changes in emissions from industrial processes without F-gases have resulted from the use of new activity data derived from a scenario run of the macroeconomic model.
- In order to improve and update the solvent model a study (Windsperger & Schmidt-Stejskal, 2008) was finalized; the main results are presented in the NIR 2009 (Umweltbundesamt 2009). The revision of the model included an update of activity data by using the structural business statistics from 2000 onwards and updating the activity data on non-solvent use and the solvent content of products. Furthermore emission factors were updated with information from surveys of companies and associations which were extrapolated using structural business statistics provided by Statistics Austria.

Agriculture (CRF Source Category 4)

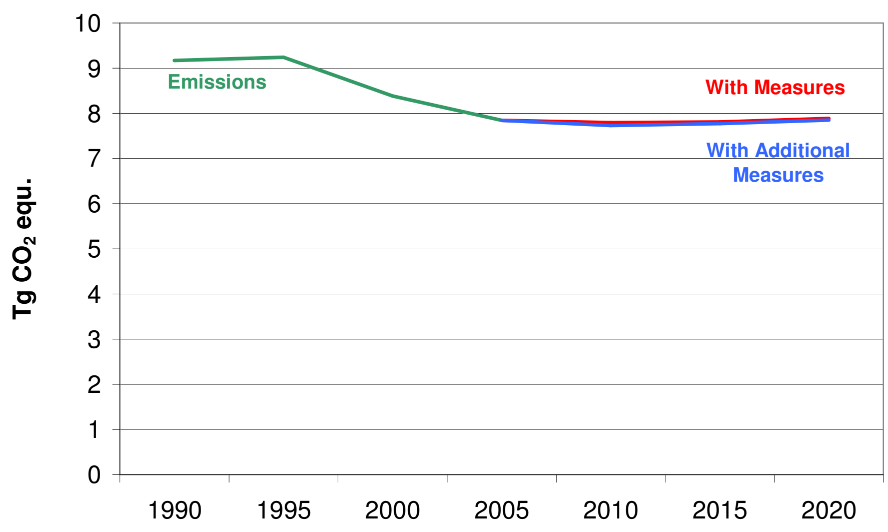


Figure 5.6: Actual and projected emissions from agriculture (4)

Table 5.10: Actual and projected emissions from agriculture (4) by gas

	Emissions						With Measures			With Additional Measures		
gas	1990	1995	2000	2005	2006	2007	2010	2015	2020	2010	2015	2020
in Tg CO_2 equivalent												
CO_2	0.00	0.00	0.00	0.00	0	0	0.00	0.00	0.00	0.00	0.00	0.00
CH_4	4.34	4.62	4.05	3.74	4.09	3.84	4.30	4.32	4.44	4.24	4.30	4.42
N_2O	4.83	4.62	4.34	4.10	3.79	4.11	3.50	3.49	3.45	3.49	3.47	3.44
Total	9.17	9.24	8.39	7.85	7.88	7.95	7.80	7.81	7.89	7.73	7.78	7.86

From 1990 to 2005, emissions showed a stable decrease, mainly due to the decreasing livestock numbers. From 2010 onwards a stabilisation of animal numbers is expected. Additionally, consumption of the mineral fertilizer N is expected to increase slightly because an expected growing demand of food, feed and biomass for energy purposes would otherwise cause a nutrient deficit and diminish the crop harvest. The trend to liquid animal waste management systems causes increasing CH_4 emissions from manure management. Anaerobic digestion in biogas plants could slightly lower CH_4 emissions from manure management.

Differences to the fourth national communication:

- The differences are linked to methodological improvements in the inventory, especially the revision of the N-excretion values.

Waste (CRF Source Category 6)

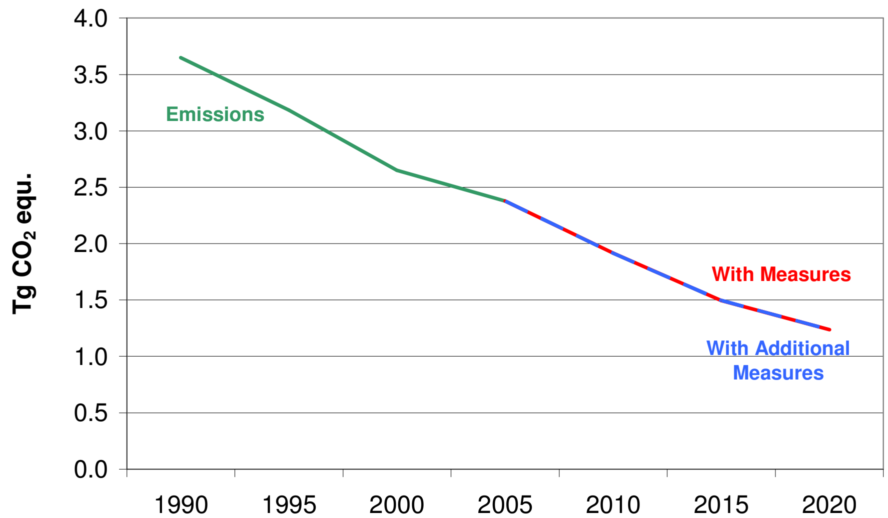


Figure 5.7: Actual and projected emissions from waste (6)

Table 5.11: Actual and projected emissions from waste (6) by gas

	Emissions						With Measures			With Additional Measures		
gas	1990	1995	2000	2005	2006	2007	2010	2015	2020	2010	2015	2020
in Tg CO_2 equivalent												
CO_2	0.03	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
CH_4	3.49	3.00	2.38	2.03	1.93	1.81	1.51	1.08	0.82	1.51	1.08	0.82
N_2O	0.13	0.17	0.25	0.33	0.35	0.35	0.40	0.40	0.40	0.40	0.40	0.40
Total	3.65	3.18	2.65	2.38	2.29	2.18	1.91	1.50	1.24	1.91	1.50	1.24

The **wm-scenario** shows a further downward trend for waste treatment and disposal up to 2020. This development follows the decline of the amount of untreated solid waste as a result of legislative regulations. As the subsector CH_4 emissions from solid waste disposal on land is responsible for the major part of greenhouse gas emissions from the sector waste treatment (80 % in the year 2007) the projected increase in N_2O emissions from the subsector wastewater handling will not change the declining trend. Emissions from the subsectors compost production and waste incineration are minor. Thus, they were projected to stay stable until the year 2020. There are no additional measures planned in this sector.

Differences to the fourth national communication:

- Until 2006 a country-specific methodology was used for inventory calculations and thus also for previous emission projections. In 2007, according to the results of a national study (Umweltbundesamt 2005), the methodology was changed to Tier 2. This method is now also used for emission projections and explains the majority of the changed projection figures. In the 2006 inventory the methodology for calculating CH_4 emissions from wastewater treatment was also changed from country-specific to IPCC, resulting in lower emissions and emission forecasts.

Land use, Land-Use Change and Forestry (CRF Source Category 5)

This section includes information on greenhouse gas projections concerning forest land remaining forest land (CRF 5.A.1) which is the most important sub-category of CRF Source Category 5. No forecast is available for other sub-categories than forest land remaining forest land (5.A.1) of CRF category 5.

Special importance was attached to the silvicultural relevance of tending activities by means of intensive preliminary cuttings and thinnings. As final cutting such stands were declared, which had a negative growth of the economic value. Additionally to the silvicultural aspects, economic and ecological facts were considered in the calculations. The harvesting costs were estimated via different harvesting models and opposed to revenues gained from diverse price scenarios[2]. Harvests on inventory plots with a positive profit margin free of harvesting costs were up-scaled to the attainable harvesting potential. Ecological aspects were concerned in the harvesting potential insofar, as the selection of the harvesting method and the parts of the trees to be harvested were determined. The results were converted into cubic metres of stem wood over bark (m^3 o.b.) on the basis of the timber assortment classifications, and finally translated into t C of whole tree biomass – for the three periods 2010, 2015 and 2020.

Due to the kind of projected harvesting activities, it is assumed that an increase of the harvesting intensity due to higher prices does not cause changes in increment, which according to the latest NFI's remained quite stable during the last decades. An

[1] 71 €: average biomass price in 2004 – 2006; 81 €: biomass price end of 2006; 100 €: assumption on moderate increase in biomass prices compared to 2004 – 2006; 162 €: assumption of doubling of biomass price (same development as oil price in period 1985 – 2005)

increase in prices mainly leads to additional preliminary cuttings of the smaller dimensions in stands.

Table 5.12: Projected emissions on forest land remaining forest land (5.A.1)

data on harvest:	**projections**			
silviculture scenario	Price scenarios	2010	2015	2020
Mio. m³ over bark	71 € / m³	26.7	27.8	29.0
	81 € / m³	28.0	29.1	30.4
	100 € / m³	29.0	30.2	31.5
	162 / m³	30.5	31.7	33.1
Mio. t CO_2	71 € / m³	32.3	33.4	34.8
	81 € / m³	33.7	34.8	36.7
	100 € / m³	34.8	36.3	37.8
	162 / m³	36.7	38.1	40.0
data on increment:				
silviculture scenario		2010	2015	2020
Mio. m³ over bark	71 € - 162 €	29.8	29.8	29.8
Mio. t CO_2	71 € - 162 €	-37.7	-37.7	-37.7
Net C uptake/release:				
silviculture scenario		2010	2015	2020
Mio. t CO_2	71 € / m³	-5.4	-4.3	-2.9
	81 € / m³	-4.0	-2.9	-1.0
	100 € / m³	-2.9	-1.4	0.1
	162 / m³	-1.0	0.4	2.3

From 2010 onwards, the modelled data for CRF 5.A.1 - forest land remaining forest land, shows a reduction in the net-sink up to 2020 in the range of -2,900 to +2,300 Gg CO_2 equivalents. The national forest inventory forms the basis for the computation of the Austrian forest carbon stock changes in future years.

5.2 Assessment for Aggregate Effects of Policies and Measures

Chapter 4 shows a comprehensive listing of policies and measures contained in the Austrian 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, '*Länder*' and Municipalities still cause some difficulties for coherent monitoring and evaluation of the effects of policies and measures.

The 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 (Umweltbundesamt 2009d).

Table 5.13: Aggregate effect of planned policies and measures by gas (sum of aggregate effects)

	2010	2015	2020
	In Tg CO_2 equivalent		
CO_2	0.92	3.85	8.46
CH_4	0.06	0.02	0.01
N_2O	0.02	0.03	0.04
F-Gases	0.00	0.00	0.00
Total	1.00	3.89	8.51

Due to the lack of a 'without measures' scenario the same estimation cannot be done for the aggregate effect of implemented and adopted policies and measures. Nevertheless, by using certain indicators (GHG intensity of certain activities) to monitor and evaluate progress with policies and measures an approximate estimate of the aggregate effect of policies and measures can be done.

For this approach the respective indicators were calculated as mean of the years 1995–2000.This indicator was then used to calculate GHG emissions for the years 2005, 2010, 2015 and 2020 by multiplying with the respective projected 'activity'. This approach assumes that without policies and measures the GHG intensity would have remained constant since 2000 and emissions would follow the development of activities only Thus, the effect of implemented and adopted policies and measures in the years 1995-2000 was assumed to be virtually zero. To calculate the aggregate effect of policies and measures, emissions from the 'with measures' scenario were subtracted subsequently from the indicator based emissions.

The aggregate effect of PaMs in the transport sector was estimated by the CO_2 intensity of driven passenger car kilometers. This indicator was considered to give a good estimate of the total transport sector. In the residential sector the CO_2 intensity of households (stock of permanently occupied dwellings) and in industry the CO_2 intensity of the gross value added of the total industry were used. The aggregate effect of PaMs in Energy Industries was estimated by the specific CO_2 emissions of public and autoproducer power plants (output by public and autoproducer thermal power stations, PJ).

Policies and measures affecting methane emissions can be mainly identified in the Waste sector and involves strict legislation concerning waste deposition and CH_4 recovery. The respective Indicator is CH_4 generated by waste deposited. By assuming an equal waste generation rate (waste per population) and an equal methane emission factor (CH_4 per waste deposited) since 2000. With this approach no effect could be calculated for N_2O emissions, because of the lack of a suitable indicator.

For fluorinated gases a 'without measures' scenario was calculated based on the same assumptions as the 'with measures' scenario but excluding assumptions on the effects of Austrian and EC policies. The aggregate effect of policies and measures affecting fluorinated gases was calculated by subtracting the 'with measures' emissions from the 'without measures' scenario.

The calculated effects of policies and measures are summarized in Table 20.

Table 5.14: Aggregate effect of implemented and adopted policies and measures by gas (indicator based approach)

	2005	2010	2015	2020
	In Tg CO_2 equivalent			
CO_2	3.46	15.80	23.30	31.43
CH_4	0.77	1.37	1.83	2.13
N_2O	-	-	-	-
F-Gases	0.42	0.82	1.08	1.24
Total	4.65	17.99	26.22	34.80

The numbers above given might include effects that are not directly attributable to policies and measures, because the GHG intensity of activities might have decreased due to other reasons too. Nevertheless, they give a good proxy on how emissions would grow from 2000 onwards without the positive developments in technology improvements, behavioral changes, legislation and other incentives for GHG emission reductions.

5.3 Supplementarity relating to mechanisms under Article 6, 12 and 17 of the Kyoto Protocol

Austria's efforts to make use of the Kyoto Protocol flexible instruments are supple¬mental to domestic efforts. From the beginning, the main policy focus was put at domestic measures in different sectors, as listed in Chapter 4 of the current and of the previous national communications. The previous section shows that adopted and implemented as well as planned measures lead to an emission reduction of almost 20 Mt CO_2 equivalents in 2010, and the effect is expected to double within the following 10 years.

Some developments with significant impact on emission trends could not be foreseen at the time when the Kyoto Protocol was signed and the EU-burden sharing was agreed. For example, emissions from road fuel sold in Austria but consumed abroad have reached a significant share of the emissions from transport after 2000. This is one reason why the Austrian JI/CDM programme has gained increasing importance. Nevertheless the JI/CDM programme is only one of the many elements of the Austrian Kyoto Strategy. In quantitative terms, the contributions from the programme are currently expected to be 9 Mt CO_2 equivalents annually.

5.4 Methodology

As already indicated, emission projections are calculated by the Austrian Environment Agency (Umweltbundesamt 2009d) using mostly the same methodologies as for the national GHG inventory. Some emission factors for fuels (e.g. for refinery fuel gas, refinery coke) or waste were derived from plant specific data. Input data regarding sectoral activity projections up to 2020 (industrial production, passenger-km, livestock numbers, etc.) and the forcast demand of energy is derived from several modeling exercises and performed by different institutions as outlined below. Resulting figures for energy demand in the Austrian economy are split according to the subsectors of the Austrian greenhouse gas emission inventory. Increasing energy efficiency, technological progress, policies and economic developments (e.g. energy prices, taxes, etc.) are based on endogenous assumptions or to some extent exogenous variables. Some underlying key variables (sector transcending) are listed in chapter 5.1.2, plus information by sector is summarized in the following sections.

The emission projections presented do not include the emission cuts by the number of allowances allocated to installations, but represent real emissions as forecast under the provided assumptions. The European ETS was assumed to continue beyond 2020 and a significant shortfall in emission certificates ensuring a substantial price for certificates was presumed. Furthermore, it has been assumed that the price is not influenced by decisions of Austrian plant operators. The following prices have been assumed in bottom-up models for the energy forecast: 20 €/t until 2010, 21 €/t until 2015; 22 €/t until 2020.The effects of recent changes to the ETS have not been considered.

5.4.1 Energy Forecast

Approach: macro-economic model (supported by bottom-up models)
Institution: Austrian Institute of Economic Research (WIFO,IER)
Sectors covered: Energy (1)

Updated energy scenarios were calculated based on the National Energy Balance of Statistics Austria and on a macroeconomic model (PROMETHEUS) of the Austrian Institute of Economic Research (Kratena and Wueger, 2005). The calculations on the basis of the macroeconomic model were supported by calculations with bottom-up models determining the

- electrical power demand (LEAP),
- domestic heating and domestic hot water supply (ERNSTL) and
- public electrical power and district heating supply (BALMOREL)

The base year for the WIFO model was 2003 while it was 2006 for the other models. The WIFO calculations (Kratena and Meyer, 2007) were not a full run of the macroeconomic model but only a scenario run based on the previous results (Kratena and Wueger, 2005).

PROMETHEUS

The general approach of the WIFO energy model is to handle most variables as endogenously as possible and therefore reduce the amount of exogenous assumptions. Considering the costs of energy sources only the price of oil has to be provided as input. Other exogenous values that have to be considered are taxes, deregulations and environmental promotion. The original energy projection by the WIFO (Kratena and Wueger, 2005) was modified by assuming an average oil price of USD 120.00 (Kratena and Meyer, 2007) and an average carbon price of € 10/t.

LEAP

For evaluating the electrical power demand the software package *Long range Energy Alternatives Planning System* (LEAP[3]; Commend 2009) was applied. It was developed by the Stockholm Environment Institute (SEI-US) and is a modelling tool for energy and economy projections based on scenarios. It is a simulation package with the aim to describe the development in an accurate way but does not perform any form of optimization (e.g. minimizing costs or emissions). Since LEAP uses a demand driven approach it can be used for the simulation of the electrical power demand. The main inputs for private households, public and private services, real assets production and other sectors are (top down approach):

- assumption for development of energy intensity
- development of gross value added (data from WIFO) (Kratena and Meyer, 2007)

[3] http://www.energycommunity.org

ERNSTL

To describe the energy consumption for domestic heating and domestic hot water supply the software package '*Energetisches Raumwärme-Simulations-Tool*' (ERNSTL[4]) (EEG 2009) was applied. This model is operated by the Energy Economics Group (EEG) of the Vienna University of Technology (TU Wien 2009). It is based on a stochastic, non-recursive, myopic and economic algorithm with the objective function to minimize costs. The myopical, stochastic optimization algorithm models the stock of buildings in a highly disaggregated manner. Therefore the simulation tool reflects characteristics of an agent-based simulation. The base algorithm was developed by Schriefl (EEG 2007). It is based on the principle of the model INVERT . It allows the calculation of the energy demand for heating (space heating and hot water) of apartment buildings and buildings of the public or private service sector including the effects of various funding instruments. The main inputs for the calculation are:

- availability of resources
- market penetration of different technologies
- maximum replacement and refurbishment periods
- minimum and maximum lifetime of technical installations

The model also evaluates the effects of different promotion schemes (investment subsidies, feed-in tariffs, tax exemptions, fuel input subsidy, CO_2 taxes, soft loans, and additional aside premium) on the energy carrier mix, CO_2 reductions and costs involved for society when promoting certain strategies. Furthermore, the ERNSTL model is designed to simulate different scenarios (price scenarios, insulation scenarios, different consumer behaviour patterns etc.) and their respective impact on future trends of renewable as well as conventional energy sources on a national and regional level.

The basic decision/selection process works on an annual basis and decides for each building segment if the system (regarding building shell and heating/domestic hot water system) remains as it is or if a new heating technology or a measure to improve the building shell has to be chosen. The overall costs (in the sense of monetary costs, societal costs or greenhouse gas emissions) of each new technology/measure are compared with respective running costs caused by the existing structure, and the technology / measure which is the most cost-saving one is chosen. The applied objective implemented in the model for all scenarios is to minimize monetary costs.

Energy demand is modelled depending on service demand and efficiency. The two energy services under investigation are space heating and water heating. Behavioural aspects in the case of space heating (such as the level of indoor temperature, ventilation habits) are considered through a service factor. This parameter describes the relation between the actual and the theoretical (calculated) energy consumption for space heating. The model calculates the service factor as a function of the thermal quality (specific heat load) of the building and the degree of automation of the heating system (central heating system vs. single stove heating system).

The final energy demand for water heating is modelled as dependent on the number of people living in the dwelling under consideration, on service demand for domestic

[4] http://eeg.tuwien.ac.at

hot water (volume of hot water with 50° C) per person and day and on the annual efficiency of the water heating system. The model incorporates the ageing of heating systems and domestic hot water systems; this means that in the model their annual efficiency decreases from year to year.

The technology options to choose from are divided into 'single measures' and 'combined measures'. Single measures include: change of heating system or domestic hot water system only, installation of new windows, insulation of facade only/ ceiling only/floor only. Combined measures include: change of heating system and domestic hot water system, insulation of facade and new windows, thermal improvement of the whole building shell, insulation of facade and ceiling, complete renovation.

Within each technology segment, a broad range of new systems can be selected for implementation, namely 20 different options for space heating systems (with the possibility of hot water integration) and 5 different options for stand-alone hot water systems. Solar hot water generation and solar combi systems (solar space and water heating) are integrated into the model. Concerning modifications of the building shell, up to 10 different insulation materials for insulation of building parts and 6 different window types are implemented. The thickness of insulations is calculated by an optimization algorithm (with upper and lower boundaries).

BALMOREL

The determination of the total public electrical power and district heating supply was realized by the optimization package BALMOREL[5] which is a bottom-up energy system model developed and used for energy policy analysis. It is a linear programming tool, which is based on the General Algebraic Modelling System (GAMS[6]), that allows the representation of electrical and district heating generation plants. Due to the linear structure of the model only generic technologies can be represented. Specific plants with corresponding capacities cannot be described within this approach. The objective function of BALMOREL is the minimization of the system costs for the generation of electrical power and district heat. The main inputs are:

- demand for electric power
- demand for district heating
- net imports of electrical power
- fuel prices
- emission factors
- emission fees (e.g. cost for CO_2 emission certificates)

The simulation starts with the year 2006 and is calibrated by data of existing power generation plants. The basic time unit is a year, which is additionally split into 12 periods to describe the seasonal change in power demand properly. Austria is handled as a single region. The output obtained by BALMOREL is:

- amount of electric power and heat generated within a time period (subdivided by generation technology)
- amount of emission caused by power generation
- marginal costs for power generation

[5] http://www.balmorel.com
[6] http://www.gams.com

The results of the different models are balanced within a few cycles. Austrian Environment Agency experts combined the data of the different models and includes additional calculations on

- energy input for the iron and steel industry
- production of electric power and district heating within industry
- use of waste as fuel in power plants and industry
- energy input of compressor stations
- demand of the energy producing sector
- total energy demand.

The output of the model ERNSTL was used in LEAP (electricity demand for heating and cooling) and in BALMOREL (demand of district heating). The electricity demand of LEAP was used in BALMOREL.

5.4.2 Transport Forecast

Approach: bottom-up, national transport model GLOBEMI and GEORG (supported by a transport demand model)
Institution: Technical University of Graz
Sectors covered: Transport (1.A.3)

The calculation of transport emissions is based on different models:

Transport demand model
The transport demand data which is the basis for emission modelling results from calculations and forecasts made by a team of authors who compiled the Austrian "Environmental Balance of Transport" 2006/2008. The Environmental Balance of Transport is a multidisciplinary inter-modal analysis of transport demand in Austria since 1950 and its impact on environment, human health and climate.

Transport volumes for road and rail are based on an amalgamation as well as an analytical synthesis of official background statistics relevant for travel and freight transport demand. Available information such as population data, of motorisation rates, vehicle fleet sizes, economic and income development statistics were used. Transport volumes for all other modes (i.e. inland waterways, local buses and trams) were derived from data collected by official Austrian bodies such as Statistics Austria (Statistik Austria 2006).

GLOBEMI
For the calculation of road emissions the GLOBEMI model is used (Hausberger, 1998). GLOBEMI was developed for the calculation of emission inventories in larger areas. Input parameters are, amongst others,

- the vehicle stock of each category (cars, light duty vehicles, …) split into layers according to the propulsion system (SI, CI, …)
- engine volume or vehicle mass
- the emission factors of the vehicles according to the year of first registration
- the passengers per vehicle and tonnes payload per vehicle.

Furthermore, the model delivers an assumption for the fuel export effect.

GEORG **(CRF Source Category 1.A.2.f, 1.A.3.c, 1.A.3.d, 1.A.4.b, 1.A.4.c, 1.A.5)**

The energy consumption and off-road emissions in Austria are calculated with the model GEORG (Grazer Emissionsmodel für Off Road Geräte) (Pischinger 2000). 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 by the 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 > 80 kW, diesel < 80 kW).

Aviation (CRF Source Category 1.A.3.a)

The projection of energy consumption and emissions is an extrapolation of the trend of the latest years. Between 2010 and 2020 the annual growth rate (of energy) is assumed to be 2.1 %.

Other transportation – pipeline compressors (CRF Source Category 1.A.3.e)

For pipeline transport no major changes are expected until 2010, and therefore the trend of the past years has been prolonged. From 2010 onwards a sharp increase in emissions is expected due to new compressor projects. Thereafter emissions are expected to increase at the same rate as in the past years.

5.4.3 Forecast: industrial processes, solvent emissions and emissions of fluorinated gases (CRF Source Category 2, 3)

Approach: expert judgement, linked bottom-up and top-down approach, methodology as in the Austrian Inventory
Institution: Environment Agency Austria
Sectors covered: Mineral Products 2E, Chemical Industry 2F, Metal Production 2C, Solvents and other product use (3)

F-Gases (CRF Source Category 2.E, 2.F, 2.C)

Assumptions for future activities were made through expert judgment under consideration of current policy (e.g. The Austrian Ordinance on fluorinated gases Federal Law Gazette II No 447/2002 bans the use of SF_6 as a protective gas in magnesium production) and taking into account plausible developments at plant level (e.g. primary aluminium production plants in Austria closed down in 1992 and will not be reopened until 2020). There is no production of halocarbons and SF_6 (2.E) in Austria and the scenario assumes that none will take place until 2020. Halocarbons and SF_6 (fluorinated gases) have been used in Austria for a wide range of applications (as refrigerants, blowing agents, fire extinguishing agents, etc.).

Emissions were calculated from projected annual stocks and emission factors. Annual stocks correspond to the amounts of halocarbons and SF_6 stored in applications the year before, minus emissions of the year before, plus consumption of the year considered. Additional emissions occur from the disposal of products containing fluorinated gases.

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.

Mineral Products, Chemical Industry, Metal Production (CRF Source Category 2.A, 2.B, 2.C)

Activities have been derived from total energy input (cement industry), estimated from the additional need of product (lime stone, iron and steel industry) or extrapolated from historical data (lime stone use, ceramic industry and soda ash use, production of urea and fertilizer). And other production has been coupled to extrapolated data (ammonia, nitric acid).

Production of pig iron and production of crude steel from basic oxygen furnaces have been calculated from the total energy input of the macroeconomic model from WIFO (Kratena and Wueger, 2005), taking into account recent data of the Austrian producer (Voestalpine 2008, 2009).

Solvents and other product use (CRF Source Category 3)

CO_2 emission projections are calculated by multiplying emissions in the latest inventory year (2007; submission 2009) by the rate of population growth until 2020.

The basis for the data of the Austrian air emission inventory (OLI) 2008 (data basis 2007) are surveys (Windsperger et al. 2002, 2002b, 2004; Windsperger & Schmid-Stejskal 2008) as well as import-export statistics (foreign trade balance) and production statistics provided by STATISTIK AUSTRIA. To determine the quantity of solvents used in Austria for the various applications, a bottom-up and a top-down approach were combined. The top down approach provided the total quantities of solvents used in Austria. The share of the solvents used for the different applications and the solvent emission factors have been calculated on the basis of the bottom-up approach. By linking the results of bottom-up and top-down approach, the quantities of solvents annually used and solvent emissions for the different applications were obtained.

The basis for the N_2O emissions data of the Austrian air emission inventory (OLI) 2008 (data basis 2007) is the Austrian Industrial Gases Association (Österreichischer Industriegaseverband, ÖIGV) and default emission factors according to IPCC Guidelines. For the projections of N_2O emissions from other product use the rate of population growth is used.

5.4.4 Agricultural Forecast

Approach: Positive Agricultural Sector Model Austria PASMA, expert consultations with the Agricultural Research and Education Centre Gumpenstein
Institution: Austrian Institute of Economical Research (WIFO)
Sectors covered: Agriculture (4)

Emissions are calculated on the basis of the methodology used for the Austrian Greenhouse Gas Inventory using the input parameters from the Agricultural forecast. A comprehensive description can be found in the Austrian National Inventory Report 2009 (Umweltbundesamt 2009).

Agricultural forecast is based on the PASMA model of the Austrian Institute of Economical Research (Sinabell & Schmid 2005) and expert consultations with the Agricultural Research and Education Centre, Gumpenstein (Pöllinger 2005, 2008). PASMA depicts the political, natural, and structural complexity of Austrian farming in a very detailed manner. The model maximises sectoral farm welfare and is calibrated to historical data of crops, forestry, livestock, and farm tourism activities by using the method of Positive Mathematical Programming (PMP). This method assumes a profit-maximizing equilibrium (e.g., marginal revenue equals marginal cost) in the base-run and derives coefficients of a non-linear objective function on the basis of observed levels of production activities.

The model considers conventional and organic production systems (crop and livestock), all other relevant management measures from the Austrian agri-environmental programme ÖPUL, and the support programme for farms in less-favoured areas (LFA). Thus the two most important components of the programme for rural development are covered on a measure by measure basis.

5.4.5 Waste Forecast

Approach: expert judgement, methodology as in the Austrian Inventory
Institution: Environment Agency Austria
Sectors covered: Waste (6)

The waste forecast is based on the Environment Agency Austria forecast of the quantity of waste deposited and wastewater handled.

For calculation of the methane emission projections of the main emission source ‘solid waste disposal on land’ the IPCC (Intergovernmental Panel on Climate Change) Tier 2 method is applied in line with the GHG inventory. For details see Austrian National Inventory Report 2009 (Umweltbundesamt 2009).

For calculating the emission projections for solid waste disposal on land the directly deposited waste is separated into the categories: ‘residual waste’ and ‘non residual waste’. The assumptions are that no ‘residual waste’ will be landfilled after the year 2008 following the measures described in chapter 4, and that the only ‘non residual wastes’ with biodegradable compounds landfilled after 2008 are the landfill fraction from the mechanical biological treatment of residual wastes, the landfill fraction from the mechanical treatment of waste and contents of grit chambers from waste water treatment. Landfill gas is collected in Austria and from 2002 to 2007 the average decrease of collected landfill gas volumes was 7% per year. For the projection it was assumed that this trend continues.

For estimating future N_2O emissions from wastewater treatment the same method as described in the National Inventory Report 2009 (Umweltbundesamt 2009) is used. The assumptions were that the annual protein intake and the denitrification rate will remain at current levels and that the level of connection to sewage treatment plants will continue to increase.

5.4.6 LULUCF Forecast

PROGNAUS (PROGNosis for AUStria) (Ledermann 2006) is a yield and silvicultural science-based model, which was developed and applied in 1995 for the first time and is updated continuously. PROGNAUS consists of several sub-models, basically a basal area increment model (Monserud and Sterba 1996), a height increment model (Nachtmann 2006), a tree recruitment model (Ledermann 2002) and a model describing tree mortality (Monserud and Sterba 1999). The performance of PROGNAUS was tested in several studies (e.g. Sterba and Monserud 1997, Sterba et al. 2002). Furthermore, PROGNAUS was applied to evaluate different forest management regimes (Ledermann and Sterba 2006).

According to the national inventory report, systematically measured statistics – such as the national forest inventory (BFW 2009) – are considered to have highest reliability in reporting forest area as well as land use changes from and to forests (Umweltbundesamt 2009). The results of the latest NFI therefore form the basis for the computation of the Austrian forest carbon stock changes in the year 2010, 2015 and 2020.

5.4.7 Sensitivity of underlying Assumptions and Uncertainty

Small differences in key input parameters may have considerable impact on resulting emissions. Sensitivity assessments for specific sectors, analysing the increase and decrease of key factors or of a combination of key factors, allow for a quantitative estimation of these impacts. Sensitivity analysis have been assessed for all subsectors, therefore it did not seem to be reasonable to provide all alternative scenarios. Instead, only some results that indicated significant deviations by 2020 compared to the wm- scenario should be presented.

The assessment in the energy sector was made on the influence of the natural gas price, electricity demand and electricity imports on CO_2 emissions of energy industries, the influence of the oil price on CO_2 emissions from manufacturing industries and construction, the influence of fuel price changes, changes of renovation rate and changes of boiler exchange rates on CO_2 emissions from the residential and commercial sector, and the influence of fuel price differences between Austria and neighbouring countries on CO_2 emissions from transport. There is an additional sensitivity analysis for the agricultural sector based on a change of product prices.

All these assessments are based on model results, obtained by calculating effects on energy or live stock. It is necessary to stress that the emission results have in general no linear dependence on changes of an input factor. This is the reason why sensitivity data cannot be seen as a functional dependency with varied parameters. The emission effect can be seen only for the specific value of the parameters given.

Energy:

For the sensitivity analysis of the public power generation three parameters have been varied: price of natural gas (+10 %, -10 %), electricity demand (+0.1 % p.a., -0.1 % p.a.) and electricity imports (+10 %, -10 %). Each variation has been studied separately. Overall the differences are rather low, with the greatest difference coming from the low electricity demand scenario.

Table 5.15: Differences to the wm-scenario of the sensitivity scenarios for the year 2020 given Gg CO2.

Parameters varied	Difference to wm [Gg CO_2] in 2020
gas price +10%	101.6
gas price -10%	-80.5
high demand	180.7
low demand	-359.2
high imports	-199.3
low imports	199.6

The sensitivity analysis shows that a variation of assumptions for the price of natural gas, electricity demand and electricity imports influences emission projections only by about 2%. This influence is considered to be low compared to the influence of economic developments on the uncertainty of emission projections in this sector.

Manufacturing industries and construction:

The impact of the oil price on CO_2 emissions has been assessed by calculation of a scenario featuring an oil price of US$ 80 (instead of 120 as in wm) (Kratena and Meyer, 2007). The CO_2 emissions increase only by 2 % if the oil price decreases by 33 %. This influence is considered to be low compared to the influence of economic developments on the uncertainty of emission projections in this sector.

Residential and Commercial:

The influence of fuel price changes (fossil fuels +30 %, gas +30 %, biomass +20 %), changes of renovation rate (+0.3 %, -0.3 %) and changes of boiler exchange rates (+1 %, -1 %) have been examined. Furthermore, minor changes in parameters were studies, in order to gain insight in the robustness of the results. The variation of the renovation rate and boiler exchange rate at the stated rates shows that there is a low influence of these parameters alone. The greenhouse gas emissions vary at most by 1 %. A more significant impact is produced by the alternation of prices. An increase of 30 % in the price of fossil fuels will reduce GHGs by about 13 % in 2020, whereas an increase in the biomass price will lead to a gain of around 4 % in greenhouse gas emissions.

Transport:

The main variable describing the fact of price- induced fuel export is the price difference between Austria and the neighbouring countries: Two sensitivity scenarios have been constructed (0: fuel price differences decline in stages until 2010 where they are assumed to be zero, X2: price differences are gradually increased so that they are twice as high in 2010 compared to the year 2007), whereas in the wm the fuel price is assumed to be constant from 2007 onwards.

CO_2 emissions develop at a lower rate in the scenario where fuel price differences converge to zero in the year 2010 and at a higher rate when fuel price differences increase. The results of the sensitivity analysis in comparison to the wm scenario can be summed up as follows: if fuel prices equalize with neighbouring countries emissions are 6.7% lower, if the fuel price difference increases emissions are 6.7 % higher.

Agriculture:
A change of product prices (expected price, low price -5 %, high price +5 %) was studied in this sector. The consequences of price changes are relatively limited. We have observed that the levels of different activities are changing in a way we would expect, but that the results are not fundamentally altered.

