THIRD

NATIONAL CLIMATE REPORT

of the Austrian Federal Government

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

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

Dritter Nationaler Klimabericht
der österreichischen Bundesregierung

Dritte nationale Mitteilung
in Übereinstimmung mit den Verpflichtungen gemäß
dem Rahmenübereinkommen der Vereinten Nationen
über Klimaänderungen (BGBl. Nr. 414/1994),
entsprechend den Entscheidungen 11/CP.4 und 4/CP.5
der Vertragsstaatenkonferenz

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Preface

In August/September 2002 the international community will meet in Johannesburg for the World Summit on Sustainable Development – one decade after the Rio Conference on Environment and Development where all nations signed up to the Framework Convention on Climate Change. This means we have just little more than half a year to live up to our commitments and to counteract climate change by bringing the Kyoto Protocol into force.

Austria has already started its domestic ratification procedure and, together with our partners in the EU, we are working towards meeting the deadline of September 2002 as a first yardstick for our political commitment. Making visible progress by 2005 is another important task. We want to show that we are on the right track and that we are taking our commitments seriously.

In accordance with the applicable working programme of the Austrian government, a detailed draft Climate Change Strategy has been elaborated by the government in close co-operation with Austria's nine Federal Provinces. The policies and measures described in that strategy will enable Austria to meet the Kyoto target which means – in accordance with the EU burden sharing agreement – a reduction of our emissions by 13 %.

Just to pick out one fundamental element of our policy, the Austrian government has set legally binding quotas for electricity generated from renewable resources, such as wind, biomass and solar energy. The law also lays down that these quotas are to be increased every two years and shall be augmented by fair feed-in tariffs.

To mention another example regarding transport emissions: By 2004 we will have introduced an electronic road pricing system for lorries. This measure aims at the internalisation of external costs of road transport, including climate change and other environmental costs, and thereby at the improvement of the competitiveness of environmentally sound modes of transport.

Efficient technologies based on renewable sources of energy are the key to sustainability. To further their development and application while addressing all climate-related problems will enable us to provide livelihoods for people in rural areas, to create new jobs and to foster economic growth.

We all have to consider our efforts in addressing climate change not as a burden but as an enormous opportunity and as a necessary precondition for global well-being. This is the real challenge: To achieve economic and social development in a way that respects our environment, our planet and its climate, on which we all depend.

W. Molterer

Mag. Wilhelm Molterer
Federal Minister for Agriculture, Forestry,
Environment and Water Management

Vienna, November 2001

The Third National Communication of Austria under the Framework Convention on Climate Change (Third National Climate Report) was drafted, co-ordinated and compiled by the Federal Ministry of Agriculture, Forestry, Environment and Water Management, Unit I/4 U (Mag. Martin Kriech, Mag. Christopher Lamport, DI Elisabeth Ratzinger, Dr. Helmut Hojesky).

The Federal Environment Agency Austria (Dr. Klaus Radunsky) has elaborated the chapter on emission inventory information. The chapters on the effects of climate change and on research and systematic observation have been drafted by the Institute of Meteorology and Physics of the University of Agricultural Sciences in Vienna (Dr. Herbert Formayer), based on information from the Second National Climate Report (original contributions by Dr. Matthias Jonas, currently IIASA).

Essential information on adaptation measures has been provided by Unit V/C7 of the FMAFEW (DI Renate Mayer), on developing country issues by the Federal Ministry for Foreign Affairs (Unit VII/4 and Erwin Künzi, GPR Consult) and the Federal Ministry of Finance (Dr. Walter Rill), on transfer of technology by the Federal Ministry on Transport, Innovation and Technology, Unit V/A/7 (DI Thomas Glöckel) and the Federal Ministry of Economic Affairs and Labour, Unit II/12 (DDr. Herwig Dürr), on education and public awareness by the Federal Ministry of Education, Science and Culture, Unit V/2 (Dr. Günter Pfaffenwimmer) and by the Länder Upper Austria, Lower Austria and Vienna.

Valuable amendments to the draft report have been contributed by the members of the Interministerial Committee for the Co-ordination of Measures on the Protection of the Global Climate (IMC Climate) in the meetings of the IMC Climate in summer and autumn 2001.

The Austrian Council of Ministers took official notice of this report on 27 November 2001.

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Chapter 1

Executive Summary / Zusammenfassung

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

The most noteworthy development since the Second National Communication is the Kyoto Protocol to the Convention on Climate Change, which contains concrete reduction targets for greenhouse gas emissions for Annex I Parties. Austria signed the Kyoto Protocol in April 1998. The member states of the European Union have agreed to fulfil their commitments under the Kyoto Protocol jointly according to Art. 4 of the Protocol. Austria, as a EU member state, has taken on a 13 % reduction target within the EU burden sharing agreement. A detailed Austrian strategy to meet this target is currently being developed in Austria; negotiations have already reached the final stage.

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 Vertragsstaaten sind verpflichtet, ihre Aktivitäten, die sie hinsichtlich der Einhaltung der Verpflichtungen aus dem Rahmenübereinkommen durchführen, in Form von nationalen Berichten darzustellen. Sie berichten dazu unter anderem über die nationalen Treibhausgas-Emissionsinventuren, 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 über Maßnahmen zur Förderung von Bildung und öffentlichem Bewusstsein auf dem Gebiet der Klimaänderungen.

Österreich hat seinen Ersten Nationalen Klimabericht im September 1994 und seinen Zweiten Nationalen Klimabericht im Juli 1997 vorgelegt. Das vorliegende Dokument ist der Dritte Nationale Klimabericht, mit dem Österreich seinen Verpflichtungen zur Übermittlung von Information an das Sekretariat der UNFCCC gemäß Art. 12 des Übereinkommens nachkommt.

Die wohl bedeutendste Entwicklung seit der Erstellung des Zweiten Nationalen Klimaberichts ist der Beschluss des Kyoto-Protokolls unter dem Rahmenübereinkommen über Klimaänderungen, welches konkrete Reduktionsziele zu den Treibhausgasen für die Annex-I-Vertragsstaaten enthält. Österreich hat das Kyoto-Protokoll im April 1998 unterzeichnet. Die Mitgliedstaaten der Europäischen Union sind übereingekommen, ihre Verpflichtungen nach dem Kyoto-Protokoll gemäß Art. 4 des Protokolls gemeinsam zu erfüllen. Österreich – als Mitglied der EU – hat im Rahmen der Aufgabenverteilung innerhalb der EU ein Reduktionsziel von 13 % übernommen. Zurzeit wird eine detaillierte österreichische Strategie zur Erreichung des Reduktionsziels erarbeitet.

1.2 National Circumstances

Austria is a land-locked country in central Europe with an area of 83,858 km^2. A large part of Austria is covered by the eastern Alps; about 40 % of the total area lies more than 1000 m above sea level. Forests make up about 47 % of the Austrian total territory; the agricultural area, including grass land and alpine pastures, has a share of approx. 41 %. 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, *Länder* and local authorities. Austria acceded to the European Union in 1995 and ceded some areas of national jurisdiction to the community.

Austria's permanent population has reached 8.09 million inhabitants in 1999; after a stagnation in the 1980s the average population increase in the last decade was about 0.5 % annually. One third of all Austrians lives 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.

The gross domestic product (GDP) at current prices was ATS 2,833 billion (€ 205 billion) in the year 2000 with a per capita GDP of ATS 349,600 (€ 25,410). Nominal GDP growth in 2000 was 4.5 %, real GDP growth 3.3 %. Industrial production in real terms showed an increase of 32 % between 1990 and 2000. The Austrian energy profile shows a high share of renewable energy, above all hydropower and biomass, with each providing about 12 % of the total primary energy supply. With a gross domestic consumption per capita of 148 MJ and a final energy consumption per capita of 116 MJ respectively in 1999 Austria belongs to the countries with lowest energy consumption among industrialised countries.

Nationale Rahmenbedingungen

Als Binnenland liegt Österreich 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. Wälder bedecken rund 47 % des Gebiets; die landwirtschaftliche Nutzfläche, einschließlich Grünland und Almen, hat einen Anteil von ca. 41 % 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 1999 belief sich die ständige Bevölkerung Österreichs auf 8,09 Millionen Einwohner. Nach einer Stagnation in den 80er-Jahren des 20. Jahrhunderts betrug der durchschnittliche Bevölkerungszuwachs im letzten Jahrzehnt rund 0,5 % pro Jahr. Ein Drittel der Bevölkerung lebt in fünf Städten mit jeweils über 100.000 Einwohnern, etwa die Hälfte in Gemeinden mit einer Größe zwischen 10.000 und 100.000 Einwohnern.

Das Bruttoinlandsprodukt (BIP) zu aktuellen Preisen lag im Jahr 2000 bei 2.833 Milliarden Schilling (205 Milliarden €), das BIP pro Kopf bei 349.600 Schilling (25.410 €). Das reale BIP-Wachstum betrug 3,3 % im Jahr 2000. Die Industrieproduktion verzeichnete zwischen 1990 und 2000 einen Anstieg um 32 %. Die Energieaufbringung in Österreich weist einen hohen Anteil an erneuerbaren Energieträgern auf, insbesondere bei Wasserkraft und Biomasse mit jeweils rund 12 % Anteil am Gesamtenergieverbrauch. Mit einem Gesamtenergieverbrauch von 148 MJ pro Kopf bzw. einem Endenergieverbrauch von 116 MJ im Jahr 1999 gehört Österreich zu den Ländern mit dem geringsten Energieverbrauch unter den Industriestaaten.

1.3 GHG Inventory

The Third National Communication lists Austria's greenhouse gas emissions as reported in the annual inventory submission from April 2001. 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 1990–1999. 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. In addition, a time series of CO_2 emissions for the years 1955 to 1989 is reported. An In-Depth Review of the Austrian greenhouse gas emission inventory took place from 8 to 12 October 2001.

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 (see Table 1.1). According to the IPCC Guidelines for National Greenhouse Gas Inventories, CO_2 emissions from biomass used as fuels are excluded from the total CO_2 emissions value.

Treibhausgas-Inventur

Der Dritte Nationale Klimabericht führt die österreichischen Treibhausgasemissionen entsprechend der jährlichen Inventurberichterstattung vom April 2001 auf. Er enthält Daten über Kohlenstoffdioxid (CO_2), Methan (CH_4), Distickstoffmonoxid (N_2O), teilhalogenierte und vollhalogenierte Fluorkohlenwasserstoffe (H-FKW und FKW) und Schwefelhexafluorid (SF_6) für die Jahre 1990–1999. 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-Äquivalent und Emissionstrends. Darüber hinaus ist auch eine Zeitreihe der CO_2-Emissionen für die Jahre 1955 bis 1989 angeführt. Eine vertiefte Überprüfung der österreichischen Treibhausgas-Inventur hat von 8. bis 12. Oktober 2001 stattgefunden.

Die Treibhausgas-Emissionen werden nach folgenden Sektoren gegliedert: Energie, industrielle Prozesse, Lösungsmittel und andere Produktverwendung, Landwirtschaft, Landnutzungsänderungen und Forstwirtschaft, Abfall und sonstige Emittenten (siehe Tab. 1.1). Gemäß den IPCC Richtlinien über nationale Treibhausgas-Inventuren werden CO_2-Emissionen

Table 1.1: Emissions of greenhouse gases in Austria 1999, in Gg CO_2 equivalent

GHG source categories	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Total
National Total	65,777.85	9,541.44	2,279.28	870.46	25.32	729.90	79,224.26
1. Energy	53,315.89	391.00	849.57				54,556.46
A. Fuel Combustion	50,657.62	272.74	849.57				51,779.93
B. Fugitive Emissions f. Fuels	2,658.27	118.26	0.00				2,776.53
2. Industrial Processes	11,943.70	2.98	179.63	870.46	25.32	729.90	13,752.00
3. Solvent & oth. Product Use	395.64		232.50				628.14
4. Agriculture	0.00	3,944.83	1,013.15				4,957.98
5. Land-Use Change & Forestry	0.00	0.00	0.00				0.00
6. Waste	122.62	5,202.63	4.43				5,329.68
7. Other	0.00	0.00	0.00	0.00	0.00	0.00	0.00

The total emissions of the greenhouse gases CO_2, N_2O, CH_4, HFCs, PFCs and SF_6 amounted to 79.2 Tg CO_2 equivalent in the year 1999. The emissions of CO_2 clearly dominate the GHG emissions in Austria with 65.78 Tg or 83 % compared to 12 % for CH_4, 3 % for N_2O and 2 % for F-gases. The ranking of the subsectors (sectors) according to their relative contribution is as follows:

1A3: Transport (23.1%)
2: Industrial Processes (17.4%)
1A4: Commercial/Instit./Resident. (16.9%)
1A1: Energy Industries (14.4%)
1A2: Manufact. Ind. & Construct. (11.0%)
6: Waste (6.7%)
4: Agriculture (6.3%).

CO_2 emissions per capita amounted to 8.13 t in 1999 and total greenhouse gas emissions per capita to 9.79 t CO_2 equivalent.

Total greenhouse gas emissions in 1999 were about the same level as 1998, but they were 2,6% above the base year emissions (base year 1990 for CO_2, CH_4, N_2O and 1995 for F-gases). However, 1999 emissions were about 2 % lower than in the years 1991 and 1997 (cf. Figure 1.1). The increase in emissions is caused by a more than 8 % increase in the sector 'Fuel Combus-

aus der energetischen Nutzung von Biomasse nicht in die Summe der Emissionen aufgenommen.

Die Gesamtemissionen der Treibhausgase CO_2, N_2O, CH_4, H-FKW, FKW und SF_6 betrugen 79,2 Millionen Tonnen CO_2-Äquivalent im Jahr 1999. Anteilsmäßig klar dominierend waren die CO_2-Emissionen mit 65,78 Millionen Tonnen bzw. 83 % im Vergleich zu 12 % für CH_4, 3 % 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 (23,1 %)
2: Industrielle Prozesse (17,4 %)
1A4: Haushalte/Gewerbe/Verwaltung (16,9 %)
1A1: Stromerzeugung & Energieumw. (14,4 %)
1A2: Verbrennung in der Industrie (11,0 %)
6: Abfall (6,7 %)
4: Landwirtschaft (6,3 %).

Die CO_2-Emissionen pro Kopf betrugen 8,13 t im Jahr 1999 und die gesamten Treibhausgasemissionen pro Kopf 9,79 t CO_2-Äquivalent.

Die gesamten Treibhausgasemissionen im Jahr 1999 waren etwa auf dem Niveau von 1998, jedoch 2,6 % über den Emissionen des Basisjahrs (Basisjahr 1990 für CO_2, CH_4, N_2O und 1995 für die fluorierten Gase). Die Emissionen von 1999 waren allerdings rund

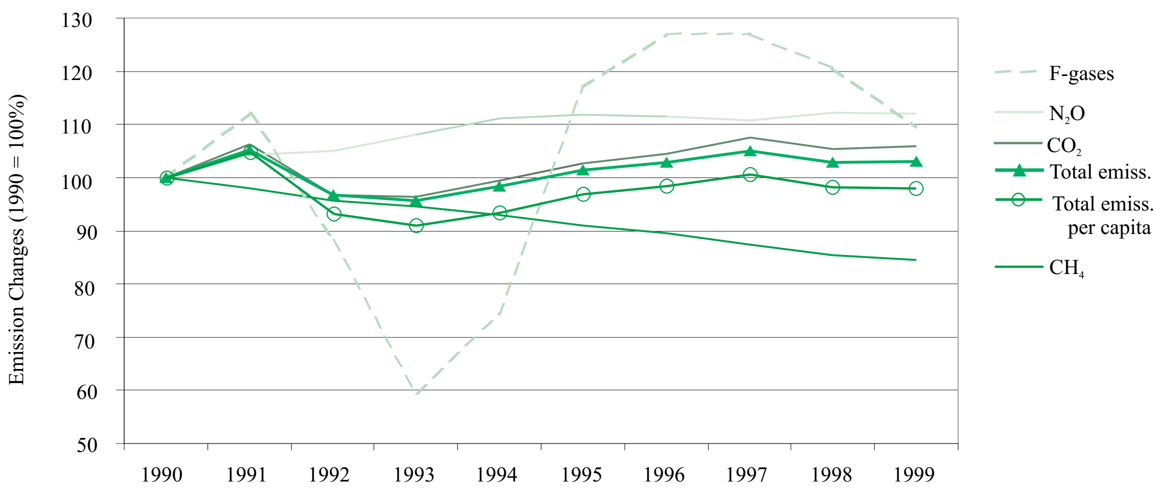


Figure 1.1: Trend of greenhouse gas emissions in Austria 1990–1999

tion' which could not be compensated byfor the decrease in other sectors such as 'Waste' and 'Agriculture'. The increase in the sector 'Fuel Combustion' is largely determined by the continuously increasing emissions from transport.