Differences to the fourth national communication:

- The original energy projection by the WIFO (Kratena and Wueger, 2005) was up-dated (Kratena and Wueger, 2007) and the overall framework EMIPRO has been extended.
- In order to provide a basic understanding of the projection models and approaches the detailed description of the mathematical background was abbreviated in favor of an overall description of the modeling framework regarding input-, output-data and the procedure.

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. The third part shows the preparation of the national adaptation strategy.

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, IPCC 2007a). Nevertheless, they might provide sufficiently realistic estimates of possible changes of the climate to undertake impact assessments at a variety of spatial scales (IPCC, 2007c).

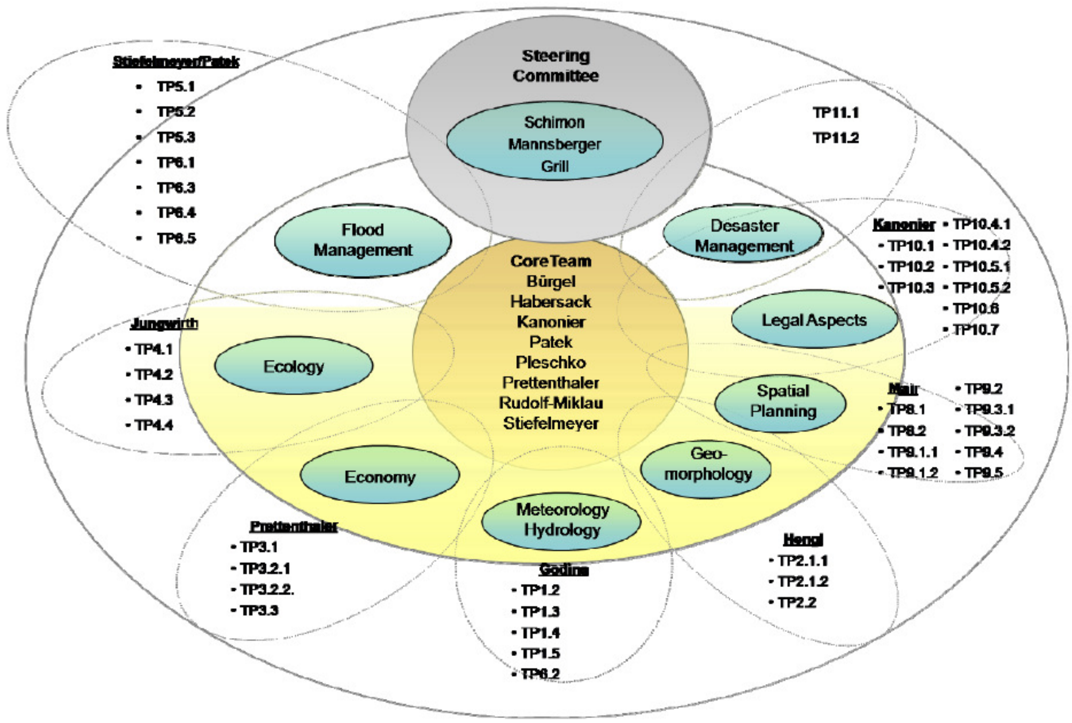
A climatic change may be characterized by changes in seasonal or annual precipitation, the ratio of solid to liquid precipitation, or the frequencies of extreme events. The European research project PRUDENCE (Christensen et al, 2002, Vitale et al., 2007) implies a shift in the seasonal cycle of the precipitation 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 1,170 mm, but it is distributed unevenly: The western part of the country receives as much as 2,500 mm, while in the densely populated east rainfall is only about 500 mm (OECD, 1995). 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 to shorter or longer dry spells (averages and extremes). Fürst et al., (2007) investigated the spatial and seasonal distribution of precipitation and run-off trends in Austria. For annual precipitation no significant changes could be detected. On a seasonal base the main Alpine ridge clearly separate Austria in two parts. On the northern part an increase in fall and winter is documented and on the southern side a decrease in precipitation and run-off has been observed.

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; regional climate change scenarios indicate that a further increase up to 25 % till 2040 is possible.

Due to the extreme events in summer 2002 (flood) and 2003 (head and drought) the two coordinated research programmes "FLOODRISKI" and "StartClim" (http://www.austroclim.at/index.php?id=40) where established. The follow up project "FloodRisk II Intensification and integration of future oriented implementation strategies for the integrated flood management" consists of 45 sub projects, which are summarized in 8 work packages. The interdisciplinary approach of this programm can be seen in the program structure in Fig. 6.1. Further information of this programm can be found at: http://www.umweltbundesamt.at/fileadmin/site/ umweltthemen/klima/FloodRisk/FRII_english-abstracts.pdf



Project structure FloodRisk II

Fig. 6. 1: Project structure of FloodRisk II.

6.1.1.2 Mountain Cryosphere

Glaciers are the most visible indicators of global change. The documentation of the changing cryosphere includes runoff measurements, snow cover records, glacier inventories, records of changes in glacier length and runoff, and mass balance measurements (Lemke et al., 2007). These data are of special significance because melting mountain glaciers are considered to be the second major contributor to sea level rise in the 20th century (Djurgerov and Meier, 2005).

In regard to climate-induced impacts on snow, Föhn (1991) has pointed out that one potential effect of global warming in the European Alps might be a delay in the first snowfall and a reduction in the length of snow cover. Analysis of satellite data from the 1980s and early 1990s shows that lowlands around the Alps experience about 3–4 weeks less snow cover than they did historically (Baumgartner and Apfl, 1994). This tendency can be expected to accelerate in a warmer climate with the consequence that early seasonal runoff will increase and thus lead to drier soil and vegetation in summer. Additionally, snow accumulation and ablation exhibit different temporal patterns than in the past and could be even more irregular in a changed climate. In higher elevations (>2500m.asl), the total accumulated snow during winter is described by precipitation amount alone and is not dependent on air temperature. Because of the high measurement errors of precipitation at high elevation sites significant temporal trends can not be derived. Time series of accumulated fresh fallen snow shows spatially variable trends for Austria (Mohnl, 1994). The fraction of snowfall at the Hohe Sonnblick in 3106 m altitude has decreased during the last decades by ten percent (see Fig. 6-2).

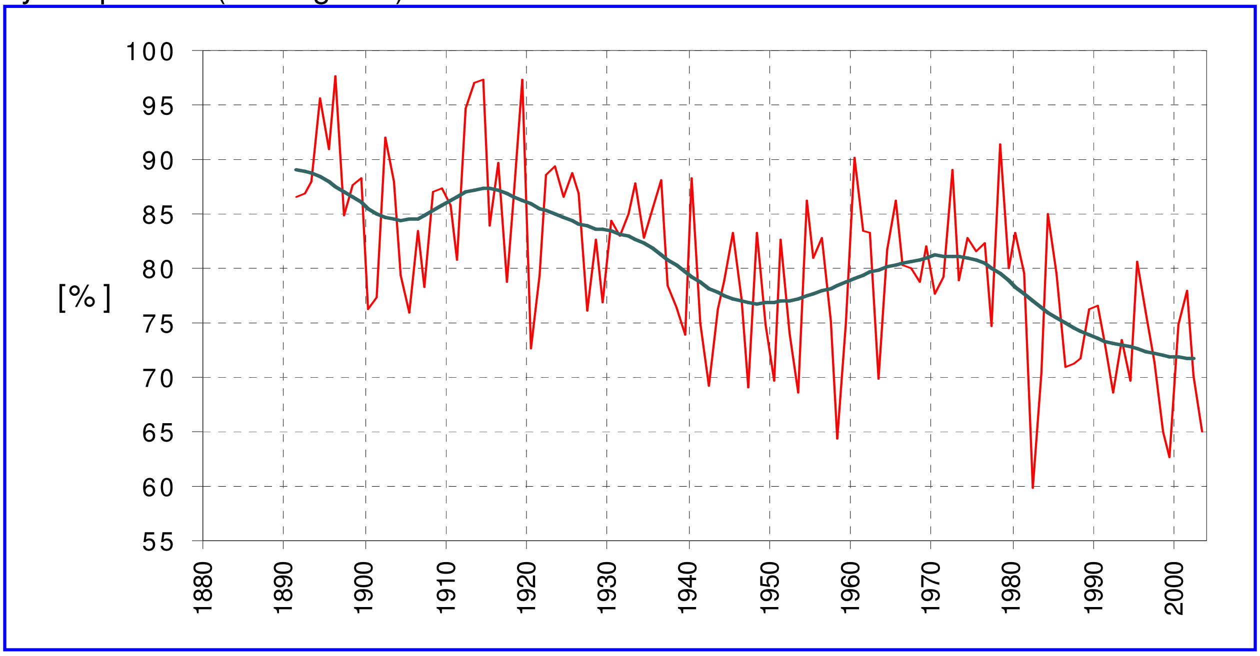


Fig. 6. 2: Fraction of snowfall in total precipitation at the Station Hoher Sonnblick (3106 m) since 1890. The fraction decreased from approximately 85 % to less than 75 %. (Schöner, 2004)

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. Mass balance is currently measured at more than 10 Austrian glaciers. The data is provided to the World Glacier Monitoring Survey which makes the data available to the international scientific community. Since 2003 the altitude of equilibrium line was above the summits in several years (Fischer and Markl, 2009). Therefore, the total glacier was subject to ablation during these years, also in high elevations. As extensive ice thickness measurements show, the ice cover on the steeper slopes surrounding the main glacier bodies is thinner than the latter and thus subject to rapid recession (Span et al., 2005, Fischer et al, 2007). 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 were lost in this single summer (Haeberli, 2004).

In Austria, two complete glacier inventories were compiled for 1969 (Patzelt, 1980) and 1998 (Lambrecht and Kuhn, 2007). The compilation of a glacier inventory of the years after 2006 is ongoing (Abermann et. al, 2009). 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 glaciers lost about 15% of their area between 1969 and 1997. In the 9 years following this period of nearly three decades, the same recession took place in the Ötztaler Alpen.

As an example, the boundaries of Hintereisferner as compliled in the glacier inventories 1969, 1998 and 2006 is displayed in Fig. 6.2. The loss of ice thickness between 1997 and 2006 affects nearly all elevation bands.

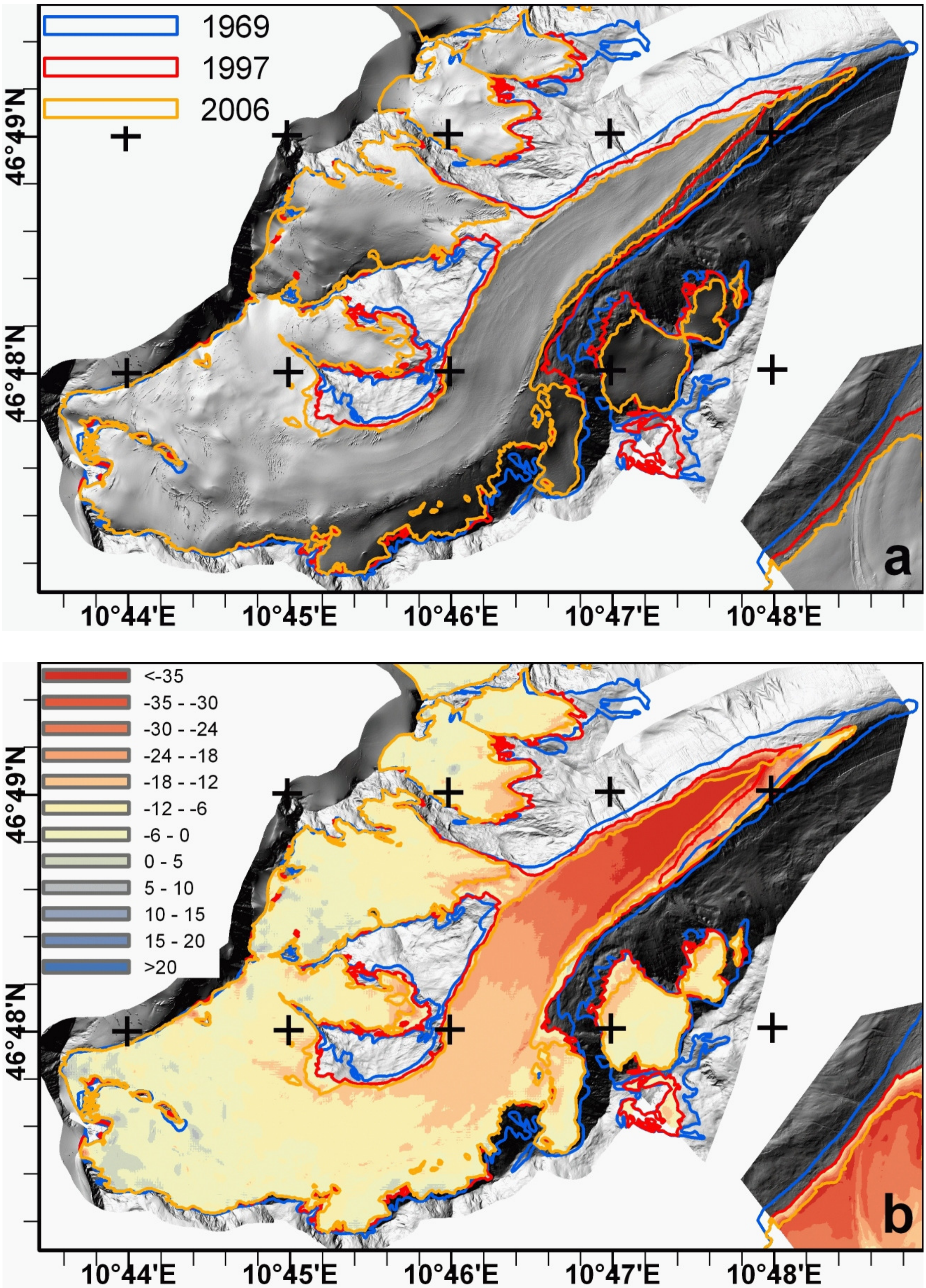


Fig.6.3 a) Area of Hintereisferner in the Ötztaler Alpen; glacier boundaries are shown for the years 2006 (red), 1997 (orange), and 1969 (blue). b) Volume change of Hintereisferner for the period 1997-2006 in percent indicated by different colours (Abermann et al, 2009).

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 the summer 2003 will occur nearly every second year.

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.

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). Systematic analyses of long term homogeneous pressure observations (Matulla et al., 2008) indicate no increase in the frequency of extreme Atlantic storm systems in the Austrian Danube basin within the last decades. For high wind speeds associated with thunderstorms or foehn storms no comparable information are available, but an increase of thunderstorm related wind damage due to climate change seems physically plausible.

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). Of particular interest are areas with discontinuous permafrost on steep talus slopes and rock walls. Due to the absence of a blocky layer, rock faces react quickly to climate change compared with debris-covered slopes (Gruber et al., 2004)

Landslide hazard research in Austria is concentrated on high mountain areas of the Alps, but mass movements occur in the low mountain area as well. Mass movements are gravity driven down-slope movements of solid rock, debris or soil. In general, they are triggered by an increase of soil moisture and pore-water pressure, caused by heavy rainfall and/or snow melting as well as by human impact on slope stability. Statistics are lacking in Austria, but studies estimate the economic loss in the low mountain areas in Germany at 150–200 Mio. Euro per year. Against the background of an actually increased economic and social relevance of mass movements it is important to know that landslides will occur more frequently due to climate change in regions, where an increase of precipitation is expected. In particular, the increase of extreme precipitation events as well as soil humidity affects the frequency and magnitude of landslides. The response of geosystems to climate and human influenced landscape change is still unknown terrain. Nature's response causes certainly massive changes to human activities, land use (agriculture, forestry, tourism) and ecology.

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, run-out length and damage in order to provide support in planning future protection measures (hazard zoning, etc.). According to Austrian avalanche reports that are published regularly since 1967/68, 764 persons were killed by avalanches until 1995/96. About 78% of winters' accidents involving death occurred during ski-mountaineering. According to control measurements, the number of avalanches threatening settlements is presently decreasing due to successful reforestation and/or avalanche control measures. Despite far-reaching control measures disastrous avalanche events still happen, as in the year 1999 in Galtür, where 38 people where killed in their houses.

Almost two thirds of all avalanches start below the potential timberline. At the research station in Obergurgl (2,000 m above sea level) high-altitude afforestation measures to prevent avalanches 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 risk 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, 1990; Solhaug, 1991); and competition processes (Bowman *et al.*, 1993; Baron *et al.*, 1994; Körner, 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 (Aulitzky *et al.*, 1982; 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℃ 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 contraction 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 species richness of vascular plant species with historical records (Gottfried et al., 1994; Grabherr et al., 1994, 1995; Pauli et al., 1996). This comparison indicated 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℃) were in most cases below 1.5 m per decade, but some species showed 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. The above moving rates, however, must be seen as minimum values because (1) the actual lower historic limits were unknown if a species was absent from the summit area – in these cases the lower limit of the summit study area was used as reference limit; (2) in several cases species had already reached the mountain top at the historic data and thus moving rate was zero, which does not represent the actual rate. More recent investigations on high summits in Eastern Switzerland showed an acceleration of the increase in species richness between 1980 and 2003 compared to the period 1900-1980 (Walther et al. 2005). Long-term studies in the Swedish Scandes suggest a great responsiveness of treeline vegetation to climate variability; this was not only apparent by tree limit rises of 100 to 150 metres during the 20th century, but also by tendencies of reversal during colder decades prior to the late 1980s (Kullman 2002, 2009).

The observed enrichment of summit floras in the Alps is seen as an effect of warming-induced upward migration of alpine plants. As a further consequence, a decrease of cold-adapted plant species is expected. A permanent plot study at the transition zone from alpine grassland to subnival vegetation (alpine-nival ecotone) on Schrankogel (Stubaier Alpen, Tyrol) showed that some pioneer species of alpine grassland has increased in cover, whereas all of the typical subnival species showed a decrease at their lower range margins (Pauli et al. 2007); this is considered as a first signal of warming-induced species declines in the high Austrian Alps.

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 disturbance factors (i.e. pests and diseases, storms, etc.) 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). For instance, recently a comprehensive stakeholder-driven vulnerability assessment and development of adaptive forest management strategies of commercial forests of the Austrian Federal Forests (OeBF AG) have been completed (Seidl et al. 2009, Lexer and Seidl 2009).

6.1.2.4 Alpine Protection Forests

In Alpine regions forests play an essential role in reducing risks of erosion and avalanches significantly, and thereby they provide an indispensable prerequisite for habitation in these regions. However, it has to be recognized that forests in mountain regions are highly sensitive to changes in climate conditions, and that this is particularly true in areas close to the timberline. . However, climate driven effects on forest and timberline has to be entangled from impacts of landuse change in alpine landscapes.

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 climatic timber line the composition and structure of natural forest communities will also change. As a consequence of intensified disturbance regimes (storms, bark beetles) Norway spruce, currently 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 (Umweltbundesamt, 1996a; BMLF, 1996; Loibl, 1995, 1996; Loibl and Smidt, 1996; Schneider et al., 1996). Vegetation reacts adversely to high ozone concentrations through disturbed photosynthetic activity. At the altitude of the timberline, the critical ozone level can be exceeded eightfold. This bioclimatic situation, which is primarily affected by traffic exhaust gases, reveals an alarming development in regard to the state of mountainous forests. Transport processes across or convective processes in the Alps affect the deposition of particles, and together with increased short-wave radiation at higher altitudes contribute to the production of ozone thus implying serious long-term consequences (Türk, 1996; Mayer, 1992; 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 (BMLF, 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, Heumader (1987) expects, for about half of the 12,000 ha of inclined forested area, technical control measures (like snow bridges) worth some1,4 billion Euros to be necessary, and a reforestation time of about 200 years.

6.1.3 Impacts on Socio-economic Systems

6.1.3.1 Mountain Agriculture

Mountain agriculture do not contribute a significant proportion of the world's total agricultural food production in terms of economic value. In mountainous countries such as in Austria where a significant part of agricultural land use is located in mountainous areas this is however different, depending on the production sector. For dairy farming, for example, mountainous areas contribute significantly to the total beef and milk production which are based on permanent grasslands. Moreover, the value for protecting of biodiversity and natural resources, for tourism (landscape functions) has significant economic impacts for other key sectors in alpine regions and in Austria.

Upland regions are characterized by altitudinal climatic gradients that can lead to rapid changes in agricultural production 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 et al., 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, 2009a; Eitzinger and Kubu, 2009). In general, a strong spatial shift of agroecological zones is expected with severe consequences for local environmental conditions and agricultural production resources (Eitzinger et al., 2009b). If, for example, 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 in regions where moisture is not a limiting factor for the relevant agricultural production system, increases in the number of extreme events may offset potential benefits. Compounded with these effects are those related to augmented duration and/or intensity of precipitation, which would enhance soil degradation (erosion, leaching, etc.) and lead to loss of agricultural productivity.

The agro-climatic impact of climate change might overlap with other factors disadvantageous to mountain agriculture such as socio-economic conditions for farms operating under more difficult topographic and climatic circumstances (Rest, 1996). There can be no doubt, however, that climate change will cause an alteration in the balance of the agricultural ecosystems (change in radiation intensity, temperature, precipitation, wind). It is not only feared that climate change will affect plant growth, but will also modify the soil functions which might lead to a reduced contents in organic matter and consequently reduced carbon absorption and an increase in gaseous emissions. Climate change leads also to changes regarding the occurrence of pest, diseases and weeds, with severe implications for production risks.

Many negative effects of climate change (such as increasing water stress for summer crops) can be compensated with several potential adaptation measures (e.g. shift of seeding or change in soil cultivation technique and crop rotations) at different levels. Adaptation however is a complex problem where much research and support for farmers is still needed (Eitzinger et al., 2009c).

6.1.3.2 Hydropower

Shifts in the seasonal precipitation distribution and the enhanced water run-off in winter due higher fraction of liquid precipitation will lead to a more uniformly distributes annual cycle of water run-off in Austria (Nachtnebel and Fuchs, 2004). In general this run-off scenario will be favourable for energy production from hydraulic power station, as the hydropower production and the demand of electricity will be more in phase.

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 today receding glaciers 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

Climate change can have direct and indirect negative effects on the commercial utilization of mountain forests. 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 – that is, their availability may be affected in the short and long-term by variability, extremes, and shifts of climate zones. These resources include the landscapes of natural and anthropogenically influenced ecosystems and climatic conditions that are suitable for specific 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 (Pröbstl et al., 2008). 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.

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 analysis of the Austrian measures to prevent natural disasters and its interaction with the commercial insurance industry after the flood 2002 was carried out. This economic analysis in context with natural disasters has been intensified within the research programmes FloodRisk I and FloodRisk II.

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 focuses on this theme (Moshammer et al., 2009). An important feature is the interaction of heat waves, ozone and particulated matter concentrations. In general, higher temperatures and hyper thermal stress are promoting extended cardiovascular and respiratory complaints, where the very young and the very old as well as the chronically ill are the most susceptible groups.

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). Also Leishmania infections transmitted by sand flies could spread under climate change conditions in Austria (Aspöck, 2008).

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 Frag-

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

ile Ecosystems –Sustainable Mountain development" identifies mountains as "fragile or vulnerable ecosystems", as they are characterised by close and continuous interactions between human being 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.

In Austria the development of a national adaptation strategy has been announced officially in the current government programme which defines goals up to 2013. The Ministry of Agriculture, Forestry, Environment and Water Management (BMLFUW) has initiated preparatory projects for developing a national adaptation strategy in 2007. An initial study (Haas et al., 2009) has been serving as a starting point for the development of a comprehensive paper, containing climate projections, vulnerability assessments and a portfolio of first recommendations for additional adaptation actions. This paper covers the sectors agriculture, forestry, water management, tourism and electricity industry. Further vulnerable sectors will be considered in 2009.

Additionally to the activities for the development of a national adaptation strategy, the Austrian Climate Research Programme (ACRP) is also financing basic research, that enhances the understanding of the vulnerabilities within the different sectors and regions in Austria.

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.

Preliminary studies (Holzmann et al., 2008) 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 21th century especially in the south east of Austria, leaded to some troubles in drinking water supply in communities depending on small and shallow springs. Also the water quality has been affected in summer 2003, as water temperature was much warmer than usually. A StartCim2005 project focuses on this issue, to define vulnerable regions in Austria and assess the potential impact of climate change (Perfler et al., 2006).

A detailed study concerning the water balance of the 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 of temperature and also sunshine duration within the last decades enhanced the lake evaporation by 10 %. Within the last 15 years also a weak decrease of 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. The return period for reaching critical lake levels for sailing has changed from ~ 30 years in 1961-1990 to 12 years in 1991-2004 and in the scenario for 2040 the critical level was reached nearly every third year, assuming no change in yearly precipitation. Also a nearly total vanishing of the lake was modelled as an eighty year event under this scenario. 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, the possible impact of climate change on lake Neusiedl has a high priority 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 58 % and 75 % and on average accounts for 70 % (Schiller and Drexler, 1993). 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 and storage 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 climate change scenario used and the application of ensembles of climate 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 to

1997 a further decrease of approximately 15 % of the total area was observed. In the 9 years following this period of nearly three decades, the same recession took place in the Ötztal Alps. This retread of glaciers and permafrost will effect the slope stability and the water run off during warm and dry summer periods.

In several studies (e.g. Breiling *et al.* 1997, Pröbstl et al., 2008) 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 to midwinter months of January and February may take place.
- Lower-situated tourist resorts are disfavoured relative to those higher up.
- In almost all Austrian skiing resorts artificial snow making can ensure snow conditions on the ski slopes within the next decades, but the demand on water and energy will increase due to climate change.

6.2.4 Ecosystem Responses

6.2.4.1 Vegetation Migration

From finalised and ongoing research studies (Gottfried et al. 1994; Grabherr et al. 1994; Pauli et. al. 1996, 2007) the important conclusion can be drawn that even a moderate warming induces migration processes. The example from the limits of plant life on high summits in the Alps is of general importance and suggests that global warming is already having a significant effect on alpine plant ecology. A small-scaled modelling study from the Tyrolean Alps showed projections of drastic area losses for the subnival and nival zones above the alpine grassland belt in an accelerating climate warming regime (Gottfried et al. 1999), where typical subnival species already were observed to decline (Pauli et al. 2007). A Europe-wide modelling study (cf. Thuiller et al. 2005) suggested that mountainous areas could be disproportionably sensitive to climate change with species losses of up to 60%. The outstanding biological richness of mountain regions and the often spatially limited distribution range of their species make these areas particularly vulnerable to irretrievable biodiversity losses. All alpine areas in Europe that lie above the climatic treeline comprise around 3 % of the continent, but approximately 20 % of Europe’s native vascular plant species have the centre of distribution within this area (Väre et al. 2003). This includes many endemic species that are restricted to the higher altitudes of single mountain regions (Pauli et al. 2003).

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 (BMLF, 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 this 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 m in elevation. 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 affect 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).

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6.2.5 Agriculture

In the recent project ADAGIO (www.adagio-eu.org) vulnerabilities and adaptation measures were analyzed and assessed for Austrian agriculture (Eitzinger et al., 2009a,b,c). The main Austrian crop production is located in the eastern and north-eastern low-lands of the country. As in these regions the yearly potential evapotranspiration has the same magnitude as the precipitation, Austrian crop production is quite sensitive to shifts in soil water availability.

There are big regional differences within short distances in the type of agricultural production systems (mainly permanent grassland and dairy production, arable crop production and orchard and wine farming) due to the topographical impact of the Alps on regional climate, especially in precipitation and temperature. These facts are also the reason why regional vulnerabilities in agriculture vary in a wide range within Austria. In recent studies it was shown that the more humid and cool alpine regions dominated by permanent grassland would increase their production potential, while the warmer and dryer regions, dominated by arable crop production would face more drought and heat stress during summer, having mostly negative impacts on production potential of summer crops. In this aspect not only the inter-annual variability of crop yields are expected to increase but also the differences between soils with high and low soil water storage capacity (increasing regional crop yield variability). Grassland dominated regions which currently are close to the climatic limit regarding precipitation and grassland water balance will face significant increase of production risk due to increasing drought and heat frequency. Especially water deficit has been a problem within the last years. In 2003 the estimated yield loss in Austrian grassland production systems due to water stress exceeded 200 Mio. Euro (Buchgraber et. al, 2004).

Regarding other weather extremes, Austrian agriculture is affected in the past years by increasing number of heavy thunderstorms, hail and extreme precipitations. In several regions the potential damages or production risk in agriculture could therefore increase by more intensive thunderstorms or rainfall (although not yet indicated by climate scenarios). Especially soil erosion could increase significantly through these extremes which needs special consideration in order to maintain long term soil productivity (based on soil functions and fertility).

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 which 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 (BMLF, 1996). Most of the torrent events (93.5%) occur from June to August, that is, during only three summer months (Andrecs, 1995), and more than 20% of them are dangerous debris flows. From 1972 and 1992 the total amount of the material eroded is estimated to add up to 16.6 million m^3 with an per-event average of 10,000 m^3 (except for the provinces Lower Austria and Styria) (Andrecs, 1995).

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. This permanent implementation of new adaptation measures motivated by socio-economic and land use changes, are beneficial for adapting to a climatic change.

Austrian adaptation measures therefore can be distinguished in measures directly motivated by impacts due to observed climate change and existing measures related to environmental risks, which have to be adapted to climate change. Till now the direct climate change motivated adaptation measures mainly are initiated by private companies or local administrations. But the extreme events during the last years highlighted the demand on a broader and coordinated treatment of all potential adaptation measures. This was the motivation to start a process, which should lead to a national strategy concerning climate change induced adaptation in Austria in 2007.

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 The Austrian Approach towards a National Adaptation Strategy

In Austria the development of a national adaptation strategy has been announced officially in the current government programme which defines goals up to 2013. The Ministry of Agriculture, Forestry, Environment and Water Management (BMLFUW) has initiated preparatory projects for developing a national adaptation strategy in 2007. Since 2007 the BMLFUW organized three national workshops on climate change adaptation to inform and discuss with stakeholders about the necessity to take action and the steps to be taken towards an adaptation strategy. Scope and meaning of “adaptation to climate change” was explained, discussions were held.

First a study (Gingrich et al., 2008) on the current status of adaptation activities in Austria was conducted. Based on a survey of existing research projects and adaptation actions, it summarizes the current status quo of adaptation to climate change in Austria. Activities that reduce negative impacts are covered as well as those capitalizing on positive impacts of climate change on human society. In this regard, the survey also encompasses activities that may serve this purpose even if the respective actors may have taken the measure without explicitly aiming at adaptation to climate change. The majority of activities take place in the following areas: Water management, protection against natural hazards, agriculture and forestry. Overall 13 areas of activity were screened. A public database containing these results has been established (http://www.klimawandelanpassung.at/datenbank/). The following conclusions can be drawn from the survey: Austria is already active with respect to climate adaptation, although most activities are taken individually and reactively. An adaptation strategy could help to capitalize on possible synergies from co-operation and would support proactive measures that also reflect future climate impacts and help to avoid increases in GHG emissions resulting from adaptation activities.

This initial study has been serving as a starting point for the development of a comprehensive paper (Haas et al., 2008), containing climate projections, vulnerability assessments and a portfolio of first recommendations for additional adaptation actions. This paper covers the sectors:

- Agriculture
- Forestry
- Water management
- Tourism
- Electricity industry

Further vulnerable sectors will be considered in 2010.

In spring 2009 a participatory process started to discuss adaptation measures, responsibilities for implementation, research needs etc. with the relevant stakeholders. A home page with relevant information on climate change adaptation in Austria was launched in June 2009 (http://www.klimawandelanpassung.at/beteiligungsprozess/).

The Austrian approach toward an National Adaptation Strategy (NAS) and the necessary steps are summarised in the figure 6.4.

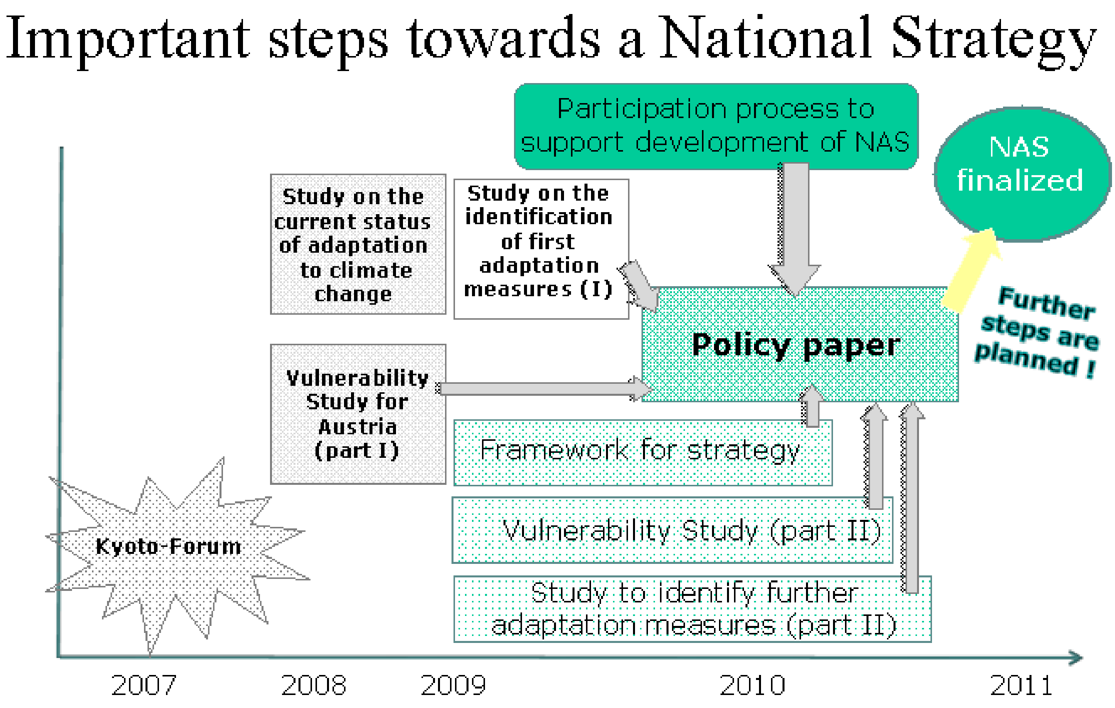

Fig. 6. 4: Steps towards a National Adaptation Strategy (NAS). Grey parts are finished activities, coloured are ongoing or planned activities.

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 and the LDCF, other MEAs and multilateral institutions. Austria's bilateral ODA is another source for funding UNFCCC related activities. Respective programmes target both mitigation and adaptation. Renewable energy and energy efficiency, sustainable forest management, sustainable agriculture and land management in the framework of rural development programmes are preferred areas of co-operation in several developing partner countries. Besides, all bilateral assistance programmes and projects are subject to environmental appraisals that 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

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 replenishments, whereby Austria has contributed its share. The GEF's 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 increase resilience to and reduce the risks, or the adverse effects, of climate change. The Austrian contribution to the GEF is financed in addition to existing commitments and payments to other international finance institutions. During the pilot phase Austria contributed a comparatively large share (about US$ 35 million or about 2.7% of the GEF Trust Fund) in order to underline its interest in international cooperation for the protection of the environment. In the 1st replenishment, Austria contributed another US$20 million. In addition, Austria financially supported a bilateral GEF Consultant Trust Fund. Table 1 offers an overview of Austrian contribution to the GEF from 2005 to 2008 in terms of ODA shares (i.e. 96% of actual amounts). In total Austria provided about US$ 30 million during this period.