2 % niedriger als in den Jahren 1991 und 1997 (siehe Abb. 1.1). Die Zunahme der Emissionen beruht auf einem über 8%-igen Anstieg im Sektor „Verbrennung fossiler Energieträger", der nicht durch Emissionsrückgänge in anderen Sektoren wie „Abfall" und „Landwirtschaft" kompensiert werden konnte. Der Anstieg im Sektor „Verbrennung fossiler Energieträger" ist zu einem wesentlichen Teil durch das kontinuierliche Emissionswachstum im Verkehrssektor bedingt.

1.4 Policies and Measures

The Ministry of Agriculture, 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 is 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), the *Kyoto Forum*, responsible for coordination of climate change policies between the Federation, the *Länder* and municipalities, and the *Austrian Committee on Climate Change* (ACCC), dealing with scientific issues.

On the basis of this institutional framework, a national programme was formulated during 2000 and 2001. The draft *Austrian Climate Strategy 2010* is due for adoption by the federal government and the provincial governments. It should be stressed that most *Länder* (e.g. Vienna, Upper Austria, Lower Austria, Salzburg) have already adopted their own regional climate change programmes, taking into account specific regional circumstances, needs and areas of competence. These programmes ideally supplement the national programme, which can only describe framework conditions and guidelines for provincial action.

Nationale Maßnahmen

Das Bundesministerium für Land- und Forstwirtschaft, Umwelt und Wasserwirtschaft ist für die Koordination der österreichischen 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), das *Kyoto-Forum*, zuständig für die Koordinierung von Maßnahmen zwischen Bund, Ländern und Gemeinden, und der *Österreichische Klimabeirat* (ACCC), der sich mit wissenschaftlichen Angelegenheiten befasst.

Auf Basis dieser institutionellen Struktur wurde zwischen 2000 und 2001 ein nationales Programm ausgearbeitet. Der Entwurf zur „Nationalen Klimastrategie 2010" soll durch die Bundesregierung und die Landesregierungen angenommen werden. In diesem Zusammenhang ist festzuhalten, dass die meisten Länder (z. B. Wien, Oberösterreich, Niederösterreich, Salzburg) bereits eigene Klimaschutzprogramme beschlossen haben, in denen spezifische regionale Umstände, Bedürfnisse und Kompetenzen berücksichtigt sind. Die Programme der Länder unterstützen im Idealfall das nationale Klimaschutzprogramm, welches nur Rahmenbedingungen und Richtlinien für die Maßnahmen der Länder vorgeben kann. Eine Reihe von wichtigen Maßnahmen ist in den letzten Jahren umgesetzt bzw. beschlossen worden, beispielsweise die Vereinbarung gemäß Art. 15a B-VG über die Einsparung von Energie, Fördermaßnah-

Several important measures have been implemented or adopted over the past years, e.g. the Energy Saving Agreement between the Federation and the *Länder*, support schemes for energy efficient construction, renovation and the use of renewable energy sources, preferential feed-in tariffs for electricity from renewables, the Landfill Regulation, CO_2 labelling of passenger cars, a fuel consumption levy and other fiscal measures etc. A broad variety of other measures, including a more focused use of existing measures (e.g. promotion schemes), are in a planning stage or under discussion. Among these are economic instruments such as a GHG emissions trading scheme for major emitters within the EU and a programme on Joint Implementation and CDM.

Planned measures are designed to have a total mitigation effect of around 14 Mt CO_2 equivalent. A likely further gap to meet the target under the EU 'burden sharing' will be bridged by making use of the flexible Kyoto mechanisms. By sectors, special emphasis will be given to measures in the buildings and transport sector (with shares in total planned mitigation effort of nearly one third and about one fourth, respectively), as well as industry (including emissions from F-gases) and energy supply (about one sixth of total reduction each). Waste management and agriculture will also make significant contributions to total mitigation by domestic measures.

However, as a member of the European Union Austria's domestic action is also influenced by initiatives taken at the European level. The European Commission published a *European Climate Change Programme* in July 2001, which was formulated in close cooperation with member states and stakeholders. The announced initiatives could have far-reaching combined mitigation effects and might also result in an adaptation of certain national measures and strategies.

men für Energiesparmaßnahmen bei Hausbau und -sanierung sowie für die Nutzung erneuerbarer Energieträger, Einspeisetarife für Strom aus erneuerbaren Energieträgern, die Deponieverordnung, die Normverbrauchsabgabe und andere fiskalische Maßnahmen. Vielfältige andere Maßnahmen, einschließlich einer verstärkten Fokussierung bestehender Maßnahmen (z. B. Förderungen), sind in Vorbereitung bzw. in Diskussion. Darunter auch ökonomische Instrumente wie ein Treibhausgas-Emissionshandelsregime für Großemittenten auf EU-Ebene und ein Programm für Joint Implementation und CDM.

Die geplanten Maßnahmen sind auf einen Reduktionseffekt von rund 14 Mt CO_2-Äquivalent ausgelegt. Eine wahrscheinliche Lücke, die sich aus dem EU-internen Übereinkommen zur Aufgabenverteilung ergibt, wird durch die Verwendung der flexiblen Instrumente des Kyoto-Protokolls geschlossen werden. Das Schwergewicht wird auf Maßnahmen in den Bereichen Raumwärme und Verkehr (knapp ein Drittel und rund ein Viertel der geplanten Gesamtreduktion) sowie Industrie (inkl. Emissionen fluorierter Gase) und Energieaufbringung (jeweils ca. ein Sechstel der Gesamtreduktion) gelegt. Abfallmanagement und Landwirtschaft werden ebenfalls signifikante Beiträge liefern.

Als Mitglied der Europäischen Union sind Österreichs nationale Politiken und Maßnahmen durch Initiativen auf EU-Ebene beeinflusst. Die Europäische Kommission hat im Juli 2001 ein *Europäisches Klimaschutzprogramm* veröffentlicht, das in enger Kooperation mit den Mitgliedstaaten und Interessenvereinigungen ausgearbeitet worden war. Die angekündigten Initiativen könnten weitreichende Reduktionseffekte mit sich bringen und auch eine Anpassung einzelner nationaler Maßnahmen erforderlich machen.

1.5 Projections and Effect of Policies and Measures

Two approaches are taken in this report to develop projections of greenhouse gas emissions and to calculate the total effect of policies and measures. On the one hand, the estimated development according to the draft *Austrian Climate Strategy 2010* is shown, which is based on expert judgements for the year 2010. On the other hand, projections for the period 2000–2020 have been developed based on the energy model DEDALUS and the macroeconomic model MULTIMAC of the Austrian Institute for Economic Research and on the Austrian Carbon Balance Model. Both approaches show quite similar results. It should be kept in mind that results of model calculations and expert judgements must be interpreted with some caution, as expert judgements and model input parameters will always be influenced by contemporary common opinions and insights, which may change within a short time after projection development, and because models usually have limited capabilities to represent the detailed structures of greenhouse gas emitting sectors.

According to the projections of the draft *Austrian Climate Strategy 2010* a 6 % increase of greenhouse gas emissions by 2010, compared to 1999, can be expected with implemented and adopted measures. The model calculations show a slightly higher increase from 1999 to 2010 of about 9 % and a further increase from 2010 to 2020 of 4 % in the 'With Measures' scenario. Additional measures will lead to a 10 % decrease from 1999 to 2010; the model calculations show a further decrease of 4 % from 2010 to 2020. Table 1.2 and Figure 1.2 on the facing page give an overview of the expected development.

Emissionsprojektionen und Effekt nationaler Maßnahmen

Im vorliegenden Bericht werden zwei Ansätze für Emissionsprojektionen und Berechnung des Gesamteffekts der nationalen Maßnahmen verfolgt. Einerseits wird die Entwicklung nach den Abschätzungen im Entwurf zur Nationalen Klimastrategie dargestellt, die auf Expertenschätzungen für das Jahr 2010 beruhen. Andererseits wurden Projektionen für den Zeitraum 2000–2020, aufbauend auf dem Energiemodell DEDALUS und dem makroökonomischen Model MULTIMAC des Instituts für Wirtschaftsforschung sowie dem „Austrian Carbon Balance Model", entwickelt. Die Ergebnisse der beiden Ansätze sind gut vergleichbar. Bei der Interpretation von Modellergebnissen und Expertenschätzungen ist jedoch generell gebührende Vorsicht angebracht, weil Schätzungen und die Auswahl von Modellparametern immer durch aktuelle Meinungen und Ansichten geprägt sind, die sich innerhalb kurzer Zeit ändern können, und weil Modelle üblicherweise nur begrenzte Fähigkeiten besitzen, die detaillierten Strukturen emissionsrelevanter Sektoren nachzubilden.

Nach den Abschätzungen im Entwurf zur nationalen Klimastrategie ist mit den umgesetzten und beschlossenen Maßnahmen ein 6%-iger Zuwachs an Treibhausgasemissionen von 1999 bis 2010 zu erwarten. Die Modellrechnungen weisen für diesen Zeitraum eine etwas höhere Zunahme von rund 9 % aus und einen weiteren Anstieg um 4 % von 2010 bis 2020 auf Basis der bereits umgesetzten und beschlossenen Maßnahmen. Die zusätzlichen geplanten Maßnahmen werden zu einem Emissionsrückgang von 10 % zwischen 1999 und 2010 führen; die Modellrechungen zeigen einen weiteren Rückgang von 4 % zwischen 2010 und 2020. Tabelle 1.2 und Abb. 1.2 illustrieren die erwartete Entwicklung.

Table 1.2: Greenhouse gas emissions in Austria – projections for 2000–2020 (in million tons CO_2 equivalent)

	Emissions			With Measures				With Additional Measures			
	1990	1995	1999	2005	2010	2015	2020	2005	2010	2015	2020
Strategy	76.94	78.04	79.22		84.4				70.65		
Models				84.72	86.06	87.47	89.34	78.62	71.60	70.16	68.98

The aggregate effect of *implemented and adopted* policies and measures, which are listed in Chapter 4 of this report, is estimated at 4–5 million tons CO_2 equivalent for the year 2010 according to the expert judgements of the draft *Austrian Climate Strategy 2010*. A slight increase of the effect up to a maximum of 6 million tons until 2020 can be expected. The effect of planned measures as estimated in the draft *Austrian Climate Strategy 2010* is about 14 million tons for the year 2010. A quite similar figure of 14.5 million tons results from the model calculations for the year 2010; the effect is expected to increase to about 20 million tons annually until 2020.

Both the draft strategy and the model calculations indicate that the actual approach is appropriate to show demonstrable progress in greenhouse gas mitigation by 2005 and to follow Austria's Kyoto target under the EU burden sharing agreement. The remaining gap of around 3-3.5 Mt CO_2 equivalent between expected emissions during the commitment period 2008-2010 and the assigned amount of 67.2 Mt CO_2 equivalent should be bridged mainly by utilising the project-based flexible instruments of the Kyoto Protocol.

Der Gesamteffekt der umgesetzten und beschlossenen Maßnahmen, die in Kapitel 4 des Berichts beschrieben werden, liegt nach den Expertenschätzungen im Entwurf zur Nationalen Klimastrategie im Jahr 2010 bei 4–5 Mio. Tonnen CO_2-Äquivalent. Ein leichter Anstieg des Reduktionseffekts auf bis zu maximal 6 Mio. t pro Jahr bis 2020 ist zu erwarten. Der Effekt der geplanten Maßnahmen wird im Entwurf zur Nationalen Klimastrategie mit rund 14 Mio. t für das Jahr 2010 geschätzt. Die Modellrechungen weisen ein sehr ähnliches Ergebnis von 14,5 Mio. t für das Jahr 2010 aus; sie zeigen weiters eine Verbesserung des Reduktionseffekts auf rund 20 Mio. t pro Jahr bis 2020.

Sowohl der Entwurf zur Klimastrategie als auch die Modellrechnungen zeigen, dass die Vorgangsweise geeignet ist, um nachweisbare Fortschritte bei der Reduktion der Treibhausgasemissionen bis 2005 zu erzielen und dem österreichischen Kyoto-Ziel unter der Aufgabenverteilung innerhalb der EU nachzukommen. Die verbleibende Lücke von rund 3-3,5 Mio. Tonnen CO_2-Äquivalent zwischen den in der Verpflichtungsperiode 2008–2010 zu erwartenden Emissionen und der zugeteilten Emissionsmenge von 67,2 Mio. Tonnen CO_2-Äquivalent soll hauptsächlich durch die Nutzung der projektbasierten flexiblen Instrumente des Kyoto-Protokolls geschlossen werden.

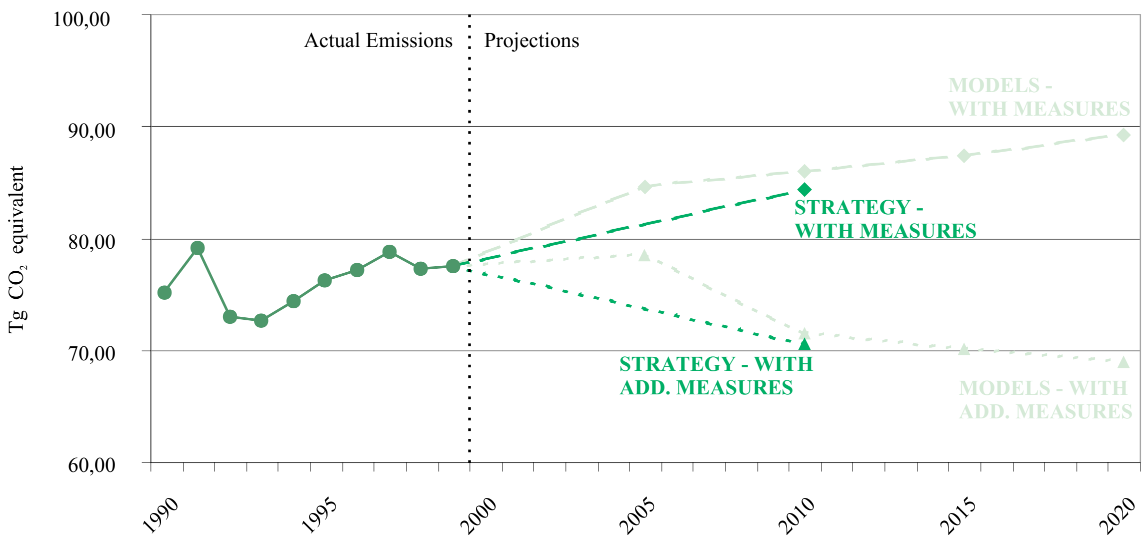


Figure 1.2: Greenhouse gas emissions in Austria – projections for 2000–2020

1.6 Vulnerability, 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 orographical structure. Although projections of climate changes are difficult to obtain and rather uncertain for mountain environments due to the limitations of current climate models, some conclusions based on current knowledge can be drawn.

It must be assumed that the length of time that snow cover remains will be reduced due to changed precipitation regimes, altering the timing and amplitude of runoff from snow, increasing evaporation, and decreasing soil moisture and groundwater recharge. As a consequence, flat areas as in the east of Austria, will experience hydrological conditions that are more distinct and severe than those in the mountains. Preliminary results imply that a rise of the European mean temperature by 1°C may reduce the length of the winter snow cover period by up to three weeks, depending on the altitude.

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

Mountains support a relatively broad distribution of climates and a high diversity of habitats within a small physical area. Changes in temperature and precipitation may lead to vegetational 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

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. 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.

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. Als Folge davon wird der Wasserhaushalt in den Ebenen, wie etwa im Osten Österreichs, ausgeprägtere Extrema aufweisen als im Bergland. Vorläufigen Ergebnissen zufolge kann ein Anstieg der europäischen Durchschnittstemperatur um 1°C je nach Höhenlage die Dauer der Schneebedeckung um bis zu drei Wochen verringern.

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 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.

With respect to adaptation, some measures have to be pointed out, which primarily serve the purpose of reduction of other environmental risks, but which are also beneficial for adapting to a climatic change. These measures range from the emission reduction of air pollutants over nature-conforming forestry to avalanche, erosion and torrent control.

Forest research and avalanche, erosion and torrent control, in particular, have a long tradition in Austria and are considered to be of vital importance to the country. About 47% of Austria is covered by forest; climate change is likely to alter the natural range of many forest tree species, the genetic diversity of which is one of the most important prerequisites for adaptation. Austria is undertaking scientific long-term efforts to evaluate macro- and microspatial genetic patterns, the impact of global change, and the impact of silviculture on the genetics of its domestic forest tree species.

The legal basis for measures of the state to control torrents and prevent avalanches was created in 1884. Nowadays the Forest Engineering Service on Torrent and Avalanche Control acts as a federal service throughout Austria for relevant protection measures. Responsibility comprises risk assessment and local planning, technical and biological counter-measures as well as quick intervention services in the event of natural disasters. Research is carried out in close co-operation with universities and other research institutions, for example the development of modelling tools for simulation of hydrology or

die Erwärmung der Erdatmosphäre bereits messbare Auswirkungen auf die alpine Pflanzenwelt zeigt.

Eine verkürzte Schneebedeckung wird auch den 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.

Im Hinblick auf die Anpassung an den Klimawandel müssen einige Maßnahmen herausgestellt werden, die in erster Linie der Minderung anderer Umweltrisiken dienen, die aber auch vorteilhaft für die Anpassung an geänderte Klimaverhältnisse sind. Diese Maßnahmen reichen von der Emissionsreduktion bei Luftschadstoffen über naturnahe Forstwirtschaft bis hin zur Wildbach- und Lawinenverbauung.

Insbesondere die Waldforschung und der Schutz vor Lawinen, Erosion und Wildbächen blicken in Österreich auf eine lange Tradition zurück und sind für das Land von grundlegender Bedeutung. Rund 47 % der Fläche Österreichs sind bewaldet; der Klimawandel wird voraussichtlich die natürliche Höhenlage vieler Baumarten ändern. Die genetische Vielfalt der Baumbestände stellt eine der wichtigsten Voraussetzungen für die Anpassung dar. Die räumliche Verteilung von Genotypen, die Auswirkungen globaler Änderungen und der Einfluss der Forstwirtschaft auf die genetischen Eigenschaften der heimischen Baumarten sind Gegenstand langfristiger Forschungsprogramme in Österreich.

Die rechtliche Grundlage für staatliche Maßnahmen zur Kontrolle von Wildbächen und zum Schutz vor Lawinen wurde bereits 1884 gelegt. Heute ist der Forsttechnische Dienst für Wildbach- und Lawinenverbauung bundesweit für die Implementierung von Schutzmaßnahmen zuständig; darunter fallen Risikobewertung und raumplanerische Aufgaben, technische und biologische Präventivmaßnahmen ebenso wie Hilfsmaßnahmen im Katastrophenfall. Naturgefahrenforschung wird dabei in enger Zusammenarbeit mit Universitäten und anderen Forschungseinrichtungen durchgeführt, beispielsweise die Entwickavalanches. Particular attention is given to the preservation and improvement of forests with respect to their protective function against erosion and avalanches.

lung von Rechenmodellen zur hydrologischen Modellierung und Lawinensimulation. Besonderes Interesse gilt auch der Erhaltung und Verbesserung des Waldes im Hinblick auf seine Schutzfunktion vor Erosion und Lawinen.

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. Since 1991 Austria has provided US$ 65 million to the GEF; the Austrian participation in the GEF has been financed in addition to existing commitments and payments to other international financial institutions.

With respect to bilateral financial assistance, it must be mentioned that projects of the Austrian official development assistance (ODA) have to comply with the target of environmental sustainability; a considerable share of projects has environment protection as main or significant additional target. Programme and project aid of the Federal Ministry for Foreign Affairs amounted to US$ 212 million from 1997 to 1999, which was about 15 % of total Austrian ODA. Austria's ODA is focused on several priority regions in Africa, the Himalayas and Central America with a large share of least developed countries. Further project-based support was granted by other ministries, Länder, municipalities and Austrian NGOs. US$ 292 million were contributed to the development assistance funds of the European Union by Austria during this period.

Bilateral efforts on projects of special relevance for climate change mitigation have been concentrated in the areas of small-scale hydro and micro hydro power plants (consulting, construction and rehabilitation, including education and training in the energy sector), solar energy and

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 in der Höhe von 65 Millionen US $ geleistet; die österreichischen Zahlungen an die GEF wurden zusätzlich zu bestehenden Verpflichtungen und Zahlungen an andere internationale Finanzinstitutionen 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 zum Ziel. Die Programm- und Projekthilfe des Bundesministeriums für Auswärtige Angelegenheiten betrug in den Jahren 1997 bis 1999 212 Mio. US $; dies entsprach rund 15 % der gesamten Öffentlichen Entwicklungshilfe in diesem Zeitraum. Die österreichische Öffentliche Entwicklungshilfe ist auf einige Schwerpunktregionen in Afrika, im Himalaja und in Zentralamerika mit einem erheblichen Anteil an am wenigsten entwickelten Ländern (LDCs) fokussiert. Darüber hinaus wurden durch andere Bundesministerien, Länder, Gemeinden und nicht-staatlichen Organisationen weitere projektorientierte Mittel zur Verfügung gestellt. Ein Beitrag von 292 Mio. US $ wurde im genannten Zeitraum an den Entwicklungsfonds der EU geleistet.

Bilaterale Projekte von besonderer Bedeutung für die Verhinderung eines Klimawandels wurden insbesondere in den Bereichen Kleinwasserkraft (Beratung, Bau und Sanierung, Ausbildungsmaßnahmen), Solar-energy efficiency in rural areas and protection of rain forests.

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

Austria is a member of institutions and initiatives that have the exchange of research results and transfer of technology as a main target, e.g. the International Energy Agency (IEA) and the Climate Technology Initiative. Austria currently participates in 11 Implementing Agreements of the IEA, 9 of 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. Examples for technology transfer in the areas of solar energy, small scale hydro power, efficient energy use and biofuel are shown in Chapter 7 of this report.

energie und Energieeffizienz in ländlichen Gebieten sowie Schutz des Regenwaldes durchgeführt.

Österreich hat außerdem Beiträge an multilaterale Institutionen geleistet wie der Internationalen Entwicklungsagentur, den Entwicklungsfonds für Afrika und Asien und dem Internationalen Fonds für Landwirtschaftliche Entwicklung. Diese Beiträge können nicht spezifisch für die Implementierung der Rahmenkonvention über Klimaänderungen angerechnet werden; eine solche Zuordnung muss auf der Ebene der einzelnen Institutionen in Übereinstimmung mit den von ihnen finanzierten Aktivitäten erfolgen.

Österreich ist Mitglied von Institutionen und Initiativen, zu deren Zielen der Austausch von Forschungsergebnissen und der Technologietransfer zählt, beispielsweise der Internationalen Energieagentur (IEA) und der *Climate Technology Initiative*. Derzeit ist Österreich an 11 *Implementing Agreements* der IEA beteiligt, von denen sich 9 mit „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 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. Entsprechende Beispiele aus den Bereichen Solarenergie, Kleinwasserkraft, Energieeffizienz und Biomasse sind in Kapitel 7 des Berichts angeführt.

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 programs, at both the national and the international level. Climate system research and research on climate change impacts

Forschung und systematische Beobachtung

Mit der Unterstützung zahlreicher Forschungsprojekte und –programme sowohl auf nationaler als auch auf internationaler Ebene engagiert sich Österreich bei der Förderung von Forschungsvorhaben und der systematischen Beobachtung des Klimasystems. Klima- und Klimafolgenforschung werden durch die are heavily influenced by the Alps, which cover almost two thirds of the surface area of Austria. A considerable share of research projects is focused on issues specific for alpine regions. With respect to mitigation technologies, biomass and solar energy are of special interest to Austrian researchers.

The Austrian Network for Environmental Research (Österreichisches Netzwerk Umweltforschung) was founded in 1996, primarily to coordinate the Austrian climate and environmental research. The main objective of the network is the promotion of international research activities and the support of environmental scientists. One of its nodes is devoted to Climate, Impacts of Climate Change and Atmospheric Environmental Research.

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

Alpen geprägt, die annähernd zwei Drittel der Fläche Österreichs einnehmen. Ein beträchtlicher Anteil an Forschungsprojekten befasst sich mit Themen, die spezifisch für alpine Regionen sind. Im Hinblick auf Technologien zur Vermeidung des Klimawandels sind Biomasse und Solarenergie von besonderem Interesse für österreichische Forscher.

Das Österreichische Netzwerk Umweltforschung wurde 1996 eingerichtet, um insbesondere die Umwelt- und Klimaforschung in Österreich zu koordinieren. Hauptaufgabe des Netzwerks ist die Förderung der internationalen Vernetzung von Forschungsaktivitäten und die Unterstützung von Umweltwissenschaftlern. Einer der Netzknoten ist der Klima-, Klimafolgen- und atmosphärische Umweltforschung gewidmet.

Die sehr heterogenen Witterungsverhältnisse 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 3106 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.

1.9 Education, Training and Public Awareness

Environmental education in schools has become 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.

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 gewid-

The implementation of a programme for sustainable development in schools was begun in the second half of the 1990s; the program aims at incorporation of the topic in teaching on the one hand and at reduced consumption of resources in school buildings on the other hand. The relevant ministries have established a forum for the development of programs, methods and materials for environmental education with dedicated funding. Awareness of climate issues in schools is strengthened by various initiatives at federal and Länder level, e.g. by competitions and workshops. Austria also plays an active role in the OECD/CERI network *Environment and School Initiatives*.

Training programmes and seminars have been established by public institutions and regional energy agencies for different target groups. Independent advisory services on energy issues, which are offered free of charge to private households by energy agencies, several non-profit environmental consulting organisations and partly by the Länder authorities themselves, have received enormous interest from the population throughout recent years. Related programmes directed especially at small and medium enterprises exist in many Länder. Training and advisory services dealing with sustainable farming and forestry are offered by the regional Chambers of Agriculture to their members.

Empirical surveys in the mid 1990s showed that the topic of the environment played an important role for the general public; air pollution and its effects such as forest damage and the greenhouse effect gave rise to major concern among the population. The activities of the Federation and Länder aimed at supporting the willingness to make personal contributions to protect the climate system and at providing relevant facts and information. Campaigns and initiatives focused on climate change in general, but also on the topics of transport and energy. The former Federal Ministry for the Environment, Youth and Family Affairs launched a climate information campaign in 1997, based on TV spots and supplemented it with an information CD-ROM, for example.

met. Die Umsetzung eines Programms für nachhaltige Entwicklung in den Schulen wurde in der zweiten Hälfte der 1990er-Jahre begonnen; das Programm zielt zum einen auf die Einbindung des Themas in den Unterricht, zum anderen auf einen verringerten Ressourcenverbrauch in den Schulgebäuden und vermehrte Nachhaltigkeit im Schulleben. Die zuständigen Ressorts haben mit dem „Forum Umwelterziehung" eine Plattform für die Entwicklung von Programmen, Methoden und Unterrichtsmaterialen eingerichtet und stellen dafür Finanzmittel zur Verfügung. 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, die den Haushalten kostenlos von Energieagenturen, Umweltberatungen und teilweise von den Ländern direkt angeboten wird, wurde in den letzten Jahren intensiv von der Bevölkerung in Anspruch genommen. In einer Reihe von Ländern bestehen auch vergleichbare Programme für Klein- und Mittelbetriebe. Die Landwirtschaftskammern bieten ihren Mitgliedern Beratung und Weiterbildung zum Thema nachhaltige Land- und Forstwirtschaft an.

Empirische Erhebungen in der Mitte der 1990er-Jahre zeigten, dass das Thema Umwelt in der Bevölkerung einen besonderen Stellenwert besitzt; besorgt zeigt sich die Bevölkerung insbesondere über Luftverschmutzung, Waldsterben sowie Treibhauseffekt. Aktivitäten von Bund und Ländern zielen darauf ab, die Bereitschaft zur persönlichen Beteiligung an Klimaschutzmaßnahmen zu unterstützen und entsprechende Fakten und Informationen zur Verfügung zu stellen. Kampagnen und Initiativen waren auf den Klimaschutz im allgemeinen, aber auch auf die Themen Verkehr und Energie ausgerichtet. Das ehemalige Bundesministerium für Umwelt, Jugend und Familie führte beispielsweise im Jahr 1997 eine Klimainformationskampagne durch, die auf Fernsehspots beruhte und durch eine Informations-CD-ROM ergänzt wurde.

Climate change issues are regularly covered in brochures, magazines and web sites published by Länder and municipalities. Many initiatives can be found which contribute to increased public awareness about climate change and mitigation measures, such as the participation of municipalities in the European 'Car Free Day' initiative, pilot projects for sustainable commuting and car-free tourism, competitions such as the 'Energy Globe Award' for outstanding projects in the fields of energy efficiency and renewable energy sources.

Particular mention must be made of the Climate Alliance, which is a partnership between more than 1000 European local authorities and indigenous rainforest peoples of Amaconia with the goal of protecting the earth's atmosphere. In Austria more than 400 municipalities and 8 *Länder* 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.

Klimarelevante Themen werden auch regelmäßig in Broschüren, Zeitschriften und Webseiten von Ländern und Gemeinden behandelt. Es ließen sich viele Initiativen aufzählen, die zum öffentlichen Bewusstsein hinsichtlich Klimawandel und seine Bekämpfung beitragen, beispielsweise die Beteiligung von Gemeinden in der europäischen Initiative „Car Free Day", Pilotprojekte für nachhaltigen Berufsverkehr und autofreien Tourismus und Wettbewerbe wie jener zum „Energy Globe Award" für herausragende Projekte in den Bereichen Energieeffizienz und erneuerbare Energieträger.

Besonders erwähnenswert ist auch das „Klimabündnis", das eine Partnerschaft zwischen mehr als 1000 Gemeinden und Städten in Europa und den indigenen Einwohnern der Regenwälder Amazoniens zum Schutz der Atmosphäre darstellt. In Österreich haben sich über 400 Gemeinden und 8 Bundesländer 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

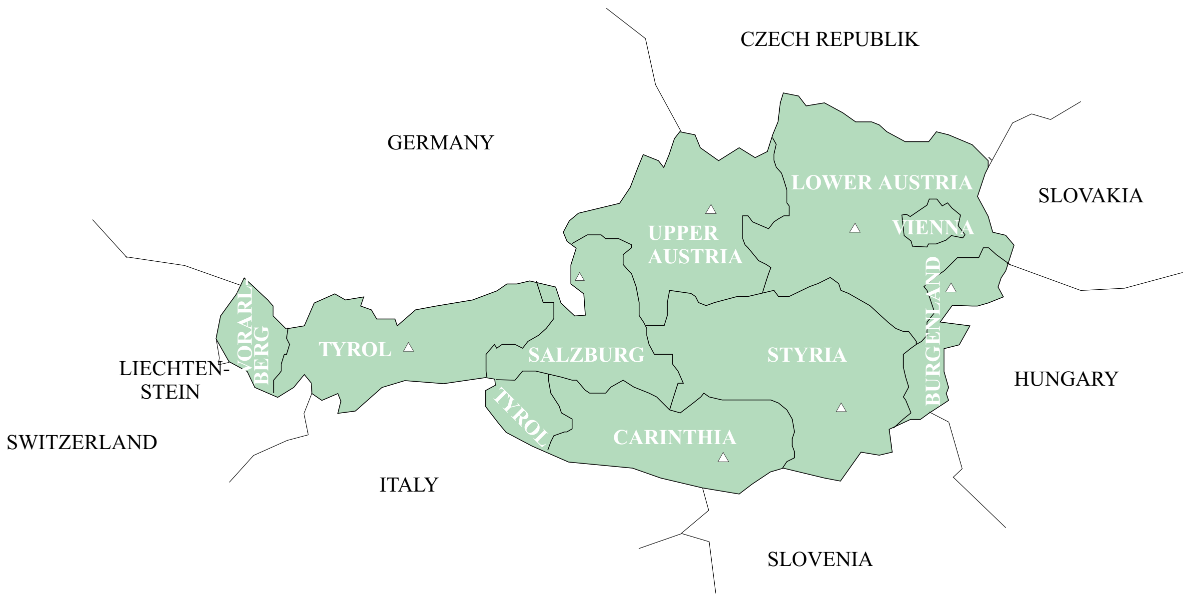


Figure 2.1: Austria and its neighbour countries

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 Geographical Profile

Austria is situated in southern central Europe, 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 exposed to all 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. 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 %).

About 70 % of Austria's surface is situated higher than 500 m, 40 % higher than 1000 m above sea level; 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.

2.2 Climate Profile

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

Since 1880 an increase of about 1.5°C in average temperatures has been measured in Austria, a trend, which could be observed in all regions, whereas precipitation shows no homogeneous trend. In the western part, a rising tendency was observed during the 20th century; in the east and south precipitation has shown a falling tendency since the 1940s. Exceptionally warm years could be observed during the last fifteen years, the last decade (1990-1999) was the warmest of the century. In Vienna, 1992, 1994 and 2000 were the years with the highest average temperature since the beginning of measurements in 1775.

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 19^{th} century. This tendency has increased since the early 1980s.

2.3 Population Profile

Austria's total permanent population reached 8.09 million inhabitants in 1999, after declines in the late 1970s and stagnation in the early 1980s (see Figure 2.2). This represents an increase of some

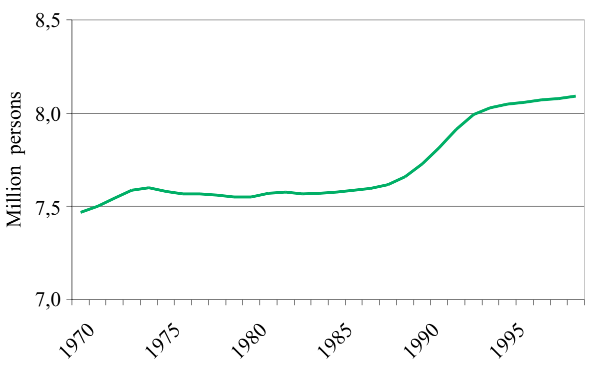


Figure 2.2: Development of Austrian Population

500,000 since 1987, which is mainly due to immigration. The population density is about 97 inhabitants per square kilometre.