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

	Contribution (millions of US$)			
	2005	2006	2007	2008
Global Environment Facility	5.31	0.00	16.02	8.44

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

The least developed countries are those countries that suffer most from climate change. They have fewer resources for coping with storms, floods, drought, disease, and with climate change induced challenges concerning food security 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.

2008 total ODA of Austria amounted to US$ 1,714 million. Roughly 70% (US$ 1,234 million) qualified as bilateral ODA. LDCs received US$ 123.03 million or about 10 % thereof. Several priority regions and countries are supported by Austria in long-term partnership programmes (see http://www.entwicklung.at/en/countries-and-regions.html).

In relation to climate change adaptation, the priority region for assistance is Sub-Saharan Africa. Whereby measures to reduce the vulnerability and increase the resilience to climate change related effects are integrated in the bilateral co-operation programmes with selected partner countries. Co-operation is gounded 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 the overarching framework. Working to achieve the MDGs, which address all these issues, is the 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

The following sections refer to Austrian ODA.

7.3.1 Bilateral financial contributions

Data on Austria's bilateral financial contributions can be accessed through the OECD DAC Creditor Reporting System. A substantial share of about 35% or about US$ 50 million of Austrian Development Co-operation's operational core budget managed by the Austrian Development Agency in 2008 were spent on measures that addressed, among others, environmental objectives.

According to the cross-cutting nature of support to climate change outlined in chapter 7.2., activities that mitigate GHG emissions or support 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 sustainable agriculture. Similar co-operation programs are financed in Mozambique and Ethiopia.

In Latin America, Austria finances the conservation of forests. In the Amazon region indigenous/local 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 the improvement of peasants' livelihood situations and measures to create awareness of the problematic environmental situation caused by forest degradation and deforestation. The stabilisation of settlement boundaries and the sustainable management of remaining forest areas are the long-term goals of these efforts.

In Bhutan Austria is co-financing the first ever project implemented with financial support from the LDCF. The project focuses on reducing glacial lake outburst flood risks.

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 assisted the FYR Macedonia in the field of geothermal energy. In both countries, a program for the promotion of solar-thermal energy was carried out. 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, too. 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 ODA expenditures to activities that include measures related to the implementation of the Convention 2005 (in US$ million)[1]

	Mitigation						Adaptation		
Recipient country/region	Energy	Transport	Forestry	Agriculture	Industry	Non -sector specific	Capacity-building[2]	Coastal zone management	Other vulnerability assessments
Albania	0,22								
Bhutan	1,25								
Brazil			0,50						
Burkina Faso				0,05	0,22		1,53		
China					0,05				
Colombia			0,39						
El Salvador				0,37					
Ethiopia							0,96		
Georgia			0,19						
Kenya							0,40		
Macedonia	0,15								
Mozambique							1,31		
Nicaragua			1,02	0,46			0,28		
Senegal			0,43				0,96		
Serbia and Montenegro	0,09								
Zimbabwe	0,02								
All other	0,34	0.22					1,14		

[1] The data are based on the DAC policy objective marker system. The figures given in tables 7.2. to 7.5. refer to disbursements made for activities containing measures addressing mitigation or adaptation objectives. The actual financial shares invested in the mitigation or adaptation related components may be very small. The tables do not allow for a quantitative analysis thereof.

[2] In most cases other forms of technical assistance may be the main components of the activities considered in tables 7.2. to 7.5. Capacity development is a cross-cutting-issue.

Table 7.3: Bilateral ODA expenditures to activities that include measures related to the implementation of the Convention 2006 (in US$ million)

	Mitigation						Adaptation		
Recipient country/region	Energy	Transport	Forestry	Agriculture	Industry	Non -sector specific	Capacity-building	Coastal zone management	Other vulnerability assessments
Albania	0,91								
Bhutan	0,36								
Brazil			0,74						
Burkina Faso				0,74	0,13		2,13		
Cape Verde	1,13						2,14		
China					0,05				
Colombia			0,32						
Cuba	0,02								
El Salvador				0,27					
Ethiopia	0,05						0,61		
Kenya							0,08		
Macedonia	0,54								
Moldova				0,02					
Mongolia					0,02				
Montenegro	0,38								
Mozambique				1,26			0,80		
Nicaragua			0,63	0,28	0,63		0,09		
Senegal			0,14				2,38		
Tanzania	0,02								
Uganda	1,59			0,08					
Zimbabwe	0,14			0,09			0,20		
All other	1,24			0,13	0,25		0,98		

Table 7.4: Bilateral ODA expenditures to activities that include measures related to the implementation of the Convention 2007 (in US$ million)

	Mitigation						Adaptation		
Recipient country/region	Energy	Transport	Forestry	Agriculture	Industry	Non -sector specific	Capacity-building	Coastal zone management	Other vulnerability assessments
Albania	0,69								
Bhutan	0,60								
Brazil			0,64						
Burkina Faso				0,54	0,24		1,57		
Cape Verde	0,71						1,26		
China					0,02				
Colombia			0,24						
El Salvador				0,24					
Ethiopia					0,02		0,22		
Ghana					0,04				
Guatemala							0,04		
Kenya							0,97		
Macedonia	0,81					0,07			
Mongolia					0,02				
Montenegro	0,02								
Mozambique							0,36		
Nicaragua			0,97	0,34	0,21		0,02		
Senegal			0,39				2,47		
Serbia	0,13								
Tajikistan							0,04		
Tanzania	0,02				0,02				
Uganda	2,04			0,09	0,02				
Zimbabwe	0,21						0,11		
All other	2,98	0,07		0,15	0,28	0,09	2,33[3]		

[3] Includes US$ 0,55 million contribution to UNFCCC LDCF

Table 7.5: Bilateral ODA expenditures to activities that include measures related to the implementation of the Convention 2008 (in US$ million)

	Mitigation						Adaptation		
Recipient country/region	Energy	Transport	Forestry	Agriculture	Industry	Non -sector specific	Capacity-building	Coastal zone management	Other vulnerability assessments
Albania	0,12								
Bhutan	1,35						0,29		
Brazil			0,90						
Burkina Faso				1,39	0,06		3,10		
Cape Verde	0,60						0,58		
China					0,31				
Colombia			0,10						
El Salvador				0,29					
Ethiopia	0,45			1,44			1,52		
Georgia			0,06						
Guatemala							0,04		
Jamaica	0,02								
Kenya							0,62		
Macedonia	1,08					0,15			
Mongolia					0,02				
Montenegro	0,02								
Mozambique	0,04			2,89			0,62		
Nepal	0,04								
Nicaragua			0,58	1,14					
Rwanda	0,08								
Senegal							2,10		
Sierra Leone	0,02								
Uganda	2,14			0,02					
Ukraine	3,00								
Zimbabwe	0,06			0,23			0,35		
All other	7,96			0,48	0,17	1,03	1,08		

7.3.2 Multilateral financial contributions

In 2005 an Austrian strategy vis-à-vis the International Financial Institutions (IFIs) has been developed for the first time. An update of this strategy has been published in 2009. The strategy contains two chapters on energy and the climate process. They form 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. 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 participants in the carbon market. They should continue to be involved in the preparation of CDM projects in the pipeline. Finally, Austria remains actively engaged in the debate on the polluter pays principle within IFIs.

Climate change relevant, ODA eligibly financial contributions to multilateral institutions and programmes are shown in Table 7.6. The contributions listed there do not include regular membership or compulsory financial shares, but voluntary support.

Austria's contributions to multilateral institutions like the International Development Association, the African and the Asian Development Fund and the International Fund for Agricultural Development are not shown in the table. These contributions could not 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.

Table 7.6.: Climate Change relevant financial contributions to multilateral institutions and programmes – Austria 2005-2008 (in US$ million)

Multilateral Organisation	Programme/Project	2005	2006	2007	2008
UNFCCC Trust Funds	Voluntary contributions to various trust funds, NWP etc.	1.07	0.25		0.35
IPCC	IPCC -Intergovernmental Panel on Climate Change	0.02	0.03		0.03

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.

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 Pumping Technologies”, “Energy Conservation in Buildings and Community Systems Programme”, “Bioenergy”, “Wind Energy Systems”, “Demand Side Management”, “Photovoltaic Power Systems”, “Hybrid and Electric Vehicles”, “Advanced Motor Fuels”, “Solar Heating and Cooling” or “Climate Technology Initiative”. The IEA’s Directorate of Global Energy Dialogue works with member and non-member countries to promote cooperation and dialogues on all aspects of energy policy and technology. Non-member countries can and do already participate as full members in the IEA network of energy technology Implementing Agreements.

7.4.2 Austria’s participation in the 7th Framework Programme for Research &Development of the EU

Trans-national cooperation is an important objective of the Research Framework Programmes of the European Union. Energy and environment including climate change are important thematic areas within the 7th Framework Programme, which has started in 2007. Already under the 6th Framework Programme several European Technology Platforms (ETPs) regarding energy and other environmentally relevant topics have been established. ETPs are particularly relevant for industrial research and Austrian research institutions and enterprises actively participate in several platforms. The Austrian Ministry of Transport, Innovation and Technology has joined and built up several multilateral programme cooperations with other countries in the EU, so-called “European Research Area Networks” (ERA-Net). With respect to climate change issues the ERA-Nets “Bioenergy”, “Erabuild”, “Hydrogen and Fuel Cells”, “Photovoltaic”, “Smart Grids ERA-Net” need to be mentioned and the “Smart Grids D-A-CH”-cooperation. Each ERA-Net is joined by several partners of different countries, including the new member states of the European Union from Central 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

In 2006 the Federal Ministry of Agriculture, Forestry, Environment and Water Management launched the Austrian CDM for Africa Initiative with the goal to promote the CDM in Sub-Sahara Africa. It both offered capacity development activities and support for concrete projects in four focus countries: Ethiopia, Ghana, Tanzania and Uganda. The initiative cooperates with the local DNA and/or project developers. The work programme for 2008 had a strong energy focus:

- Calculation of „grid emission factors“ for the electricity grids in the four focus countries
- Compilation of a handbook and "hands on" training for the DNA on applying and updating the factors
- Review with regard to a compilation of an information pack for the DNA concerning CDM-potentials in the cement industry

Furthermore, Austrian Development Cooperation has been supporting Capacity Building and preparation of CDM documents for a hydropower plant in Bhutan from 2005 to 2008. This activity was embedded in the wider policy framework of Austrian Development Cooperation for Energy for Sustainable Development.

Besides, the Austrian JI/CDM Programme supports Non-Annex I Country Kyoto Parties with grants in the project development phase.

7.4.5 Further Initiatives

Since 1999 Austria is playing a key role as initiator and supporter of the Global Forum on Sustainable Energy GFSE. GFSE is a neutral multi-stakeholder platform which is facilitating international dialogue on energy for sustainable development by taking into accounts the special interests and challenges of developing countries. It plays a crucial role in facilitating sustainable energy projects, by bringing together donors, investors and project developers. Their interaction produces new opportunities and enhances existing initiatives in the field of sustainable energy. Annual conferences are the visible peak of the GFSE activities. They are feeding into the international energy discourse, raising awareness, and disseminating information.

An initiative for the development of an Austrian Master Plan Environmental Technology has been launched by the Federal Ministry of Agriculture, Forestry, Environment and Water Management and the Federal Province of Lower Austria in 2006; the Master Plan has been published in 2007. It is supported by the Competence Center for Environmental and Energy Technology which has been set up in 2008. The environmental technologies industry in Austria has a considerable share of small and medium size enterprises which often have a strong focus on their home market. One of the objectives of the initiative is to promote the international networking of the enterprises and to support exports. As a forerunner the Export Initiative Environmental Technology should be mentioned, which was launched in 2005. In a joint effort by the government and the private sector, numerous presentations of Austrian environmental technologies were held by business delegations under the auspices of the government, raising the awareness level of Austrian technologies in foreign countries.

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.

Project/programme title: Bhutan: Hydropower plant Dagachhu			
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$ 6 million	Since 2004
Description: Hydropower plant (run-of-river type) with a capacity of 114 MW is planned and installed in Bhutan, located in the South-Western part of the country on the left bank of the Dagachhu river . Work is carried out by local contractors. Austrian support consists of technical assistance and capacity development for O&M.			
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**
Macedonia (Former Yugoslav Republic of)	Energy supply	> US$ 2.30 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: Environmentally sound technologies and cleaner production for SMEs in Nicaragua			
Purpose: Enhancing the competitiveness and productivity of industry in Nicaragua, promoting sustained social advance in a way compatible with environmental protection			
Recipient country	**Sector**	**Total funding**	**Years in operation**
Nicaragua	Small and medium Scale enterprise development	US$ 0.94 million	Since 2006
Description: The project will foster the development and diffusion of Environmentally Sound Technologies (ESTs) with a special focus on solar energy in order to enhance the quality and productivity of the national industries providing them with the necessary tools that will facilitate access to national and regional markets with environmentally sound products and improving the ability of national enterprises to successfully negotiate their position in the global markets. The project will rely upon the experience of the Nicaraguan National Cleaner Production Center in Nicaragua with companies mainly from the food, metalmechanic and tourism sectors, in which the CPC has already gained significant experience through the implementation of CP (Cleaner Production) and EST measures. The activities of the project will focus on capacity building in the development, EST development and promotions, policy advice and implementation of demonstration projects.			
Indicate factors that led to project's success: Up-scaling of pilot activities of the partners; tailor made approaches involving comprehensive support packages.			
Technology transferred: Solar thermal systems			

Project/programme title: Rural water supply and sanitation in Sofala Province			
Purpose: Improved water supply and sanitation in a fragile and natural disaster prone livelihood context			
Recipient country	**Sector**	**Total funding**	**Years in operation**
Mozambique	Water supply and sanitation	US$ 6.80 million	Since 1999
Description: ADC supports the provincial government of Sofala and the district and local administrations in the implementation of water supply and sanitational infrastructure and the design of respective development strategies and plans. The living conditions of the local population could be considerably improved through access to clean water. The project focuses on investments in the construction of wells. Where appropriate climate-friendly solar powered water pumps are installed. The region is repeatedly plagued by extremely heavy rainfall and tropical cyclones leading to devastating floods, as in the year 2000. These events are likely to increase in frequency and intensity as a result of climate change. At the same time, however, periods of drought are likely to be longer and more frequent. Planning for water supply and sanitation will have to take all these risks into account and ensure that sufficient access to clean water is improved even under these changed conditions.			
Indicate factors that led to project's success: District administration is leading the planning and implementation; participatory planning together with communities; appropriate technology for local context			
Technology transferred: Sustainable sanitation infrastructure; solar powered water pumps			

Project/programme title: Sustainable Natural Resource Management Programme, North Gondar Zone			
Purpose: Improved sustainable management of natural resources and alternative livelihoods promotion			
Recipient country	**Sector**	**Total funding**	**Years in operation**
Ethiopia	Agriculture	> US$ 7.68 million	Since 2008
Description: North Gondar Zone is suffering from degraded lands. Local biodiversity and ecosystem services are at risk, including from the effects of climate change The project works towards sustainably managing watersheds to increase agricultural productivity and the development of opportunities for increased income from livestock development and tourism. Important components include reforestation and rehabilitation of degraded lands, pasture management and the promotion of sustainble forest management and biogas for cooking.			
Indicate factors which led to project's success: Learning from experiences of previous projects in the agricultural sector; continuity; Intensive involvement of local inhabitants in planning and implementation			
Technology transferred: know-how regarding pasture management, 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. Research on adaptation has gained importance during the last years. 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. The Federal Ministry of Science and Research and the Federal Ministry of Transport, Innovation and Technology hold a central position in co-ordination, administration and financing of research. 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 2.54 % in 2007. 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 and FFG) 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 (FWF) was set up as a bottom-up oriented instrument for basic research funding in 1967. About 85% 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 granted in 2007 was EUR 150 million.

The Austrian Research Promotion Agency (FFG) 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 2007 about EUR 400 million were granted for projects; about 80 % go to enterprises.

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 Science and Research 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 Science and Research), "Technologies for Sustainable Development" (Ministry of Transport, Innovation and Technology) and "Pfeil10" (Ministry of Agriculture, Forestry, Environment and Water Management). ProVISION deals with key questions like adaptation to climate change and its consequences, responsible use of natural and industrial resources, and environmental protection (http://www.provision-research.at/). Pfeil10 deals 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 (International Geosphere-Biosphere Programme), WCRP (World Climate Research Programme) and IHDP (International Human Dimensions Programme on Global Environmental Change).

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. The main focus has been put on extreme events and on climate change and its impacts on health, tourism and energy. Adaptation to climate change is the main topic for 2008 and 2009.

The Austrian Climate Change and Energy Fund has been established in 2007. Its task is the funding of research and development in the field of sustainable energy technologies and climate change (as well as funding of projects for the market penetration of sustainable energy technologies and funding of projects for sustainable transport). A budget of EUR 500 million has been allocated to the fund for the years 2007 to 2010.

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. All aspects of the hydrological cycle, including the interaction with the biosphere have attracted a number of research groups. An increasing number of groups is using high resolution climate models for process studies. 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 E, Table E.2*.

8.2.2 Modelling and Prediction, Including Global Circulation Models

In view of the limited resources available to a small country, the Austrian climatological research community has refrained from entering into global circulation model (GCM) research as such. There are, however, 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 and the follow up project reclip:century, a research group including scientists from three universities and two research institutions, works on a systematic evaluation of the potential of different LAMs for Austria and the development of dynamical downscaled climate change scenarios. The members of this group also participate in the relevant EC-founded European research projects (e.g. ACQWA, CECILIA, CLAVIER).

For examples of research projects and activities in which Austria has been particularly active, confer *Appendix E, Table E.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, lakes, glaciers, etc. As climate change impact is an interdisciplinary problem, the research programs ACRP, StartClim, Floodrisk and ProVision have been launched within the last decade, 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, which is climatologically more related to Central and Eastern Europe (CEE) than the Alps. In this region water shortage could lead to difficulties for agriculture in the future. The impacts of the hot and dry summer 2003 have emphasized the need for research in this area. Several national and international projects are dedicated to this problem.

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

8.2.4 Socio-economic Analysis, including both of the Impacts of Climate Change and of Response Options

Austrian research in this field has grown and the spectrum of research has broadened within the last years. The traditionally important topics, which are the estimation of costs and economical as well as social benefits of increased renewable energy supply technologies at the one hand and the development of regional response options aiming at reducing greenhouse gas emissions from energy generation at the other hand, are still carried on and are supported by several research lines of the Climate and Energy Fund and by ProVision.

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 810 municipalities in Austria representing more than 60 % of the Austrian inhabitants have joined the *Klimabündnis* dedicating themselves to halve their CO_2 emissions until 2030.

Apart from research on regional response strategies, Austria's research is also investigating socio-economic impacts related to the introduction of renewable energy systems. Within this context, social as well as economical factors for innovation and adoption of these technologies in Austria have been identified.

In addition to these energy related research topics other important socio-economic sectors (e.g agriculture, tourism) have been investigated too. In several interdisciplinary projects comprehensive analyses of all relevant socio-economic effects in case study regions have applied.

To foster the research on socio-economic aspects of climate change in Austria the Wegener Center for Climate and Global Change ("WegCenter" http://www.wegcenter.at/) was founded in 2005. The WegCenter brings together about 40 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 E, Table E.4*.

8.2.5 Research and development on mitigation and adaptation technologies

Research on mitigation technologies is high developed in Austria. The research topics reach from process optimization in agriculture (e.g. diary production) to sustainable cooling. 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. Concerning biomass, research is mainly directed towards biomass utilization in small and medium (up to 50 MW) heating facilities.

In the field of solar energy technologies a certain peculiarity in the Austrian research landscape exists. 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.

With the national research programs "New Energies 2020" ("Neue Energien 2020": http://www.ffg.at/content.php?cid=821) and „Building of Tomorrow plus", ("Haus der Zukunft plus": http://www.hausderzukunft.at/) a systematic research line, focusing on all aspects of new energy and the mitigation options in building, has been installed within the last years. More than 80 Mio Euro have been assigned within the last two years to several hundred interdisciplinary projects.

A wide range of research projects, reports on pilot projects and demonstration projects, supported by the Ministry of Transport, Innovation and Technology in the research programs on Technologies for Sustainable Development ("Building of Tomorrow plus", "Factory of Tomorrow", "New Energies 2020" and their previous programs) is listed on the website: http://www.nachhaltigwirtschaften.at/.

In 2008 the Austrian government initiated the development of a "national adaptation strategy". Part of this process are a series of workshops to start the communication between experts and stakeholders, a study to summarize the current information on the status of adaptation to climate change in Austria, and a data base gathering all relevant information on Austrian adaptation activities. (http://www.klimawandelanpassung.at/datenbank/)

The new inter-disciplinary research programs in Austria as well as the WegCenter in Graz have also a focal point on the development on adaptation techniques.

For examples of research projects and activities in which Austria has been particularly active, confer *Appendix E, Table E.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 F* 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 1000 stations are measuring at least temperature and precipitation. 150 of these stations are exchanged internationally within the WWW, 9 within CLIMAT, 3 within the GSN and 1 within the GAW program. All stations are in the responsibility of the Central Institute for Meteorology and Geodynamics (ZAMG). The Austrian GAW station is located at the "Hohen 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. Starting in the 1990ies, additional measurements (e.g. Ozone, UVB) are using the infrastructure of the observatory. Information of all activities at the Sonnblick observatory can be found under http://www.sonnblick.net/portal/index.php.

Two institutions are responsible for maintenance of the stations and quality control; the ZAMG and the Subdepartment VII/3 – Water Balance of the Federal Ministry of Agriculture, Forestry, Environment and Water Management. The Subdepartment Water Balance is also responsible for the river discharge measurements (550 stations),the ground water storage (3066 stations) and lake water temperature measurements (30 Stations).

The measurements of atmospheric constituents are in the responsibility of the *Länder* and are focusing on air quality aspects. Data from more than 120 stations are collected and published by the Federal Environment Agency. From the long-lived greenhouse gases only CO_2 is measured at one site.

For a summery of activities see Tables F.1–F.3. For examples of activities in which Austria has been particularly active, confer *Appendix F, Table F.4*.

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 glaziological method are established since decades. All these data are reported internationally to the World Glacier Monitoring Service.

To describe the water runoff within the complex terrain of Austria more than 1300 stations with precipitation measurements, 550 stations for the river discharge measurements and 3066 stations for the ground water storage are established, but also more than 900 stations with snow depth measurements (responsible institutions Subdepartment Water Balance of the Federal Ministry of Agriculture, Forestry, Environment and Water Management, ZAMG).

In Austria the LTER network (as part of the ILTER network on “International Long Term Ecological Research”) rapidly expanded within the last years and today 27 ILTER sites are established in Austria. Within the UNESCO’s Programme on “Man and the Biosphere” the following 6 sites are Biosphere Reserves:

- 1977: Gossenköllesee (Tirol)
- 1977: Gurgler Kamm (Tirol)
- 1977: Lobau (Wien)
- 1970: Neusiedler See (Burgenland)
- 2000: Grosses Walsertal (Vorarlberg)
- 2005: Wienerwald

(Additional information on ILTER networks and Biosphere Reserves can be found at: http://www.ilternet.edu/ and http://www.biosphaerenparks.at/index_engl.cfm)

For examples of activities in which Austria has been particularly active, confer *Appendix F, Table F.4*.

8.3.3 Space-based observing programs

Austrians space based activities are coordinated by the Austrian Space Agency (ASA) which was founded in the year 1972. 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. Since 2005 the agenda of ASA are hosted in the Aeronautics and Space Agency (ALR) of the FFG (Austrian Promotion Agency).

The ALR acts as the central contact point for the coordination of all aeronautical and space-related activities in Austria and is the docking station to the international aeronautical and space scene. The agency supports the participation of Austrian researchers in international and bilateral aerospace collaborations and fosters the creation and development of international networks. It implements Austrian aeronautical space policy and represents Austria's interests in international aeronautical and space organisations. The agency's main focus is on managing the contributions of the Republic of Austria to the programmes of the European Space Agency (ESA) and is responsible for the management of the Austrian Space Programme ASAP. Several ASAP projects have dealt with earth observation and climate change issues. Information of all ALR activities and the actual ASAP projects can be found on the ALR web-page (http://www.ffg.at/content.php?cid=29)

For examples of activities in which Austria has been particularly active, confer *Appendix F, Table F.4*.

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. Consequent 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.

The present chapter is divided into three parts. First, focus is laid on education as part of the school programme. Afterwards "training and advising programs" are presented. At last raising public awareness on climate change is subject matter.

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 *Austrian Strategy for Education for Sustainable Development* was tabled by the Federal Ministry for Education, Arts and Culture, the Federal Ministry for Agriculture, Forestry, Environment and Water Management and the Federal Ministry of Science and Research and passed the Austrian Council of Ministers on November 12, 2008.

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 Regional programmes

Various programmes supporting environmental education do exist on the *Länder* level. Some examples should be mentioned here:

- *Lower Austria*

  ÖKOLOG NÖ is a school network for the "ecologisation" of schools and based on a programme for environmental education and school development (see also Section 9.1.3). It has set up a team of assistants to support and guide schools towards establishing a sustainable "school culture". The annual ÖKOLOG-meeting offers educationalists lectures and workshops, as well as a platform to share their experiences. Teaching aids, such as a catalogue giving 400 different ways of providing environmental education, compiled by 80 organisations, and a newsletter reaching each of the 1400 schools in Lower Austria, covering highly topical workshops, guided field trips, exhibitions, films and competitions, such as "Energy-checker", complete the range of offers for schools. The new "Environmental Education Network" with 52 partner organizations aims to increase interest in protecting the environment and promote the leading of a sustainable lifestyle by all citizens, independent of age, education and profession. Once a year, the conference "FOCUS on Environmental Education" and a symposium on different topics, such as the ecological footprint or environment & economy & sustainability, are offered free of charge for all who are interested in the field of environmental protection pedagogy.

- *Salzburg*

  Environmental quiz and local school competition. Every year Salzburg organizes competitions regarding various environmental topics, e.g. climate change, ecological footprint etc. (http://www.salzburg.at > Umwelt/Natur/Wasser > Umweltschutz > Schulwettbewerb)

- *Styria*

  The ecological footprint is an initiative raising awareness regarding our way of life and its impact on planet earth. In fall 2007 a wide initiative particularly for schools, but also for municipalities etc., has been launched. The offer is free of charge for schools and is offered by Styria with Cooperation with the Umwelt-Bildungs-Zentrum Steiermark (UBZ). The UBZ also instructed "Footprint Coaches" and developed information and education materials.
  (http://www.ubz-stmk.at, http://www.footprintrechner.at)

  Another initiative is a programme called "Energie macht Schule" which is focused on schools and is offered by the Climate Alliance Styria (http://www.klimabuendnis.at) in cooperation with the Energy Consulting Office, "Energieberatungsstelle des Landes Steiermark". Children get information about energy and climate change and in some schools solar heating systems were built by the pupils and installed from experts.

- *Upper Austria*

  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 a "solar day" and an excursion of the Upper Austrian Academy for Nature and the Environment). In addition to theory training also practical projects regarding energy, mobility and development-policy 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.
  (http://www.klimarettung.at)

- *Vorarlberg*

  Within the framework of the "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.
  (http://www.vorarlberg.at) > Natur und Umweltschutz > Daten & Fakten > Mitwelt- und Solarpreis

9.1.3 Federal initiatives

- *Energy budgeting and Contracting in Schools*

  All higher education schools (grammar schools as well as middle and higher vocational schools) are obliged to energy budgeting since the mid nineties. In 1999 the Austrian Federal Ministry for Education, Arts and Culture in collaboration with the Bundesimmobiliengesellschaft (BIG) has started a contracting programme for energy saving in 46 higher education schools, since the school year 2008/09 175 school contracting projects are going on. The contracting report 2006 informs that 30.700 tons of CO_2 were saved in the period 1999 – 2006.
  (http://www.big.at/projekte/contracting/)

  In addition a number of communities run contracting programmes for compulsory schools, the maintenance of which are in their responsibility.

- *FORUM Environmental Education (EE) (FORUM Umweltbildung)*

  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

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 in the period 2006–2009:

Focus theme information with the programme "Ecologisation of Schools – Education for Sustainable Development ÖKOLOG" (see below) on Mobility (2007 – 2008) and Sustainable Consumption and Life style (2008 and 2009).

- ✓ Internet-Information and Tools: Teaching information on Energy; (http://www.klimainfo.at)
- ✓ Info-Folder to the film of Al Gore "An Inconvenient Truth" and on the "Ecological Foot print" together with a didactical hand book.
- ✓ Timeline: An Internet activity searching for traces from Chernobyl to climate change.

All these productions are accompanied by a series of workshops, with advisory meetings in Schools to implement the use of this information offer. (http://www.umweltbildung.at).

- *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.
  (http://www.umweltzeichen.at/schulen)

- *Education for Sustainable Developement (ESD) – Innovations in Teacher Education (Bildung für Nachhaltige Entwicklung (BINE) – Innovationen in der Lehrer/innenbildung)*

  ESD is a nation wide University study course for in-service training for teacher educators for ESD. The aim is to promote ESD in teacher education, to foster innovative didactics, to encourage exchanging experiences and methods and to help teacher educators develop research competencies.

  2008/2009 is the second run of the 4 Semester course after a pilot course 2004/2005. The approximately 20 participants take part in 3 five days moduls, they plan, conduct, evaluate and document an ESD project in their own institution. The principles of ESD are threefold:

  - ✓ to put equal emphasis on theoretical-methodical foundation and learning from own practical experiences,
  - ✓ to closely relate projects on Sustainable Development and research activities to each other,
  - ✓ to stabilise innovation by the participants' taking into account the structural framework of their institutions.

One of the strengths of the project is the cooperation of Universities and an NGO (FORUM Umweltbildung) and a big emphasis on networking both nationally and internationally. The pilot study course ESD has contributed to the EU project CSCT (see "International Networks") and results of the competency concept developed in that project influenced the further development of the course for the second run. There is also a close connection to the ENSI product "Qualtity Criteria in ESD schools".
(http://www.nachhaltigkeit.at/projekte)

- *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. In 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 four years, the ÖKOLOG-school network grew to 300 schools with about 60.000 students being involved. Special bi-annual focus themes were Participation, Mobility, Sustainable Consumption and Life style, for the period 2010–2012 the focus will be on energy. All topics were supported by information material, in-service training and partly by local advising.
  (http://www.umweltbildung.at) > Schwerpunkte > Ökologisierung von Schulen

- *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 was the legal basis for the University-level training institute for educational professions in agricultural and ecological affairs which started in fall 2007. This institute is essentially supporting the development and dissemination of appropriate methods and practices of teaching, training and creation of awareness in ecological matters.
  (http://www.agrarhochschule.at/)

- *Climate protection issues in the Agricultural and Forestry Schools*

  These secondary schools, which offer a professional education regarding agriculture and forestry, are engaged in different projects related to climate change with indirect or direct involvement of students. Projects concern changes in the physical school environment (energy contracting for school buildings, ecological ways of construction for buildings, installation of photovoltaic systems), awareness changes (ranging from acquisition of organic products for the school kitchens to integrated improvement processes in order to join the ÖKOLOG school network or to get awarded the Austrian eco-label for schools) as well as hands-on training (organic farming in school farms, eco-driving for tractors).

9.1.4 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). 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 Switzerland, with Austria having had the ENSI presidency from 2004 until 2008.
  (http://www.ensi.org)

- *European Commenius project: CSCT - Curriculum, Sustainable development, Competences, Teacher training*

  16 Teacher Training institutions from 9 European countries developed a dynamic model of ESD competencies in Teacher Education as a framework for a competency based curriculum for Education for Sustainable Development for initial teacher training and in-service training institutions. The resulting competency model is an attempt to give some structure to the complexity of ESD. Due to the concept of ESD as a regulative idea the teacher competences are formulated as generic as possible, to serve as a framework for all kinds of educators for all subjects and target groups.
  (http://www.csct-project.org/)

- *EU COMENIUS III Network 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)

- *EU-COMENIUS 3 Network project "Partnership and Participation for a Sustainable Tomorrow" SUPPORT (2007 – 2010)*

  Austria is partner in this network project. The goal of SUPPORT is to promote and enhance the quality of education for sustainable development by linking schools, research institutions and communities in a web-based network. SUPPORT aims to increase participation in science studies by making these more attractive, reduce the gender imbalance in science education and promote entrepreneurship by supporting a school culture of innovation and responsibility.

  A main initiative within SUPPORT is the *international school campaign CO2nnect*, in 2009. The theme for CO_2nnect is transport and climate. The goals reach far beyond getting a deeper understanding of the emission problems related to transportation and include understanding the interlinking of social, environmental, cultural and economic aspects of the local transport system as well as acquiring skills to actively participate in local democratic processes. By submitting information to the shared database, pupils will also experience how to use ICT and the internet interactively for partnership and data analysis and what it is like to collaborate with researchers and generate reliable information.

  In short, pupils will feed into the database their home-school distance and what means of transport they use. They will be able to see how much CO_2 this transportation generates and be able to compare their data with that of pupils in other schools in other countries. The idea is that this data is used as a basis for discussion and analysis of the local transportation system. After discussions in the class room, schools are encouraged to invite local politicians, parents and other stakeholders to discuss ways to improve the situation or hear the pupils' ideas.
  (http://ec.europa.eu/education/programmes/socrates/comenius/activities/comenius3_en.html)

9.1.5 NGO Partcipation

Valuable work is done by several NGOs such as the Climate Alliance Austria, WWF, Naturschutzbund, Umweltberatung, etc. Some of these NGOs, interest groups and communication agencies have organised project competitions, provided teaching materials, organised workshops for teachers or have acted as consultants. Expert lessons in schools or outdoors have been provided. By doing so, these groups offer valuable additional support to interested teachers and schools, which cannot be provided by school authorities alone.

- *Climate Alliance Austria (see also Section 9.3.)*
  - ✓ About 170 schools and kindergartens have "joined" the Climate Alliance and take part in activities municipalities
  - ✓ Climate Alliance Austria offers different workshops for schools with the focus to traffic, energy and partnership
  - ✓ The "Green footprint campaign" invites primary schools and kindergartens in Austria to carry out one or more activity weeks 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. The aim of the campaign is to encourage children to collect as many Green Footprints (each representing one kilometre) as possible. Until 2008 about 1000 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 the cost savings from reduced energy consumption in school buildings.
- ✓ Special Workshops inform teachers about how to bring climate protection into the class.
- ✓ Specific educational material has been created (the topics are covered: mobility, climate and energy)
- ✓ Mobility management for schools (on behalf of ministry of Agriculture, Forestry, Environment and Water Management): The project is providing a basic package of information and teaching materials for 500 interested schools or teachers in Austria. Additionally 125 schools are benefiting from a more intensive programme. Over the course of a year, a mobility manager helps children, teachers and parents to find local solutions to enhance climate friendly means of transport. This may be achieved via road safety measures or via innovative approaches such as roundtables with children and community members, including transport company staff. These measures include better options for children making their way to school. There is less car traffic around the schools and more awareness of children’s need for physical activity, clean air and more pleasant journeys to school. (see also klima:aktiv initiative)

http://www.klimabuendnis.at/

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 Energy

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. 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. Some examples are shown below.