Infant mortality is at 4.4 per 1,000 live births. The number of births per woman has been continuously decreasing since the sixties and is currently at 1.31. The balance of births shows a birth-deficit for the first time in 1999 since 1986. Life expectancy at birth is 75.1 years for male and 80.9 years for female persons.

In 1999, 17 % of the Austrian population was younger than 15 years of age, 63 % was between the ages of 15 and 59 and 20 % was 60 years old or older. The Austrian population is aging; in 2030 over a third of all Austrians is expected to be 60 years or older. Future trends of Austrian population growth and age structure will be primarily determined by immigration policies.

2.4 Government structure

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

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

Every federal province 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-

Table 2.1: Development of GDP in the period 1970-2000 (Source: OECD National Income Accounts)

	GDP at Current Prices			GDP per Capita		GDP at 1995 Prices			GDP per Capita		GDP Price Index		GDP %-Share of Sectors		
Year	10^9 ATS	10^9 €	Chg.	10^3 ATS	10^3 €	10^9 ATS	10^9 €	Chg.	10^3 ATS	10^3 €	Index	Chg.	Prim.	Sec.	Tert.
1970	389.4	28.3		52.1	3.79	1192.8	86.7		159.7	11.61	32.6		2.7	31.2	66.1
1975	679.7	49.4		89.7	6.52	1446.5	105.1		190.9	13.87	47.0		2.4	31.0	66.6
1980	1028.0	74.7		136.2	9.90	1702.3	123.7		225.5	16.39	60.4		2.3	30.5	67.2
1985	1385.1	100.7		183.3	13.32	1827.7	132.8		241.8	17.57	75.8		2.3	29.4	68.4
1990	1838.4	133.6		238.2	17.31	2142.0	155.7		277.5	20.17	85.8		2.1	29.0	68.8
1995	2370.7	172.3		294.6	21.41	2370.7	172.3		294.6	21.41	100.0		2.4	29.2	68.4
1996	2450.0	178.0	3.3 %	304.0	22.09	2418.2	175.7	2.0 %	300.1	21.81	101.3	1.3 %	2.5	29.2	68.3
1997	2513.5	182.7	2.6 %	311.4	22.63	2450.4	178.1	1.3 %	303.6	22.06	102.6	1.2 %	2.4	29.8	67.8
1998	2614.7	190.0	4.0 %	323.7	23.52	2530.2	183.9	3.3 %	313.2	22.76	103.3	0.7 %	2.4	30.0	67.7
1999	2712.0	197.1	3.7 %	335.2	24.36	2601.6	189.1	2.8 %	321.5	23.36	104.2	0.9 %	2.3	29.8	67.9
2000	2833.9	205.9	4.5 %	349.6	25.41	2685.3	195.1	3.2 %	331.3	24.07	105.5	1.2 %	2.2	30.4	67.4

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') in which they agree to undertake certain actions, jointly or separately.

2.5 Economic Profile

Austria's economic performance in terms of GDP growth lists in the top ranks of the industrialised countries. In 2000 GDP at current prices was ATS 2833.9 billion (€ 205.9 billion). With a per capita GDP of ATS 349,600 (€ 25,410) Austria belongs to the most prosperous economies of the world. Both the opening of Central and Eastern Europe in 1989 and the accession of Austria to the European Union in 1995 have been shaping the growth and structure of the Austrian economy.

Austria has the characteristics of a small open economy, with imports amounting to 58.8 percent of GDP and exports reaching 54.8 % of GDP. Its main trading partner is Germany with a 33 % share of total exports and 44 % share of total imports. Trade with the economies in transition of Central and Eastern Europe has outperformed other countries.

The sectoral composition of Austria's GDP has been remarkably stable at least in terms of the 1999 GDP shares of primary production (2.2 %), secondary production (30.4 %) and tertiary production (67.4 %). Austria is one of the few countries in the world that heavily depends on exports from tourism. Obviously this sector is highly vulnerable to weather conditions. This is one way in which climate change might impact not only the tourist regions, but also the economy as a whole.

2.6 Energy Profile

Compared to other industrialized countries the Austrian energy sector has a rather low energy intensity (both in terms of GDP and per capita) and a rather high share of renewables that amounts to 11.6 % hydro power and 11.9 % other renewables (mainly biomass) of total gross energy consumption in 1999 (see Figure 2.3). Public awareness of the importance of renewables is high since they also offer economic opportunities; this may be illustrated by the fact that Austria is among those countries with the highest installed area of solar collectors per capita in Europe.

Nevertheless energy supply in Austria is still heavily dependent on fossil fuels, with shares of 11.3 % of coal products, 41.0 % of oil products, and 24.1 % of natural gas of total gross energy consumption in 1999. There has been a shift towards natural gas and a decline in coal with oil products remaining comparatively stable over the last fifteen years (see Figure 2.4 on the next page). Around two thirds of gross energy consumption stem from imports, a share that has been also rather stable.

Final energy consumption is characterized by increasing shares of electricity (19.4 %), gas (18.1 %) and district heating (4.6 %). The share of coal has been reduced by half to 6 % since 1980; oil has held a constant share of approx. 40 % since the 1980s, after a steady decrease from more than 50 % during the 1970s. Renewables including waste now com-

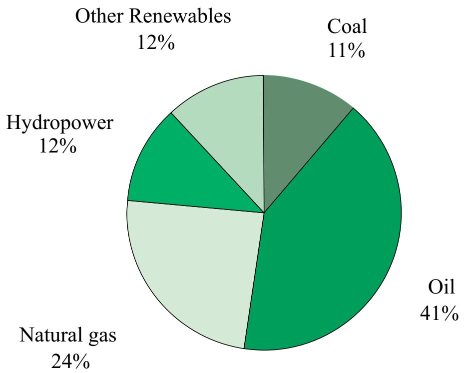


Figure 2.3: Structure of gross energy consumption 1999 (Source: IER)

Table 2.2: Supply of energy and structure of energy supply to final consumers by fuel (Source: Statistik Austria. Figures from 1993 onwards are based on a different methodology than those prior to that year.)

	Gross domestic consumption		Final consumption		Domestic production	Imported energy	% Shares in Supply to final consumers					
							Fossil fuels					
Year	PJ	MJ/cap.	PJ	MJ/cap.	PJ	PJ	Solid	Liqu.	Gas	Renewables	District heating	Electricity & hydro
1970	793.7	106.3	616.6	82.6	378.6	469.5	19.9	51.6	11.0	4.3	0.9	12.3
1975	867.3	114.2	668.9	88.3	354.7	533.5	13.2	52.4	14.6	4.1	1.4	14.3
1980	948.1	125.6	749.8	99.3	348.0	718.1	12.4	47.5	16.2	5.7	2.0	16.2
1985	997.9	131.7	749.1	98.9	410.0	719.4	13.3	41.8	15.5	8.7	2.9	17.8
1990	1116.7	144.5	832.7	107.7	418.5	771.6	8.6	39.1	15.6	15.3	2.9	18.5
1995	1133.4	140.8	880.4	109.4	382.5	829.0	7.1	39.4	17.8	12.7	4.0	18.9
1996	1177.7	146.1	923.3	114.6	379.2	896.2	7.1	38.1	18.4	13.2	4.6	18.6
1997	1193.2	147.8	927.5	114.9	380.4	900.9	7.1	39.2	18.1	12.6	4.3	18.7
1998	1191.0	147.4	928.9	114.5	385.4	940.2	6.5	39.8	18.1	12.1	4.4	19.0
1999	1198.3	148.1	939.5	116.1	405.1	924.6	6.1	39.7	18.1	12.2	4.6	19.4

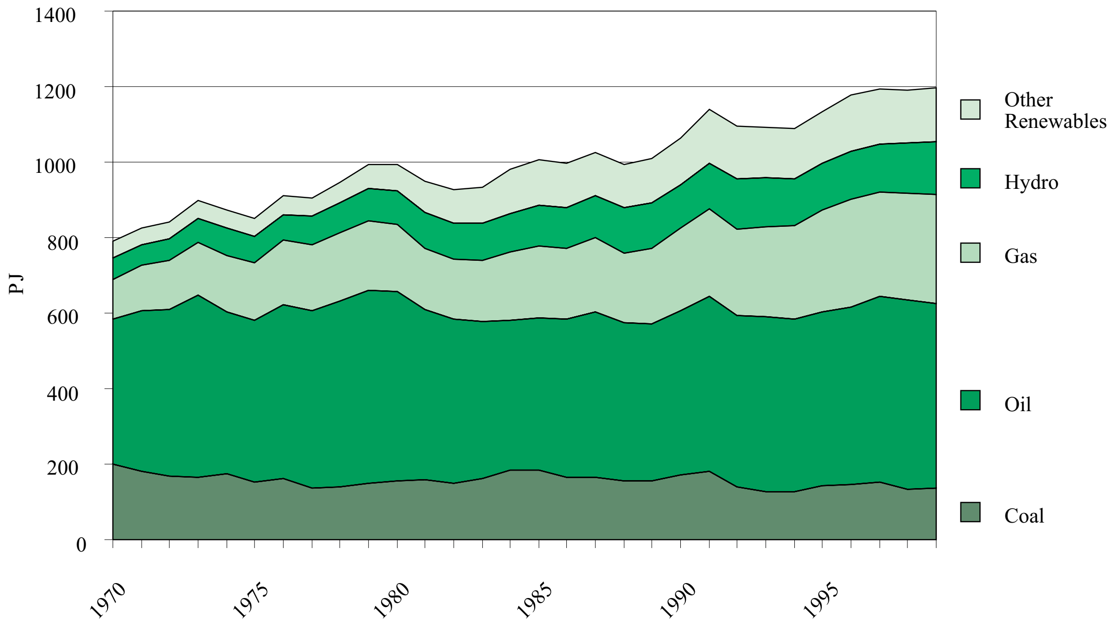


Figure 2.4: Gross energy consumption 1970–1999 (Source: IER)

prise about 12 %. Some 70 % of electricity is generated by hydro power. Final energy consumption per capita amounted to 116 MJ in 1999.

Table 2.3: Final energy consumption by branches and application 1999 (Source: Statistik Austria)

	PJ	%-share
Total final energy	939.5	100.0
by branches		
Agriculture	36.3	3.9
Goods production	370.2	39.4
Services	176.5	18.8
Private households	356.5	37.9
by application		
Transportation	255.3	27.2
Space heating, hot water,		
air conditioning	339.3	36.1
Lighting, electronic		
data processing	27.6	2.9
Steam generation	78.6	8.4
Industrial furnaces	141.3	15.0
Stationary engines	95.9	10.2
Electrochemical use	1.4	0.2

Energy demand shares by sectors have remained almost stable during recent years. The share of private households (1999: 38 %) shows a falling tendency; the share of goods production (39 %) has grown, although energy consumption in this sector did not rise to the same extent as goods production itself grew. In 1999 final energy input amounted to 939.52 PJ, of which 36 % was used for space heating and hot water generation, 27 % for transport, 15 % for industrial furnaces, 10 % to stationary engines, 8.4 % to steam generation and 3 % for lighting/electronic data processing.

Energy demand shares by sectors have remained almost stable during recent years. The share of private households (1999: 38 %) shows a falling tendency; the share of goods production (39 %) has grown, although energy consumption in this sector did not rise to the same extent as goods production itself grew. In 1999 final energy input amounted to 939.52 PJ, of which 36 % was used for space heating and hot water generation, 27 % for transport, 15 % for industrial furnaces, 10 % to stationary engines, 8.4 % to steam generation and 3 % for lighting/electronic data processing.

2.7 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 1999 the share of agriculture and forestry in GDP was 1.3 %. The agricultural quota of the working population amounts to 4.2 %.

According to the 1999 Farm Structure Survey 217,500 farms are managed in Austria, of which more than one third are mountain farms. Despite increased structural change, Austrian agriculture and forestry are small-structured; two thirds of the holdings comprise less than 20 hectares. 70 % of the holdings and 69 % 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 41 %, grassland 27 %, extensive grassland 30 % and other types of agricultural land use (vineyards, orchards and house gardens, . . .) 2 %.

62 % of final production stem from animal products, 38 % from plant production. 2.15 million heads of cattle were counted in 1999, which is 17 % less than in 1990. The number of pigs decreased by 7 % to 3.43 million. The number of chickens (1999: 13.8 million) grew as did the number of sheep, goats and horses (less than half a million combined). Domestic production was 10 % higher than domestic consumption for meat, 6 % for grain and rather balanced for most other animal products.

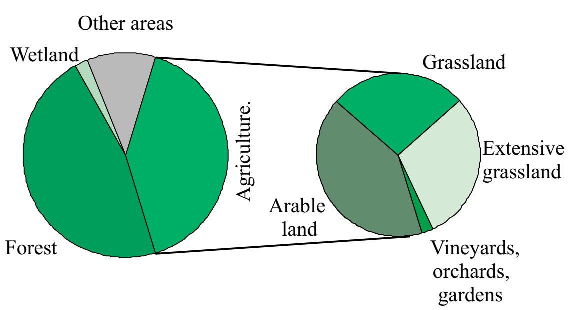


Figure 2.5: Land cover / land use in Austria 1999

The number of organic farms increased from 200 in 1980 to 19,741 in 1999. 70 % of all agricultural enterprises are participating in the Austrian environmental programme 'ÖPUL', the results are reduced use of fertilisers, the increased application of organic methods and resources and the expansion of crop rotation. Since the mid 1970s, consumption of mineral fertiliser has been halved as a result of a trend towards a fertilization meeting the demands. With 50 kg of mineral nitrogen-fertiliser used per hectare agricultural area[1] annually Austria lies below the EU average, about the same amount of nitrogen from manure is applied per year on average.

The Austrian Forest Inventory 1992–96 showed an increase in wooded area of 7,700 hectares per year, mainly in agricultural areas and alpine pastures, and a trend towards mixed forest stands with a higher percentage of leaf-wood. During recent years, the annual felling quantity has been less than the annual growth. As a result, growing stock in Austria's forests has increased to approx. one billion cubic metres of solid timber.

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

2.8 Waste

According to the *Federal Waste Management Plan 2001* the total estimated amount of waste generated in Austria in 1999 was about 49 million tons per year. Excavation material accounted for nearly half of this (20 million t/a), while the mass potential for hazardous waste is estimated at 1 million t/a or 2.1 % of total waste. The change in total mass potential compared to the *Federal Waste Management Plan 1998* (1996: 46.5 million t/a) is mainly due to a better understanding of the generation of individual types of waste and the introduction of Austrian Standard ÖNORM S 2100 (waste

[1]Figures in relation to the agricultural area which is deemed to be appropriate for fertilisation; pastures for example are not covered.

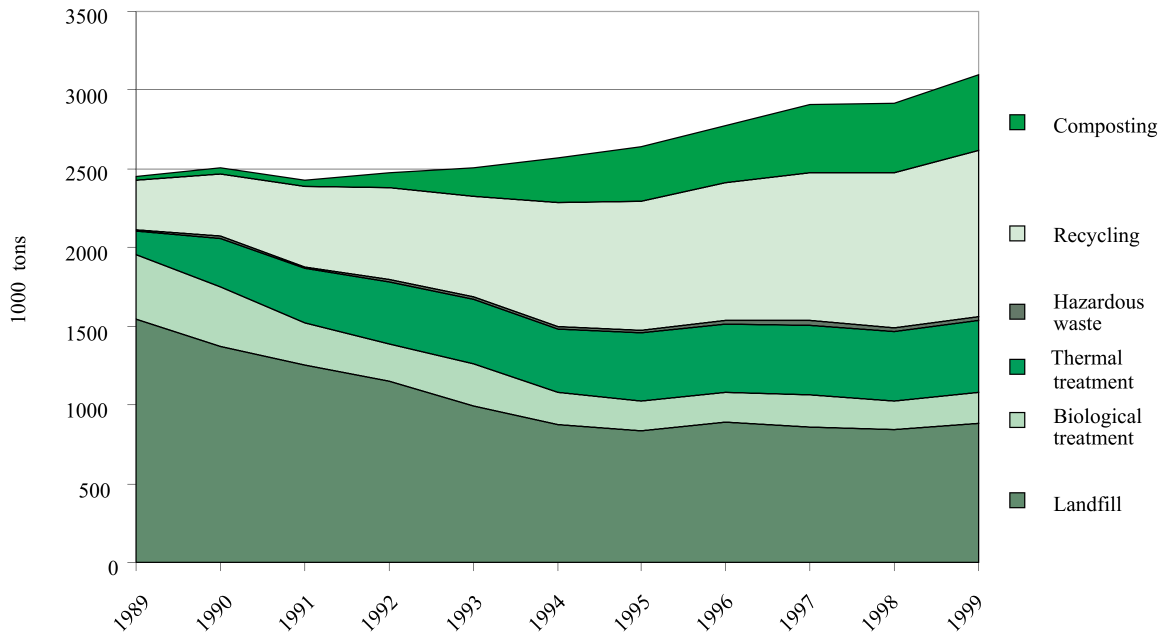


Figure 2.6: Household waste, treatment and recycling 1989–1999

catalogue) and cannot be seen as an overall increase in the amount of waste.

About 10 % of total waste excluding excavation material is incinerated for energy recovery; 63 % is collected for conditioning and recovery; 27 % undergo other treatments.

Waste from households and similar institutions rose by 12 % between 1996 and 1999 to 3.1 million tons. In 1999, 28.5 % went directly without pretreatment to sanitary landfills, compared to 63.1 % in 1989. Including residues from treatment, 43.1 % of household waste was disposed of in landfills (1989: 74.8 %). Residual and bulk waste has been reduced by approx. 27 % since the end of the 1980s. However, since 1998, an increase has been registered. As a result of separate collection, 1.06 million tons of secondary material (glass, paper, metal, ...) and 478,000 tons of organic waste were collected in 1999. See figure 2.5

The Landfill Ordinance, passed in 1996, regulates the equipment and operational mode of sanitary landfills according to the state of the art. It allows the disposal of waste containing more than 5 % of total organic carbon (TOC) only until 1 January 2004, under certain circumstances until 31 December 2008. Since 1991, methane emissions caused by waste management have been decreasing.

2.9 Transportation

Economic and demographic development in the past decades entailed an enormously increased transport performance in terms of passenger as well as freight transport. The number of motor vehicles rose from 2.2 million in 1970 to 5.6 million in 2000.

In 1999 Austria's passenger transport amounted to approx. 118 billion passenger kilometres. This translates into a distance travelled per inhabitant per year of 14,860 km, which is almost a doubling compared to 8,460 km in 1970. In the previous decade (1990–1999) passenger transport rose by 22 %. About 74 billion passenger kilometres were travelled by passenger cars, about 28 billion by public transport, 7.5 billion by plane. Above all, transport by passenger cars and air transport, which have continuously gained in importance since the 1980s, are expected to go on rising. (See also Fig. 2.7 on the facing page)

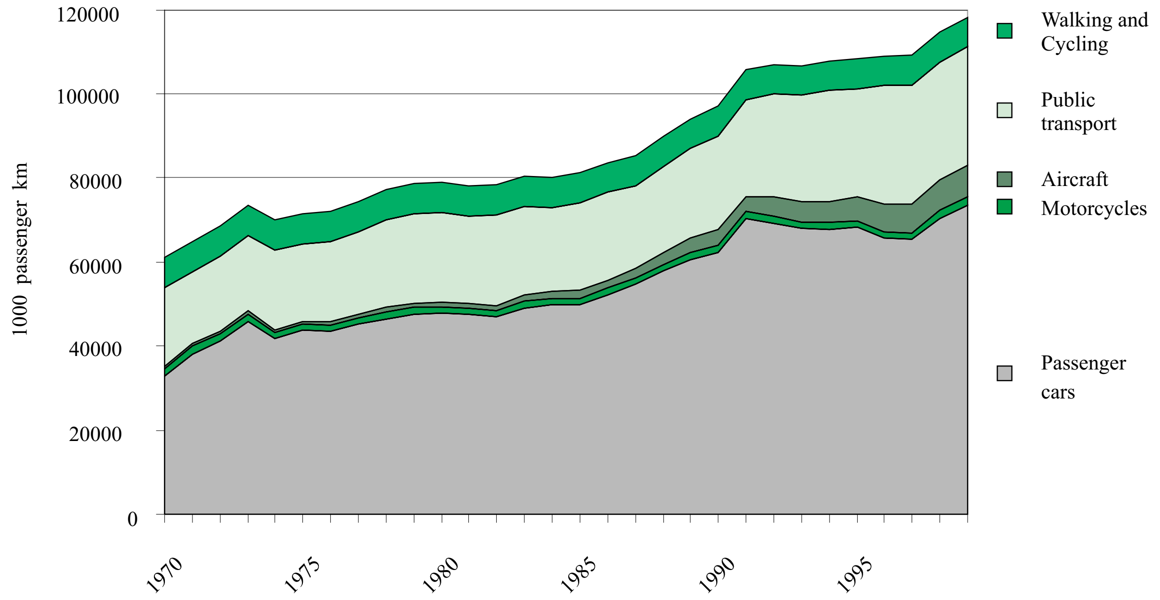


Figure 2.7: Trend in passenger transport in the period 1970–2000

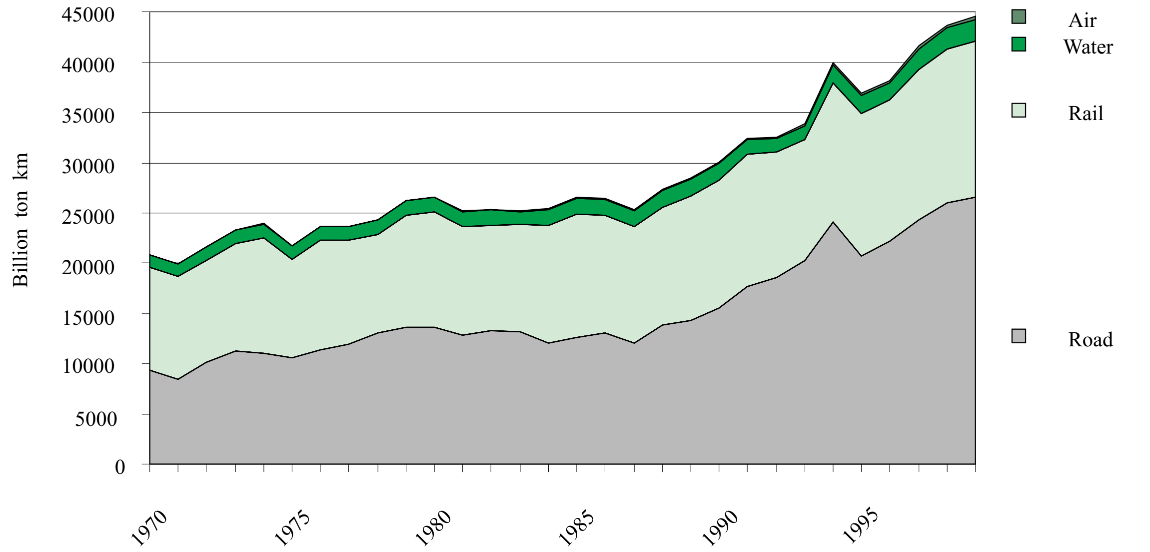


Figure 2.8: Trend in freight transport in the period 1970–2000

The total performance in freight transport in 1999 amounted to approx. 45 billion ton kilometres, of which road transport counted for nearly 27 billion, rail for nearly 16 billion and ship for some 2 billion ton kilometres. Therefore, freight transport is also predominated by the proportion of road transport. Particularly noticeable is the considerable increase in the transport of goods by road transport from the mid 1980s onward. In the period from 1990 to 1999 total freight transport rose by 48 %, whereas road transport grew by 71 %. (See also Fig. 2.8 on the preceding page)

After a slight decrease in the mid 1990s, CO_2 emissions caused by transport have been increasing during recent years. The main sources are passenger cars and lorries. Emissions of nitrogen oxides and volatile organic compounds have been significantly reduced by introducing the mandatory use of a catalytic converter in cars with gasoline engines and of activated carbon filters for tanks and by considerable improvements in fuel quality.

Due to its geographic location in the heart of Europe, being a junction for north-south as well as for west-east traffic, Austria severely suffers from transit transport. Transit transport accounts for nearly one third of total freight transport. Increasing national and international commerce and the improvement of the road network caused an increase in goods transport and a shift towards road haulage. A large part of the transit freight transport follows the Brenner route where in 1999 alone, the freight volume increased by 14 %; only 24 % of the goods were transported by rail. The transit problem has to be solved at the international level, also taking EU enlargement into consideration, meaning a new challenge in this context.

2.10 Building stock and urban structure

About 38 % of Austria's total area is, in principle, available for settlement, with a smaller share of only 25 % in the Alpine region. Population density in this area is 257 persons/km^2. One fifth of all Austrians (1.6 million), live in Vienna, the only

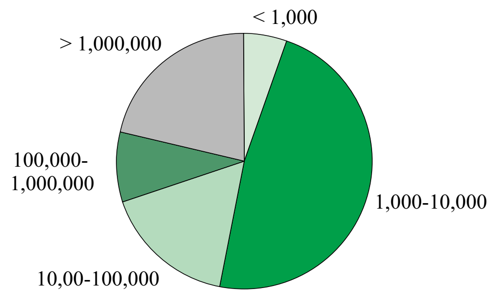


Figure 2.9: Population distribution according to size of communes

Austrian city with more than one million inhabitants. 8.8 % live in the four cities with more than 100,000 inhabitants each, these being Graz, Linz, Salzburg and Innsbruck. About one half of all Austrians live in communes with between 1,000 and 10,000 inhabitants. Two thirds live in municipal communes, one third in rural communes (census 1991).

In recent decades, the number of households and dwellings increased to a much higher extent than population did. While in 1999 the number of households (3.25 million) was 41 % higher than in 1961, population growth was 14 % during the same time. The percentage of single households has reached 30 % compared to 20 % in 1961. On average, 2.4 people live in a household. The tendency towards single households is projected to continue. Average useful floor space has increased from 84 m^2 per dwelling in 1991 to 91 m^2 in 2000 and from 33 m^2 per person to 37 m^2.

According to 1999 micro census, 19.7 % of the dwellings (principal residences) were built before 1919; 21.9 % between 1919 and 1960; 32.7 % between 1961 and 1980; and 25.7 % after 1981. As the greatest part of energy in the residential sector is used for space heating, a large share of energy savings has to come from improving existing buildings. Energy losses can be considerably reduced by insulation and replacing inefficient heating systems with highly efficient ones. Since 1980 the share of dwellings with central heating and district heating has risen from 33 to 60 %.

2.11 Industry

With regard to the growth of its industrial sector, Austria ranks among the leaders within the EU countries. In real terms, industrial production showed an increase of 32 % between 1990 and 2000. Economic growth has manifested itself mainly in the areas of traditional industrial goods and in the labour-intensive sectors. In the research- and capital-intensive sector little growth is registered. Compared to other industrialized countries basic materials industries still plays a decisive role in Austria.

Some 30 % of Austria's economic productivity is derived directly from industry. The most important branches of goods production are machines and steel construction, electrical industry, chemicals, iron and metal goods, food and vehicles. Turnover per employee in the manufacturing and building sector was ATS 1.29 million (€ 93,000) in 1998, which means an increase of 31 % compared to 1995; net production per employee rose by 16 % to ATS 631,000 (€ 45,857). The investment rate was 6.9 % of turnover in 2000.

ATS 50.2 billion (€ 3.65 billion), that is 1.79 % of GDP, were spent for research and technology development in 2000, compared to a share of 1.49 % in 1990. A 2.5 % share of RTD expenditure in GDP is targeted for 2005 to strengthen the competitiveness of Austrian products and production.

Austria's industry has been very successful in the decoupling of growth of production and energy consumption since the mid 1970s by energy-saving and efficiency-raising measures. After a steady decrease of about 5 million tons altogether, starting in the early 1980s, CO_2 emissions from energy consumption in industry did not begin to rise until the mid 1990s. In 1999, they were 1.2 million tons above the 1990 level. Emissions from production processes have been stable since the early 1980s and were slightly below the 1990 level in 1999.

Chapter 3

Greenhouse Gas Inventory Information

The total emissions of the greenhouse gases CO_2, N_2O, CH_4, HFCs, PFCs and SF_6 amounted to about 79 million tons CO_2 equivalent in the year 1999. Total GHG emissions were dominated by CO_2 with a share of 83 %. Total emissions were 2.4 % higher than in the base year, but lower than in some of the intermediate years. 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 showed fluctuations between 67 and 57 Tg since then.

3.1 Methodology

The Austrian greenhouse gas inventory for the period 1990 to 1999 was compiled according to the recommendations for inventories set out in the UNFCCC reporting guidelines according to Decision 3/CP.5, the Common Reporting Format (CRF) (version 1.01) and the Revised IPCC 1996 Guidelines for National Greenhouse Gas Inventories, which specify the reporting obligations from Articles 4 and 12 of the UNFCCC. An In-Depth Review of the Austrian greenhouse gas emission inventory took place from 8 to 12 October 2001.

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 (*Österreichische Luftschadstoff-Inventur – OLI*). The underlying energy source data for OLI are derived from the energy balances commonly approved of as official, which are provided on an annual basis by the *Austrian Institute for Economic Research* (WIFO) for 1980–1995 and by the *Statistics Austria* for 1996-1999. A consistent revision of the time series from 1990 onwards is envisaged by Statistics Austria for the year 2001, resolving remaining inconsistencies.

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 1999

Austria's CO_2 emissions amounted to 65.78 Tg in 1999, which is a 83 % share of all greenhouse gas emissions. Total emissions of the greenhouse gases CO_2, N_2O, CH_4, HFCs, PFCs and SF_6 were 79.2 Tg in the year 1999, with the transport sector contributing about one quarter of total emissions, followed by industrial processes and energy industries with about one sixth and one seventh respectively.

3.2.1 Total emissions of direct greenhouse gases

The total emissions of the greenhouse gases CO_2, N_2O, CH_4, HFCs, PFCs and SF_6 (given as CO_2

equivalents based on the global warming potential GWP evaluated for a reference period of 100 years; factors according to the IPCC Second Assessment Report) amounted to 79.2 Tg in the year 1999 (see Table B.3). The ranking of the subsectors (sectors) according to their relative contribution is as follows:

- **1A3:** Transport (23.1 %)
- **2:** Industrial Processes (17.4 %)
- **1A4:** Other Sectors[1] (16.9 %)
- **1A1:** Energy Industries (14.4 %)
- **1A2:** Manufacturing Industries and Construction (11.0 %)
- **6:** Waste (6.7 %)
- **4:** Agriculture (6.3 %).

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 (28.3 %[2] versus 23.1 %).

The emissions of CO_2 clearly dominate the GHG emissions in Austria with 65.78 Tg or 83 % compared to 12 % for CH_4 and 2.9 % for N_2O. F-Gases: HFCs 1.1 %, PFCs 0.03 % and SF_6 0.9 %.

3.2.2 CO_2

CO_2 had the largest share of all greenhouse gases with emissions of 65.78 Tg in 1999. This amounted to 83 % of all greenhouse gas emissions in Austria (see Table B.1 on page 180). The sector 'Fuel Combustion' (1A) accounted for 50.66 Tg or 77 % with the subsector 'Transport' (1A3) showing the largest contribution to sector 1A with 17.64 Tg or 26.8 %. The next largest subsectors were 'Other Sectors' (1A4) with 13.01 Tg (19.8 %) and 'Energy Industries' (1A1) with 11.37 Tg (17.3 %). The sector with the second largest contribution was 'Industrial Processes' with 11.94 Tg or 18.2 %, this contribution being significantly larger compared to subsector 'Manufacturing Industries and Construction' (1A2) with 8.63 Tg (13.12 %). The sector 'Land Use Change & Forestry' (5) was a sink in 1999 amounting to minus 7.63 Tg CO_2 due to the increase in Biomass Stock Change.

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

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

The uncertainty of CO_2 emissions was estimated to be quite low (around 2 %).

3.2.3 CH_4

In 1999 the CH_4 emissions of Austria were estimated to be 454.35 Gg (see Table B.1). The sector 'Waste' (6) shows the largest contribution with 247.74 Gg (54.5 %), and subsector 'Solid Waste Disposal on Land' (6A) is the most important subsector with emissions as high as 210.66 Gg (46.4 %). The sector 'Agriculture' (4) accounted for 187.85 Gg or 41.3 % with the subsector 'Enteric Fermentation' (4A) showing a contribution of 127.93 Gg (28.2 %).

Compared to CO_2, the uncertainty of the emissions was significantly larger due to two main factors: uncertainty of activity of waste input in solid waste disposal and uncertainty of emission factors for enteric fermentation and solid waste decomposition.

3.2.4 N_2O

In 1999 the N_2O emissions of Austria were estimated to be 7.35 Gg (see Table B.1). The subsectors 'Agricultural Soils' (4D) and 'Transport' (1A3) represent the main contributions with 3.26 Gg (44.4 %) and 1.88 Gg (25.6 %) respectively. The next largest subsector was 'Solvent and Other Product Use' (3) accounting for 0.75 Gg or 10.2 %.

As regards the relatively high uncertainty of N_2O emissions, the main influence was estimated to be the emission factor of N_2O from soils.

3.2.5 HFCs, PFCs, SF_6

In 1999 the actual and potential emissions of HFCs, PFCs and SF_6 were calculated (see Table B.1). The main contributions of the total actual HFC emissions of 870.46 Gg CO_2 equivalent originated from the use of the HFC-134 in the foam blowing industry (39 % of total emissions of HFCs, PFCs and SF_6) and mobile/stationary refrigeration (16 % of total emissions of HFCs, PFCs and SF_6).