- *Energieberatung Salzburg*

  With help of the e5- energy efficiency programme for communities (energy award for communities) Salzburg supports communities that want to contribute to a sustainable energy policy and urban development through the rational use of energy and an increased use of renewable energies. Information and motivation according energy-reduction both – private households and commercial sites/industry – are in the focus of energy consultancy supported in Salzburg. "Energieberatung Salzburg" (energy consulting Salzburg) and Umwelt Service Salzburg (environmental service salzburg) inform their target groups, how to reduce energy in heating systems, electricity, thermal insulation. The core strength is to combine expert knowledge in energy-saving with private or commercial investors. Umwelt Service Salzburg (environmental service salzburg) also maintains Communities and commercial sites to reduce their environmental impact generated by traffic.
  (http://umweltservicesalzburg.at)

- *Klima:Aktiv (http://www.klimaaktiv.at)*

  In 2004 the Federal Ministry of Agriculture and Forestry, Environment and Water Management ("Lebensministerium") has launched an eight-year initiative programme for active climate protection. klima:aktiv is embedded in the Austrian federal climate strategy, consisting of a bundle of measures of regulation, taxes, subsidies. klima:aktiv has gathered all the voluntary and supporting measures under one umbrella. In the four thematic clusters Renewable Energy, Building, Energy Efficiency and Mobility specific programmes are carried out by various programme managers of different elected institutions. These programmes follow a comprehensive and systematic approach in supporting the market introduction of climate-friendly technologies, services and activities.

The advantage of combining all these various topics under one umbrella programme mainly results from the fact that the instruments used - training, advising, quality management, networking and awareness campaigns - might differ in content but not so much in form. Thus, the individual thematic programmes profit from each other.

klima:aktiv follows the idea of market transformation. The following aspects are characteristic for this approach: market transformation is a targeted effort to change the market and is – in case of success – very likely to have long-lasting and far-ranging consequences and results. Typical for the market transformation approach is an active and comprehensive inclusion of all relevant market players and stakeholders. The main advantages of a market transformation approach are comparably low costs and high sustainable effects. In this case, market transformation wants to raise the share of energy efficient products and services.

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 aiming to enhance quality and accelerate the introduction of climate friendly technologies and services, which shall become the self-evident alternatives for companies, communities 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 programs 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. promoters 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. Next to investment subsidy programs and legal and fiscal instruments, klima:aktiv provides targeted support for e.g. further education and vocational training of key players, for standard setting and quality management or for target-group specific information, motivation and marketing as well as building and activating of networks:

- ✓ Training of klima:aktiv pros
- ✓ Setting standards and safeguarding quality
- ✓ Providing information and raising awareness
- ✓ Providing advise and support
- ✓ Activating and networking partners
- ✓ Building the network

- *Ökomanagement Niederösterreich*

The Lower Austrian government launched Ökomanagement – the Lower Austrian Environment Advisory Scheme for Business and the Private Sector – in 1999. Ökomanagement aims to create a basis for a process of continuous environmental improvement and sustainable development in the region of Lower Austria in accordance with the regional development plan. The scheme provides financial support and expertise to private companies, public bodies, local government and municipalities in implementing resource management and pollution prevention measures and environmental and/or integrated (environmental, safety and quality) management systems. Energy is one of the most meaningful topics.

Ökomanagement NÖ offers private and public organisations the possibility to get support in environmental issues from professional consultors once a year in the amount of 1 up to 15 days. Every organisation that proves to realise measures with positive effects on the environement and the climate will be awarded a certificate by the Lower Austrian Regional Government. Ökomanagement NÖ covers awareness-raising and information initiatives by several public relation campaigns. One overall objective of Ökomanagement NÖ is to reduce Green-house Gas emissions in Lower Austria. Funded and implemented measures were consequently monitored and reported in a programme database, which contains quantified information on environmental improvements including GHG emission reductions.

- *Energieinstitut der Wirtschaft*

  The Austrian Chamber of Commerce has founded the "Energieinstitut der Wirtschaft" (Business Energy Institute) as a platform for facilitating implemen-tation of energy efficiency measures for businesses. It is involved in a number of projects, such as offering courses and workshops for energy consultants, with the aim to further enhance the existing knowledge in the sector and create new resources, to develop standardised training and documentation concepts, and to facilitate access to qualified external consultants, especially for small enterprises (http://www.energieinstitut.net).

- *AEE*

  The "Arbeitsgemeinschaft Erneuerbare Energie – AEE" (Society for Renewable Energy) was founded in 1988 as an independent association to promote the practical use of renewable energy 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.
  (http://www.aee.at)

- *Austrian Biomass Association*

  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. Up to now about 800 plumbers received the certification "bio heat-plumbers" ("Biowärme-Installateur").
  (http://www.biomasseverband.at)

9.2.2 Transport

- *klima:aktiv mobil (http://www.klimaaktivmobil.at)*

  klima:aktiv mobil – the climate protection initiative of the Federal Ministry of Agriculture, Forestry, Environment and Water Management is part of the Austrian Climate Strategy. The klima:aktiv mobil programmes motivate and support transport producing stakeholders and actors to develop and implement measures to reduce GHG in their transport and mobility activities promoting alternative clean fuels and vehicles as well as environmentally friendly transport modes and mobility management while at the same time increase transport efficiency and stimulating energy saving and renewables. The entire strategic concept consists of four interconnecting modules – consulting, financial supporting, motivating and awarding of partners – with a clear target to reduce CO_2 emissions.

  - ✓ Consulting programmes to promote mobility management – from the project idea to financial support and implementation
  - ✓ Funding programmes – financial support for mobility management projects to reduce CO_2 emissions
  - ✓ Motivation for fuel efficient driving and environmentally friendly mobility – Eco-Driving and cycling campaigns
  - ✓ Awards and certificates – commitment to climate protection

  Successful results
  700 klima:aktiv mobil project partners are already reducing more than 325,000 tons of CO_2 per year with their projects! About half of the carbon reduction results from fleet conversions (125,000 t CO_2/y, around 4,600 alternative vehicles promoted). The programme is right on track to exceed the 300,000 t CO_2/y reduction target determined in the Austrian (Kyoto) Climate Strategy in 2010. Also klima:aktiv mobil has been stimulating environment and economy. Funding from the klima:aktiv mobil financial support programme induces about ten times higher private investments in infrastructure and environmental technologies, supporting Austrian companies and municipalities and causing their positive environmental effects entirely in Austria. With only 11 € per ton of CO_2 funding the efficiency is very high.

- *Driving license*

  The legislation regarding training in driving schools has been amended in 2008: Eco driving has become a mandatory part of the training.

9.2.3 Agriculture

The chambers of agriculture (LKÖ), the Rural Adult Education Institutes (LFI), Bio Austria and the Austrian Council for Agricultural Engineering and Rural Development (ÖKL) are important institutions for extension related to climate protection issues.

Agricultural extension and further training for adult farmers comprise the following topics with regard to climate protection:

- The Austrian agri-environmental programme ÖPUL (z.B. reduced utilisation of nitrogen and nutrient balance)
- Cross Compliance
- Organic farming (pig and cattle raising, arable farming, horticulture, vegetable and potato growing, viticulture and fruit growing)
- Preparation of farm manure (composting) with the aim of keeping nitrogen emission into the air low
- Stable construction with special regard to the right storage of farm manure (see above)
- Energy efficiency on the farm
- Construction material from renewable resources
- Minimum tillage to minimise greenhouse gases
- State-of-the-art crop rotation and greening
- Bio energy/ renewable resources
- Special seminars for operators of biogas plants
- Fertilisation according to the needs of the very plant

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 Background

In order to increase the effectiveness of climate change communication activities the project titled “How to comprehensibly communicate climate change” was carried out in 2004/2005. It was the aim of this psychologically based project 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 probably 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 Regional Programmes

- *Upper Austria*

  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 € 5,000 in cash for climate protection measures). Networking with the Climate Alliance and the federal programme klima:aktiv is working very well.
  (http://www.klimarettung.at)

  The “Energiesparmesse”, an exhibition about energy efficiency, thermal insulation and renewable energy and related products celebrated this year its 25th anniversary. It is held annually in Wels (Upper Austria) and is an event with a widespread effect. In 2009, over 103.000 visitors attended the event where over 900 exhibitors showed their products. The “Energiesparmesse” received excellent coverage in Austrian media. Also the Austria climate protection initiative klima:aktiv was one main theme in Wels.
  (http://www.energiesparmesse.at)

  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 2009, more than 850 delegates from 53 countries attended the conference and the related seminars.
  (http://www.esv.or.at)

- *Vienna*

  There`s 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 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.
(www.wien.at/umwelt/klimaschutz)

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.
(http://www.wien.gv.at/umwelt/klimaschutz/sonne/)

- *Lower Austria*

  “Radland NÖ/Nextbike” is an initiative in Lower Austria to increase cycling to 14 %. A significant contribution to this makes “Leihradl Nextbike” which is an easy to use rental system for bikes.

  Under the title “KlimaAktionsTag” on 5th of June (World Environment Day) more than 300 different activities all over Lower Austria raise awareness for climate change and for measures to reduce greenhouse gas emissions.

  Lower Austria does not only count 322 communities having joined the Climate Alliance, it also puts its focus on “Climate Alliance Regions”. As a measure of the Lower Austrian climate programme, such a region receives special and coordinated support for some years. The first Climate Alliance Region was established in 2001 in an area east of Vienna and one of its communities, Bruck an der Leitha, has in the mean time realised a more than 50 % reduction of fossil CO_2 emissions.

9.3.3 Federal Initiatives

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.

- *Eco-Check*

  The Ministry of Agriculture and Forestry, Environment and Water Management created an Eco-Check, 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 CO2.
  (http://ecocheck.lebensministerium.at)

- *Eco-Driving Austria (Spritspar-Initiative)*

  Since summer 2004, the Mobility Department in the Austrian Federal Ministry of Agriculture, Forestry, Environment and Water Management 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: car drivers have been invited to take part in the annual championship for fuel-saving driving. The competition aims at spreading the idea of ECO-DRIVING among car drivers and also among driving schools. From several thousands of applicants some 400 drivers were selected for the competitions that stated in each region. The finalists, i.e., the 25 winners of the regional competitions, were called for the national competition. The winner was awarded a brand-new, fuel efficient car. The result was that the national winner drives the car with 30% less fuel than the amount determined in type-approval. Along with the competition leaflets, radio-spots, print media coverage etc. have been organised.

- ✓ Eco-Driving training certificate for driver trainers: In pilot seminars driving teachers have been educated and certified to ECO-DRVIVING-trainers (”Spritspar-Trainer”) that ensure a high quality level of teaching the subject; on average, 10% of fuel savings during trainings were achieved in all categories, such as cars, trucks, busses and agricultural tractors.
- ✓ Co-operation with fleet operators on fuel efficient driving.
- ✓ Awareness raising, marketing and public relations: The project is accompanied by elements of PR activities 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 emphasis was also put on the general public (car drivers).

(http://www.spritspar.at/)

- *Austrian National Cycling Startegy (“Masterplan Radfahren”)*

In 2006 the Austrian Federal Ministry of Agriculture, Forestry, Environment and Water Management presented the Austrian National Cycling Strategy which aims to double the cycling share from 5% to 10% until 2015. The Austrian National Cycling Strategy contains 17 measures to promote daily cycling use in Austria. Main elements are:

- ✓ Investments in cycling infrastructrure (Bike&Ride, cycling routes)
- ✓ free cycling consulting within the klima:aktiv mobil programme (see above) for stakeholders (mobility management in companies, public administrations, communities, schools, leisure and land use planning)
- ✓ Awareness campaign for stakeholder and the public in cooperation with the cycling industry and regional governments
- ✓ “bike2business” an award for cycling friendly companies (http://www.bike2business.at)
- ✓ “fahrRad” cyclist competition with an online kilometrage diary (http://www.fahrradpass.at)
- ✓ Installation of a national cycling coordination the Mobility Department in the Austrian Federal Ministry of Agriculture, Forestry, Environment and Water Management to coordinate the implementation of “Masterplan Radfahren”.

(http://www.klimaaktiv.at/article/articleview/64794/1/24460)

- *Organic farming*

Public relation plays an important role for the Federal Ministry of Agriculture, Forestry, Environment and Water Management. Only well-informed consumers will appreciate the advantages of organic farming and its products. Information is published by the Federal Ministry of Agriculture, Forestry, Environment and Water Management itself and can thus be downloaded from the homepage of the Federal Ministry of Agriculture and Forestry, Environment and Water Management (www.lebensministerium.at, www.landnet.at), or may be ordered by mail.

Internet pages (www.bio-erleben.at) were created by the Agrarmarkt Austria GmbH 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“

9.3.3 Initiatives at international level

- *European Carfree Day*

  In the context of the *European Carfree Day* (September, 22) Austria sensitizes and motivates its citizens for pollution free mobility since the year 2000 and offers sustainable solutions. Walking, cycling and the 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 406 cities and municipalities altogether (cooperation with the Austrian Climate Alliance) in 2007, the Carfree Day was one of Austria’s most successful public awareness campaigns regarding transport.
  (http://www.autofreiertag.at)

- *Energy Globe Award*

  In a competition for initiatives in the fields of energy efficiency and renewable energy sources from all over the world, the Energy Globe Award, organized by the Energy Globe Foundation based in Austria, honours outstanding projects. The competition is organized at regional, national and international level. In the last ten years more than 6000 entries from all over the world participated in 5 categories. The Energy Globe Award is presented during an international TV gala ceremony.
  (http://www.energyglobe.at)

9.3.5 NGO-Participation – Climate Alliance

Environmental NGOs such as *WWF*, *Greenpeace*, *Global 2000*, *Naturfreunde* and *Umweltdachverband* contribute to public awareness on climate change issues by various activities, covering articles in their members’ magazines and specific public campaigns, information brochures and scientific studies, practical tools and GHG mitigation tips and many more activities that are too numerous to be mentioned here.

The *Climate Alliance* is a NGO with climate change as its main topic. It is a global partnership for climate protection, set up by about 1500 European municipalities and the indigenous rainforest peoples. In Austria more than 700 municipalities and all federal provinces, about 400 private companies and more than 170 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. Members have committed themselves to:

- ✓ half their greenhouse gas emissions by 2030;
- ✓ support the indigenous partners in Amazonia in preserving their culture, their way of life and the rainforest

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 yearly nation-wide Climate Alliance meeting allows 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.
- ✓ From 16 to 22 September thousands of European towns and cities participate in the European Mobility Week (EMW) and invite their citizens to a wide range of activities promoting sustainable mobility. In Austria Climate Alliance Austria coordinates this initiative.
- ✓ Information on different subjects of climate protection was offered at about 250 local seminars and regional meetings.
- ✓ A periodical, issued four times a year, informs the members and public about current activities and serves as project exchange for the members.
- ✓ Information campaigns have been realised 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. Currently about 400 companies have joined Climate Alliance

After the competitions in 2002, 2004 and 2007, the European Climate Alliance has for the forth time invited all European local authorities to apply with exemplary climate protection actions and measures for a “Climate Star” in 2009. 444 cities and municipalities from 11 countries applied for the European award, 15 cities, municipalities and associations of local authorities were decorated with a Climate Star. The solemn award ceremony was held on invitation of Lower Austria.

- *Rainforest peoples*

An important part of the activities of the Climate Alliance is the *partnership with indigenous rainforest peoples* and raising awareness for these issues in Austria. Representatives of indigenous peoples 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 "Alto Rio Negro" region since 1993. The Alto Rio Negro is a tributary of the Amazon in the North-West of Brazil. In this region 23 indigenous peoples have joined together into the umbrella organisation FOIRN. Climate Alliance Austria supports the FOIRN in their efforts for economic and cultural autonomy and in 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. Thanks to the support on communal, regional and federal level an area of 10 million hectare of rain forest has been declared as indigenous territory. This prepares the ground for many initiatives and projects of the indigenous peoples in the Rio Negro region.
(http://www.klimabuendnis.at/start.asp?ID=102646)

Appendix A

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BGBl. Nr. 185/1993 i.d.F. 74/2008: Bundesgesetz über die Förderung von Maßnahmen in den Bereichen der Wasserwirtschaft, der Umwelt, der Altlastensanierung und zum Schutz der Umwelt im Ausland (Umweltförderungsgesetz — UFG), mit dem das Altlastensanierungsgesetz, das Abfallwirtschaftsgesetz, das Luftreinhaltegesetz für Kesselanlagen, das Bundesfinanzgesetz 1993, das Bundesfinanzierungsgesetz und das Wasserrechtsgesetz 1959 geändert werden

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BGBl. II Nr. 447/2002 i.d.F. BGBl II Nr. 139/2007 Verordnung des Bundesministers für Land- und Forstwirtschaft, Umwelt und Wasserwirtschaft über Verbote und Beschränkungen teilfluorierter und vollfluorierter Kohlenwasserstoffe sowie von Schwefelhexafluorid (HFKW-FKW-SF6-V);

BGBl. I Nr. 98/2004: Bundesgesetz, mit dem das Chemikaliengesetz 1996 geändert wird (Chemikaliengesetz-Novelle 2004 - ChemGNov 2004)

BGBl. I Nr. 135/2004 i.d.F. BGBl. I Nr. 89/2009: Bundesgesetz über ein System für den Handel mit Treibhausemissionszertifikaten (Emissionszertifikategesetz – EZG)

BGBl. II Nr. 19/2006 Bund-Länder gemeinsame Qualitätsstandards für die Förderung der Errichtung und Sanierung von Wohngebäuden: Vereinbarung gemäß Art. 15a B-VG zwischen Bund und Ländern über gemeinsame Qualitätsstandards für die Förderung der Errichtung und Sanierung von Wohngebäuden zum Zweck der Reduktion des Ausstoßes an treibhausgasen - aufgehoben durch BGBl. II Nr. 251/2009

BGBl. I Nr. 137/2006 Energieausweis-Vorlagegesetz - EAVG: Bundesgesetz über die Pflicht zur Vorlage eines Energieausweises beim Verkauf und bei der In-Bestand-Gabe von Gebäuden und Nutzungsobjekten (Energieausweis-Vorlage-Gesetz)

BGBl. I Nr. 40/2007 Klima- und Energiefondsgesetz KLI:EN-FondsG: Bundesgesetz über die Errichtung des Klima- und Energiefonds.

BGBl. I Nr. 44/2008 i.d.F. 114/2008 Ökostromgesetz – ÖSG: Bundesgesetz, mit dem Neuregelungen auf dem Gebiet der Elektrizitätserzeugung aus erneuerbaren Energieträgern und auf dem Gebiet der Kraft-Wärme-Kopplung erlassen werden.

BGBl. Nr. 54/2008 Abfallwirtschaftsgesetz Novelle Batterien: Bundesgesetz mit dem das Abfallwirtschaftsgesetz 2002 geändert wird.

BGBl. I Nr. 111/2008 (KWK-Gesetz): Bundesgesetz, mit dem Bestimmungen auf dem Gebiet der Kraft-Wärme-Kopplung neu erlassen werden

BGBl. II Nr. 251/2009 Bund-Ländern Maßnahmen Gebäudesektor zum Zweck der Reduktion des Ausstoßes an Treibhausgasen: Vereinbarung gemäß Art. 15a. B-VG zwischen dem Bund und den Ländern über Maßnahmen im Gebäudesektor zum Zweck der Reduktion des Austoßes an Treibhausgasen

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Council Directive 92/42/EEC of 21 May 1992 on efficiency requirements for new hot-water boilers fired with liquid or gaseous fuels

Council Directive 1999/13/EC of 11 March 1999 on the limitation of emissions of volatile organic compounds due to the use of organic solvents in certain activities and installations

Council Directive 1999/31/EC of 26 April 1999 on the landfill of waste

Council Regulation (EEC) No 2078/92 of 30 June 1992 on agricultural production methods compatible with the requirements of the protection of the environment and the maintenance of the countryside

Council Regulation (EC) No 1257/1999 of 17 May 1999 on support for rural development from the European Agricultural Guidance and Guarantee Fund (EAGGF) and amending and repealing certain Regulations

Council Regulation (EC) No 1782/2003 of 29 September 2003 establishing common rules for direct support schemes under the common agricultural policy and establishing certain support schemes for farmers and amending Regulations (EEC) No 2019/93, (EC) No 1452/2001, (EC) No 1453/2001, (EC) No 1454/2001, (EC) 1868/94, (EC) No 1251/1999, (EC) No 1254/1999, (EC) No 1673/2000, (EEC) No 2358/71 and (EC) No 2529/2001

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Directive 1999/96/EC of the European Parliament and of the Council of 13 December 1999 on the approximation of the laws of the Member States relating to measures to be taken against the emission of gaseous and particulate pollutants from compression ignition engines for use in vehicles, and the emission of gaseous pollutants from positive ignition engines fuelled with natural gas or liquefied petroleum gas for use in vehicles and amending Council Directive 88/77/EEC

Directive 2000/60/EC of the European Parliament and of the Council establishing a framework for the Community action in the field of water policy (EU Water Framework Directive)

Directive 2001/77/EC of the European Parliament and of the Council of 27 September 2001 on the promotion of electricity produced from renewable energy sources in the internal electricity market

Directive 2002/91/EC of the European Parliament and of the Council of 16 December 2002 on Energy Performance of Buildings

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

Directive 2003/54/EC of the European Parliament and of the Council of 26 June 2003 concerning common rules for the internal market in electricity and repealing Directive 96/92/EC - Statements made with regard to decommissioning and waste management activities

Directive 2003/87/EC of the European Parliament and of the Council of 13 October 2003 establishing a scheme for greenhouse gas emission allowance trading within the Community and amending Council Directive 96/61/EC

Directive 2004/8/EC of 11 February 2004 on the promotion of cogeneration based on a useful heat demand in the internal energy market

Directive 2004/ 26/EC of the European Parliament and of the Council of 21 April 2004 amending Directive 97/68/EC on the approximation of the laws of the Member States relating to measures against the emission of gaseous and particulate pollutants from internal combustion engines to be installed in non-road mobile machinery

Directive 2004/42/CE of the European Parliament and of the Council of 21 April 2004 on the limitation of emissions of volatile organic compounds due to the use of organic solvents in certain paints and varnishes and vehicle refinishing products and amending Directive 1999/13/EC

Directive 2004/101/EC of the European Parliament and of the Council of 27 October 2004 amending Directive 2003/87/EC establishing a scheme for greenhouse gas emission allowance trading within the Community, in respect of the Kyoto Protocol's project mechanisms

Directive 2005/32/EC of the European Parliament and of the Council of 6 July 2005 establishing a framework for the setting of ecodesign requirements for energy-using products and amending Council Directive 92/42/EEC and Directives 96/57/EC and 2000/55/EC of the European Parliament and of the Council

Directive 2006/32/EC of the European Parliament and of the Council of 5 April 2006 on energy end-use efficiency and energy services and repealing Council Directive 93/76/EEC amended by 2008/28/EC.

Directive 2006/40/EC of the European Parliament and of the Council of 17 May 2006 relating to emissions from air-conditioning systems in motor vehicles and amending Council Directive 70/156/EEC.

Richtlinie 6 des Österreichischen Instituts für Bautechnik (OIB RL 6): Energieeinsparung und Wärmeschutz, http://www.oib.or.at/

Appendix B

Indicators

This Annex presents the indicators pursuant to Article 3 (1) j of the EU Greenhouse Gas Monitoring Decision (280/2004/EC), a detailed description of the indicators can be found in Annex II of Commission Decision of 10 February 2005 laying down rules implementing Decision No 280/2004/EC of the European Parliament and of the Council concerning a mechanism for monitoring Community greenhouse gas emissions and for implementing the Kyoto Protocol (2005/166/EC).

Table B.1: CO_2 emissions indicators (Source: Umweltbundesamt 2009b)

No	Indicator	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007
	Priority										
1	Total CO_2 intensity of GDP [t CO_2/Mio Euro]	384.9	357.1	317.8	335.8	339.6	365.2	354.0	350.4	332.9	308.8
2	Energy related CO_2 intensity of GDP [t CO_2/Mio Euro]	335.3	314.0	278.6	297.0	298.8	324.6	314.9	309.9	291.7	267.0
3	Specific CO_2 emissions of passenger cars [1)] [g CO_2/ km]	212.0	206.7	192.5	189.1	185.8	183.1	180.7	177.0	171.6	168.6
4	Energy related CO_2 intensity of industry [t/Mio Euro]	316.6	295.8	265.1	260.3	270.8	272.4	265.6	278.6	265.6	248.5
5	Specific CO_2 emissions of households [t CO_2/dwelling]	3.36	3.17	2.95	3.04	2.99	3.35	2.96	2.82	2.53	2.18
6	CO_2 intensity of the commercial and institutional sector [t CO_2/Mio Euro]	28.75	32.23	18.85	26.49	22.00	23.28	20.92	17.04	21.73	14.04
7	Specific CO_2 emissions of public and auto-producer power plants [t CO_2/TJ]	166.8	150.9	128.7	132.7	131.5	133.4	133.4	127.5	119.7	116.6
	Additional Priority										
1	Freight transport on road [1)] [g CO_2/ ton-km]	147.4	126.6	100.1	95.8	92.9	91.6	92.3	89.6	88.0	86.8
2	Total CO_2 intensity – iron and steel industry [t CO_2/Mio Euro]	4 022	5 376	4 171	4 003	4 915	5 224	5 509	6 127	6 005	5 641
3	Energy related CO_2 intensity – chemical industry [t CO_2/Mio Euro]	519.5	576.2	551.1	652.6	604.6	612.8	538.9	482.4	494.4	412.8
4	Energy related CO_2 intensity – glass, pottery and building materials industry [t CO_2/Mio Euro]	730.2	716.9	676.3	641.3	734.3	723.1	776.6	707.7	738.3	773.5

No	Indicator	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007
5	Specific CO_2 emissions of iron and steel industry [t CO_2/t production]	2.17	1.92	1.82	1.75	1.79	1.78	1.73	1.79	1.78	1.71
6	Specific energy related CO_2 emissions of cement industry [t CO_2/t production]	0.225	0.226	0.214	0.200	0.204	0.189	0.211	0.194	0.207	0.213
	Supplementary										
1	Specific diesel related CO_2 emissions of passenger cars [1)] [g CO_2/ km]	193.1	189.3	177.9	175.2	172.9	171.3	169.8	166.4	159.7	158.1
2	Specific petrol related CO_2 emissions of passenger cars [1)] [g CO_2/ km]	216.3	213.5	204.1	201.4	198.1	195.5	193.5	190.4	187.5	183.4
3	Passenger transport on road [1)] [g CO_2/passenger -km]	155.6	159.7	157.0	156.0	155.0	153.2	151.7	149.1	144.9	142.9
4	Passenger transport by air [kg CO_2/passenge r]	234.0	226.1	125.8	104.2	109.6	107.0	106.2	110.8	110.7	111.5
5	Energy related CO_2 intensity – food, drink and tobacco industry [t CO_2/Mio Euro]	292.9	230.2	223.6	230.1	278.2	217.7	193.0	217.1	210.0	200.5
6	Energy related CO_2 intensity – paper and printing industry [t CO_2/Mio Euro]	861.1	778.4	638.4	555.1	613.7	678.9	621.1	612.9	545.4	503.4
7	Specific CO_2 emissions of households for space heating [t CO_2/m²]	35.78	32.19	28.40	29.14	28.27	31.40	26.68	25.20	22.72	19.17
8	Specific CO_2 emissions of commercial and institutional sector for space heating [kg CO_2/m²]	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
9	Specific CO_2 emissions of public power plants [t CO_2/TJ]	166.4	143.5	133.4	131.0	128.7	130.5	125.9	117.6	111.9	103.9
10	Specific CO_2 emissions of autoproducer plants [t CO_2/TJ]	168.2	168.2	117.6	137.8	139.2	143.8	158.7	162.1	144.1	151.2

No	Indicator	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007
11	Carbon intensity of total power generation [t CO_2/TJ]	68.37	58.70	48.04	54.69	53.22	64.83	62.26	60.74	57.61	54.13
12	Carbon intensity of transport [t CO_2/TJ]	65.93	64.04	63.45	64.17	65.38	66.14	65.52	64.93	63.51	63.17
13	Specific energy related CO_2 emissions of paper industry [t CO_2/t production]	0.755	0.643	0.536	0.497	0.499	0.518	0.458	0.462	0.420	0.421
14	Carbon intensity in Industry [kt CO_2 /PJ]	58.58	61.76	54.15	54.16	55.33	57.23	55.15	55.39	51.54	49.88
15	Carbon intensitiy Households [kt CO_2 /PJ]	40.86	37.51	35.27	34.23	33.81	34.78	33.65	32.41	30.52	29.35

[1)] Please note that for the road transport indicators activity data has been adjusted to reflect also the transport activity abroad, driven by fuel sold in Austria but consumed abroad. Activity data used for the calculation is therefore higher than those shown in Chapter 2.

Appendix C

Greenhouse Gas Inventory Information – Tables

Table B.1 Summary report for CO_2 equivalent emissions 2007 (CRF Summary 2)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 (1)	CH_4	N_2O	HFCs (2)	PFCs (2)	SF_6 (2)	Total
	CO_2 equivalent (Gg)						
Total (Net Emissions) (1)	**56 778.63**	**6 955.65**	**5 648.19**	**860.63**	**182.71**	**409.58**	**70 835.38**
1. Energy	**64 380.52**	**1 015.44**	**751.03**				**66 146.99**
A. Fuel Combustion (Sectoral Approach)	64 143.48	310.06	751.03				65 204.57
1. Energy Industries	13 928.60	6.16	79.57				14 014.33
2. Manufacturing Industries and Construction	15 667.82	14.02	142.69				15 824.53
3. Transport	23 922.60	20.83	280.92				24 224.35
4. Other Sectors	10 579.85	269.03	246.85				11 095.73
5. Other	44.61	0.03	1.00				45.64
B. Fugitive Emissions from Fuels	237.04	705.38	IE,NA				942.42
1. Solid Fuels	IE,NA,NO	IE,NA,NO	IE,NA				IE,NA,NO
2. Oil and Natural Gas	237.04	705.38	IE,NA				942.42
2. Industrial Processes	**9 535.22**	**19.05**	**270.01**	**860.63**	**182.71**	**409.58**	**11 277.19**
A. Mineral Products	3 505.54	IE,NA	IE,NA				3 505.54
B. Chemical Industry	530.62	18.96	270.01	NO	NO	NO	819.59
C. Metal Production	5 499.05	0.09	NA	NO	NO	NA,NO	5 499.14
D. Other Production	NA						NA
E. Production of Halocarbons and SF_6				NA	NA	NA	NA
F. Consumption of Halocarbons and SF_6 (2)				860.63	182.71	409.58	1 452.91
G. Other	NA	NA	NA	NA	NA	NA	NA
3. Solvent and Other Product Use	**248.53**		**160.27**				**408.80**
4. Agriculture		**4 110.42**	**3 839.07**				**7 949.49**
A. Enteric Fermentation		3 214.83					3 214.83
B. Manure Management		885.50	877.66				1 763.16
C. Rice Cultivation		NO					NO
D. Agricultural Soils(3)		8.86	2 961.10				2 969.96
E. Prescribed Burning of Savannas		NO	NO				NO
F. Field Burning of Agricultural Residues		1.24	0.31				1.55
G. Other		NA	NA				NA
5. Land Use, Land-Use Change and Forestry(1)	**-17 397.91**	**0.05**	**274.89**				**-17 122.97**
A. Forest Land	-19 539.13	0.05	0.01				-19 539.07
B. Cropland	2 034.08	NA,NO	274.88				2 308.96
C. Grassland	-1 265.62	NO	NO				-1 265.62
D. Wetlands	371.78	NO	NO				371.78
E. Settlements	530.55	NA,NO	NA,NO				530.55
F. Other Land	470.44	NA,NO	NA,NO				470.44
G. Other	NE	NA	NA				NA,NE
6. Waste	**12.26**	**1 810.69**	**352.91**				**2 175.87**
A. Solid Waste Disposal on Land	NA,NO	1 744.20					1 744.20
B. Waste-water Handling		31.32	279.40				310.72
C. Waste Incineration	12.26	0.01	0.03				12.30
D. Other	NA	35.17	73.47				108.65
7. Other ***(as specified in Summary 1.A)***	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**

Memo Items: (4)							
International Bunkers	2 175.79	0.90	22.57				2 199.26
Aviation	2 175.79	0.90	22.57				2 199.26
Marine	NA,NO	NA,NO	NA,NO				NA,NO
Multilateral Operations	**NO**	**NO**	**NO**				**NO**
CO_2 Emissions from Biomass	**18 660.74**						**18 660.74**

Total CO_2 Equivalent Emissions without Land Use, Land-Use Change and Forestry	87 958.35
Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry	70 835.38

Table B.2 Summary report for national emissions in 2007 (CRF Summary 1.A)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Net CO_2 emissions/removals	CH_4	N_2O	HFCs[1]		PFCs[1]		SF_6		NO_x	CO	NMVOC	SO_2
				P	A	P	A	P	A				
	(Gg)			CO_2 equivalent (Gg)				(Gg)					
Total National Emissions and Removals	**56 778.63**	**331.22**	**18.22**	**1 372.88**	**860.63**	**451.77**	**182.71**	**0.02**	**0.02**	**219.22**	**767.56**	**179.38**	**25.52**
1. Energy	**64 380.52**	**48.35**	**2.42**							**212.19**	**735.93**	**68.50**	**24.24**
A. Fuel Combustion — Reference Approach [2]	68 448.71												
Sectoral Approach [2]	64 143.48	14.76	2.42							212.19	735.93	65.76	24.05
1. Energy Industries	13 928.60	0.29	0.26							14.60	4.38	0.68	5.97
2. Manufacturing Industries and Construction	15 667.82	0.67	0.46							32.29	166.12	2.19	11.17
3. Transport	23 922.60	0.99	0.91							140.62	220.62	20.63	0.23
4. Other Sectors	10 579.85	12.81	0.80							24.60	344.54	42.24	6.66
5. Other	44.61	0.00	0.00							0.09	0.27	0.02	0.01
B. Fugitive Emissions from Fuels	237.04	33.59	IE,NA							IE,NA	IE,NA	2.74	0.18
1. Solid Fuels	IE,NA,NO	IE,NA,NO	IE,NA							IE,NA	IE,NA	IE,NA	IE,NA
2. Oil and Natural Gas	237.04	33.59	IE,NA							IE,NA	IE,NA	2.74	0.18
2. Industrial Processes	**9 535.22**	**0.91**	**0.87**	**1 372.88**	**860.63**	**451.77**	**182.71**	**0.02**	**0.02**	**1.71**	**24.70**	**4.90**	**1.22**
A. Mineral Products	3 505.54	IE,NA	IE,NA							IE,NA	9.78	IE,NA	IE,NA
B. Chemical Industry	530.62	0.90	0.87	NO	NO	NO	NO	NO	NO	0.34	11.15	1.32	0.77
C. Metal Production	5 499.05	0.00	NA				NO		NO	0.11	2.85	0.49	0.46
D. Other Production [3]	NA									1.26	0.91	3.08	NA
E. Production of Halocarbons and SF_6					NA		NA		NA				
F. Consumption of Halocarbons and SF_6				1 372.88	860.63	451.77	182.71	0.02	0.02				
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table B.2 continued