Estimation of total PFC emissions resulted in 25.32 Gg CO_2 equivalent originating mainly from the semiconductor industry. Estimation of total SF_6

emissions resulted in 729.90 Gg CO_2 equivalent. The semiconductor industry (23 % of total emissions of HFCs, PFCs and SF_6) and production of noise insulate windows (12 % of total emissions of HFCs, PFCs and SF_6) are the main emission sources.

3.2.6 Indirect greenhouse gases

NMVOC: The main contributions to the total of 230.51 Gg of NMVOC emissions in Austria (see Table B.1) originated from the following sectors (subsectors):

- **3:** Solvent and Other Product Use (55.1 %)
- **1A3:** Transport (17.2 %)
- **1A4:** Other Sectors (15 %)

NO_x: The main contributions to the total of 168.08 Gg of NO_x emissions in Austria (see Table B.1) originated from the following sectors (subsectors):

- **1A3:** Transport (53.6 %)
- **1A4:** Other Sectors (17.6 %)
- **2:** Industrial Processes (9.2 %)
- **1A2:** Manufacturing Industries and Construction (9 %)

CO: The main contributions to the total of 864.27 Gg of CO emissions in Austria (see Table B.1) originated from the following sectors (subsectors):

- **1A4:** Other Sectors (47.8 %)
- **1A3:** Transport (28.3 %)
- **2:** Industrial Processes (20.5 %)

SO_2: The main contributions to the total of 41.76 Gg of SO_2 emissions in Austria (see Table B.1) originated from the following sectors (subsectors):

- **1A4:** Other Sectors (29.4 %)
- **2:** Industrial Processes (22.4 %)
- **1A2:** Manufacturing Industries and Construction (21.3 %)

3.2.7 Land-use change and forestry

In 1999 the sector land-use change and forestry was a sink of −7.63 Tg CO_2 due to changes in forest and other woody biomass stocks. This value is rather uncertain and will be recalculated after data of the forest inventory including the year 1999 are available (the latest forest inventory covered the years 1992 to 1996). The uncertainty range for individual years extends from ± 20 to ± 74 % for years with a high sink and years with a low sink respectively. This uncertainty can be explained by different growth increments depending mainly on variability in annual weather circumstances and harvest activities. It should be noted that under the UNFCCC this value is not included in the national total and that specific rules including inventory methodologies and good practice guidance are under development under the Kyoto Protocol, which will allow for inclusion.

3.3 Trend of emissions from 1990 to 1999

Total Austrian greenhouse gas emissions were about the same level as 1998, lower than in 1991 and 1997, but 2,6 % above the base year emissions. An increase in the sector 'Fuel Combustion' could not be compensated for by the decrease in other sectors. CO_2 emissions increased by about 6 %, mainly caused by an increase in the sector 'Transport'. CH_4 emissions decreased by about 15 %.

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

3.3.1 Total greenhouse gas trend

For the year 1999 total Austrian greenhouse gas emissions were 79.2 Tg CO_2 equivalents (see Table B.2 on page 183). These emissions were about the same level as 1998, but they were 2,6 % above the base year emissions (base year 1990 for CO_2, CH_4, N_2O and 1995 for industrial F-gases) (see Figure 3.1). This increase in emissions is because of an increase in the sector 'Fuel Combustion' (4.08 Tg CO_2 equivalents) which could not be compensated for by the decrease in other sectors like 'Waste' (0.91 Tg CO_2 equivalents).

The development of emissions of the individual greenhouse gases between 1990 and 1999 is shown in Figure 3.2 on page 34. Figure 3.3 shows that the

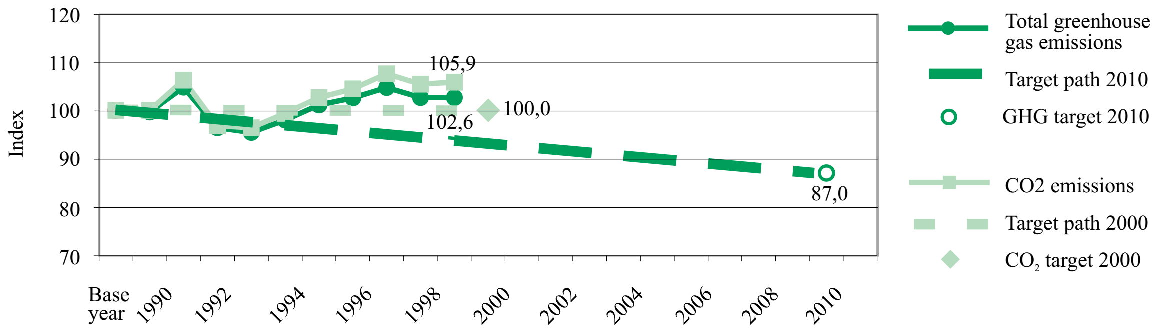


Figure 3.1: Austrian greenhouse gas emissions compared with targets for 2000 and 2008–2012 (excluding Land-Use Change and Forestry)

sector 'Energy' was the largest source in Austria in 1999, with a share of about 70 % of total greenhouse gas emissions. About 95 % of the emissions of this sector came from fossil fuel consumption. In 1999 greenhouse gas emissions from the sector 'Energy' were 9 % above 1990 levels. All other sectors showed decreasing emissions from 1990 to 1999, particularly the two sectors 'Waste' (-15 %) and 'Agriculture'(-11 %).

3.3.2 CO_2

The emissions of CO_2 showed an increase of 5.9 % between 1990 and 1999 (see Table B.4 on page 186 and Figure 3.4 on page 35). The main source of CO_2 emissions is fossil fuel combustion, accounting for an increase of about 4 Tg CO_2 which is due to the strong increase of 30 % in the sector 'Transport' (4.1 Tg CO_2). From 1990 to 1999, energy-related emissions in 'Manufacturing Industries and Construction' increased by 16 %, whereas CO_2 emissions from 'Energy Industries' as well as from the sector 'Industrial Processes' showed an altogether decrease in emissions of 1.8 Tg following declining coal consumption.

The difference of the CO_2 emissions for the years 1990 to 1995, compared to the Second Austrian National Communication, are mainly caused by the following reasons:

- ▷ More detailed information about emissions and fuel consumptions of iron and steel industry and oil refineries
- ▷ More detailed information about other industrial activities
- ▷ New energy statistics from the reporting year 1994 onwards
- ▷ Improved emission factors and calorific values for the different fuel types
- ▷ Improved sectoral allocation of emission sources

3.3.3 CH_4

CH_4 emissions decreased by 15,5 % (83.25 Gg) from the base year to 1999 (see Table B.5 on page 188 and Figure 3.5 on page 35). The decrease in 'Solid Waste Disposal on Land' (minus 48.32 Gg) and 'Agriculture' (minus 29.58 Gg due to a reduction in cattle population) were mainly responsible for this trend.

The difference of the CH_4 emissions, compared to the Second Austrian National Communication, is mainly caused by the following reasons:

- ▷ Emissions of managed forests which were previously allocated to the sector 'Land Use Change and Forestry' are not further considered in the national total[3]
- ▷ A more detailed study about emissions from waste disposal

[3]Previously some emissions of forests which did not address changes in carbon stocks were included in the national total. As a consequence of the review process, these emissions are now regarded as non-anthropogenic emissions.

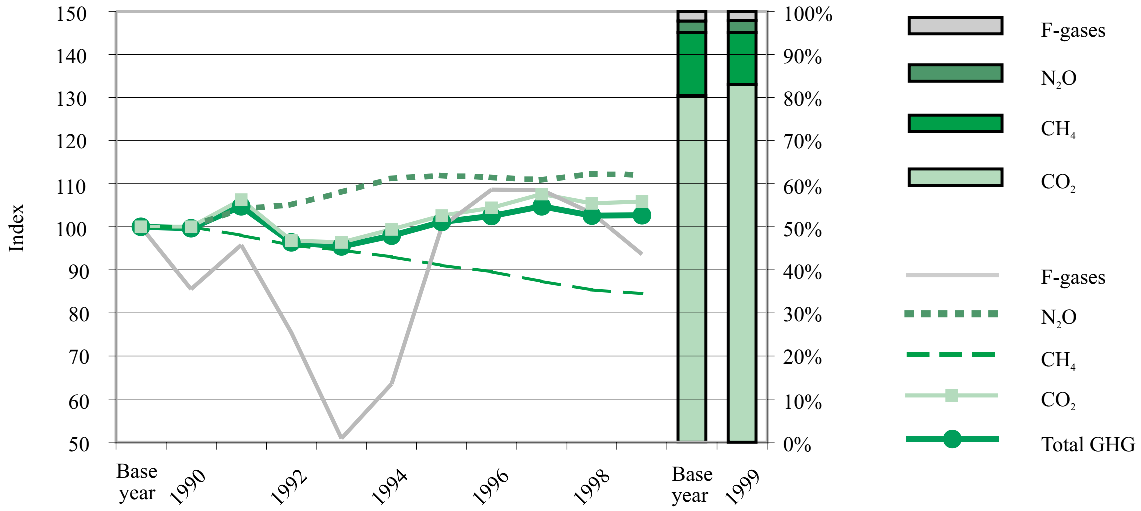


Figure 3.2: Greenhouse gas emissions (excluding Land-Use Change and Forestry): split into gases

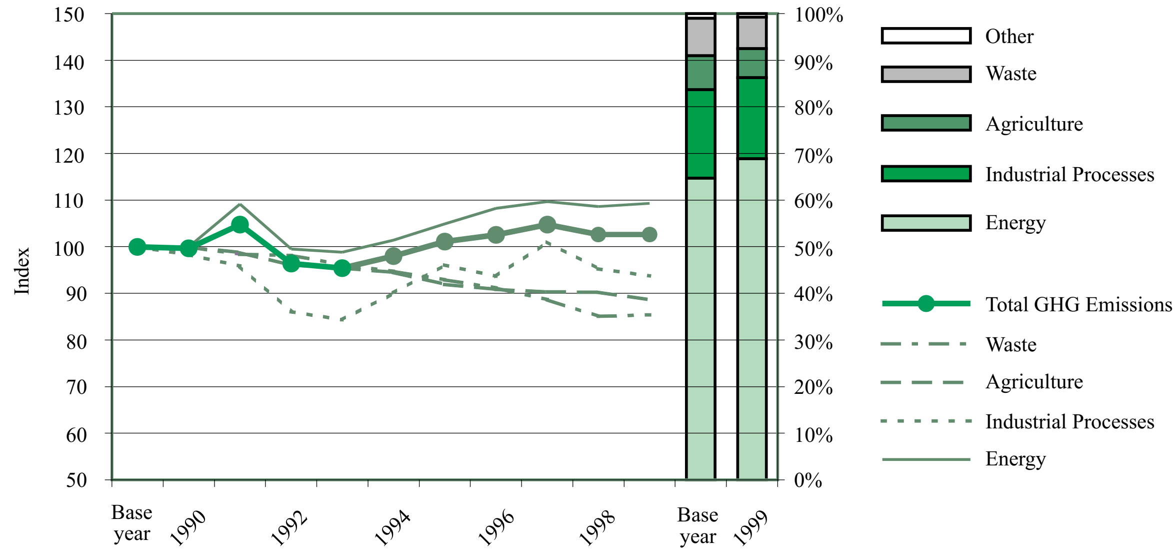


Figure 3.3: Greenhouse gas emissions (excluding Land-Use Change and Forestry): sector split

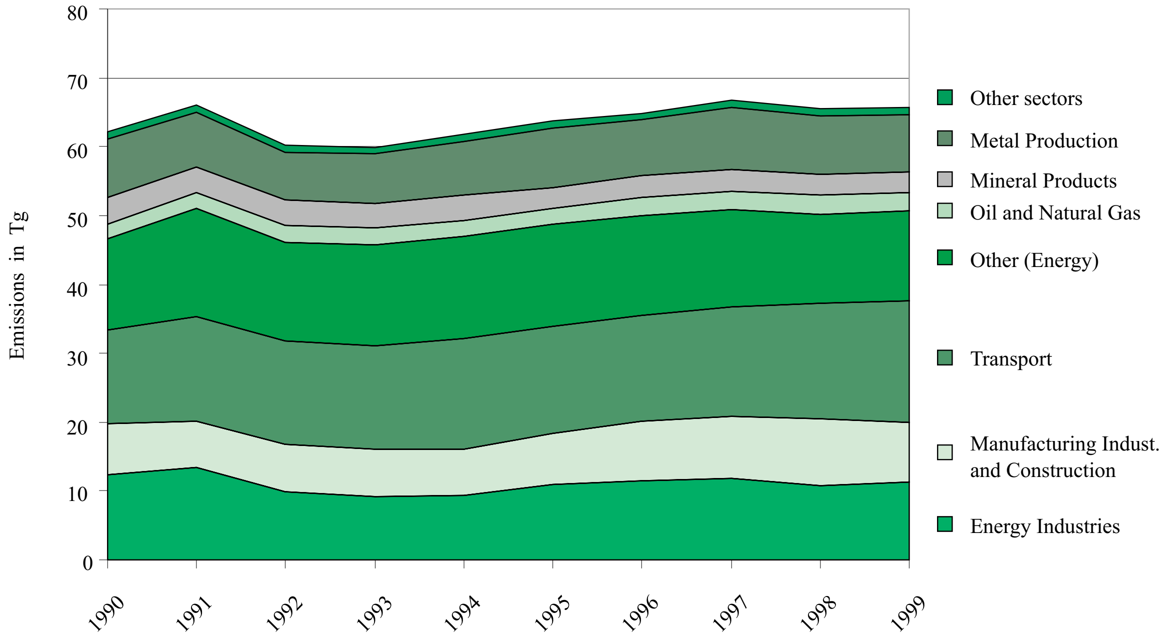


Figure 3.4: Emission trend CO_2

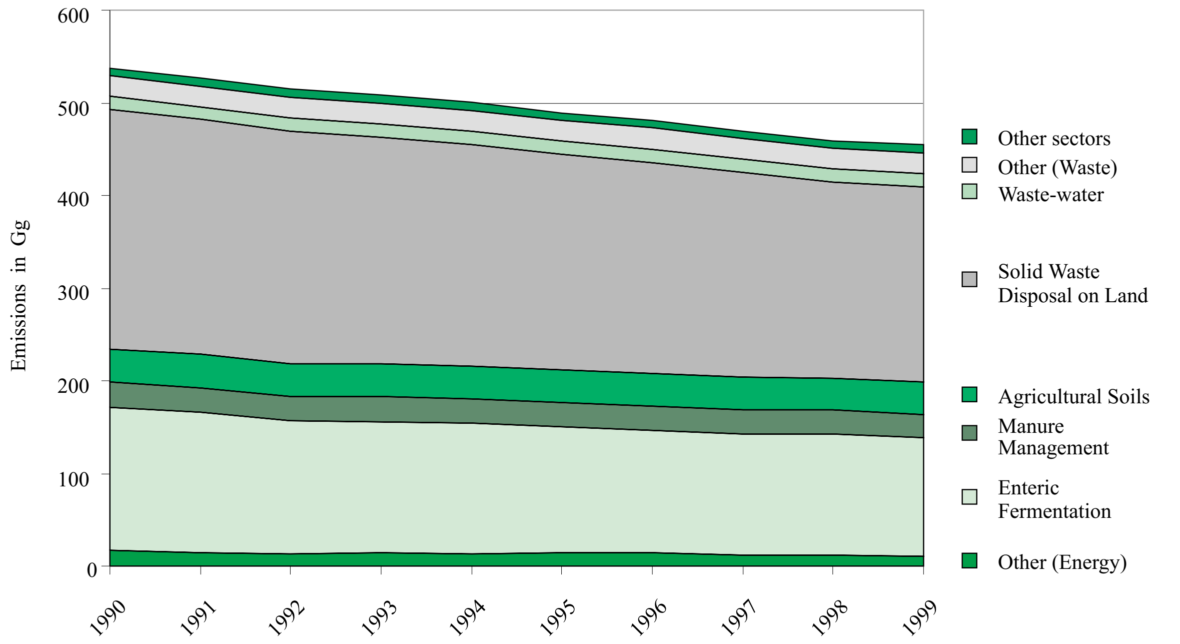


Figure 3.5: Emission trend CH_4

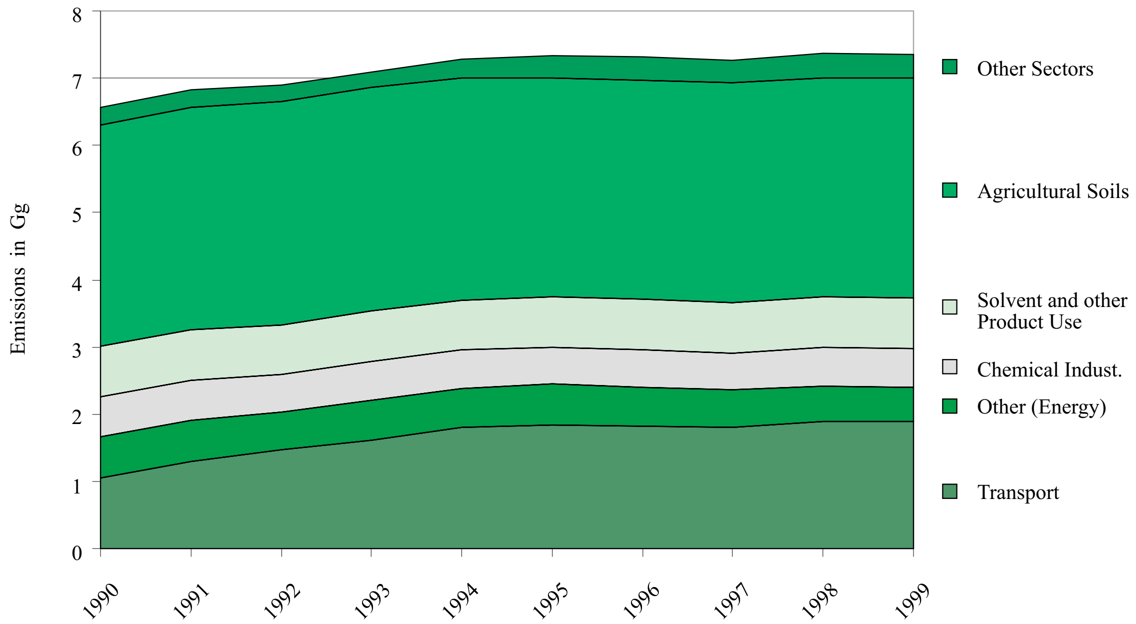


Figure 3.6: Emission trend N_2O

▷ Improved emission factors for fuel combustion activities

▷ Better information about activities in agriculture

3.3.4 N_2O

In 1999 N_2O emissions were 12,1 % (0.79 Gg) above the level of the base year (see Table B.6 on page 190 and Figure 3.6). This increase is mainly due to the increase in the sector 'Transport' (0.84 Gg). The emissions of the other sectors (subsectors) remained practically constant. They increased considerably in the first half of the 1990s, after introducing the catalytic converter, but stabilised between 1994 and 1997.