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Net CO_2 emissions/removals	CH_4	N_2O	HFCs [1]		PFCs[1]		SF_6		NO_x	CO	NMVOC	SO_2
				P	A	P	A	P	A				
	(Gg)			CO_2 equivalent (Gg)						(Gg)			
3. Solvent and Other Product Use	**248.53**		**0.52**							**NA**	**NA**	**104.09**	**NA**
4. Agriculture		**195.73**	**12.38**							**5.27**	**1.07**	**1.81**	**0.00**
A. Enteric Fermentation		153.09											
B. Manure Management		42.17	2.83									NE,NO	
C. Rice Cultivation		NO										NO	
D. Agricultural Soils[4]		0.42	9.55									1.70	
E. Prescribed Burning of Savannas		NO	NO							NO	NO	NO	
F. Field Burning of Agricultural Residues		0.06	0.00							0.03	1.07	0.11	
G. Other		NA	NA							5.23	NA	NA	0.00
5. Land Use, Land-Use Change and Forestry	(5) **-17 397.91**	**0.00**	**0.89**							**IE,NA,NE**	**IE,NA,NE**	**NA,NE**	**NA**
A. Forest Land	(5) -19 539.13	0.00	0.00							NE	NE	NE	
B. Cropland	(5) 2 034.08	NA,NO	0.89							IE	IE	NE	
C. Grassland	(5) -1 265.62	NO	NO							IE	IE	NE	
D. Wetlands	(5) 371.78	NO	NO							NA	NA	NA	
E. Settlements	(5) 530.55	NA,NO	NA,NO							NA	NA	NA	
F. Other Land	(5) 470.44	NA,NO	NA,NO							NA	NA	NA	
G. Other	(5) NE	NA	NA							NA	NA	NA	NA
6. Waste	**12.26**	**86.22**	**1.14**							**0.05**	**5.86**	**0.08**	**0.06**
A. Solid Waste Disposal on Land	(6) NA,NO	83.06								NA,NO	5.85	0.08	
B. Waste-water Handling		1.49	0.90							NA	NA	NA	
C. Waste Incineration	(6) 12.26	0.00	0.00							0.05	0.01	0.00	0.06
D. Other	NA	1.67	0.24							NA	NA	NA	NA
7. Other *(please specify)* [7]	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Net CO_2 emissions/removals	CH_4	N_2O	HFCs		PFCs		SF_6		NO_x	CO	NMVOC	SO_2
				P	A	P	A	P	A				
	(Gg)			CO_2 equivalent (Gg)						(Gg)			
Memo Items: [8]													
International Bunkers	**2 175.79**	**0.04**	**0.07**							**8.87**	**2.39**	**0.95**	**0.69**
Aviation	2 175.79	0.04	0.07							8.87	2.39	0.95	0.69
Marine	NA,NO	NA,NO	NA,NO							NO	NO	NO	NO
Multilateral Operations	**NO**	**NO**	**NO**							**NO**	**NO**	**NO**	**NO**
CO_2 Emissions from Biomass	**18 660.74**												

Table B.3 Emission trends summary

GREENHOUSE GAS EMISSIONS	Base year (1990)	1991	1992	1993	1994	1995	1996	1997	1998	1999
	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)
CO_2 emissions including net CO_2 from LULUCF	48 651.29	46 335.17	45 931.01	42 365.69	44 103.99	47 698.54	56 225.05	47 086.40	48 534.27	42 924.50
CO_2 emissions excluding net CO_2 from LULUCF	62 081.53	65 671.09	60 226.24	60 542.84	60 929.63	63 965.30	67 407.08	67 200.32	66 774.88	65 553.99
CH_4 emissions including CH_4 from LULUCF	9 183.31	9 162.00	8 874.21	8 851.27	8 658.62	8 541.86	8 352.15	8 074.60	7 953.22	7 780.02
CH_4 emissions excluding CH_4 from LULUCF	9 183.05	9 161.93	8 874.04	8 851.12	8 658.55	8 541.81	8 352.11	8 074.58	7 953.10	7 780.01
N_2O emissions including N_2O from LULUCF	6 419.53	6 755.27	6 344.86	6 163.60	6 625.63	6 779.60	6 447.46	6 471.01	6 582.51	6 559.97
N_2O emissions excluding N_2O from LULUCF	6 167.40	6 502.52	6 091.46	5 909.39	6 370.62	6 523.93	6 190.88	6 213.50	6 324.22	6 300.60
HFCs	23.03	45.21	48.68	157.34	206.83	267.34	346.84	427.42	494.89	542.20
PFCs	1 079.24	1 087.08	462.67	52.90	58.61	68.69	66.20	96.75	44.65	64.44
SF_6	502.58	653.36	697.85	793.71	985.70	1 139.16	1 218.05	1 120.15	907.99	683.96
Total (including LULUCF)	**65 858.99**	**64 038.10**	**62 359.28**	**58 384.50**	**60 639.38**	**64 495.18**	**72 655.75**	**63 276.35**	**64 517.55**	**58 555.09**
Total (excluding LULUCF)	**79 036.84**	**83 121.20**	**76 400.94**	**76 307.31**	**77 209.93**	**80 506.24**	**83 581.17**	**83 132.73**	**82 499.73**	**80 925.20**

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year (1990)	1991	1992	1993	1994	1995	1996	1997	1998	1999
	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)
1. Energy	55 594.99	59 509.54	54 579.42	55 009.32	55 058.97	57 929.50	61 763.26	60 859.25	60 846.33	59 823.96
2. Industrial Processes	10 110.82	10 152.82	8 999.19	8 750.64	9 274.83	9 729.22	9 601.24	10 192.53	9 674.37	9 391.10
3. Solvent and Other Product Use	511.80	465.98	417.65	418.48	403.26	422.45	405.66	424.37	406.32	392.26
4. Agriculture	9 170.66	9 353.59	8 868.31	8 636.40	9 136.46	9 242.05	8 771.75	8 745.25	8 748.54	8 585.15
5. Land Use, Land-Use Change and Forestry[(5)]	-13 177.85	-19 083.10	-14 041.66	-17 922.81	-16 570.55	-16 011.06	-10 925.41	-19 856.37	-17 982.19	-22 370.12
6. Waste	3 648.57	3 639.26	3 536.38	3 492.47	3 336.42	3 183.01	3 039.25	2 911.33	2 824.18	2 732.74
7. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total (including LULUCF)[(5)]	**65 858.99**	**64 038.10**	**62 359.28**	**58 384.50**	**60 639.38**	**64 495.18**	**72 655.75**	**63 276.35**	**64 517.55**	**58 555.09**

Table B.3 continued

GREENHOUSE GAS EMISSIONS	2000	2001	2002	2003	2004	2005	2006	2007	Change from base to latest reported year
	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	(%)
CO_2 emissions including net CO_2 from LULUCF	48 716.70	50 129.18	55 825.09	60 485.69	59 973.37	61 587.16	60 151.88	56 778.63	16.71
CO_2 emissions excluding net CO_2 from LULUCF	65 951.25	70 056.03	72 014.92	78 055.04	77 590.77	79 008.75	77 586.14	74 176.54	19.48
CH_4 emissions including CH_4 from LULUCF	7 621.48	7 526.86	7 413.20	7 460.65	7 313.00	7 177.62	7 080.13	6 955.65	-24.26
CH_4 emissions excluding CH_4 from LULUCF	7 621.43	7 526.83	7 412.94	7 460.41	7 312.98	7 177.58	7 080.04	6 955.61	-24.26
N_2O emissions including N_2O from LULUCF	6 464.21	6 351.19	6 358.94	6 302.05	5 602.96	5 594.62	5 643.28	5 648.19	-12.02
N_2O emissions excluding N_2O from LULUCF	6 203.92	6 086.84	6 094.24	6 037.66	5 335.53	5 326.14	5 375.65	5 373.29	-12.88
HFCs	596.26	694.45	781.21	862.96	896.71	907.91	860.74	860.63	3 636.78
PFCs	72.21	82.02	86.73	102.39	125.68	125.22	135.67	182.71	-83.07
SF_6	633.31	636.62	640.83	593.52	513.12	286.50	480.24	409.58	-18.51
Total (including LULUCF)	**64 104.18**	**65 420.31**	**71 106.01**	**75 807.26**	**74 424.84**	**75 679.03**	**74 351.94**	**70 835.38**	**7.56**
Total (excluding LULUCF)	**81 078.39**	**85 082.78**	**87 030.88**	**93 111.98**	**91 774.79**	**92 832.10**	**91 518.47**	**87 958.35**	**11.29**

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000	2001	2002	2003	2004	2005	2006	2007	Change from base to latest reported year
	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	(%)
1. Energy	59 581.92	63 829.89	65 253.03	71 412.24	71 056.08	71 905.71	70 050.88	66 146.99	18.98
2. Industrial Processes	10 034.18	9 907.41	10 591.37	10 662.20	9 984.86	10 306.44	10 880.85	11 277.19	11.54
3. Solvent and Other Product Use	425.06	424.79	428.96	423.34	379.04	393.53	412.16	408.80	-20.12
4. Agriculture	8 386.35	8 331.73	8 211.12	8 020.07	7 872.85	7 848.10	7 880.47	7 949.49	-13.32
5. Land Use, Land-Use Change and Forestry(5)	-16 974.21	-19 662.47	-15 924.88	-17 304.72	-17 349.95	-17 153.07	-17 166.53	-17 122.97	29.94
6. Waste	2 650.88	2 588.95	2 546.39	2 594.13	2 481.96	2 378.32	2 294.10	2 175.87	-40.36
7. Other	NA	NA	NA	NA	NA	NA	NA	NA	0.00
Total (including LULUCF)(5)	**64 104.18**	**65 420.31**	**71 106.01**	**75 807.26**	**74 424.84**	**75 679.03**	**74 351.94**	**70 835.38**	**7.56**

Table B.4 CO_2 emissions 1990–2007

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year (1990)	1991	1992	1993	1994	1995	1996	1997	1998	1999
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)
1. Energy	**54 196.23**	**57 988.96**	**53 091.71**	**53 492.98**	**53 564.73**	**56 381.95**	**60 141.34**	**59 326.06**	**59 274.47**	**58 219.53**
A. Fuel Combustion (Sectoral Approach)	54 094.21	57 877.94	52 971.69	53 380.96	53 437.20	56 254.93	60 070.31	59 205.55	59 132.64	58 049.00
1. Energy Industries	13 792.26	14 622.47	11 481.05	11 466.09	11 761.38	12 918.63	13 804.54	13 885.39	12 993.72	12 841.59
2. Manufacturing Industries and Construction	12 686.76	13 075.89	11 783.68	12 249.55	13 237.05	13 489.17	13 703.31	15 231.65	13 987.22	13 065.11
3. Transport	13 768.78	15 231.97	15 205.42	15 338.40	15 388.86	15 670.92	17 220.21	16 244.14	18 347.08	17 808.03
4. Other Sectors	13 811.39	14 910.52	14 467.86	14 287.51	13 008.35	14 143.65	15 303.36	13 807.28	13 762.22	14 292.70
5. Other	35.01	37.09	33.68	39.41	41.57	32.56	38.90	37.09	42.40	41.57
B. Fugitive Emissions from Fuels	102.03	111.03	120.03	112.03	127.53	127.03	71.03	120.51	141.83	170.53
1. Solid Fuels	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO
2. Oil and Natural Gas	102.03	111.03	120.03	112.03	127.53	127.03	71.03	120.51	141.83	170.53
2. Industrial Processes	**7 579.11**	**7 425.25**	**6 938.52**	**6 853.28**	**7 183.49**	**7 382.43**	**7 081.29**	**7 670.77**	**7 314.65**	**7 162.44**
A. Mineral Products	3 269.05	3 127.22	3 147.24	3 081.86	3 196.46	2 856.93	2 769.36	2 968.65	2 815.30	2 801.11
B. Chemical Industry	585.10	609.31	632.54	605.93	555.09	583.65	590.28	582.88	579.72	583.12
C. Metal Production	3 724.96	3 688.72	3 158.74	3 165.49	3 431.94	3 941.84	3 721.65	4 119.24	3 919.62	3 778.22
D. Other Production	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	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3. Solvent and Other Product Use	279.30	233.48	185.15	185.98	170.76	189.95	173.16	191.87	173.82	159.76
4. Agriculture										
A. Enteric Fermentation										
B. Manure Management										
C. Rice Cultivation										
D. Agricultural Soils										
E. Prescribed Burning of Savannas										
F. Field Burning of Agricultural Residues										
G. Other										
5. Land Use, Land-Use Change and Forestry[(2)]	**-13 430.24**	**-19 335.92**	**-14 295.23**	**-18 177.16**	**-16 825.64**	**-16 266.77**	**-11 182.04**	**-20 113.92**	**-18 240.60**	**-22 629.50**
A. Forest Land	-15 913.42	-21 954.88	-16 890.81	-20 864.41	-19 544.99	-18 604.71	-13 635.79	-22 488.35	-20 388.33	-24 780.25
B. Cropland	1 735.40	1 741.74	1 754.72	1 789.94	1 798.68	1 798.84	1 849.95	1 866.08	1 874.49	1 899.69
C. Grassland	-1 021.55	-1 011.04	-1 001.89	-994.52	-1 011.76	-1 134.84	-1 157.09	-1 179.37	-1 200.72	-1 210.87
D. Wetlands	199.73	215.89	232.04	248.19	254.13	255.80	281.84	287.56	272.72	283.06
E. Settlements	759.66	843.14	762.19	775.83	845.28	674.22	778.54	743.06	587.55	582.87
F. Other Land	809.95	829.23	848.52	867.80	833.03	743.93	700.51	657.10	613.68	596.00
G. Other	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
6. Waste	**26.89**	**23.40**	**10.86**	**10.60**	**10.65**	**10.97**	**11.30**	**11.62**	**11.94**	**12.26**
A. Solid Waste Disposal on Land	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
B. Waste-water Handling										
C. Waste Incineration	26.89	23.40	10.86	10.60	10.65	10.97	11.30	11.62	11.94	12.26
D. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
7. Other ***(as specified in Summary 1.A)***	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
Total CO_2 emissions including net CO_2 from LULUCF	**48 651.29**	**46 335.17**	**45 931.01**	**42 365.69**	**44 103.99**	**47 698.54**	**56 225.05**	**47 086.40**	**48 534.27**	**42 924.50**
Total CO_2 emissions excluding net CO_2 from LULUCF	**62 081.53**	**65 671.09**	**60 226.24**	**60 542.84**	**60 929.63**	**63 965.30**	**67 407.08**	**67 200.32**	**66 774.88**	**65 553.99**
Memo Items:										
International Bunkers	**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**
Aviation	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
Marine	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
Multilateral Operations	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
CO_2 Emissions from Biomass	9 803.18	10 666.58	10 403.39	10 958.18	10 570.44	11 260.05	11 960.02	11 735.76	11 506.23	13 229.61

Table B.4 continued

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000	2001	2002	2003	2004	2005	2006	2007	Change from base to latest reported year
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	%
1. Energy	**57 980.32**	**62 145.96**	**63 522.07**	**69 611.30**	**69 231.10**	**70 079.71**	**68 221.25**	**64 380.52**	**18.79**
A. Fuel Combustion (Sectoral Approach)	57 815.79	61 963.22	63 355.03	69 378.26	69 021.07	69 874.67	67 989.22	64 143.48	18.58
1. Energy Industries	12 352.81	14 127.97	13 670.35	16 116.27	16 351.64	16 095.33	15 545.20	13 928.60	0.99
2. Manufacturing Industries and Construction	13 742.07	13 539.51	14 081.68	14 428.46	14 430.23	15 684.37	15 965.73	15 667.82	23.50
3. Transport	18 792.82	20 025.42	21 932.44	23 744.69	24 355.12	24 995.31	23 652.66	23 922.60	73.75
4. Other Sectors	12 887.28	14 228.96	13 628.65	15 046.38	13 841.05	13 056.09	12 781.56	10 579.85	-23.40
5. Other	40.80	41.36	41.91	42.47	43.03	43.56	44.06	44.61	27.44
B. Fugitive Emissions from Fuels	164.53	182.73	167.03	233.04	210.04	205.04	232.04	237.04	132.33
1. Solid Fuels	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	0.00
2. Oil and Natural Gas	164.53	182.73	167.03	233.04	210.04	205.04	232.04	237.04	132.33
2. Industrial Processes	**7 766.11**	**7 693.74**	**8 260.57**	**8 205.30**	**8 153.75**	**8 696.86**	**9 104.76**	**9 535.22**	**25.81**
A. Mineral Products	2 958.13	2 976.77	3 085.41	3 072.98	3 162.59	3 119.72	3 293.94	3 505.54	7.23
B. Chemical Industry	587.27	539.50	551.22	592.50	528.09	563.47	599.25	530.62	-9.31
C. Metal Production	4 220.70	4 177.48	4 623.93	4 539.83	4 463.06	5 013.66	5 211.58	5 499.05	47.63
D. Other Production	NA	NA	NA	NA	NA	NA	NA	NA	0.00
E. Production of Halocarbons and SF_6									
F. Consumption of Halocarbons and SF_6									
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	0.00
3. Solvent and Other Product Use	192.56	204.07	220.02	226.18	193.66	219.93	247.86	248.53	-11.02
4. Agriculture									
A. Enteric Fermentation									
B. Manure Management									
C. Rice Cultivation									
D. Agricultural Soils									
E. Prescribed Burning of Savannas									
F. Field Burning of Agricultural Residues									
G. Other									
5. Land Use, Land-Use Change and Forestry(2)	**-17 234.55**	**-19 926.85**	**-16 189.83**	**-17 569.35**	**-17 617.41**	**-17 421.59**	**-17 434.26**	**-17 397.91**	**29.54**
A. Forest Land	-19 339.66	-22 013.93	-18 195.26	-19 647.35	-19 620.30	-19 593.24	-19 566.19	-19 539.13	22.78
B. Cropland	1 909.14	1 910.47	1 913.18	1 974.87	1 944.88	1 978.91	1 980.89	2 034.08	17.21
C. Grassland	-1 220.98	-1 207.83	-1 268.54	-1 259.15	-1 291.15	-1 265.56	-1 288.27	-1 265.62	23.89
D. Wetlands	293.40	301.63	309.87	318.10	326.65	318.79	337.67	371.78	86.14
E. Settlements	545.22	522.17	507.97	518.92	510.95	641.66	617.51	530.55	-30.16
F. Other Land	578.31	560.63	542.95	525.26	511.56	497.85	484.15	470.44	-41.92
G. Other	NE	NE	NE	NE	NE	NE	NE	NE	0.00
6. Waste	**12.26**	**12.26**	**12.26**	**12.26**	**12.26**	**12.26**	**12.26**	**12.26**	**-54.39**
A. Solid Waste Disposal on Land	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0.00
B. Waste-water Handling									
C. Waste Incineration	12.26	12.26	12.26	12.26	12.26	12.26	12.26	12.26	-54.39
D. Other	NA	NA	NA	NA	NA	NA	NA	NA	0.00
7. Other *(as specified in Summary 1.A)*	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**0.00**
Total CO_2 emissions including net CO_2 from LULUCF	**48 716.70**	**50 129.18**	**55 825.09**	**60 485.69**	**59 973.37**	**61 587.16**	**60 151.88**	**56 778.63**	**16.71**
Total CO_2 emissions excluding net CO_2 from LULUCF	**65 951.25**	**70 056.03**	**72 014.92**	**78 055.04**	**77 590.77**	**79 008.75**	**77 586.14**	**74 176.54**	**19.48**
Memo Items:									
International Bunkers	**1 695.58**	**1 651.28**	**1 540.85**	**1 452.97**	**1 724.93**	**1 959.83**	**2 048.88**	**2 175.79**	**145.58**
Aviation	1 695.58	1 651.28	1 540.85	1 452.97	1 724.93	1 959.83	2 048.88	2 175.79	145.58
Marine	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0.00
Multilateral Operations	NO	NO	NO	NO	NO	NO	NO	NO	0.00
CO_2 Emissions from Biomass	12 511.85	13 788.02	14 335.54	15 067.75	15 313.27	16 511.05	18 394.07	18 660.74	90.35

Table B.5 CH_4 emissions 1990–2007

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year (1990)	1991	1992	1993	1994	1995	1996	1997	1998	1999
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)
1. Energy	40.31	42.83	41.86	42.42	41.25	42.79	44.81	41.14	41.05	42.15
A. Fuel Combustion (Sectoral Approach)	21.99	23.84	22.03	21.69	19.86	20.31	21.07	16.52	15.90	15.98
1. Energy Industries	0.16	0.19	0.16	0.16	0.15	0.16	0.18	0.19	0.18	0.17
2. Manufacturing Industries and Construction	0.34	0.37	0.37	0.36	0.39	0.39	0.41	0.43	0.42	0.41
3. Transport	3.09	3.38	3.39	3.39	3.22	3.00	2.72	2.45	2.36	2.08
4. Other Sectors	18.40	19.90	18.12	17.78	16.10	16.76	17.76	13.45	12.93	13.31
5. Other	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	18.32	18.99	19.84	20.73	21.39	22.48	23.74	24.62	25.15	26.17
1. Solid Fuels	0.52	0.45	0.37	0.36	0.29	0.28	0.24	0.24	0.24	0.24
2. Oil and Natural Gas	17.80	18.54	19.46	20.37	21.10	22.21	23.50	24.38	24.91	25.93
2. Industrial Processes	**0.71**	**0.70**	**0.67**	**0.70**	**0.71**	**0.69**	**0.70**	**0.71**	**0.74**	**0.70**
A. Mineral Products	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA
B. Chemical Industry	0.70	0.70	0.66	0.70	0.71	0.68	0.69	0.70	0.73	0.69
C. Metal Production	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
D. Other Production										
E. Production of Halocarbons and SF_6										
F. Consumption of Halocarbons and SF_6										
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3. Solvent and Other Product Use										
4. Agriculture	**230.11**	**226.89**	**218.42**	**218.90**	**219.21**	**220.24**	**216.89**	**213.88**	**213.02**	**208.92**
A. Enteric Fermentation	179.21	176.72	169.02	168.98	169.88	171.25	168.83	165.89	164.56	162.93
B. Manure Management	50.49	49.78	49.02	49.39	48.86	48.48	47.55	47.48	47.94	45.47
C. Rice Cultivation	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Agricultural Soils	0.33	0.33	0.31	0.47	0.40	0.44	0.45	0.45	0.45	0.45
E. Prescribed Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
F. Field Burning of Agricultural Residues	0.07	0.07	0.07	0.06	0.07	0.07	0.07	0.07	0.07	0.07
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
5. Land Use, Land-Use Change and Forestry	**0.01**	**0.00**	**0.01**	**0.01**	**0.00**	**0.00**	**0.00**	**0.00**	**0.01**	**0.00**
A. Forest Land	0.01	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.01	0.00
B. Cropland	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
C. Grassland	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Wetlands	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
E. Settlements	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
F. Other Land	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
6. Waste	**166.17**	**165.86**	**161.63**	**159.46**	**151.13**	**143.04**	**135.32**	**128.78**	**123.91**	**118.71**
A. Solid Waste Disposal on Land	160.79	160.48	156.27	154.09	145.77	137.79	130.36	124.17	119.61	114.61
B. Waste-water Handling	4.85	4.84	4.70	4.56	4.39	4.21	3.87	3.53	3.19	2.93
C. Waste Incineration	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
D. Other	0.52	0.55	0.65	0.82	0.98	1.04	1.09	1.08	1.12	1.18
7. Other ***(as specified in Summary 1.A)***	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
Total CH_4 emissions including CH_4 from LULUCF	**437.30**	**436.29**	**422.58**	**421.49**	**412.32**	**406.76**	**397.72**	**384.50**	**378.72**	**370.48**
Total CH_4 emissions excluding CH_4 from LULUCF	**437.29**	**436.28**	**422.57**	**421.48**	**412.31**	**406.75**	**397.72**	**384.50**	**378.72**	**370.48**
Memo Items:										
International Bunkers	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.03	0.03
Aviation	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.03	0.03
Marine	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
Multilateral Operations	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
CO_2 Emissions from Biomass										

Table B.5 continued

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000	2001	2002	2003	2004	2005	2006	2007	Change from base to latest reported year
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	%
1. Energy	41.96	43.92	44.94	46.67	48.07	48.83	49.71	48.35	19.96
A. Fuel Combustion (Sectoral Approach)	15.03	16.60	16.52	17.69	16.98	16.87	16.43	14.76	-32.86
1. Energy Industries	0.16	0.20	0.21	0.24	0.27	0.23	0.30	0.29	80.12
2. Manufacturing Industries and Construction	0.44	0.45	0.46	0.51	0.54	0.57	0.65	0.67	98.22
3. Transport	1.90	1.76	1.69	1.57	1.41	1.27	1.11	0.99	-67.94
4. Other Sectors	12.54	14.20	14.16	15.37	14.75	14.80	14.36	12.81	-30.36
5. Other	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	22.25
B. Fugitive Emissions from Fuels	26.93	27.32	28.42	28.98	31.10	31.96	33.28	33.59	83.35
1. Solid Fuels	0.27	0.26	0.30	0.25	0.05	0.00	0.00	IE,NA,NO	-100.00
2. Oil and Natural Gas	26.66	27.07	28.11	28.74	31.05	31.96	33.28	33.59	88.74
2. Industrial Processes	**0.70**	**0.67**	**0.71**	**0.70**	**0.70**	**0.75**	**0.92**	**0.91**	**28.42**
A. Mineral Products	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	0.00
B. Chemical Industry	0.70	0.67	0.70	0.69	0.70	0.75	0.92	0.90	28.23
C. Metal Production	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	88.15
D. Other Production									
E. Production of Halocarbons and SF_6									
F. Consumption of Halocarbons and SF_6									
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	0.00
3. Solvent and Other Product Use									
4. Agriculture	**206.69**	**204.53**	**200.17**	**198.49**	**196.72**	**195.40**	**194.57**	**195.73**	**-14.94**
A. Enteric Fermentation	161.95	159.56	156.67	154.87	154.45	153.06	152.45	153.09	-14.58
B. Manure Management	44.23	44.46	43.05	43.15	41.81	41.91	41.66	42.17	-16.49
C. Rice Cultivation	NO	NO	NO	NO	NO	NO	NO	NO	0.00
D. Agricultural Soils	0.45	0.43	0.38	0.41	0.37	0.37	0.41	0.42	28.40
E. Prescribed Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO	0.00
F. Field Burning of Agricultural Residues	0.06	0.07	0.07	0.06	0.09	0.06	0.06	0.06	-14.46
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	0.00
5. Land Use, Land-Use Change and Forestry	**0.00**	**0.00**	**0.01**	**0.01**	**0.00**	**0.00**	**0.00**	**0.00**	**-81.50**
A. Forest Land	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	-81.50
B. Cropland	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0.00
C. Grassland	NO	NO	NO	NO	NO	NO	NO	NO	0.00
D. Wetlands	NO	NO	NO	NO	NO	NO	NO	NO	0.00
E. Settlements	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0.00
F. Other Land	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0.00
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	0.00
6. Waste	**113.57**	**109.30**	**107.18**	**109.40**	**102.74**	**96.80**	**91.95**	**86.22**	**-48.11**
A. Solid Waste Disposal on Land	109.68	105.62	103.73	106.16	99.26	93.21	88.80	83.06	-48.34
B. Waste-water Handling	2.68	2.43	2.18	1.95	1.96	1.97	1.49	1.49	-69.25
C. Waste Incineration	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-90.13
D. Other	1.21	1.24	1.27	1.29	1.52	1.62	1.66	1.67	221.88
7. Other *(as specified in Summary 1.A)*	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**0.00**
Total CH_4 emissions including CH_4 from LULUCF	**362.93**	**358.42**	**353.01**	**355.27**	**348.24**	**341.79**	**337.15**	**331.22**	**-24.26**
Total CH_4 emissions excluding CH_4 from LULUCF	**362.93**	**358.42**	**353.00**	**355.26**	**348.24**	**341.79**	**337.14**	**331.22**	**-24.26**
Memo Items:									
International Bunkers	0.03	0.03	0.03	0.04	0.04	0.04	0.04	0.04	195.58
Aviation	0.03	0.03	0.03	0.04	0.04	0.04	0.04	0.04	195.58
Marine	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0.00
Multilateral Operations	NO	NO	NO	NO	NO	NO	NO	NO	0.00
CO_2 Emissions from Biomass									

Table B.6 N_2O emissions 1990–2007

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year (1990)	1991	1992	1993	1994	1995	1996	1997	1998	1999
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)
1. Energy	**1.78**	**2.00**	**1.96**	**2.02**	**2.03**	**2.09**	**2.20**	**2.16**	**2.29**	**2.32**
A. Fuel Combustion (Sectoral Approach)	1.78	2.00	1.96	2.02	2.03	2.09	2.20	2.16	2.29	2.32
1. Energy Industries	0.15	0.18	0.14	0.15	0.15	0.16	0.16	0.15	0.17	0.17
2. Manufacturing Industries and Construction	0.26	0.28	0.27	0.29	0.30	0.31	0.35	0.36	0.37	0.41
3. Transport	0.61	0.74	0.76	0.79	0.82	0.83	0.86	0.84	0.95	0.92
4. Other Sectors	0.76	0.81	0.79	0.79	0.75	0.78	0.83	0.81	0.79	0.82
5. Other	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	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA
1. Solid Fuels	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA
2. Oil and Natural Gas	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA
2. Industrial Processes	**2.94**	**2.99**	**2.70**	**2.83**	**2.66**	**2.77**	**2.82**	**2.78**	**2.89**	**2.98**
A. Mineral Products	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA
B. Chemical Industry	2.94	2.99	2.70	2.83	2.66	2.77	2.82	2.78	2.89	2.98
C. Metal Production	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
D. Other Production										
E. Production of Halocarbons and SF_6										
F. Consumption of Halocarbons and SF_6										
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
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
4. Agriculture	**13.99**	**14.80**	**13.81**	**13.03**	**14.62**	**14.89**	**13.60**	**13.72**	**13.79**	**13.54**
A. Enteric Fermentation										
B. Manure Management	3.24	3.20	3.08	3.09	3.09	3.16	3.10	3.07	3.06	3.02
C. Rice Cultivation										
D. Agricultural Soils	10.75	11.60	10.73	9.94	11.53	11.74	10.50	10.65	10.73	10.52
E. Prescribed Burning of Savannas	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
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
5. Land Use, Land-Use Change and Forestry	**0.81**	**0.82**	**0.82**	**0.82**	**0.82**	**0.82**	**0.83**	**0.83**	**0.83**	**0.84**
A. Forest Land	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B. Cropland	0.81	0.82	0.82	0.82	0.82	0.82	0.83	0.83	0.83	0.84
C. Grassland	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Wetlands	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
E. Settlements	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
F. Other Land	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
6. Waste	**0.43**	**0.43**	**0.42**	**0.43**	**0.49**	**0.54**	**0.60**	**0.63**	**0.68**	**0.73**
A. Solid Waste Disposal on Land										
B. Waste-water Handling	0.35	0.35	0.33	0.31	0.35	0.40	0.45	0.48	0.52	0.57
C. Waste Incineration	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	0.09	0.12	0.14	0.14	0.15	0.15	0.15	0.16
7. Other *(as specified in Summary 1.A)*	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
Total N_2O emissions including N_2O from LULUCF	**20.71**	**21.79**	**20.47**	**19.88**	**21.37**	**21.87**	**20.80**	**20.87**	**21.23**	**21.16**
Total N_2O emissions excluding N_2O from LULUCF	**19.89**	**20.98**	**19.65**	**19.06**	**20.55**	**21.04**	**19.97**	**20.04**	**20.40**	**20.32**
Memo Items:										
International Bunkers	**0.03**	**0.03**	**0.04**	**0.04**	**0.04**	**0.05**	**0.05**	**0.05**	**0.06**	**0.05**
Aviation	0.03	0.03	0.04	0.04	0.04	0.05	0.05	0.05	0.06	0.05
Marine	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
Multilateral Operations	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
CO_2 Emissions from Biomass										

Table B.6 continued

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000	2001	2002	2003	2004	2005	2006	2007	Change from base to latest reported year
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	%
1. Energy	**2.32**	**2.46**	**2.54**	**2.65**	**2.63**	**2.58**	**2.53**	**2.42**	**36.00**
A. Fuel Combustion (Sectoral Approach)	2.32	2.46	2.54	2.65	2.63	2.58	2.53	2.42	36.00
1. Energy Industries	0.17	0.20	0.20	0.23	0.25	0.22	0.24	0.26	66.02
2. Manufacturing Industries and Construction	0.43	0.42	0.42	0.42	0.42	0.44	0.46	0.46	79.16
3. Transport	0.94	0.97	1.05	1.08	1.07	1.03	0.95	0.91	48.10
4. Other Sectors	0.78	0.86	0.86	0.91	0.89	0.90	0.88	0.80	5.44
5. Other	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	14.69
B. Fugitive Emissions from Fuels	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	0.00
1. Solid Fuels	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	0.00
2. Oil and Natural Gas	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	0.00
2. Industrial Processes	**3.07**	**2.54**	**2.60**	**2.85**	**0.91**	**0.88**	**0.90**	**0.87**	**-70.39**
A. Mineral Products	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	0.00
B. Chemical Industry	3.07	2.54	2.60	2.85	0.91	0.88	0.90	0.87	-70.39
C. Metal Production	NA	NA	NA	NA	NA	NA	NA	NA	0.00
D. Other Production									
E. Production of Halocarbons and SF_6									
F. Consumption of Halocarbons and SF_6									
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	0.00
3. Solvent and Other Product Use	0.75	0.71	0.67	0.64	0.60	0.56	0.53	0.52	-31.07
4. Agriculture	**13.05**	**13.02**	**12.93**	**12.43**	**12.07**	**12.08**	**12.24**	**12.38**	**-11.51**
A. Enteric Fermentation									
B. Manure Management	2.98	2.95	2.89	2.87	2.86	2.83	2.82	2.83	-12.67
C. Rice Cultivation									
D. Agricultural Soils	10.07	10.07	10.03	9.56	9.21	9.25	9.42	9.55	-11.16
E. Prescribed Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO	0.00
F. Field Burning of Agricultural Residues	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-14.52
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	0.00
5. Land Use, Land-Use Change and Forestry	**0.84**	**0.85**	**0.85**	**0.85**	**0.86**	**0.87**	**0.86**	**0.89**	**9.03**
A. Forest Land	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-81.50
B. Cropland	0.84	0.85	0.85	0.85	0.86	0.87	0.86	0.89	9.05
C. Grassland	NO	NO	NO	NO	NO	NO	NO	NO	0.00
D. Wetlands	NO	NO	NO	NO	NO	NO	NO	NO	0.00
E. Settlements	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0.00
F. Other Land	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0.00
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	0.00
6. Waste	**0.82**	**0.91**	**0.91**	**0.92**	**1.01**	**1.07**	**1.13**	**1.14**	**166.92**
A. Solid Waste Disposal on Land									
B. Waste-water Handling	0.65	0.74	0.74	0.74	0.79	0.85	0.90	0.90	157.67
C. Waste Incineration	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-74.43
D. Other	0.17	0.17	0.17	0.18	0.21	0.23	0.23	0.24	210.71
7. Other ***(as specified in Summary 1.A)***	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**0.00**
Total N_2O emissions including N_2O from LULUCF	**20.85**	**20.49**	**20.51**	**20.33**	**18.07**	**18.05**	**18.20**	**18.22**	**-12.02**
Total N_2O emissions excluding N_2O from LULUCF	**20.01**	**19.63**	**19.66**	**19.48**	**17.21**	**17.18**	**17.34**	**17.33**	**-12.88**
Memo Items:									
International Bunkers	**0.06**	**0.06**	**0.05**	**0.05**	**0.06**	**0.07**	**0.07**	**0.07**	**135.63**
Aviation	0.06	0.06	0.05	0.05	0.06	0.07	0.07	0.07	135.63
Marine	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0.00
Multilateral Operations	NO	NO	NO	NO	NO	NO	NO	NO	0.00
CO_2 Emissions from Biomass									