The difference of the total N_2O emissions compared to the Second Austrian National Communication are mainly caused by the following reasons:

▷ Improved emission factors for the transport sector

▷ Emissions of managed forests which were previously allocated to the sector 'Land Use Change and Forestry' are not further considered in the national total[4]

3.3.5 HFCs, PFCs, SF_6

For F-gas emissions (HFCs, PFCs and SF_6) the year 1995 was selected as base year, as 1995 figures are considered to be less uncertain compared to data in 1990. In 1999, emissions were 6,4 % (0,1 Tg) below the level of the base year (see Table B.11 on page 200 and Figure 3.7 on the facing page).

In 1995 HFC emissions amounted to about 32 % of total emissions of HFCs, PFCs and SF_6. The main contributions of HFC emissions originated from the foam blowing industry (more than 30 %). HFC emissions increased from 1995 to 1998 and accounted for about 54 % of total emissions of HFCs, PFCs and SF_6 in 1999. This increase in emissions was caused by an increasing consumption of HFCs in foam blowing cans and the increasing use of HFCs (especially HFC-134) in stationary and mobile refrigeration.

[4]Previously some emissions of forests which did not address changes in carbon stocks were included in the national total. As a consequence of the review process, these emissions are now regarded as non-anthropogenic emissions.

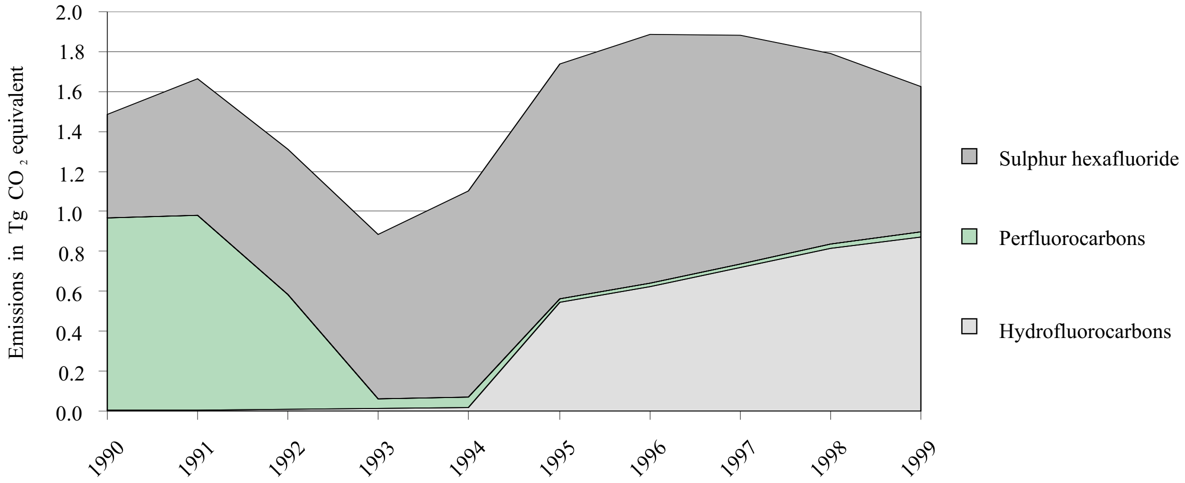


Figure 3.7: Emission trends HFCs, PFCs, SF_6

Emissions of SF_6 increased from 1990 to 1996 and then dropped in 1999, down to the half value of 1996. Accounting for about 67 % of the F-gas emissions in 1995, SF_6 represented the biggest contribution by far. The three main sources of SF_6 were the semiconductor industry, the magnesia production and SF_6 from noise insulate windows. From 1995 to 1998, there was a reduction in emissions by about 43 %. This reduction is due to the fact that SF_6 was no longer used in the magnesia industry and that the SF_6 consumption in noise insulation windows was reduced.

From 1990 to 1992 PFC emissions contributed to about 65 % to the total emissions of HFCs, PFCs and SF_6. The quite high amount was caused by primary aluminium production. Since termination of primary aluminium production in Austria in 1992 the contribution of PFC to the total emissions of HFCs, PFCs and SF_6 has been very low (about 1,6 %).

3.3.6 Indirect greenhouse gases

NMVOC: The NMVOC emissions showed a decrease of more than 33 % (or 114.03 Gg) from 1990 to 1999 (see Table B.7 on page 192). The sectors/subsectors 'Transport' (56 Gg), 'Solvent and other Product Use' (41 Gg) and 'Other Sectors' (16 Gg) contributed to this decrease. 'Industrial Processes' (4.84 Gg) showed a significant increase of NMVOC emissions (as well as 'International Aviation and Marine').

NO_x: The NO_x emissions showed a decrease of more than 12 % (or 23.12 Gg) from 1990 to 1999 (see Table B.8 on page 194). The (sub)sectors 'Transport' (8.67 Gg), 'Energy Industries' (6.22 Gg), 'Manufacturing Industries and Construction' (4.14 Gg), 'Industrial Processes' (2 Gg) and 'Fugitive Emissions from Oil and Natural Gas' (1.07 Gg) contributed to this decrease among others. No sectors/subsectors with the exception of 'International Aviation and Marine' showed a significant increase of NO_x emissions (3.15 Gg or 94.7 %).

CO: CO showed decreasing emissions (33.8 % or 442 Gg) (see Table B.9 on page 196) as did the other two precursors of tropospheric ozone. The sectors 'Transport' (239 Gg), 'Other Sectors' (100.7 Gg) and 'Industrial Processes' (93.7 Gg) among others, contributed to this decrease. As in the case of NO_x no sectors/subsectors with the exception of 'International Aviation and Marine' showed a significant increase of emissions.

SO_2: The SO_2 emissions showed a decrease of 54 % (or 49 Gg) from 1990 to 1999 (see Table B.10 on page 198). The sectors/subsectors 'Other Sectors' (17.6 Gg), 'Manufacturing Industries and Construction' (16.9 Gg), 'Energy Industries' (11.1 Gg) and 'Industrial Processes' (1.2 Gg) contributed, among others, to this decrease.

3.3.7 Land-use change and forestry

There was a decrease in the net sink from about 12 % of the total greenhouse gas emissions in 1990 to 10 % in 1999.

3.4 Fuel split of CO_2 emissions

The contribution of solid, liquid and gaseous fuels to the CO_2 emissions of sector 'Fuel Combustion' (1A) are presented. In comparison with the Second Austrian National Communication, the split is now based on the Common Reporting Format with a distinction between solid, liquid, and gaseous fuels as well as biomass.

3.4.1 Split in 1999

In 1999 sector 'Fuel Combustion' (1A) accounted for 50.66 Tg emissions of CO_2 (see Table B.12 on page 201). Liquid fuels contributed 59 % or 29.87 Tg, gaseous fuels 30 % or 15.19 Tg and solid fuels 11 % or 5.56 Tg. The remaining 0.04 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.

For reasons of comparison, in addition to the emission figures, the activity data are also provided. In 1999, the fuels combusted were equivalent to 974.6 PJ. Liquid fuels contributed 433.58 PJ or 44.5 %, gaseous fuels 278.23 PJ or 28.6 % and solid fuels 126.85 PJ or 13 %. Biomass contributed 132.08 PJ or 13.6 % to fuel combustion. The remaining 3.8 PJ are summed up under 'Other Fuels'.

3.4.2 Trend of split from 1990 to 1999

A comparison of the figures given in Table B.12 shows that from 1990 to 1999 the CO_2 emissions from the sector 'Fuel Combustion' increased by 8.5 % or 4 Tg whereas the activity increased by 11.6 % or 101.3 PJ. The liquid and gaseous fuels show an increase of 4 and 4.15 Tg CO_2 whereas the solid fuels had a decrease of 4 Tg. The CO_2 emissions of biomass show an increase of 2.13 Tg or 18.5 %.

3.5 Time series of CO_2 emissions

The trend of the CO_2 emissions is presented for the period from 1980 to 1999 and for the period from 1955 to 1979, which are each consistent. The separate presentation of these two periods has been chosen because the emissions have been calculated according to two different methodologies. Therefore, figures according to the IPCC sector split are only available for the period 1980 to 1999.

3.5.1 Time series from 1980 to 1999

Consistent data for CO_2 emissions based on CORINAIR94 methodology and an output according to the Common Reporting Format are available for the time period from 1980 to 1999. However there can be found a break between 1995 and 1996, which is due to adapted energy statistics as made available by Statistics Austria. The total value for CO_2 emissions has remained unchanged, whereas the sectoral split has been changed. As Statistics Austria is currently preparing consistent energy statistics from 1990 onwards, further adaptations of the emission inventory can be expected.

Between 1980 and 1999, the CO_2 emissions showed a fluctuation between 66.83 Tg (1997) and 56.51 Tg (1983) (see Tables B.14 and B.16 as well as Figures 3.8 on the facing page and 3.11 on page 41). Between 1990 and 1999, the fluctuation was between 59.90 (1993) and 66.83 (1997). From 1990 to 1999, the CO_2 emissions increased by 3.65 Tg. However, a mathematical analysis of the time series shows this increase is not robust in a statistical sense. The trend might be more robust if the data were corrected for temperature and production impacts. The record shows decreasing emissions for the years 1981, 1982, 1983, 1986, 1988, 1992, 1993 and 1998 and increasing emissions for the other years of the period under investigation. The change between years with increasing and decreasing CO_2 emissions results in a curve with several minima and several maxima. The largest decrease of emissions between a year and the following year was minus 8.9 % (from 1991 to 1992) and the largest increase was plus 7,2 % (from 1989 to 1990).

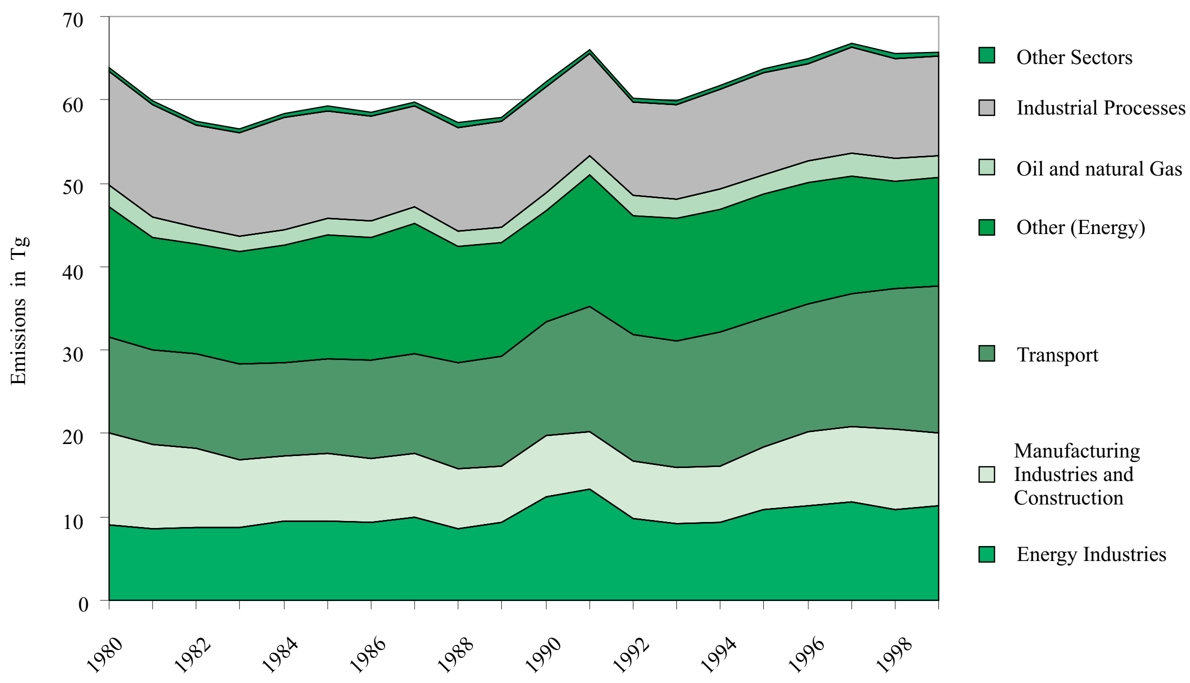


Figure 3.8: Time series CO_2 1980 – 1999 (sectors)

It is not surprising that the sector 'Fuel combustion' (1A) shows a very similar trend compared to the total CO_2 emissions. However, the different subsectors show different trends. Subsector 'Energy Industries' (1A1) shows a lot of fluctuation (lowest emissions in 1981, 1988 and 1993 and highest emissions in 1991, 1997 and 1987) with an average increase of 25.7 %, subsector 'Manufacturing Industries and Construction' (1A2) mainly decreasing emissions (from 1980 to 1999 by 21.4 %), subsector 'Transport' (1A3) an increasing trend (increase from 1980 to 1999 by 53,2 %) and subsector 'Other Sectors' (1A4) also fluctuating emissions like 1A1 (lowest emissions in 1998, 1982 and 1990 and highest emissions in 1991, 1987 and 1980). Like subsector 1A2, sector 'Industrial Processes' also shows a decrease from 1980 to 1999 (by 11.9 %).

3.5.2 Time series from 1955 to 1979

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

The CO_2 emissions increased from 29.75 Tg CO_2 in 1955 to 63.56 Tg CO_2 in 1979 (see Tables B.13 and B.15 as well as Figures 3.9 on the next page and 3.10 on page 41). In 1968, the emissions corresponded to the emissions according to the Toronto target (which means 20 % below the emissions of 1988). During the period from 1955 to 1979 the trend is determined by the economic growth that drove increasing energy demand and which resulted in increasing CO_2 emissions.