Table B.7 HFC, PFC and SF_6 emissions 1990–2007

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year (1990)	1991	1992	1993	1994	1995	1996	1997	1998	1999
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)
Emissions of HFCs(3) - (Gg CO_2 equivalent)	**23.03**	**45.21**	**48.68**	**157.34**	**206.83**	**267.34**	**346.84**	**427.42**	**494.89**	**542.20**
HFC-23	NA,NE,NO	NA,NE,NO	NA,NE,NO	0.00	0.00	0.00	0.00	0.00	0.00	0.00
HFC-32	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	0.00	0.00	0.00	0.00	0.00	0.00
HFC-41	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
HFC-43-10mee	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
HFC-125	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	0.00	0.00	0.01	0.01	0.01	0.02
HFC-134	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
HFC-134a	0.00	0.00	0.00	0.08	0.11	0.15	0.19	0.23	0.27	0.30
HFC-152a	IE,NA,NO	IE,NA,NO	IE,NA,NO	0.04	0.05	0.06	0.07	0.08	0.09	0.10
HFC-143	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
HFC-143a	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	0.00	0.00	0.01	0.01	0.01
HFC-227ea	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	0.00	0.00	0.00	0.00
HFC-236fa	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
HFC-245ca	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
Unspecified mix of listed HFCs(4) - (Gg CO_2 equivalent)	20.81	41.52	44.02	45.92	47.89	50.17	52.32	52.97	47.67	49.48
Emissions of PFCs(3) - (Gg CO_2 equivalent)	**1 079.24**	**1 087.08**	**462.67**	**52.90**	**58.61**	**68.69**	**66.20**	**96.75**	**44.65**	**64.44**
CF_4	0.14	0.14	0.05	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO
C_2F_6	0.02	0.02	0.01	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO
C_3F_8	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO
C_4F_{10}	NA,NE,NO	NA,NE,NO	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
c-C_4F_8	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO
C_5F_{12}	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
C_6F_{14}	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
Unspecified mix of listed PFCs(4) - (Gg CO_2 equivalent)	29.05	36.89	44.73	52.57	58.30	68.39	65.92	96.48	44.40	64.19
Emissions of SF6(3) - (Gg CO_2 equivalent)	**502.58**	**653.36**	**697.85**	**793.71**	**985.70**	**1 139.16**	**1 218.05**	**1 120.15**	**907.99**	**683.96**
SF_6	0.02	0.03	0.03	0.03	0.04	0.05	0.05	0.05	0.04	0.03

Table B.7 continued

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000	2001	2002	2003	2004	2005	2006	2007	Change from base to latest reported year
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	%
Emissions of HFCs(3) - (Gg CO_2 equivalent)	**596.26**	**694.45**	**781.21**	**862.96**	**896.71**	**907.91**	**860.74**	**860.63**	**3 636.78**
HFC-23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00
HFC-32	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	100.00
HFC-41	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0.00
HFC-43-10mee	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	334.35
HFC-125	0.02	0.03	0.03	0.04	0.05	0.05	0.06	0.06	100.00
HFC-134	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0.00
HFC-134a	0.31	0.33	0.35	0.37	0.35	0.33	0.29	0.28	20 840.33
HFC-152a	0.11	0.24	0.35	0.43	0.53	0.57	0.44	0.39	100.00
HFC-143	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0.00
HFC-143a	0.01	0.02	0.03	0.03	0.04	0.04	0.05	0.05	100.00
HFC-227ea	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00
HFC-236fa	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0.00
HFC-245ca	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0.00
Unspecified mix of listed HFCs(4) - (Gg CO_2 equivalent)	51.57	53.04	54.48	54.49	51.39	47.77	31.91	17.38	-16.48
Emissions of PFCs(3) - (Gg CO_2 equivalent)	**72.21**	**82.02**	**86.73**	**102.39**	**125.68**	**125.22**	**135.67**	**182.71**	**-83.07**
CF_4	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	-100.00
C_2F_6	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	-100.00
C_3F_8	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	0.00
C_4F_{10}	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00
c-C_4F_8	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	0.00
C_5F_{12}	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0.00
C_6F_{14}	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0.00
Unspecified mix of listed PFCs(4) - (Gg CO_2 equivalent)	71.98	81.80	86.52	102.20	125.49	125.04	135.50	182.55	528.36
Emissions of SF6(3) - (Gg CO_2 equivalent)	**633.31**	**636.62**	**640.83**	**593.52**	**513.12**	**286.50**	**480.24**	**409.58**	**-18.51**
SF_6	0.03	0.03	0.03	0.02	0.02	0.01	0.02	0.02	-18.51

Appendix D

Policies and Measures included in the Projection Scenarios

PAMs included in the ´with measures´ and ´with additional measures´ scenario of energy industries (1.A.1)

Policies & Measures in the wm-scenario
03_EN: Emission Trading Directive (2003/87/EC) and amendments thereto (including National Allocation Plans)
02_EN: Amendment to the green electricity act 2008 (Federal Legal Gazette I No 114/2008) which promotes the use of renewable energy sources (RES) in power production
06_EN: Combined Heat and Power (CHP) Act (Federal Legal Gazette I No 45/2008)
05_EN: Austrian climate and energy fund (KLI.EN)
04_EN: EU Water Framework Directive (2000/60/EC)
01_EN: Domestic Environmental Support Scheme (UFI)
Policies & Measures in the wam-scenario
07_EN: Directive 2006/32/EC on energy end-use efficiency and energy services and the corresponding first Austrian energy efficiency action plan
02_EN: Amendment to the green electricity act 2008 (Federal Legal Gazette I No 114/2008): more stringent exploitation of hydropower
08_EN: Eco Design Directive and amendments (2005/32/EC) thereto

PAMs included in the ´with measures´ and ´with additional measures´ scenario of transport (1.A.3)

Policies & Measures in the wm-scenario
01_TRA: ACEA – voluntary agreement (CO_2 emissions of newly registered vehicles) 1998: (ACEA, KAMA, JAMA1) [COM(98) 495 final.];(Basis: Strategy [COM(95) 689.])
02_TRA: CO_2 Labelling and guidelines: Dir. 1999/94/EC
03_TRA: Toll for heavy duty vehicle „Bundesgesetz über die Mauteinhebung auf 'Bundesstraßen' (Federal Highways Toll Act, Federal Legal Gazette I No 109/2002); the toll was introduced on 1.1.2004
04_TRA: EU-Biofuels directive: Dir 2003/30/EG. Implemented with the legislative act of 'Kraftstoffverordnung' (Fuel Ordinance), 4.11.2004 (Federal Legal Gazette II No 417/2004). Substitution of fuel by bio fuels (measured by the energy content of fuels put in circulation):
05_TRA: EURO classification (EURO 4, 5 & 6 for passenger cars, light duty vehicles and heavy duty vehicles), EURO 3 for Motorcycles, stage 3b for off road machinery
06_TRA: Numerous measures concerning infrastructure, public transport and mobility management.
07_TRA Klima:aktiv →mobile programme
Policies & Measures in the wam-scenario
08_TRA: Enhanced fuel efficiency of passenger cars
09_TRA: Control of speed limits, traffic control systems and fuel saving driving style

PAMs included in the ´with measures´ and ´with additional measures´ scenario of residential and commercial (1.A.4 and 1.A.5)

Policies & Measures in the wm-scenario
01_ED increased use of renewable energy in the sector residential and commercial (Erneuerbare)
02_ED increased building renovation (Sanierung)
03_ED increased replacement of heating systems (Heizkesseltausch)
04_ED public support for new buildings (Neubau)
06_ED National energy efficiency action plan (Energieeffizienzaktionsplan, EEAP) in the residential and commercial sector without fuel energy for heating and hot water
Policies & Measures in the wam-scenario
05_ED additional measures to reduce energy consumption in the sectors residential and commercial
07_ED additional measures to reduce electric power consumption in the sector residential and commercial without energy use for heating and hot water

PAMs included in the ´with measures´ and ´with additional measures´ scenario of industrial processes (2) and solvent (3)

Policies & Measures in the wm-scenario
07_IP, 08_IP, 09_IP Halocarbons and SF_6: The scenario includes the Austrian Regulation on fluorinated gases (Federal Legal Gazette II No 447/2002) and its amendment 2007 (Federal Legal Gazette II No 139/2007), the EC Regulation on certain fluorinated greenhouse gases (842/2006/EC) and the EC Directive relating to emissions from air-conditioning systems in motor vehicles (2006/40/EC).
01_IP Solvent Ordinance
02_IP Ordinance for paint finishing system
03_IP Federal Ozone Law 04_IP_ Ordinance for industrial facilities and installations applying chlorinated hydrocarbon
05_IP Ordinance for emissions of volatile organic compounds (VOC) due to the use of organic solvents in certain activities and installations
06_IP Ordinance on the limitation of emissions during the use of solvents containing lightly volatile halogenated hydrocarbons in industrial facilities and installations
Policies & Measures in the wam-scenario
There are no sector-specific additional measures. No additional measures are assumed for Halocarbons and SF_6.

PAMs included in the ´with measures´ and ´with additional measures´ scenario of agriculture (4)

Policies & Measures in the wm-scenario
01_AGR Common Agricultural Policy (CAP) 2003 reform
02_AGR Austrian variant of implementation
03_AGR Funds transfer from 'modulation'
04_AGR Land is maintained in good agricultural and ecological condition ('cross compliance')
05_AGR The programme for rural development is maintained in an unmodified way
06_AGR Implementation of the biofuels directive in Austria
07_AGR Grassland maintenance
08_AGR Prices increase for the crops
Policies & Measures in the wam-scenario
09_AGR 25% more organic farming payments for investments in emission reducing animal production technologies (funded by the programme for rural development) e. g. slurry and manure store facilities, slurry hose techniques
10_AGR payments for investments in emission reducing animal production technologies
11_AGR Set aside additional land for short rotation forests (+ 5 000 ha in 2008 and + 20 000 ha from 2010 onwards)
12_AGR Usage of 800 000 m^3 slurry for biogas production
13_AGR Usage of 13 500 hectares of set aside land for biogas production from silage-maize (from 2008 on)
14_AGR Usage of 10 000 ha silage of grassland and alfalfa (from 2008 on)

Table 1: PAMs included in the ´with measures´ and ´with additional measures´ scenario of waste (6)

Policies & Measures in the wm-scenario
01_WASTE Austrian landfill ordinance (deposition of untreated biodegradable waste) Federal Legal Gazette No 164/1996 of the year 1996 according to the Austrian Waste Management Act.
02_WASTE Austrian landfill ordinance (collection and drainage of landfill gas)
03_WASTE Remediation of Contaminated Sites Act Federal Legal Gazette No 299/1989
04_WASTE The Guideline for the Mechanical Biological Treatment of Wastes
Policies & Measures in the wam-scenario
A discussion with experts about additional measures in the sector waste came to the conclusion that no additional measures in the field of waste management were foreseen until 2020.

Appendix E

Examples of Research Projects

Table E.1 Interdisciplinary programmes

ACCENT - Atmospheric composition change: A European Network Helga Kromp-Kolb helga.kromp-kolb@boku.ac.at http://www.accent-network.org/	ACCENT's goals are to promote a common European strategy for research on atmospheric composition change, to develop and maintain durable means of communication and collaboration within the European scientific community, to facilitate this research and to optimise two-way interaction with policy-makers and the general public.
CIRCLE Markus Leitner Markus.leitner@umweltbundesamt.at http://www.umweltbundesamt.at/umwelt/circle/ or www.circle-era.net	Umweltbundesamt coordinates the EU network-project ERA-Net CIRCLE, which aims at networking and collaborating with more than 20 national research programmes in the field of climate change impacts, adaptation and vulnerability in more than 20 European countries (including Israel and Turkey). The core tasks of CIRCLE are to align research agendas of its participating national and regional research programmes and to design and execute transnational activities like joint initiatives and calls for research.
FloodRisk Jochen Bürgel Jochen.buergel@umweltbundesamt.at http://www.umweltbundesamt.at/umweltschutz/klima/projekte/floodrisk2/	The project FloodRisk II Intensification and integration of future oriented implementation strategies for the integrated flood management" coordinated from the Umweltbundesamt, consists of 45 sub projects, which are summarized in 8 workpackages. The project FloodRisk II contains essential suggestions in all areas of the integrated flood management.
Climate and Energy Fund (Klima und Energiefonds) office@klimafonds.gv.at http://www.klimafonds.gv.at/	The Klima- und Energiefonds (Climate and EnergyFund) is an important instrument of the Austrian Federal government for setting incentives in climate policy. The Climate and EnergyFund was founded in the year 2007 to contribute to a realization of a sustainable energy supply, a reduction of greenhouse gas emissions and to foster the Austrian climate strategy. Within the Climate and Energy Fund framework, several programme lines have been established. One example is the Austrian Climate Research programme (ACRP). This is a climate research programme that provides a conceptual and institutional framework for supporting climate research in Austria.

proVISION Karolina Begusch-Pfefferkorn karolina.begusch-pfefferkorn@bmwf.gv.at http://www.provision-research.at	proVISION is a research programme introduced by the Federal Ministry of Science and Research. It is aimed at implementing Austria's FORNE strategy (on research for sustainable development). Together with complementary research programmes, proVISION provides the scientific basis for the country's sustainability strategy.
Reclip http://systemsresearch.ac.at/projects/reclip.tom/K-wiss.htm	reclip: Research for Climate Protection is the first K-wiss- programme being concentrated on scientific competence building and supporting coorperation between research on universities and on non-university institutions. The programme has two central goals. The first one is to assess the future, small scale climate change in Austria and the second one is to assess and estimate the strategies for mitigation of greenhouse gases emmisions. reclip:more, reclip:tom and reclip:strat are three subprojects of reclip.
StartClim Helga Kromp-Kolb helga.kromp-kolb@boku.ac.at www.austroclim.at/startclim/	StartClim started in 2003. Many Austrian scientist from different Austrian research institutions deal and dealt with the thematic areas climate change & extreme meteorological events and their impacts on economy, agriculture, tourism, health, energy, etc., especially in Austria. StartClim is initiating research on topics not yet established in Austria and wants to promote young scientists. The short term projects allow to react to currently important subjects and show where further research is necessary. StartClim-projects have supplied a wealth of new data and understanding that they are also of practical relevance. Until now StartClim has eight funding partners (see logos at the bottom) consisting of ministries and other institutions. Administrative tasks are assumed by the Austrian Federal Environmental Agency.

Table E.2 Examples of climate process and climate system studies, including modelling.

AgroClim - Yield trend in agriculture and drought hazards under altered climate conditions in Styria Andreas Gobiet andreas.gobiet@uni-graz.at http://www.wegcenter.at	How productivities and hazards from droughts will behave in future periods under climate change conditions is part of the project AgroClim. Investigations concerning this matter can only be conducted by means of coupling climate and growth models. The methodological main-objective of the project is to develop a coupled regional climate growth model with the aid of the methods mentioned above. The study area is the Styrian territory. Because grassland in Styria is the main type of agricultural exploitation, the main-focus of the project lies on hazards of grassland by means of droughts from climate change.

Analyses and climate change scenarios concerning snow cover within the Schladming region. Helga Kromp-Kolb helga.kromp-kolb@boku.ac.at	Aim of this subproject of STRATEGE is the analyses of climatological parameters like temperature, precipitation and snow cover, to derive the historical and present "secureness of snow cover" in different altitudes of the Schladming region. To estimate potential climate change effects, regional climate change scenarios are derived for the region, and a local scale snow modelling, factoring in altitude, exposure or vegetation is developed.
Analysis of total ozone and UV-radiation in Austria Stana Simic stana.simic@boku.ac.at https://forschung.boku.ac.at/fis/suchen.projekt_uebersicht?sprache_in=de&menue_id_in=300&id_in=7415	The following questionings will be addressed to in the research project: Determination of the long-term variability of the biologically relevant UV-radiation, the contribution of the different influencing parameters (ozone, clouds, albedo, aerosols) to UV-variability, exploration and evaluation of methods suitable to estimate UV-radiation in the past and the future, investigation of the long-term effects of increased biologically relevant UV-radiation on humans and the ecosystem in general in Austria.
Austrian Forest Fire Research Initiative Harald Vacik https://forschung.boku.ac.at/fis/suchen.projekt_uebersicht?sprache_in=en&ansicht_in=&menue_id_in=300&id_in=7029	The study design of this Austrian Forest Fire Research Initiative (AFFRI) encompasses two major objectives (i) to identify Forest Fire “hot spots” in Austria in dependence of vegetation, climate and location, and (ii) to develop a fire-vegetation simulator for Austrian conditions.
Carbon balance of mountain grassland ecosystems Georg Wohlfahrt Georg.Wohlfahrt@uibk.ac.at www.biomet.at.tt	The aim of the study is to quantify interaction between climate and land use and carbon balance, as well as to calibrate the models using this data and produce simulations for future climate and land use scenarios. This has been implemented by determination of carbon balance using the eddy covariance method at several locations in Tyrol ever since 2001.
CLAVIER Andreas Gobiet, Franz Prettenthaler andreas.gobiet@uni-graz.at, franz.prettenthaler@joanneum.at http://www.wegcenter.at, http://www.joanneum.at/rtg	CLAVIER is a specific targeted research project coordinated by the Max Planck Institute for Meteorology, Hamburg. The project focuses on ongoing and future climate changes in Central and Eastern European Countries (CEEC) using measurements from the last century and existing global and regional climate change scenarios to determine possible developments of the climate and to address their related uncertainty. In addition, climate projections with very high horizontal resolution will be carried out for CEEC to fulfill the need for a large amount of detail in time and space which is inherent in local and regional impact assessment. CLAVIER will establish a large data base, tools and methodologies, which contributes to reasonable

	planning for a successful development of society and economy in CEEC countries under climate change conditions.
Climate change and heavy-precipitation weather patterns in Austria Seibert Petra petra.seibert@boku.ac.at https://forschung.boku.ac.at/fis/suchen.projekt_uebersicht?sprache_in=en&ansicht_in=&menue_id_in=300&id_in=5601	This study focussed on the development of the clustering method, the identification of regions with similar heavy precipitation patterns, and the investigation of the precipitation patterns for the different synoptic situations identified. The next step proposed here is to apply this methodology to the past and to future climate scenarios in order to study how the frequency and intensity of synoptic patterns which are responsible for heavy precipitation in Austria has developed in the past ~25 years, how well the statistics of the occurrence of these patterns is reproduced by GCM control runs and how the occurrence of these patterns would change in simulated future climate scenarios.
Climate change and ice cap history on Kilimanjaro: Application of direct field measurements and large-scale gridded data to a physical mass balance model Thomas Mölg, Michael Winkler, Georg Kaser, Nicolas Cullen, Douglas Hardy Georg.kaser@uibk.ac.at http://www.uibk.ac.at/geographie/tropical-glaciology/	The analyses of energy and mass fluxes on ice surfaces of glaciers on Kilimanjaro in the context of local, regional, and large scale atmospheric conditions and processes reveal present day and past climate conditions in the tropical troposphere over East Africa.
Climate in 2030 and Quantification of Consequences Helga Kromp-Kolb, Herbert Formayer helga.kromp-kolb@boku.ac.at, herbert.formayer@boku.ac.at https://forschung.boku.ac.at/fis/suchen.projekt_uebersicht?sprache_in=en&ansicht_in=&menue_id_in=300&id_in=7459	In this project module an evaluation will be made whether downscaling approaches (GCM-RCM-statistical downscaling) or trend scenarios will give better results for the purposes needed in the other tasks (in particular for the bio-physical process analysis module).
Comparison of N-C Analysis and NIR – Measurement – Technique of Soluble Organic Matter (SOM) of Soil	The research of indicators for the identification of ecological effects of climate change is important for sustainable agriculture. Economic conditions cause reduction of production facilities (Wenzl, 1997). Different basic data for the nutrient cycle and soil fertility are more relevant as before: Data for nitrogen fraction for arable farming, reference quantity for a well-

Wilfried Wenzl wilfried.wenzl@gumpenstein.at http://www.raumberg-gumpenstein.at	balanced manure cycle, reference data for N-C transportation and N-C-balance, value for the production of humus in relation to accumulation or gauntness. With the comparison of two different methods of measure in chemistry laboratories at HBLFA-Raumberg-Gumpenstein and Bioresearch Austria it was succeeded to develop exact data for NIRS-Modelling.
Development and comparative evaluation of different individual tree growth models Hubert Sterba Hubert.sterba@boku.ac.at https://forschung.boku.ac.at/fis/suchen.projekt_uebersicht?sprache_in=de&menue_id_in=300&id_in=7280	At the moment there are three forest growth models available at BOKU: PICUS, a hybrid model, that started from a gap model approach and now contains important parts of a process model, BGC-model, i.e. a mechanistic model, that started from BIOM-BGC and has been developed further for species sensitivity and PROGNAUS, a statistical growth model, mainly developed for evaluating the effect of different forest management on individual tree growth. Within the project Klien.Wamod these three models will be evaluated for their ability to now, or after further development, respond to climate change.
Development of a model for the exact determination of draught damages in particular grassland regions of Austria Karl Buchgraber karl.buchgraber@raumberg-gumpenstein.at http://www.raumberg-gumpenstein.at	Eastern parts of Austria have been affected by intense drought periods with considerable damages in agricultural areas. A simple soil water balance model according to FAO is implemented in GIS in order to quantify water stress and its influence on grassland yield. Results from long-term field trials are used for developing an empirical Grassland Statistical Model (GRAM) which estimates yield under limited water availability.
DML precipitation regime and EPICA ice core interpretation Elisabeth Schlosser http://imgi.uibk.ac.at/IceClim/IceClim/Polar/sissi.html	The project investigates the precipitation regime of Dronning Maud Land, Antarctica, a region where recently two deep ice cores have been retrieved in the frame of the European Project for Ice Coring in Antarctica (EPICA). For a correct interpretation of ice core properties a thorough understanding of the processes that are responsible for moisture transport and precipitation is necessary. Apart from the precipitation study based on model data, 65 shallow firn cores from Dronning Maud Land are investigated in order to gain a better understanding of the relationship between air temperature and water stable isotopes, which is crucial for paleoclimatological studies with ice cores.
Drought and water balance assessment and its effect on agricultural crops in semi arid regions of Austria and Czech Republic	In the semi-arid regions of Austria and Czech Republic a further increase of droughts or negative water balance will have serious consequences for agricultural crop production, as already indicated by climate warming. In this project these developments will be simulated for several climate scenarios by application of crop models and potential adaptation measures will be evaluated.

Josef Eitzinger https://forschung.boku.ac.at/fis/suchen.projekt_uebersicht?sprache_in=en&ansicht_in=&menue_id_in=300&id_in=6312	
ECSN-CC-AUT Climate Modeling at the Austraian governmental Weather Service (ZAMG) Christoph Matulla christoph.matulla@zamg.ac.at http://www.zamg.ac.at/forschung/klimatologie/klimamodellierung/ECSN-CC-AUT/	As a part of an ECSN initiative the Austrian weather service (ZAMG) launches a project to support impact assessment throughout certain kinds of socio-economically relevant fields by making future climate data available. The Climate modelling group is devoted to the modelling of the present and future climate by the use of CLM, as well as the evaluation of the impacts on society and ecosystems in general. The latter scope of duties is assessed by analyzing of historical observations and statistical and dynamical downscaling (when it comes to possible future climate states).
Environmental risk assessment for Neodryinus typhlocybae Gudrun Strauss gudrun.strauss@ages.at, pflanzengesundheit@ages.at	The potential of Neodryinus typhlocybae for establishment, spread, direct and indirect effects on non-target organisms in Austria was assessed. The CLIMEX® software was applied to predict the potential area of establishment of N. typhlocybae in Austria.
Eurasian glacier recession and environmental warming (EGREW), a zonal comparison study Astrid Lambrecht astrid.lambrecht@uibk.ac.at	For many regions in continental Asia melt-water from glaciers is an important source during dry periods. A comparison between well studied glaciers in the Alps and the glacier evolution along the Eurasian mountains from the Alps to Southern Siberia will provide a new insight into the influence of climatic conditions on glaciation. For most regions historic data are available which will be combined with modern field observations and remote sensing data to determine changes in the glacier systems during the last 30-40 years, with a focus on the development of supraglacial debris cover. The comparison of all regions allows a conclusion on the overall conditions of the regional ice cover and its potential future development. The significance of the glacier systems for the seasonal and long-term water production will be quantified.
EXSTO http://www.zamg.ac.at	The aim of the EXSTO project is to study the time progression of storm events in the alpine region. In this context it should be straightened out if and to what extent the storm climate has been changed and will be changed in the next decades.
FERMAP	The proposed multidisciplinary activity will substantially contribute to the assessment of the

http://www.zamg.ac.at	present environmental status of the Arctic by closing the knowledge gap that FJL currently constitutes. This assessment study will be used to establish a long-term observation system for changes of climate, cryosphere, hydrosphere and terrestrial ecosystems of the FJL archipelago. Recovery of historical data (aerial photographs, satellite imagery, climate instrumental data) will be the base to reconstruct regional changes over the last century. New scientific frontiers will be achieved by interdisciplinary approaches and the use of advanced techniques of remote sensing and geo-informatics.
Future river runoff scenarios in the Cordillera Blanca, Peru Irmgard Juen, Daniel Maurer, Georg Kaser Georg.kaser@uibk.ac.at http://www.uibk.ac.at/geographie/tropical-glaciology/	Glacier melt is a major contribution to dry season runoff from the Cordillera Blanca in Peru. Based on different climate scenarios produced from regional atmospheric modelling future changes in runoff and respective water availability are calculated.
GIS-sustained simulation of diminishing habitats of snow grouse, black grouse, chamois and capricorn under conditions of global warming and heightening forest limits StartClim2005.F Jakob Schaumberger jakob.schaumberger@gmx.at http://www.raumberg-gumpenstein.at	The natural elevation of the tree line strongly depends on temperature. The climate model used for this analysis shows that the relevant isotherms will rise by approx. 450 m over the next 50 years. Assuming that the future tree line will adjust to the changed calculated temperature of the decade 2040 - 2050, this shift will lead to a dramatic loss in suitable habitats, which may range from 78% to 98% depending on the season and animal species.
Global change in tropical forests Peter Hietz https://forschung.boku.ac.at/fis/suchen.orgeinheit_projekte sprache_in=de&menue_id_in=204&id_in=H891&laufzeit_in=laufend	The project will be an important contribution to understand how tropical forests have responded to global change in the past and are likely to do in the future and provide insight into short-term growth dynamics.
GLORIA network – across continent comparison of recent vegetation and plant diversity changes in high	The first sites established at the turn of the millennium in 18 regions in Europe (5th RTD FP GLORIA-Europe) were resurveyed in 2008 (supported by the Swiss MAVA Foundation for

mountain areas. Harald Pauli, Michael Gottfried harald.pauli@univie.ac.at, michael.gottfried@univie.ac.at http://www.gloria.ac.at/	Nature Conservation and the Austrian Federal Ministry BMWF). Data are expected to yield first comparative data of warming-induced vegetation changes across the continent. The next resurveys are planned for 2009 in the western USA; GLORIA currently is active in 67 mountain regions on 5 continents.
GRÜNLOCH minimum temperatures Reinhold Steinacker reinhold.steinacker@univie.ac.at http://www.univie.ac.at/IMG-Wien	The project is established by Department of Meteorology und Geophysics on the University of Vienna and its aim is the analysis of the long-term changes of minimum temperatures in Austrian dolines.
Holocene climate reconstruction from multi-proxy lake sediment core data (Ob. Landschitzsee, Niedere Tauern) (FWF P14912-B06: Alpine lake temperatures and ice as climate signals) Roland Schmidt roland.schmidt@oeaw.ac.at	Transfer functions between algal bio-indicators 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- and ice-cover variation showed the strongest lake impact. Climate oscillations coincided with cold and wet periods on Northern hemispheric scale. Mid-Holocene as well as Roman and Medieval warm periods approximated present temperatures.
Hydrological change of runoff Hubert Holzmann https://forschung.boku.ac.at/fis/suchen.projekt_uebersicht?sprache_in=en&ansicht_in=&menue_id_in=300&id_in=6784	In four test areas with varying meteorological and topographical boundaries (Bregenzerache, Obere Salzach, Traisen, Lavant) the potential change of the hydrological response will be investigated. In the current project the climate change scenarios are defined by the REMO-UBA climate model. Daily data of air temperature and rainfall are generated by a stochastic weather generator. These data serve as input for snowmelt model and a conceptual hydrological model. The models provide time series of a hundred year based on different climate scenarios. The results will be analysed and compared with the present state conditions.
Icecave 2100 http://www.zamg.ac.at	ICE.CAVE.2100 project was approved in the spring 2006 by Austrian Academy of Science (programme Alpine Research). Under supervision of Institute of Geology, University of Innsbruck this pilot study should provide research of potential of ice caves for the climate studies.

IMHC-Pilot - Integrated Modelling of the Hydrological Cycle. Pilotproject Andreas Gobiet andreas.gobiet@uni-graz.at http://www.wegcenter.at	The main objective of the project IMHC is to set up a coupled model system which is dedicated to optimise the interface between the atmospheric and the hydrological model components and to simulate the hydrological impacts of global climate change on regional and local scales. In the pilot phase (IMHC-Pilot), die basis for one-way coupling of an atmospheric model with an integrated hydrological model and a glacier model is established, but following the ideas of global earth system modelling, the regional model framework will be implemented in a flexible way that allows feedback between the model components and the addition of further components at a later stage.
INDICATE - Indicators of Atmospheric Climate Change from Radio Occultation Andi Steiner andi.steiner@uni-graz.at http://www.wegcenter.at	The main aim of this FWF project is the exploration and provision of benchmark indicators of atmospheric climate change for the UTLS region by using available RO based climatologies and, for exploring the long-term value, “proxy” RO climatologies from re-analyses and climate model runs, thereby making a substantial contribution to climate change monitoring and research. The datasets will be systematically explored for finding the most robust and sensitive RO based change indicators both by testing pre-defined potentially useful indicators within a multi-model/multi-ensemble approach and by using a new visualization-driven 4D field exploration technique.
Integrated modelling of the hydrological cycle in a changing climate (IMHC) Andreas Gobiet, Hans Kupfersberger, Andrea Fischer meteorologie@uibk.ac.at	Based on downscaled atmospheric model data hydrological properties of two alpine areas are calculated
ISSYMOD, Integrated Soil System Modelling: Standardized Sustainable Management, Restoration of Deserted Soils, Climate Change and Land Use Impacts Willibald Loiskandl willibald.loiskandl@boku.ac.at	The main objective: to provide tools to account for the complex nature of soil system to ensure a standardised sustainable management. An Integrated Soil-System-Model will be developed to model all relevant processes, the soil-water balance and matter transport and transformation. This model will be applied exemplarily on selected sites which stand for different soils, climatic conditions and land uses. Based on the results, standardised sustainable management strategies for soil management and restoration of soils will be developed.
KarstNPB/SnowNPB - Modelling the effect of climate change on the hydrological system in the Berchtesgaden Alps u.strasser@uni-graz.at,	This project aims at setting up the hydrological model WaSiM-ETH for the region of the Berchtesgaden Alps to investigate the effects of climate change on the water system and resources of the Berchtesgaden Alps. The model will be forced and validated with meteorological recordings from several automatic weather stations which are located in the area and distributed over the entire altitude range. Snow cover processes and the effect of

Harald.Kunstmann@imk.fzk.de, h.franz@nationalpark-berchtesgaden.de http://www.nationalpark-berchtesgaden.bayern.de/projekte/klimawandel/hydrologie/index.htm	karst will be considered with sophisticated modelling approaches which will be included into WaSiM-ETH. For future scenario simulations, a stochastic weather generator and downscaled regional climate model output will be utilized.
KLI.EN-Project: The effect of climate change on Austria's forests development and comparing evaluation of different predicting models Hubert Sterba https://forschung.boku.ac.at/fis/suchen.projekt_uebersicht?sprache_in=en&ansicht_in=&menue_id_in=300&id_in=7280	Further development and comparative evaluation of tools (forest growth simulators) for evaluating the effects of climate change on Austria's forests: Project part WAFO: Formal description of the different model types, their ability to describe the effects of climate change on forest ecosystems, distinguishing between the formal logic of the models and the reasonable estimation of individual parameters. Application of the models to a test data set representing Austrian forests.
Long term changes and climatology of UV radiation over Europe Philipp Weihs https://forschung.boku.ac.at/fis/suchen.projekt_uebersicht?sprache_in=en&ansicht_in=&menue_id_in=300&id_in=5369	The main objective of this action is to advance the understanding of UV radiation distribution under various meteorological conditions in Europe in order to determine UV radiation climatology and assess UV changes over Europe.
Mathematics and the Soil-Root System - Model development for agriculture under water stress conditions Willibald Loiskandl, Margarita Himmelbauer willibald.loiskandl@boku.ac.at, ml.himmelbauer@boku.ac.at	Due to increasing droughts worldwide as a result of climate change, agriculture under water stress conditions needs a careful choice of the optimal crop species and irrigation strategy. Mathematical models support our understanding of the involved processes of water transport and uptake. The objective of the project is to develop a closed simulation line, starting with model development based on physical processes, adaptation of equations, and parameter estimation by laboratory measurements and identification by inverse modelling. Final focus is the application of the model to realistic scenarios.
MedCLIVAR	- description of climate past evolution - assessment of climate variability at different space and time scales

http://www.zamg.ac.at	- understanding the mechanisms responsible for the observed climate variability - identifying trends and providing climate prediction in relation to future emission scenarios
MESOCLIM: FWF-Projekt Nr P 18296 Reinhold Steinacker reinhold.steinacker@univie.ac.at http://www.univie.ac.at/IMG-Wien/projects/mesoclim/MESOCLIM-Preview.pdf	The high resolution analysis tool VERA which has been developed at the Department of Meteorology and Geophysics of the University of Vienna, has been used to evaluate mesoscale phenomena in the Alpine region climatologically by analyzing high resolution synoptic data. A problem that had to be faced was the huge number of missing data in the MARS and ERA40 archives of ECMWF in the time period of interest. Within the project MESOCLIM, these results are to be extended and improved. The originally used synoptic data set should be enlarged to a 30-year climate period, which would improve the quality and significance of our results substantially. After establishing a comprehensive data archive, an upgraded and improved version of the VERA analysis method will be used to produce 3- and 4-dimensional analyses of meteorological parameters over complex topography.
Modelling of Nutrient Flow in Austrian Alpine Dairy Production Systems and Emerging Emissions Relevant to Climate and Ecosystem Werner Zollitsch werner.zollitsch@boku.ac.at	Dairy production systems which differ with regard to production intensity and hence in their use of external production factors will be analysed concerning their internal nutrient flow. Based on the total nutrient balance and the internal nutrient flow, the emissions from the production systems will be estimated. Most promising mitigation strategies will be identified. Modelling will be conducted using available simulation programmes, their suitability for Austrian alpine production systems will be critically evaluated, potential shortcomings will be identified.
Modelling of spatio-temporal variation of snow cover Andreas Schaumberger andreas.schaumberger@raumberg-gumpenstein.at http://www.raumberg-gumpenstein.at	A stochastic snow model based on precipitation, temperature and global radiation is implemented by GIS. It simulates snow cover for each day of the winter. Results are available in daily grids in a resolution of 50 meters. Due to some necessary simplifications, only the water equivalent of snow is determined. This causes a lack of information about snow pack consistency and density.
Multi-scale analyses of the climate-glacier relationship on tropical Lewis Glacier, Mount Kenya, East Africa Rainer Prinz, Lindsey Nicholson, Georg Kaser Georg.kaser@uibk.ac.at http://www.uibk.ac.at/geographie/tropical-glaciology/	While Kilimanjiaro carries ice in a dry and cold environment, Mt. Kenya glaciers exist and much lower elevations where changes in air temperature have an effect on melt conditions. By comparing the tow East African glacier sites we expect to decipher tropospheric climate conditions over East Africa and a complex manner.

Netnode "Climate, Climate Change and Atmospheric Environment Research", Austrian Network for Environmental Research Helga Kromp-Kolb helga.kromp-kolb@boku.ac.at https://forschung.boku.ac.at/fis/suchen.projekt_uebersicht?sprache_in=de&menue_id_in=300&id_in=3227	Tasks in the scope of Austrian Network for Environmental Research build a base of this project. It provides the enhancement of integration of national research to international research activities.
Neobiota and climatic change Christian Wiesner https://forschung.boku.ac.at/fis/suchen.projekt_uebersicht?sprache_in=de&menue_id_in=300&id_in=6638	The project tasks include the development of a "black list" to label invasive species, the compilation of essential species-specific information (fact sheet) and dispersal history. Furthermore research on potential trends of dispersal and invasiveness regarding the climatic change will be done and an expert-network and an early warning system will be developed.
Nucleation of Nanoclusters Paul Wagner paul.wagner@univie.ac.at	The influence of atmospheric aerosols on global climate has not yet been clarified sufficiently. Particle new formation in the atmosphere is connected with the nucleation of nanclusters. We are investigating the activation of neutral and electrically charged nanoclusters under well-defined laboratory conditions (see Winkler et. al., Heterogeneous nucleation experiments bridging the scale from molecular ion clusters to nanoparticles", Science 319, 1374 (2008)).
Pest risk analysis of Metcalfa pruinosa in Austria Gudrun Strauss gudrun.strauss@ages.at, pflanzengesundheit@ages.at	The analysis includes a CLIMEX® simulation based on climate data from locations where M. pruinosa is established to scientifically predict the potential geoprahical distribution of this species in Austria and to identify the regions most at risk.
PRISKCHANGE http://www.zamg.ac.at	The project PRISKCHANGE should provide specific answers on issues of intensity and recurrence of extreme precipitation events in Austria.
reclip:century – Development of a basic data set for regional climate scenarios	Climate change impact research needs detailed climates scenarios which are currently not sufficiently available for Austria. reclip:century will deliver an ensemble of regional climate

Andreas Gobiet, Herbert Formayer andreas.gobiet@uni-graz.at, herbert.formayer@boku.ac.at http://www.wegcenter.at, http://www.boku.ac.at	scenarios (up to 2050) for Austria including uncertainty estimates. The project consortium consists of the major players in climate modeling in Austria, the Wegener Center, (Univerity of Graz), Institute of Meteorology (BOKU-Vienna), the Central Institute for Meteorology and Geodynamics and is led by the Austrian Research Centers – system research.
Reclip:more (Research for climate prediction) - Sub project BOKU-Met Helga Kromp-Kolb helga.kromp-kolb@boku.ac.at https://forschung.boku.ac.at/fis/suchen.projekt_uebersicht?sprache_in=en&ansicht_in=&menue_id_in=300&id_in=4920	The Institute of Meteorology is a partner of the k-wiss research project Reclip:more which investigates the reliability of nested regional climate models in Austria. The main focus of the institute's work is the definition and the evaluation of sensitivity tests and the model results.
Risk Analysis of the establishment of the Western Flower Thrips (Frankliniella occidentalis) under outdoor conditions in Austria as a result of the climatic change Andreas Kahrer andreas.kahrer@ages.at, pflanzengesundheit@ages.at http://www.austroclim.at/index.php?id=startclim2005	Winter temperature conditions were analyzed for most northerly locations in Italy, where damages of Frankliniella occidentalis in typical outdoor cultures were reported. By application of these data to temperature scenarios A1B and A2 it was concluded that outdoor establishment in Austria of this glasshouse pest would be possible in the middle of this century.
Runoff under environmental change Hubert Holzmann	Extreme hydrological events like floods and droughts are often interpreted as a response to environmental change. But the quantification of the change signal is difficult with respect to imprecise climate change scenarios or the lack of homogeneous reference periods. Furthermore total runoff comprises of particular sub processes, which exhibit different sensitivities to environmental changes. The objective of the project, which is designed as a pre-feasibility study for a comprehensive research project, are the inventory of existing process based models, the testing of dynamic modular model assumptions and the preparation of a draft project application.
Seasonal climate impact on land-use development in	Siliceous algae-based reconstructions of the dates of spring and autumn lake mixing enabled to

the Austrian Alps during the last 4,000 years – a multi-proxy approach study (CLIM-LAND) (ÖAW) Roland Schmidt roland.schmidt@oeaw.ac.at	estimate spring and autumn temperature anomalies as well as ice-cover over the last 4000 years in an Austrian alpine lake sediment core. Temperature reconstruction indicated a close relationship between warm climate and four pulses of alpine land use (Bronze, Hallstatt, Roman, High Medieval). Climate seemed to be an important trigger of Alpine land use.
Sensitive mountain limits of snow and vegetation Michael Gottfried, Michael Hantel, Georg Grabherr michael.gottfried@univie.ac.at, michael.hantel@univie.ac.at, georg.grabherr@univie.ac.at http://www.univie.ac.at/mountainlimits	An interdisciplinary approach between the Dept. of Meteorology and Geophysics and Dept. of Conservation Biology, Vegetation and Landscape Ecology (both Univ. Vienna) focuses on vegetation/snow relationships in high mountain regions and on implications under accelerated climate warming; fieldsites include the GLORIA master site Schrankogel (Tyrol) and in a further step other European GLORIA sites.
Spatial modelling of grassland yield changes based on soil water balance and water stress from climate scenario data Andreas Schaumberger andreas.schaumberger@raumberg-gumpenstein.at http://www.raumberg-gumpenstein.at	Grassland yield in Styria is estimated in respect to water availability for the years 1981 to 1990 and 2041 to 2050 based on a climate scenario derived from the mesoscale model MM5. Due to increasing temperatures and higher evapotranspiration rates yield will increase in regions with sufficient water supply. Contrarily grasslands in the southern part of Styria will suffer from water stress as the consequence of high evapotranspiration and less precipitation, resulting in reduced yield.
Spatial modelling of grassland yield in consideration of weather impact Andreas Schaumberger andreas.schaumberger@raumberg-gumpenstein.at http://www.raumberg-gumpenstein.at	Information from different fields (meteorology, grassland research, soil science, etc) is integrated in GIS and processed to get high resolved grassland yield data. Yield reduction due to limited water availability is calculated by accumulated temperature and radiation under consideration of daily water stress. Formerly developed Grassland Statistical Model (GRAM) is recalibrated to improve its stability and performance.
Spatial Modelling of Thermal Growing Season for Austria Andreas Schaumberger andreas.schaumberger@raumberg-gumpenstein.at	The thermal growing season is defined as a temperature based approach for determining begin, end, and duration of growing season. These dates are calculated for continuous raster data surfaces with 250 meter resolution for the whole area of Austria. Different approaches have to be analysed (changes in temperature thresholds, frost periods, etc.). The developed algorithms are applied for longer time spans in order to set up representative average values.

http://www.raumberg-gumpenstein.at	
Stratosphere-Climate Links with Emphasis on the UTLS, Scout-03 Phillipp Weihs https://forschung.boku.ac.at/fis/suchen.projekt_uebersicht?sprache_in=en&ansicht_in=&menue_id_in=300&id_in=5354	The central aim of this research is to provide best scientific knowledge for international assessments on ozone depletion and climate change for the Montreal and Kyoto Protocols.
Studies on the importance, geographical distribution and epidemiology of phytoplasmic diseases in Austrian viticulture Robert Steffek robert.steffek@ages.at, pflanzengesundheit@ages.at http://dx.doi.org/10.1111/j.1365-2338.2007.01102.x	The project included the conduction of a PRA: “Analysis of the pest risk from Grapevine flavescence dorée phytoplasma to Austrian viticulture”, published in the EPPO-Bulletin. One of its conclusions was that climate will not limit the establishment and spread of the vector Scaphoideus titanus in the Austrian vine growing regions.
Test operation of an air quality forecast model for ozone based on operational regional weather forecast Helga Kromp-Kolb helga.kromp-kolb@boku.ac.at https://forschung.boku.ac.at/fis/suchen.projekt_uebersicht?sprache_in=en&ansicht_in=&menue_id_in=300&id_in=5811	A new model system based on the operational regional weather prediction model ALADIN and on the chemical transport model CAMx is tested for the forecast of surface layer ozone concentrations in northeast Austria during the summers 2005 and 2006. Comparing the model results with measurements, the model is validated and improved for operational application.
The Copenhagen Diagnosis – Glaciers and Ice Caps Georg Kaser Georg.kaser@uibk.ac.at	Updating the World on the latest climate science. A document to be presented at the COP 15 in Copenhagen, December 2009.

http://www.uibk.ac.at/geographie/tropical-glaciology/	
Tree ring analysis and historical dating Michael Grabner michael.grabner@boku.ac.at http://www.map.boku.ac.at/6404.html	The tree-ring research group of the University of Natural Resources and Applied Life Sciences, Vienna, is working in the field of dendroclimatology. Long-time tree-ring chronologies using sub-fossil stems in lakes and bogs were set up. Additionally a network of precipitation limited sites in eastern Austria was set up. In cooperation with the Federal Research and Training centre for Forest, Natural Hazards and Landscape we are analysing different provenances of softwood species to test their reaction on drought periods.
Tropical Glaciers as Climatic Indicators. Separating Local from Mesoscale Influences. Javier Corripio Georg.kaser@uibk.ac.at http://www.uibk.ac.at/geographie/tropical-glaciology/	A multi- method and multi-scale approach to separate local from meso-scale signals detected in tropical glaciers. An analysis of several year data series obtained on different glacier sites in the Cordillera Blanca, Peru.
Water Relations of Alders in a Soil Bioengineering Context Rosemarie Stangl rosemarie.stangl@boku.ac.at	The primary aim is to quantify the water relations of three specific Alnus species native to the northern hemisphere. Considered are the plants' transpiration rates, stomata conductance, sap flow rates, soil water content dynamics and limitations due to soil water stresses. Better quantification of plant water relations plays a key role in the assessment of the transpiration of an entire bioengineering system and thus its contribution to slope stabilisation.

Table E.3 Examples of research on the impacts of climate change.

"Development of a temperature model for the Traun-Ager- Vöcklasystem in Upper Austria"; Assessment of the fish ecological status Stefan Schmutz, Andi Melcher stefan.schmutz@boku.ac.at, andreas.melcher@boku.ac.at	On the basis of water temperature data of Austrian rivers from 1976 to 2005 and other abiotic parameters influencing water temperature, regression models have been developed by means of multiple linear regression analyses. Furthermore the water temperature of reference fish sampling sites has been predicted. It showed significant correlation with the fish assemblage types and typical temperature ranges could be assigned to the river regions. Analyses of water temperature time series showed a warming trend over the last 30 years, which is apparently stronger in lakes and lake outflows than in rivers.

https://forschung.boku.ac.at/fis/suchen.projekt_uebersicht?sprache_in=de&menue_id_in=300&id_in=6495	
ACQWA - Assessing Climatic Change and Impacts on the Quantitiy and Quality of Water Helga Kromp-Kolb, Herbert Formayer helga.kromp-kolb@boku.ac.at, herbert.formayer@boku.ac.at https://forschung.boku.ac.at/fis/suchen.projekt_uebersicht?sprache_in=de&menue_id_in=300&id_in=7195	The aim of WP3.1.2 is to investigate the role of Mediterranean cyclones in alpine hydrology, under the assumption that current RCMs are capable of reproducing these events. Available RCM runs, forced by ERA40, will be compared with observations on daily time scale. If the evaluation results prove to be satisfactory, the climate change signal concerning all aspects of Mediterranean cyclones will be quantified, using objective analysis tools that will be developed within this project.
ACQWA -Alpine Climate Change and Impacts for the Quantity and Quality of Water Andras Gobiet andreas.gobiet@uni-graz.at www.wegcenter.at	The ACQWA Project is a large-scale integrating EU project, coordinated by the University of Geneva, Switzerland. ACQWA aims to assess the impacts of a changing climate, focusing on the quantity and quality of water originating in mountain regions, particularly where snow- and ice melt represent a large, sometimes the largest, streamflow component. The goal of the project is to use advanced modeling techniques to quantify the influence of climatic change on the major determinants of river discharge at various time and space scales and analyze their impact on society and economy, also accounting for feedback mechanisms. The focus will be on continuous transient scenarios from the 1960s up to 2050. WegCenter is responsible for the provision of high-resolution climate scenarios for hydrological climate change impact studies within ACWQA.
ALPCHANGE – Climate Change and Impacts in Southern Austrian Alpine Regions. Gerhard Karl Lieb, Andreas Kellerer-Pirklbauer, Michael Avian gerhard.lieb@uni-graz.at, andreas.kellerer@uni-graz.at, michael.avian@TUGraz.at http://www.alpchange.at	ALPCHANGE is a project on climate change and impacts on climate-sensitive glacial and periglacial alpine environments in the recent past (since 1850 AD) and at present in southern Austria (46.8-47.1°N, 12.7-13.5°W). The project was launched in summer 2006 by two universities in Graz (University of Graz and Graz University of Technology) and is funded by the Austrian Science Fund (FWF) for a period of three years. Focus within the project is laid on the analysis of signals from various dynamic landscape parameters - permafrost, geomorphodynamics, glaciers and snow - for the ongoing climate change by a series of methods and by looking at different time scales.
Auswirkung von Klimaänderungen auf das Abflussverhalten von vergletscherten	Data from the Austrian glacier inventory 1998 are used to estimate the runoff changes with the OEZ runoff model.

Einzugsgebieten in Hinblick auf Speicherkraftwerke (Startclim 2007). Andrea Fischer, Michael Kuhn, Marc Olefs meteorologie@uibk.ac.at	
Beschneiungsklimatologie Österreich Andrea Fischer, ,Marc Olefs, Josef Lang meteorologie@uibk.ac.at	Up to 40 years of wet-bulb temperature time series on 14 locations in Austria were analyzed. Aim was to investigate variability of conditions for artificial snow production.
Carbon Storage in Soils Projects: AQUATERRA, CLISO, Waldhumus Martin H. Gerzabek martin.gerzabek@boku.ac.at	The impact of land use and land management is in the focus of these research efforts. The evaluation of long-term, field experiments in Sweden and Austria are an important basis for modeling of land-use and management on carbon dynamics. Additionally, the institute established a soil chronosequence in the National Park Donauauen. Further a soil climosequence was established in the Hochschwab massif, where numerous methods are applied to quantify the impact of a climate gradient on soil organic matter dynamics. One of the projects deals with the in-depth characterization of humus horizons in forest soils of Austria. The impact of forest stand characteristics, climate, geological bedrock on the molecular characteristics of soil organic matter is investigated.
Central and Eastern Europe Climate Change Impact and Vulnerability Assessment Helga Kromp-Kolb helga.kromp-kolb@boku.ac.at http://www.cecilia-eu.org/	The main objective of CECILIA is to deliver a climate change impacts and vulnerability assessment in targeted areas of Central and Eastern Europe. Emphasis is given to applications of regional climate modelling studies at a resolution of 10 km for local impact studies in key sectors of the region. The project contains studies of hydrology, water quality, and water management, air quality issues in urban area, agriculture, and forestry.
CIRCE - Climate Change and Impact Research: the Mediterranean Environment Helga Kromp-Kolb, Petra Seibert helga.kromp-kolb@boku.ac.at, petra.seibert@boku.ac.at	The CIRCE Integrated Project, funded under the European Commission's Sixth Framework Programme, aims to reach this objective, highlighting impacts and possible adaptation actions of the climate change in the Mediterranean region that includes Europe, North Africa and Middle East. Research at the Institute of meteorology, University of natural resources and applied life sciences, Vienna deals with climate and climate change, agro-meteorology, boundary layer and environmental meteorology and radiation and is based on field experiments, model development and theoretical studies.

http://www.boku.ac.at/met/envmet/circe.html	
Climate change impacts in a karst landscape of the Austrian Alps: effects on the soil resources Franz Zehetner franz.zehetner@boku.ac.at	The study area of the project is located on the Hochschwab karst massif, from where drinking water is supplied to Austria's biggest cities of Vienna and Graz. Three methodological approaches are combined to investigate climate effects on soil organic matter and soil microbial community: the empirical study of soils along climatic gradients; manipulation experiments (i.e. downward translocation of soil cores) with subsequent monitoring; in-situ litter decomposition experiments in different elevation zones.
Climate Change Impacts on Beech Forest Ecosystems in the Westpanonic Area Elisabeth Pötzelsberger https://forschung.boku.ac.at/fis/suchen.projekt_uebersicht?sprache_in=en&ansicht_in=&menue_id_in=300&id_in=7311	The goal of this project ist to assess the vulnerability of broadleave forests to potential climate change in the Hungarian - Austrian region. Specific tasks are: - developing of a joint data base - assessing drought stress scenarios - assessing productivity changes using biogeochemical-mechanistic models - adaptation options within beech forests - know how transfere and education
CLIMPHEN - Climate impact on plant and insect phenology in Austria Helfried Scheifinger, Christoph Matulla, Peter Cate, Andreas Kahrer, Elisabeth Koch Helfried.Scheifinger@zamg.ac.at	This project aims at a comprehensive analysis of the Austrian phenological observations with respect to the impact of the climate variability on plants and insects. Up to now only parts of the Austrian phenological data set have been analysed. The Austrian phenological data set has features, which make it unique. There is for instance a large number of phases (244, of which about 50 to 100 can be used for analysis, depending on the required data density), which have been observed continuously since 1951 in Austria including the Alps.
future.scapes Wolfgang Loibl wolfgang.loibl@arcs.ac.at http://www.boku.ac.at/futurescapes/	future.scapes examines and downscales global change effects to the local and regional level. The research will focus on those most pressing economic, societal and landscape transitions. It aims to support practitioners in recognising, understanding and managing change. To ensure an integrated view as well as local applicability following key topics for three landscape types will be examined: urban.scapes: structural, economic change in industrial urban regions agri.scapes: viability of family farms in rural regions mountain.scapes: climate change in an alpine tourist region

Global Change Impacts Lower Austria Franz Prettenthaler franz.prettenthaler@joanneum.at www.joanneum.at/rtg	Vulnerability assessment of winter tourism in Lower Austria with respect to Climate Change
Impact of Climate Change and Variability on European Agriculture: CLIVAGRI Josef Eitzinger https://forschung.boku.ac.at/fis/suchen.projekt_uebersicht?sprache_in=en&ansicht_in=&menue_id_in=300&id_in=6405	CLIVAGRI is a very important activity for coordination of methods and comparison of results in the field of climate change impact research on agriculture in Europe. Based on the research activities in this field at our Institution we will contribute especially to WG 1 and WG 4 regarding evaluation and comparison of modelling tools and evaluation of climate change impacts on the selected crops in the different regions.
Impact of climate change on Austrian forests – development and comparative evaluation of different modelling tools (WAMOD) Hubert Hasenauer https://forschung.boku.ac.at/fis/suchen.projekt_uebersicht?sprache_in=en&ansicht_in=&menue_id_in=300&id_in=7291	The purpose of this project is to - analyse the role of forests for the carbon cycle in Austria - analyse adaptation options and scenarios - compare different modelling tools (population versus mechanistic approaches) to assess the potential impact of climate change on forest ecosystems in Austria. The data for this study come from the national forest inventory plus from our own field experiments.
Impact of climate change on tree growth at their upper and lower distribution limit in the Central Eastern Alps Walter Oberhuber Walter.Oberhuber@uibk.ac.at	In the Alps climate change will primarily affect tree growth at the altitudinal treeline and at xeric sites within dry inner alpine valleys. Long-term study plots were therefore established to focus on influence of climate variability and extreme climate events on intra-annual dynamics of stem growth, growing season length and lag effects. Ecophysiological, dendroclimatological and histological techniques are applied.
Impacts of Climate Change on Upper Austria Helga Kromp-Kolb, Ingeborg Schwarzl helga.kromp-kolb@boku.ac.at,	Analysis of possible impacts of climate change on Upper Austria 1. Observed changes of heat spells in Upper Austria and estimation of possible future development 2. Estimation of impacts of heat on mortality in Upper Austria

https://forschung.boku.ac.at/fis/suchen.projekt_uebersicht?sprache_in=en&ansicht_in=&menue_id_in=300&id_in=6419	3. Floods and climate change: Impacts of climate change on flood-events in Upper Austria
Lower Austria Climate Project– Floodwaters https://forschung.boku.ac.at/fis/suchen.projekt_uebersicht?sprache_in=en&ansicht_in=&menue_id_in=300&id_in=7002	The impact of the climate change in the area of the catchment basin of Lainsitz river has been investigated. The aim is to make statements about discharge building, development of flooding and low flows, as well as about snow cover duration and dry weather patterns.
Mineralization of soil-carbon in mountain forests caused by climatic change Gerhard Glatzel https://forschung.boku.ac.at/fis/suchen.projekt_uebersicht?sprache_in=en&ansicht_in=&menue_id_in=300&id_in=5190	Mineralization of soil-carbon in mountain forests caused by climatic change
Neusiedler See Impact of Climate Change on Waterbalance of the Lake "Neusiedler See" Josef Eitzinger https://forschung.boku.ac.at/fis/suchen.projekt_uebersicht?sprache_in=en&ansicht_in=&menue_id_in=300&id_in=5376	This research project investigates the climatic water balance of the lake "Neusiedlersee" under various regionalized climate scenarios und the hydrological conditions. The various impacts on evapotranspiration during the year will be considered and parameterised. A sensitivity analysis will investigate the climatic conditions, which can lead to a drain of the lake.
Sources of air pollution relevant for Austrian biosphere reserves: quantification, trends, scenarios (OeAW-MaB) Petra Seibert petra.seibert@boku.ac.at https://forschung.boku.ac.at/fis/suchen.projekt_uebe	This study focuses on the sources of air pollution, impacting the biosphere reserve Wienerwald. Various numerical models combined with the measurement data have been used for this purpose, whereas detailed study of how different sources of pollutants contribute to air pollution is planed.

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The impact of climate change on slope stability of Flysch regions in the north-eastern Austrian prealps Bodo Damm bodo.damm@ku-eichstaett.de	The study comprises the screening of landslides, their distribution and causes. Important objectives are the compilation of a database on landslides and the combination with climate data regarding the possible increase in precipitation that is predicted by climate scenarios in the study region. Statistical calculation of threshold values in relation to slope stability maps allows the development of GIS-models, response and feedback functions, as well as scenarios adaptable to variable climate parameters.
The impact of glaciers and winter snow cover on the runoff of large river systems Georg Kaser, Ben Marzeion, Martin Großmann Georg.kaser@uibk.ac.at http://www.uibk.ac.at/geographie/tropical-glaciology/	An analysis of commonly available data for producing plots that show the impact of glaciers and seasonal snow cover on the runoff in large river systems from mountain regions in different climates around the world. A contribution to a document to be presented by the Norwegian Government and the former US Vice President Al Gore at the COP 15 in Copenhagen, December 2009.
Trend analysis of hydrometeorological extreme events Hans-Peter Nachtnebel https://forschung.boku.ac.at/fis/suchen.projekt_uebersicht?sprache_in=de&menue_id_in=300&id_in=7176	The aim of this project is to analyse possible changes in extreme events under changing climate conditions. The results are the statements about possible changes, trends of hydro-meteorological variables in the next decades (2020-2070), as well as about changes in precipitation intensity and frequency, in drought periods, temperature extremes, wind patterns and discharge extremes. Findings cover all typical Austrian regions.

Table E.4 Examples of socio-economic analysis, including both of the impacts of climate change and response options.

40 years of flood prevention in Gailtal, Carinthia: Evaluation of the enabled economic development Franz Prettenthaler franz.prettenthaler@joanneum.at	The project seeks to comprehensively describe the economic consequences of 40 years of flood prevention investment in the Gailtal, Carinthia.

http://www.joanneum.at/rtg	
9. Österreichischer Klimatag, Forschung zu "Klima, Klimawandel und Auswirkungen in Österreich Helga Kromp-Kolb helga.kromp-kolb@boku.ac.at http://www.austroclim.at/index.php?id=39	The “Climate Day” is an informal event for contact and exchange between all people who are interested in research of “Climate, Climate Change and Impacts“ in Austria. It shall also serve for networking between natural science and socio economics.
A Tale of two Valleys Franz Prettenthaler franz.prettenthaler@joanneum.at http://www.joanneum.at/rtg	The contrary strategies in two neighbouring Alpine valleys to deal with climate variability and climate change
A toolbox of models of a sustainable economy Franz Sinabell Franz.Sinabell@wifo.ac.at http://www.provision-research.at	The goal of this research project of proVISION is to measure and evaluate the interdependencies between the economy and the natural environment in a spatial framework. Existing models (the agricultural sector model PASMA and the macro-economic model PROMETEUS) are used as analytical instruments and their capacities will be enhanced during the project. The aim is to establish an integrated modelling framework in order to take into account a wide range of environmental indicators and biodiversity. The interface to link different types of models and data-constructs is land use in regional context. The whole country is the object of the analysis, the level of spatial detail is as disaggregated as data allow – the objective is to provide results for all municipalities in Austria.
Additional module for the ÖHV destinations study 2008 Franz Prettenthaler franz.prettenthaler@joanneum.at http://www.joanneum.at/rtg	Analysing Austrian tourism destinations with regard to their specific socio-economic vulnerability with respect to climate change.
AGRISOLAR Karl Steininger	In this project we evaluate different options of expansion in renewable energy products grown on agricultural land. We focus first on which of the various cultures are advisable for Austria under future climate change conditions. Second we analyze in detail the economic implications

karl.steininger@uni-graz.at http://www.wegcenter.at	of such a transition in land use and crop use for the energy sector in competition with (material) use in other sectors. Since local climate change and economic impacts vary across regions, we apply our analysis to one particular focus region, the wider Feldbach region. The method developed can serve as a role model for other Austrian regions.
Assesment of climate change's impact on sustainable cooling and ventilation strategies of office blocks in urban areas Tania Berger tania.berger@donau-uni.ac.at	Thermal comfort in office rooms, which is crucial for office workers' performance, is at stake with outdoor air temperatures rising due to climate change. Sustainable cooling and ventilation strategies have to be scrutinized and optimized in this respect. Therein effects of urban heat islands call for particular attention. This is a PhD project integrating results from further 3 Master theses.
Basic principles for breeding, multiplication and variety testing for organic agriculture Funded by the Austrian Federal Ministry of Agriculture, Forestry, Environment and Water Management and the Austrian federal states Clemens Flamm clemens.flamm@ages.at	The dryness tolerance of 12 winter wheat genotypes has been proved. In 2005-2007 two trials at two organic locations with 12 genotypes respectively were implemented. One trial had been exposed to both, natural precipitation and irrigation during the dry seasons. The second one was covered with foil tunnel, which prevented rain exposure of the field. After the rain it was opened in order to have the same climatic situation as in the other trial. The findings showed marked quality and variety differences between two humidity situations. In additional trials with peas and vetches similar results could be identified in this project.
Biofuels – Potentials, Risks, Scenarios Klaus Peter Zulka klaus-peter.zulka@umweltbundesamt.at http://www.provision-research.at	The project of proVISION program comprises several project modules. Results from all modules will perpetually communicate to students within the framework of FBK (ForschungsBildungsKooperation, co-operation between research and education). In communication projects, students and researchers study problems, solutions and their adverse side effects.
Building regional capacities for an integrative response to climate change – in the alpine district of Murau Philipp Späth spaeth@ifz.tugraz.at http://www.ifz.tugraz.at/index_en.php/article/articleview/1458/1/76	There is a great potential to develop and implement such strategies at the regional level, where tight social networks and initiatives can be linked with national and international carbon management programmes. Moreover, regionalised global climate change data are now available to support strategy processes profoundly influenced by regional specificities. The project elaborates a process design for developing regional portfolios of climate change adaptation and mitigation measures and applies this design in a participative strategy process for an alpine, rural district in Upper Styria (Murau).

Climate change impacts on energy use for space heating and cooling in Austria II Wolfgang Streicher w.streicher@tugraz.at http://www.wegcenter.at	The project HEAT.at will build upon the results of an ongoing project (StartClim 2006), where the changes of heating and cooling degree days due to climate change are investigated for Austria on a regional basis, based on high resolution climatology and a climate change scenario for the 2040s. In the project specific representative building types will be closer examined regarding the relation between meteorological conditions and energy consumption. It was shown, that the space heating energy demand will be reduced by about 20 % by 2050 and the cooling demand will be doubled, but is, apart from passive houses, far below the space heating energy demand.
Climate Change Terrestrial Adaptation and Mitigation in Europe Erwin Schmid https://forschung.boku.ac.at/fis/suchen.projekt_uebersicht?sprache_in=en&ansicht_in=&menue_id_in=300&id_in=7305	The project will assess the impacts of agricultural, climate, energy, forestry and other associated land use policies, considering the resulting feedbacks on the climate system.
iLand - Developing a framework for integrated forest landscape modeling under changing climate and disturbance regimes Rupert Seidl, Manfred J. Lexer Rupert.seidl@boku.ac.at mj.lexer@boku.ac.at	Climate change is a major challenge for sustainable forest management. Impacts on the disturbance regime are particularly relevant in this regard. In a sound science-based sustainable forest management/ ecosystem management approach potential changes in climate and disturbance regimes need to be considered explicitly. Disturbance dynamics, however, are still poorly understood especially in ecosystems with interacting, climate-sensitive disturbance agents. To successfully address (interactions between) disturbances as emerging property of the modeled system as well as to provide relevant levels of information in the context of SFM an individual-based, process-oriented landscape modeling approach is proposed. The framework will be parameterized and evaluated for two cases studies in the Eastern Alps (Austria) and the Pacific Northwest (USA), focusing on wind - bark beetle and fire - bark beetle disturbance interactions respectively. Overall, the integrated modeling framework aims at contributing to questions of sustainable forest management under changing climate and disturbance regimes and facilitating a landscape perspective in forest resource management.
Climate Plan Martin Treberspurg https://forschung.boku.ac.at/	The task of the research assignment is the creation of the climate plan for South Tyrol. The first part will be an analysis of the recent development and the actual situation of the energy consumption incl. the CO_2-emissions. The second part consists of possible scenarios of the development in the energy sector. The third part will be a catalogue

	of measures which describes the aim of a sustainable use and supply of the energy.
Climate Protection in Austrian Cities - Survey on Climate Protection Activities within the Members of the Austrian Association of Cities Gerhard Lang lang@grazer-ea.at	The aim of this survey was to get an overview over the climate protection activities within the Members of the Austrian Association of Cities, that are cities with more than 10,000 inhabitants and some other smaller cities which are very ambitious. The questionnaire covered all operational fields of cities: energy production, buildings, mobility, street lighting, procurement, zoning, furtherance, activities/programmes and further measures of adjustment on climate change. Within the survey shining examples were identified and furthermore measures to save energy and CO2 have been analysed and evaluated.
Climate Study - Lower Austria Raphaela Böswarth post.ru3@noel.gv.at http://www.noel.gv.at/bilder/d33/NOE_Klimastudie_2007.pdf?13263	Impacts of climate change on four typical regions of lower Austria are simulated and their influence on the local economy is estimated.
ClimChAlp - Climate change, impacts and adaptation strategies in the Alpine Space Raphaela Böswarth post.ru3@noel.gv.at http://www.climchalp.org	ClimChAlp is an Interreg IIIB "Alpine Space" transnational project, co-financed by the European Union. Aim of the project is to support political decisions regarding protection and prevention against natural disasters caused by climate change in the Alps. Based on climate models and impacts of historical climate changes future scenarios and their effects on natural hazards, spatial development and key economic sectors are assessed. The federal state of lower Austria is partner of the project which is led by the Bavarian State Ministry of the Environment.
Competitive Energy Services (Energy-Contracting, ESCo Services) Jan W. Bleyl Bleyl@grazer-ea.at http://www.ieadsm.org	Task XVI: In order to contribute to the future market development of Energy Services the objectives of Task XVI are to: - establish an IEA DSM energy services expert platform - develop and follow up country specific activities to implement energy contracting in the market with the focus on selected market segments - design, elaborate and test competitive and innovative energy services and financing models - position the Task XVI ES-expert platform as a competence centre for international dissemination and assistance services (e.g coaching, training, etc.) in the field of ESCo services
COST 730 - Towards a Universal Thermal Climate Index UTCI for	The main objective of the action is to develop and make easily available physiological relevant assessment model of the thermal environment in order to significantly enhance applications

Assessing the Thermal Environment of the Human Being Philipp Weihs http://cost.cordis.lu/scr(action_detail.cfm?action=730	related to health and well-being.
Doctoral School Sustainable Development Andreas Muhar andreas.muhar@boku.ac.at http://www.dokne.boku.ac.at	dokNE is located at BOKU University of Natural Resources and Applied Life Sciences, Vienna, funded by BOKU, the Austrian Sustainability Research Program proVISION of the Federal Ministry for Science and Research (bm.w_f), the Provinces of Vienna, Lower Austria and Styria and the Federal Ministry of Agriculture, Forestry, Environment and Water Management (BMLFUW). Interdisciplinary research programme, 18 PhD projects, all of them working on different aspects of sustainable development, six of them in strong context to climate research.
Evaluation system for measures of the Climate Programme of Lower Austria Raphaela Böswarth post.ru3@noel.gv.at http://www.noel.gv.at/Umwelt/Klima/Klimaprogramm/klimaberichte.html	The project is focused on a monitoring model for the measures of the Climate Programme of Lower Austria. Herewith the measures will be checked for the level of implementation (non started / started / finished) and for visible effects in national and regional surveys (Österreichische Luftschadstoffinventur und Bundesländerinventur). The evaluation system interprets the trends in the surveys in connection to the Climate Programme.
EWCR I Franz Prettenthaler, Christoph Töglhofer franz.prettenthaler@joanneum.at, christoph.toeglhofer@uni-graz.at http://www.klimarisiko.at, http://www.wegcenter.at, http://www.joanneum.at/rtg	This project aims to increase knowledge about the weather sensitivity of the Austrian economy and to foster a capacity building in managing weather and climate risks among stakeholders. Analysis of intra-sectoral weather risks in vulnerable economic sectors will be done as well as an assessment of inter-sectoral possibilities to transfer weather risks, either from one sector to the other, or to the capital market. A communication platform will be created under the domain www.wetterrisiko.at, thereby allowing a transfer and exchange of knowledge with other Austrian research groups, weather sensitive enterprises and other stakeholders on the weather market
future.scapes - Global change and its influence on landscape and society, subproject agri.scapes Darnhofer Ika	The proVISION project future.scapes is lead by ARC Systems Research, the BOKU leads the subproject agri.scapes. Farmers cultivate most of Austria's rural area and thus shape its cultural landscape. Global change leads also to changes in farm structure and cultivation practices. agri.scapes will investigate promising management approaches and strategies. agri.scapes aims to develop

https://forschung.boku.ac.at/	scenarios and to identify structures enhancing the resilience of family farms in the face of global change.
Global Change 2048 - The Climatic Window for Human Activities in 2048: Exploring Adaption to and Shaping of Emerging Conditions Karl Steininger karl.steininger@uni-graz.at http://www.wegcenter.at	This project addresses the orientation and long-term strengthening of national efforts within the international context of global change research. It includes an International Conference “The Climatic Window for Human Activities in 2048: Exploring Adaptation to and Shaping of Emerging Conditions” (2007) and its Proceedings.
HEAT.at Andreas Gobiet andreas.gobiet@uni-graz.at http://www.wegcenter.at	The project HEAT.AT investigates the impact of climate change on heating and cooling energy demand in Austria under different socio-economic scenarios. Specific reference buildings will be used to model the response of different building types to temperature changes according to the Austrian implementation of the European Building Directive (EPBD). This specific energy demand for each reference building will be combined with a regionalised database of the current building stock in Austria.
HEAT.NÖ Christoph Töglhofer christoph.toeglhofer@uni-graz.at http://www.wegcenter.at	This project aims to examine the regional impacts of climate change on the energy demand for space heating and cooling in Lower Austria. On the one hand the heating and cooling energy demand will be considered on a regional basis for the sub regions in the federal state of Lower Austria and will be compared with the other Austrian federal states. On the other hand it will be analyzed how changes of temperature may affect investment decisions in the building sector. Furthermore the effects of climate policy instruments to support low-carbon technologies will be considered in this model.
Impact of climate change in mountain areas – Socio-economic effects and strategies of adaptation Oliver Tamme http://www.berggebiete.at/	The aims of the project are to analyze the impact of the climate change on mountain areas and show possible strategies of adaptation. The effects of climate changes bring about great challenges especially for mountain, which are in Austria alpine areas. It is expected that climate change may have favourable and unfavourable effects on mountain areas. The project will determine the different impact (agriculture, forestry, transport, health etc.) as well as special effects (environment, biodiversity, alpine settlement and tourism). In a first step the project is going to sum up the outcome of impact studies which have a socio-economic relevance for the mountain areas.
Interactions between anthropological impacts and environmental changes	The aim of this research program is to describe and quantify the interaction between the economy and the environment on a regional level, as well as to assess it from a perspective of

in a sustainable economy: determinants of quality of life and social welfare in rural regions Erwin Schmid https://forschung.boku.ac.at/fis/suchen.projekt_uebersicht?sprache_in=en&ansicht_in=&menue_id_in=300&id_in=7233	sustainability for both, economical and ecological point of view.
KlimAdapt - Development of high priority adaptation measures and of an implementation strategy for those measure and technology portfolios Helga Kromp-Kolb , Herbert Formayer helga.kromp-kolb@boku.ac.at, herbert.formayer@boku.ac.at https://forschung.boku.ac.at/fis/suchen.projekt_uebersicht?sprache_in=en&ansicht_in=&menue_id_in=300&id_in=7199	Analysis of the impact of climate change on the Austrian energy system up to the year 2050. Development of high priority adaptation measures and of an implementation strategy for those measure and technology portfolios. Energy demand, electricity and biomass supply will be subject of the analysis. One of the main targets is to achieve synergies with other measures in the energy system as well as simultaneous GHG mitigation and adaptation effects.
Leisure mobility and climate change Unbehaun Wiebke https://forschung.boku.ac.at/fis/suchen.projekt_uebersicht?sprache_in=en&ansicht_in=&menue_id_in=300&id_in=5561	The survey focuses on the destination and activity choice of winter sport tourists in the European Alps contingent on changes in trends in tourism, in spatial resistances and in the performance of skiing regions. Interviews with Experts of market research companies lead to knowledge about lifestyles and future trends in leisure and recreation. A Discrete Choice Experiment estimates the contingent reactions and choices of tourist and helps to identify the dominant factors for decision. The results offer a framework to forecast of future potentials of different skiing regions and support the consideration of social, ecological and economic impacts for a sustainable regional development.
MOORCLIM Bogs in Austria - between climatic stress and climate protection Franz Essl	The project (2009-2011) aims to search for climatic thresholds allowing bog persistence and a quantification of their carbon-sink relevance in Austria. Monetary costs of protection measures will be evaluated compared to long-term carbon storage. The question how financial instruments and land-use practices should be developed in the future is addressed.

franz.essl@umweltbundesamt.at	

Table E.5 Examples of research and development on mitigation and adaptation technologies

Identification of recommended actions for adaptation to climate change in Austria Wille Haas willi.haas@uni-klu.ac.at http://www.umweltnet.at/article/articleview/71921/1/7098/	The aim of the study was to identify the first recommended actions in fields of water management (protection from and of water, water use), agriculture, forestry, tourism and electricity sector (generation and distribution) based on expert opinion. About sixty recommended actions within five workshops have been identified. Basic content of the workshops were current climate change scenarios for Austria, assessment of vulnerability of fields of interest, as well as the broad email survey
ADAGIO - Adaptation of Agriculture in European Regions at Environmental Risk under Climate Change Josef Eitzinger Josef.Eitzinger@boku.ac.at https://forschung.boku.ac.at/fis/suchen.projekt_uebersicht?sprache_in=en&ansicht_in=&menue_id_in=300&id_in=6307	ADAGIO will evaluate and disseminate potential adaptation measures to climatic change in agriculture, considering 3 main vulnerable regions of Europe (South Europe and Mediterrranean Area, Middle Europe and Eastern Europe) in cooperation with 11 Partners (Austria, Spain, Bulgaria, Serbia, Czech Republic, Poland, Greece, Italy, Russia, Egypt, Romania).
Active glacier protection: development/optimization of innovative glacier protection methods Andrea Fischer, Heribert Insam, Michael Kuhn, Friedrich Obleitner, Roland Psenner, Birgit Sattler meteorologie@uibk.ac.at	Four different methods to reduce ablation in Austrian glacier ski resorts are compared: Covering the glacier with sheets, densification of snow, injection of water and the use of wind drift.
AMARA - Adequacy of Mitigation and Adaptation Options for a Case Study Region in Austria Olivia Koland olivia.koland@uni-graz.at	In this research project a scheme of mitigation and adaptation strategies for Austria is derived and assessed, given up to date forecasts on the likely outcomes of changing climatic conditions in Austria. Fostering the use of biomass to substitute fossil energy resources is at the focus of the present study. Given that climatic change will have an impact on the production capacity of biomass in Austria, the mitigation strategy boosting the production of biomass is potentially at threat. Adaptation to altered future conditions is therefore a central element of an overall

http://www.wegcenter.at	strategy to cope with climatic change. In order to answer the question on how mitigation and adaptation strategies can be successfully interlinked, an Austrian case study is carried out.
Climate protection by soil protection - key competence spatial planning Gerlind Weber gerlind.weber@boku.ac.atc	In the scope of mitigation measures for climate change and the maintenance of the future scope of action, the project "Climate protection by soil protection - key competence spatial planning" on behalf of the insurance company Österreichische Hagelversicherung has been implemented. The role of soil for climate protection and how land consumption is occurring in Austria is demonstrated. It is also being illustrated by which activities land consumption including the aspect of climate protection can be controlled.
CLISP Jochen Bürgel Jochen.buergel@umweltbundesamt.at http://www.clisp.eu/	CLISP (2008 - 2011) is focusing on the challenges to spatial planning in the face to climate change and shall contribute to climate change adaptation by providing climate-proof spatial planning solutions. The project aims at preventing, reducing and mitigating climate-change related spatial conflicts, vulnerability of spatial development and spatial structures to adverse climate change impacts and consequential damages and costs.
COMET - alpS Konrad Bergmeister https://forschung.boku.ac.at/fis/suchen.projekt_uebersicht?sprache_in=de&ansicht_in=&menue_id_in=300&id_in=7498	Construction of a full application for the formation of a COMET K2 centre of competence. The name of the centre is alpS, Centre for Climate Change Adaptation Technologies and its content is mainly adaptation to climate change strategies.
Conception and Accomplishment of Participation Prozess to support the Development of the Austrian Adaptation Strategy Andrea Prutsch Andrea.prutsch@umweltbundesamt.at http://www.klimawandelanpassung.at	Organisation and accomplishment of a participation process (2009 - 2010) to discuss adaptation measures, responsibilities for implementation, research needs etc. with relevant stakeholders. A Homepage with relevant information on climate change adaptation is already available.
Interreg IV B Projekt AdaptAlp: Adjustment strategies for the improvement of natural hazard- and risk management in Alpine regions	AdaptAlp is an Alpine Space Programme (Priority 3: Environment and Risk Prevention) project, which is part of the European Territorial Cooperation 2007-2013. 16 project partners from six different countries are involved in AdaptAlp with the overall aim of assessing impacts of and

Johannes Hübl, Barbara Mayer https://forschung.boku.ac.at/fis/suchen.projekt_uebersicht?sprache_in=en&ansicht_in=&menue_id_in=300&id_in=7485	adaptation to climate change in the Alpine Space. In the course of the project, recommendations for policy-makers and local stakeholders will be derived regarding adaptation strategies and disaster risk management. In various pilot regions the experiences and results of the project activities will be brought together in order to find 'best-practice' examples.
Glacier mass balance in ski resorts Andrea Fischer, Olefs Marc meteorologie@uibk.ac.at	Volume and volume change data is used for the development of plans for local glacier conservation in ski resorts. Local change of mass balance due to wind drift is investigated.
Possibilities for implementation of "Domestic Offset Projects" in Austria" Franz Prettenthaler franz.prettenthaler@joanneum.at http://www.joanneum.at/rtg	The European Union in its 2007 energy and climate package has set itself ambitious future energy and Climate targets in its 2007 energy and climate package. Austria already now has to take the decisions initiatives to meet these goals. In those sectors, that are not covered by the EU-ETS additional instruments will be required. These include a framework for domestic offset projects (DOPs). The possibility of implementation and the designs of DOP-systems will be analyzed in the framework of this project.
CCTAME - Climate Change Terrestrial Adaptation and Mitigation in Europe – Forestry Manfred J. Lexer mj.lexer@boku.ac.at	The project will assess the impacts of agricultural, climate, energy, forestry and other associated landuse policies, considering the resulting feedbacks on the climate system. The proposed structure of the integrated CCTAME model cluster allows us, to provide an evaluation of policy options at a great level of detail for EU25(27) in a postKyoto regime, as well as to offer perspectives on global longerterm policy strategies in accordance with the principles and objectives of the UNFCCCC. Close interactions with policymakers and stakeholders will ensure the policy relevance of CCTAME results.
Salzburg's Winter Tourism and Adaptation to Climate Change Meinhard Breiling meinhard.breiling@tuwien.ac.at http://ttl.tuwien.ac.at/docs/Klimasensibilitaet%20Salz	In Salzburg 10% of the economic income depends on snow. The length of winter tourism season is shrinking due to climate change. Different kinds of climate adaptations were examined. None of them seems able to maintain present-day level of economic importance of winter tourism in a warmer climate.

burger%20Wintertourismus.pdf	
Snow in Kitzbühel: how winter tourism is adapting to climate change Meinhard Breiling meinhard.breiling@tuwien.ac.at	Kitzbühel is one of the best known winter resorts of Austria but situated in comparatively low altitude, not exceeding 2000m in the location Kitzbühel and 2600m in the district Kitzbühel. This report describes the ongoing climate adaptation measures - artificial snow production and others structured into physical, technical and social adaptation measures - and the future potential to cope with ongoing climate change.
StartClim2008: Adaptation to Climate Change in Austria Helga Kromp-Kolb, Ingeborg Schwarzl helga.kromp-kolb@boku.ac.at, ingeborg.schwarzl@boku.ac.at http://www.austroclim.at/index.php?id=startclim2008	The sixth StartClim scientific program deals just like former StartClim programs with a subject of climate change and its impacts in a first line on Austria. Startclim2008 -"Adaptation to Climate Change" underlines the importance of adaptation possibilities being a necessary and essential aspect of climate protection. It consists of 7 subprojects with topics chosen in such a way that they cover a wide spectrum of ideas and approaches to this subject.
Which adaptations of soil erosion protection measures can be recommended for expected climate change impacts? Andreas Klik https://forschung.boku.ac.at	Topic of this project is to evaluate the efficiency of the recommended soil tillage/management systems in a small agricultural used watershed in the North-eastern part of Austria for future climate conditions (2020 and 2050) with respect to reduction of soil erosion and increase of water retention. If target values are not fulfilled adaptations of the measures will be worked out and the effects will be evaluated. Based on the results site specific recommendations will be developed.

Appendix F

Systematic Observation and GCOS

Table F.1: National contributions to the surface-based atmospheric essential climate variables ("Table 1a"[†])

Contributing networks specified in the GCOS implemenatation plan	ECVs	Number of stations or platforms currently operating	Number of stations or platforms operating in accordance with the GCMPs	Number of stations or platforms expected to be operating in 2015	Number of stations or platforms providing data to the internatio-nal data centres	Number of stations or platforms with complete historical record available in international data centres
GCOS Surface Network (GSN)	Air Temperature	**1080**	**1080**	**1080**	**150**	**9**
	Precipitation	**1335**	**1335**	**1335**	**150**	**9**
Full World Weather Watch/Global Observing System (WWW/GOS) surface network	Air Temperature, air pressure, wind speed and direction, water vapour	**150**	**150**	**150**	**150**	
	Precipitation	**150**	**150**	**150**	**150**	
Baseline Surface Radiation Network (BSRN)	Surface radiation					
Solar radiation and radiation balance data	Solar radiation	**230**	**230**	**230**	**150**	

[†] Table number according to Decision 11/CP.13.

Table F.2: National contributions to the atmospheric composition ("Table 1c")

Contributing networks specified in the GCOS implemenatation plan	ECVs	Number of stations or platforms currently operating	Number of stations or platforms operating in accordance with the GCMPs	Number of stations or platforms expected to be operating in 2015	Number of stations or platforms providing data to the international data centres	Number of stations or platforms with complete historical record available in international data centres
World Meteorological Organisation/Global Atmosphere Watch (WMO/GAW) Global Atmospheric CO_2 & CH_4 Monitoring Network	Carbon dioxid	**1**	**1**	1		
	Methan					
	Other greenhouse gases: O3,SO2,H2O	**117, 102, 344**	**117, 102, 344**	**117, 102, 344**		
WMO/GAW ozone sonde network‡	Ozon	**1**	**1**	**1**		
WMO/GAW column ozone network§	Ozon	**1**	**1**	**1**		
WMA/GAW Aerosol Network**	Aerosol optical depth	**1**	**1**	**1**		
	Other aerosol properties	**1**	**1**	**1**		

‡ Including SHADOZ, NDACC, remote sensing and ozone sondes.
§ Including filter, Dobson and Brewer stations.
** Including AERONET, SKYNET, BSRN and GAWPFR.

Table F.3: National contributions to the terrestrial domain essential climate variables ("Table 5")

Contributing networks specified in the GCOS implemenatation plan	ECVs	Number of stations or platforms currently operating	Number of stations or platforms operating in accordance with the GCMPs	Number of stations or platforms expected to be operating in 2015	Number of stations or platforms providing data to the international data centres	Number of stations or platforms with complete historical record available in international data centres
GCOS baseline river discharge network (GTN-R)	River Discharge	**550**	**550**	**550**	**65 (ETN-R)**	**70 (GRDC, NE-Friend)**
GCOS Baseline Lake Level/Area/Temperature Network (GTN-L)	Lake level/area/temperature	**30**	**30**	**30**	**14 (ETN-R)**	
WWW/GOS Synoptic network	Snow cover	**1000**	**1000**	**1000**		
GCOS glacier monitoring network (GTN-G)	Glacier mass balance and length, also ice sheet mass balance	**104**	**104**	**104**		
GCOS permafrost monitoring network (GTN-P)	Permafrost borehole-temperatures and activ-layer thickness	**4**	**4**	**4**		

(GRDC – Global Runoff Data Centre; ETN-R – European Terrestrial Network River Runoff; NE-Friend – Northern European Flow Regimes from International Experimental and Network Data)

Tab. F.4 Examples of data collection, monitoring and systematic observation, including data banks.

ALPNAP - Monitoring and minimisation of traffic-induced noise and air pollution along major Alpine transport routes Petra Seibert petra.seibert@boku.ac.at http://www.alpnap.org/	A network of regional experts aims at the integrated use of advanced science-based methods to monitor, assess, and predict air pollution and noise and their impact on the environment, quality of life and health along major transport routes. These methods are adapted to the Alpine topography. The purpose of the project is to promote these methods to regional and local authorities, to supplement standard methods towards more reliable predictions and scenario assessments, to quantify the tolerable limits of emissions if given air quality and noise standards are met, and to assess the environmental impact of traffic flow changes due to regulations, new infrastructure, or modal shifts.
ALS-X Kombination und Bewertung von flugzeuggestützten Laserscandaten und Terra SAR-X Daten für glaziologische und schneehydrologische Fragestellungen (ALS-X und SAR-X) Rudolf Seiler, Hans Stötter, Andrea Fischer meteorologie@uibk.ac.at	Products of two different sensors (time synchronous airborne laser scanning data and TerraSAR-X satellite data) are compared with respect to measured glacier mass balance.
Analysis and Monitoring of Water and Nutrient Cycles Andreas Bohner, Markus Herndl andreas.bohner@raumberg-gumpenstein.at, markus.herndl@raumberg-gumpenstein.at http://www.raumberg-gumpenstein.at	To analyse and monitor water and nutrient cycles in grassland ecosystems in different altitudes a lysimeter and weather monitoring station was installed at the Agricultural Research and Education Centre Raumberg-Gumpenstein (700 m a.s.l.) and at the mountain Stoderzinken (1830 m a.s.l.) in Styria, Austria.
BACCHUS KlosterneuBurg wine And Climate CHange in (Lower) AUStria Elisabeth Koch and Christa Hammerl e.koch@zamg.ac.at, christa.hammerl@zamg.ac.at http://www.zamg.ac.at	Interdisciplinary research of historians and climatologists: retrieving phenological time series of grapes from the Middle Ages to the present stored in historical archives in Austrian vine growing regions with the aim to extend temperature-time series into the pre- instrumental era and compare the Austrian series with other European data-sets. Reconstructed time series of meteorological elements are used to check the significance of variability simulated by climate models and to detect and quantify anthropogenic effects.

Climate station Vent and totalisator network Rofental Michael Kuhn, Gerhard Markl und Andrea Fischer meteorologie@uibk.ac.at	Basin precipitation and climate in the inner alpine Rofen valley is monitored since the 1930s
COST725 Establishing a European Phenological Data Platform for Climatological Applications Elisabeth Koch and Wolfgang Lipa e.koch@zamg.ac.at, wolfgang.lipa@zamg.ac.at http://www.zamg.ac.at/forschung/klimatologie/klimafolgen/cost725/	ZAMG chaired the COST* action 725 having started in 2004. The main objective of this action is to establish a European reference data set of phenological observations that could be used for climatological purposes, especially climate monitoring, and detection of changes.
Crop Drougth Stress Monitoring by Remote Sensing Werner Schneider https://forschung.boku.ac.at/fis/suchen.projekt_uebersicht?sprache_in=en&ansicht_in=&menue_id_in=300&id_in=5460	Drought effects on important crops are being studied and methods of monitoring and early detection of this and other stress factors are being developed at many places. The aim is to allow to plan long and short term agro-technical measures (e.g. in crop rotation, fertilization, soil cultivation, irrigation scheduling) to avoid reduction in crop production. The aim of this project is to adapt and develop remote sensing based methods of detection and monitoring of drought stress of agricultural crops exploiting these new potentials of optical remote sensing and the synergetic effects of the different sensor types.
Ecological research at the GLORIA master site Schrankogel (Stubaier Alpen, Tyrol) Michael Gottfried, Harald Pauli michael.gottfried@univie.ac.at, harald.pauli@univie.ac.at http://www.gloria.ac.at/?a=42&b=56	The Schrankogel high mountain research site is the largest ecological research and monitoring site in the Alps that includes the subnival and nival zones. It was established in 1994 for assessing impacts of climate change on low-temperature determined ecosystems and biodiversity. Besides continued monitoring of species migration and assessments of species losses, research focuses on effects of snow patterns on vegetation, transect studies across vegetation zones, age structure of selected high alpine plants, micro-climate of cushion plants, among others.
Entwicklung eines integralen Gletschermonitoringsystems Andrea Fischer meteorologie@uibk.ac.at	Volume differences between geodetic and direct glaciological method on Hintereisferner and Kesselwandferner are investigated. A Method for including webcam data and using data assimilation is developed to improve spatial interpolation of point measurements of mass balance.

GAW – DACH cooperation August Kaiser, Helfried Scheifinger, Gerhard Schauer August.Kaiser@zamg.ac.at www.zamg.ac.at	The GAW – DACH project is a joint cooperation between the German, Austrian and Swiss (D-A-CH) national weather services DWD, ZAMG and MeteoSwiss. It coordinates the national monitoring activities within the Global Atmosphere Watch (GAW) Programme of the World Meteorological Organization by supplementing the monitoring program at the German global stations Zugspitze/Hohenpeissenberg and the Swiss global station Jungfraujoch with measurements at the Sonnblick (Austria).
Global Monitoring of Soil Moisture for Water Hazards Assessment (GMSM) Eitzinger Josef josef.eitzinger@boku.ac.at https://forschung.boku.ac.at/fis/suchen.projekt_uebersicht?sprache_in=en&ansicht_in=&menue_id_in=300&id_in=7448	The overall goal of the proposed project is to advance the use of soil moisture services based on METOP ASCAT and complementary satellite systems, most importantly SMOS and ENVISAT ASAR, by extending the Hydrology SAF products to Africa and Australia, carrying out extensive calibration and validation (Cal/Val) activities and by developing novel water hazards applications.
Global Observation Research Initiative in Alpine Environments (GLORIA) Harald Pauli, Michael Gottfried harald.pauli@univie.ac.at, michael.gottfried@univie.ac.at http://www.gloria.ac.at/	Around 50 research teams have established permanent observation sites in 67 mountain regions on 5 continents. The expansion of this long-term observation network for warming-induced impacts on high mountain ecosystems is still much in progress. In each region four summit sites of different altitude are established, where data on species composition, species cover and frequency are collected on different spatial scales (0.1x0.1m; 1x1m, 10x10m and larger sites covering the entire summit area). Standard summit sites of the international GLORIA long-term observation network are to be resurveyed at intervals of 5 to 10 years. In addition, soil temperature is continuously measures on four positions per summit at hourly intervals. Two of the currently 67 target regions are in Austria: the GLORIA master site Schrankogel and Hochschwab; a further is in setup in Gesäuse Nationalpark and sites are planned in Hohe Tauern Nationalpark.
Hazard Monitoring for Risk Assessment and Risk Communication MONITOR Renate Mayer, Hubert Siegel renate.mayer@raumberg-gumpenstein.at hubert.siegel@lebensministerium.at	MONITOR is a trans-national INTERREG IIIB Cadses project which aims at disaster management with focus on monitoring methods and risk communication.

www.monitor-cadses.org	
HISTALP - HISTORICAL instrumental climatological surface time series of the greater alpine region http://www.zamg.ac.at/histalp/	The HISTALP database consists of monthly homogenised temperature, pressure, precipitation, sunshine and cloudiness records for the „Greater Alpine Region“ (GAR, 4-19 deg E, 43-49 deg N, 0-3500m asl). The longest temperature and air pressure series extend back to 1760, precipitation to 1800, cloudiness to the 1840s and sunshine to the 1880s.
How representative are measured monitored glaciers for global assessments of land ice mass changes? Susanna Hoinkes, Georg Kaser Georg.kaser@uibk.ac.at http://www.uibk.ac.at/geographie/tropical-glaciology/	A comparative study is performed for the Oetztal Alps in Austria and the Cordillera Blanca in Peru.
HUMUS - Establishing a data base in order to study the emission and storage of the main greenhouse gases in agricultural systems and regions in Austria Martina Kasper martina.kasper@boku.ac.at https://forschung.boku.ac.at/fis/suchen.projekt_uebersicht?sprache_in=de&menue_id_in=300&id_in=7320	The main focus of the project is to estimate the potential sources and sinks of relevant greenhouse gases in agriculture using the integrative REPRO modelling tool. It combines the analysis of C, N and energy flows in the soil-plant-animal environment system and allows the identification of relevant greenhouse gas emissions at the operational level. Furthermore, conventional and organic farming systems will be compared based on the humus content in order to determine their efficiency in terms of the carbon storage in the soil.
Integrated Monitoring Zöbelboden Thomas Dirnböck thomas.dirnboeck@umweltbundesamt.at http://www.umweltbundesamt.at/en/umweltschutz/oekosystem/im/	Under the auspices of the Economic Commission for Europe (UN-ECE), 49 countries are working on the reduction of transboundary air pollution in Europe within the framework of the Geneva Clean Air Convention. This is also the purpose of the programme on “Integrated Monitoring”. For “Integrated Monitoring”, the participating countries select important sensitive areas in order to establish national sites for long-term ecosystem monitoring. National site Zöbelboden in Austria is established in 1992 from Umweltbundesamt and has a size of 90ha. Ever since, over 600 parameters have been continuously measured there.
Mass balance measurements on Hallstätter Glacier	Hallstätter Glacier is located on the Northern margin of the Main Alpine Ridge and therefore precipitation on the glacier is very high compared to inner alpine glaciers. A monitoring program including mass balance, meteorological and ice thickness measurements collects data to compare the behaviour of

Kuhn, Michael; Fischer, Andrea, Kay Helfricht meteorologie@uibk.ac.at	Hallstätter Glacier to inner alpine glaciers.
Mass balance Mullwitzkees Michael Kuhn, Andrea Fischer, Martin Stocker-Waldhuber meteorologie@uibk.ac.at	Mullwitzkees on the south side of Hohe Tauern/Venediger Group is a shallow glacier exposed to the south. Mass balance and meteorological measurements are carried out since 2007.
MOMBASA http://www.zamg.ac.at	In the region of GAW site Sonnblick the glacier mass balance has been measured. Glacier mass balance is extremly sensitive indicator for climate change and has been measured as a part of worldwide monitoring program (World Glacier Monitoring Service, IAHS-UNEP-UNESCO).
Monitoring activities HBLFA Raumberg-Gumpenstein Analysis and evaluation of long-term changes in the vegetation and soil development Andreas Bohner andreas.bohner@raumberg-gumpenstein.at http://www.raumberg-gumpenstein.at	In the National Park "Gesäuse" and in the Enns Valley (Styria, Austria) more than 150 permanent plots have been established. These permanent plots can be used for recording, documentation, analysis and evaluation of long-term changes in the vegetation and soil development.
Monitoring Blockgletscher Hochebenkar Karl Krainer, Ulrike Nickus, Jakob Abermann, Andrea Fischer, Michael Kuhn meteorologie@uibk.ac.at	Rock glacier Hochebenkar in Ötztal Alps near Obergurgl is monitored since more than 60 years. Measurements of runoff, flow velocity and geomorphological mapping are carried out. The chemistry of runoff water is investigated.
Monitoring of plant diseases occurring in organic agriculture with special regard to the influence of global warming Herbert Huss herbert.huss@raumberg-gumpenstein.at http://www.raumberg-gumpenstein.at	In the course of the project Monitoring of plant diseases occurring in organic agriculture with special regard to the influence of global warming, specific plant diseases are documented which newly or increasingly occur in Austria due to climate change.

Monitoring of spectral UV radiation in Vienna area Helga Kromp-Kolb helga.kromp-kolb@boku.ac.at https://forschung.boku.ac.at/fis/suchen.projekt_uebersicht?sprache_in=en&ansicht_in=&menue_id_in=300&id_in=4083	Since 1997 the UV-radiation monitoring with long-term stable instruments (Bentham-spectral radiometer) has been implemented in the local area of Vienna. The collected data are the basis for the understanding of future trends and the implementation of process studies, essential for understanding the transfer of UV-radiation. The aim of this project is to continue the monitoring of spectral UV-radiation in this area, thus providing more insight in prevailing UV-radiation impact on the surface.
Monitoring of total ozone and spectral UV radiation at Sonnblick Helga Kromp-Kolb helga.kromp-kolb@boku.ac.at http://www.boku.ac.at/imp/strahlung.htm	The long-term monitoring and analysis of ozone and UV-B-radiation in the atmosphere aim to estimate the future changes in stratospheric ozone concentration and UV-B radiation and to assess the interaction between both atmospheric dynamics and ozone and UV-B radiance and ozone.
Monitoring the mass balance of glaciers in different parts of South Tyrol, Italy Stephan Galos, Rainer Prinz, Georg Kaser Georg.kaser@uibk.ac.at http://www.uibk.ac.at/geographie/tropical-glaciology/	A monitoring and analysing program for the Hydrology Department of the Regional Government of South Tyrol, Italy, which started in 1991 and which focuses on 3 different glaciers.
OMI-ASAP Validaton of Ozone Monitoring Instrument (OMI) Ground UV Products (OMI-ASAP) Philipp Weihs https://forschung.boku.ac.at/fis/suchen.projekt_uebersicht?sprache_in=en&ansicht_in=&menue_id_in=300&id_in=6406	Good quality UV maps are only achievable by using satellite information and satellite data. The present project deals with the validation of the UV products retrieved with the (Ozone Monitoring Instrument) OMI instrument on board of NASA/EOS AURA satellite. The project is closely connected with the ESA project (ID 2945) “Validation of OMI products over Europe with ground-based UV instruments”. It is vital for producing good quality science within the scope of the ESA project (since no money is available from ESA) and it treats the important aspects in more detail than the former one.
Operation of Sonnblick station for the UV-B monitoring network	The issue of this contract is to continue the operation of Robertson-Berger biometer at the site Hoher Sonnblick, which is a part of Austrian UV-B monitoring network and is used for monitoring of UV-Radiance causing erythema.

Helga Kromp-Kolb helga.kromp-kolb@boku.ac.at https://forschung.boku.ac.at/fis/suchen.projekt_uebersicht?sprache_in=en&ansicht_in=&menue_id_in=300&id_in=4082	This contract includes the servicing of the instruments and collection of data, as well as the data transfer to the UV-B monitoring network.
Ozone Monitoring Instrument - Calibration Philipp Weihs https://forschung.boku.ac.at/fis/suchen.projekt_uebersicht?sprache_in=en&ansicht_in=&menue_id_in=300&id_in=5580	Within the scope of this project a validation of ground ultraviolet (UV) irradiance determined by using satellite data is performed.
Pasterze http://www.zamg.ac.at	The Central Institute for Meteorology and Geodynamics Vienna is measuring mass balance of the Pasterze glacier. These data are the basis for a climatic mass-balance model, ment to forecast future developements of the glacier.
PermaNET - Permafrost long-term monitoring network Andreas Kellerer-Pirklbauer, Gerhard Karl Lieb andreas.kellerer@uni-graz.at, gerhard.lieb@uni-graz.at www.permanet-alpinespace.eu.	The overall objective of PermaNET is to make an important contribution to the mitigation of natural hazards that result from climate change impacts on alpine permafrost. It was launched in summer 2008 and is funded for a three years period by the European Union through the Alpine Space Program of the European Territorial Cooperation. The project consortium consists of 14 participating institutions. The four Austrian project participants are: the Central Institute for Meteorology and Geodynamics in Salzburg and Vienna, the University of Innsbruck, the University of Graz and the Austrian Federal Ministry of Agriculture, Forestry, Environment and Water Management, Forest Department.
PERSON http://www.zamg.ac.at	A new monitoring programme PERSON (Permafrost monitoring Sonnblick) was assigned in December 2005 by Federal Ministry of Agriculture, Forestry, Environment and Water Management. This project, started on January 1, 2006 established a permafrost monitoring in the area of Sonnblick as an addition to permafrost monitoring at the Sonnblick.
The establishment of Decision Support Systems for assessment of interaction between Climate Change-Hydropower and Ecology Habersack Helmut	The aim of this project is to establish the database and discussion base as well as to develop Decision Support Systems „DSS“ as a helpful tool for assessment of interaction between Climate Change-Hydropower and Ecology with respect to socio-economic aspects.

https://forschung.boku.ac.at/fis/suchen.projekt_uebersicht?sprache_in=en&ansicht_in=&menue_id_in=300&id_in=7264	
WegenerNet - Pilotprojekt: Klimastationsnetz Südoststeiermark Gottfried Kirchengast gottfried.kirchengast@uni-graz.at http://www.wegcenter.at	The Region Feldbach (Styria/Austria) has been selected by the WegenerCenter as a focus area for a lead experiment of Austrian and international climate research. The 'WegenerNet climate observation network Region Feldbach' is comprised of over 150 weather stations. These have been measuring weather and climate development in a tightly spaced grid (2x2 km) with a previously unknown level of accuracy. Many research projects investigating climate, environmental change as well as common weather observation will benefit from this measurements.

Appendix G

Summary of Reporting according to the Kyoto Protocol

Table G.1 Summary of reporting of the supplementary information under Article 7, paragraph 2, of the Kyoto Protocol in the NC5

Information reported under Article 7, paragraph 2	NC5 section
National systems in accordance with Article 5, paragraph 1	3.5
National registries	3.6
Supplementarity relating to the Mechanisms pursuant to Articles 6, 12, 17	5.3
Policies and measures in accordance with Article 2	4.3
Domestic and regional programmes and/or legislative arrangements and enforcement and administrative procedures	4.2
Information under Article 10:	
Article 10a	3.5
Article 10b	4.2, 6.3
Article 10c	7.4
Article 10d	8
Article 10e	9
Financial resources	7.1-7.3

Appendix H

Abbreviations, Terms and Units of Measurement

Abbreviations and Terms

ACEA	Association des Constructeurs Européens d'Automobiles; European automobile manufacturers association
AEA	Österreichische Energieagentur (Austrian Energy Agency)
BGBl.	Bundesgesetzblatt (Federal Law Gazette)
CAP	European Common Agriculture Policy
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
EEG	Energy Economics Group, Technical University Vienna
ETS	Emissions Trading Scheme
EU	European Union
EUR	Euro
EZG	Emissionszertifikategesetz (Emissions Allowance Trading Act)
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
GHG	greenhouse gas
HFCs	hydrogenated fluorocarbons
ICAO	International Civil Aviation Organisation
IEA	International Energy Agency
IIASA	International Institute for Applied Systems Analyses
IPCC	Intergovernmental Panel on Climate Change
JAMA	Japanese automobile manufacturers association
JI	Joint Implementation
KAMA	Korean automobile manufacturers association
KLI.EN	Klima- und Energiefonds (Austrian Climate and Energy Fund)
KPC	Kommunalkredit Public Consulting

Land	Federal Province of Austria
Länder	Federal Provinces of Austria
LDCF	Least Developed Countries Fund
NAP	National Allocation Plan
NGO	non-governmental organisation
NMVOC	non-methane volatile organic compound
NO_x	oxides of nitrogen
N_2O	nitrous oxide
ODA	Official Development Assistance
OECD	Organisation for Economic Cooperation and Development
PFCs	perflourocarbons
pkm	passenger kilometres
PSRP	poverty reduction strategy paper
tmk	tonne kilometres
UFI	Umweltförderung im Inland (Environmental support scheme)
UNEP	United Nations Environment Program
US$	United States Dollar
VOC	volatile organic compounds
WIFO	Österreichisches Institut für Wirtschaftsforschung (Austrian Institute of Economic Research)
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