The development during 1955–1979 shows a distinct differentiation into two segments: Until 1975, the trend of CO_2 emissions runs parallel to the economic development. After 1975, however, a decoupling phenomenon between GDP and CO_2 emissions is observable. The CO_2 emissions remain more or less constant despite still rising GNP values. Such a decoupling has apparently been trig-

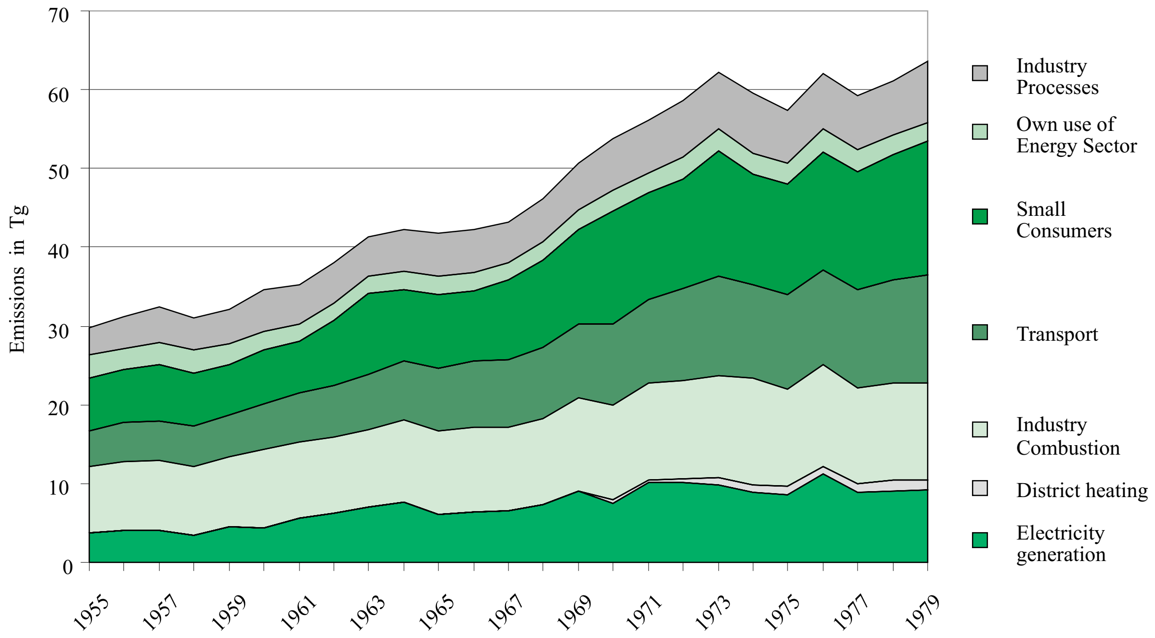


Figure 3.9: Time series CO_2 1955 – 1979 (sectors)

gered by the events around the oil price crises that have exerted a considerable impact onto the western economies and that has consequently lowered the energy intensity (= E/GNP) of the Austrian economy. It is worth noting that only a continuous and intense effort is able to result in such CO_2 growth rates near to zero, but certainly not a single event of measures during a limited period. In the moment when efforts are loosening, the initially observed increase rates for CO_2 emissions would enter into force again. Consequently, if in a given future period the efforts to implement reduction measures were weakened, the assumption of a continuation of the present trend into the future would not be applicable. This fact has to be considered when evaluating the potentials for emission reduction and the emission scenarios linked up with them.

The differentiation during this statistical period is according to the energy balances provided by the Austrian Institute for Economic Research and therefore differs from the one presented in the above paragraph. The relative shares of traffic emissions and emissions from combustion in industry are roughly equal around 1970 (10 Tg CO_2 and 12 Tg CO_2 respectively). The striking difference between the two, however, is their development during time: the sector traffic shows a steady increase whereas the sector industry begins to level off during the seventies. Two other components of the Austrian total related to industry show an analogous trend: Processes and electricity generation in industry. In the 1960's they grew on an average by 3-5 % annually; in the late 1970's, when they exhibited a value of 7 Tg CO_2 and 2.6 Tg CO_2 respectively, their growth rate declined to -2 % to -4 %. The emissions from small consumers (households and commerce) have sharply grown from 1955 to 1975 to around 16 Tg CO_2 but then reached a maximum. Public electricity generation grew markedly (around 7 %/year) during the early sixties but its increase rate fell continuously until the late seventies, if seen on an average. Austrian CO_2 emissions from electricity generation are substantially marked among others by the water-carriage of rivers and thus the availability of hydropower which necessitates strongly fluctuating input of fossil fuels. On a relative scale, the sector of district heating shows the highest rates of increase: up to 10 % per year in the decade until 1980.

The emission shares differentiated by fuels have changed along the period envisaged according to the international trend: Whereas in 1955 the

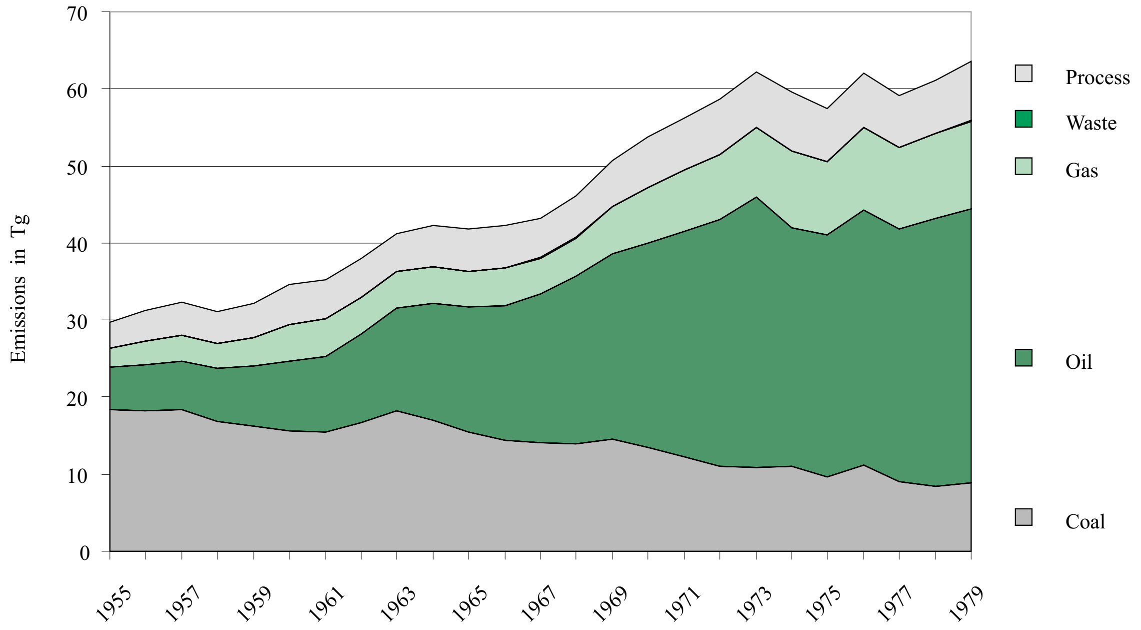


Figure 3.10: Time series CO_2 1955 – 1979 (fuels)

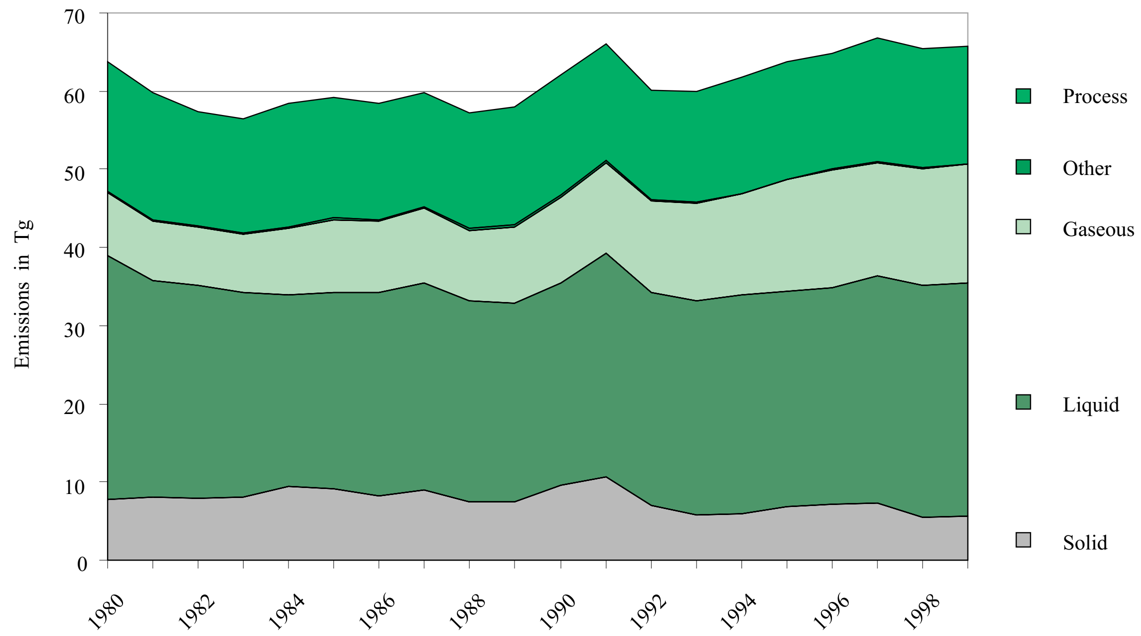


Figure 3.11: Time series CO_2 1980 – 1999 (fuels)

largest share was occupied by coal, it can be seen that towards the seventies oil products took over the lead. High rates of increase can be observed for gas throughout the period 1955 to 1979.

Chapter 4

Policies and Measures

The draft national programme *Austrian Climate Strategy 2010* takes into account the distribution of jurisdiction among the Federation, the federal provinces (*Länder*) and the municipalities. It described measures at federal level and framework conditions and guidelines for provincial action. Most *Länder* have already adopted their own regional climate change programmes, taking into account specific regional circumstances, needs and areas of competence.

Several important measures have been implemented or adopted over the past years, e.g. the Energy Saving Agreement between the Federation and the *Länder*, support schemes for energy efficient construction, renovation and the use of renewable energy sources, preferential feed-in tariffs for electricity from renewables, the Landfill Regulation, CO_2 labelling of passenger cars, a fuel consumption levy and other fiscal measures. A broad variety of other measures, including a more focused use of existing measures, are in a planning stage or under discussion. Among these are economic instruments such as a GHG emissions trading scheme for major emitters within the EU and a programme on Joint Implementation and CDM. At the national level special emphasis will be given to measures in the buildings and transport sector.

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 the draft bill with other ministries and takes into consideration the opinions of different interest groups. The bill is then submitted to the Council of Ministers. Since the decision in the Council of Ministers must be taken unanimously, consensus on a bill must be possible both in political (i.e. between the parties represented in the government) and interministerial terms. 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, taxation, price regulation and crisis management; for energy supply, transport and shipping policy; regulations on motor vehicles, and issues of railway infrastructure.

4.1.2 The *Länder* ('Federal Provinces')

The parliaments of the nine *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, construction law, 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.

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

4.1.4 Institutional Arrangements for Designing a National Climate Change Programme

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

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

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 of Agriculture, 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. For the development of a detailed policy programme, subgroups have been established for several topics (energy supply, space heating, transport, industry, waste, agriculture, fluorinated gases, financial coordination, and economic instruments). These subgroups consist of experts from Federation and *Länder* administrations and from the different interest groups.

Austria's draft *Climate Strategy 2010* is due for adoption by the federal government and provincial governments. It should be highlighted that most *Länder* (e.g. Vienna, Upper Austria, Lower Austria, Salzburg) already formulated their own regional climate change programmes, taking into account specific regional circumstances, needs and areas of jurisdiction. These programmes ideally supplement the national programme, which can only describe at an abstract level framework conditions and guidelines for provincial action.

4.2 Policies and Measures and their Effects

The highly fragmented responsibilities for climate change mitigation among the different levels of state (Federation, *Länder*, municipalities) caused some difficulties for coherent monitoring and evaluation of policies and measures in the past. This is due to a lack of complete and comparable information on policies and measures and also to the fact that many measures, e.g. in energy consumption, transport or waste management, are not undertaken primarily for the purpose of climate change mitigation. A variety of other environmental, social and economic needs are responsible for specific action. Only in recent years has increasing attention been given to GHG mitigation, which had up to then only been a positive, but rarely measured and evaluated, side effect. As a consequence, estimation of effects on greenhouse gas emissions is impossible for many individual measures undertaken in the past.

In order to improve monitoring and evaluation of policies and measures, the Federal Minister of Environment and the Environment Ministers from the *Länder* agreed in June 2001 to initiate a common process at the expert level.

In the following section, GHG mitigation effects are – in most cases – indicated for policy packages or whole sectors. Only in specific cases can effects be assumed for individual measures. Even if effects could be specified for each individual measure, those could not be simply summarised to express the total effect of measures within a sector because of strengthening or weakening impacts between policies and measures. However, sectoral GHG mitigation effects of the draft *Austrian Climate Strategy 2010* have been calculated in the model based projections from the Austrian Economic Research Institute and the Austrian Research Centres Seibersdorf (for model description, see Chapter 5).

Sector-specifc allocation of energy-related activities

In the draft *Austrian Climate Strategy 2010,* policies and measures in the energy sector are broken down into the energy supply and the energy demand sectors. Energy supply ('Energy Industries' of the CRF) comprises emissions from electricity generation and district heating, as well as emissions from refineries. Data exclude emissions from their own electricity generation in the manufacturing industry. Energy demand (1A4 – 'Other Sectors' of the CRF) mainly represents emissions from individual heating and hot water preparation in buildings (dwellings, trade and public services), being responsible for around 90 % of total emissions covered under 'other sectors' (rest: non-heating fuel demand in agriculture and forestry). In some cases, cross-cutting impacts take place, e.g. district heating influences both emissions on the energy supply and energy demand sides; electric heating or cooling as well as electricity demand for, e.g., household appliances have no direct impact on demand side emissions but influence emissions on the supply side.

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

4.2.1 Energy Demand

Categories of the Common Reporting Format affected: 1A4 ('Other Sectors')
GHG affected: CO_2 (almost exclusively)

CO_2-emissions, which are responsible for roughly 97 % of GHG-emissions from the sector, declined slightly over the period 1990-1999 (without climate and production adjustments). After a stabilisation at a level significantly above the 1990 level, emissions even declined sharply between 1996 and 1998. Climate and production adjusted data show stable emissions over the whole period, although the number of dwellings increased substantially from 2.9 million principal residences to 3.23 million between 1990 and 2000, mainly due to population growth. At the same time, average numbers of persons per dwelling fell from 2.6 to 2.5. Also trade and public service sectors had rising demand for building net square meters. Efficiency of heating systems and buildings could be improved accordingly, due to technical progress, strengthened legal standards and better public support schemes for energy efficient buildings and heating systems.

Renewable energy sources for heating in households, notably individual wood-fired heating systems, came under increasing pressure during the 1990s. The number of households with wood-fired systems shrank by 15 % between 1990 and 1999, mainly due to price pressure from fossil fuels and a general trend towards more comfortable heating systems. The relative market share declined from 21 % in 1990 to 16.2 % in 1999. However, modern wood heating systems, which can be fired comfortably with 'pellets' and wood-chippings, stopped or probably even reversed the negative trend over the past two years. This development was also significantly influenced by rising energy prices for fossil fuels and improved support schemes for bio-heating systems (see M3.2). Also positive, from an environmental perspective, is a more than 100 % increase in households with district heating since 1990, holding a market share of above 15 % in 1999. Installation of oil and gas-fuelled systems in households increased substantially between 1990 and 1999 by 19 % and 52 %, respectively. At the same time, coal-fired systems in households was reduced by more than 70 %, with a still shrinking market share of only 3.7 % in 1999. (See also Table 4.1 on the next page.)

It should also be mentioned that density of thermal solar use is among the highest in Europe. About 2.18 million square metres of solar panels were installed by the end of 2000, corresponding to 0.27 square metres per resident.

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

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

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

4.2.1.1 Implemented Policies and Measures

M1 Agreement between the Federation and the *Länder* on energy-saving

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

In 1995, the Federation and the nine ('*Länder*') agreed to undertake measures to improve thermal standards of buildings, to raise efficiency of small heating systems, to come to consumption-oriented energy pricing (when central heating systems apply) and to support energy efficiency in the residential, industry and trade sectors. The agreement was made on the basis of article 15a of the Federal Constitution Act (see section 4.1.1.). The Minister

Table 4.1: Energy sources used for heating in principal households in Austria (Source: Statistics Austria)

Energy source	1990		1992		1995		1997		1999	
Wood	608	(21 %)	598	(20 %)	572	(18 %)	514	(16 %)	521	(16 %)
Coal/coke	405	(14 %)	358	(12 %)	215	(7 %)	182	(6 %)	120	(4 %)
Fuel oil	781	(27 %)	807	(27 %)	843	(27 %)	863	(27 %)	925	(29 %)
Natural gas	579	(20 %)	658	(22 %)	777	(25 %)	793	(25 %)	882	(27 %)
Electricity	260	(9 %)	269	(9 %)	312	(10 %)	308	(10 %)	286	(9 %)
District heating	231	(8 %)	269	(9 %)	347	(11 %)	390	(12 %)	488	(15 %)
Other	29	(1 %)	30	(1 %)	56	(2 %)	98	(3 %)	45	(1 %)
Total	2,893	(100 %)	2,990	(100 %)	3,123	(100 %)	3,148	(100 %)	3,223	(100 %)

for Economic Affairs, who was in charge of energy policy, signed the agreement on behalf of the Federation.

As a consequence, almost all *Länder* improved minimum standards for different construction components (walls, windows, roofs, doors etc.) and with regard to the efficiency of heating systems. The agreement also opens the possibility to express thermal standards of buildings with an energy consumption code, which is a prerequisite for establishing comparable building codes. Several *Länder* have undertaken steps in that direction.

M2 Minimum thermal standards for buildings

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

Thermal minimum standards for buildings are defined in the Technical Construction Regulations of the *Länder*. In all regulations, the thermal standard of buildings is determined by way of U-values (=k-values) for different construction components (see Table 4.2 on the facing page), although most *Länder* opened the possibility for a more flexible approach by defining certain energy demand codes for the whole building (per square meter), in line with the Agreement on Energy-saving.

In most *Länder*, without prejudice to Technical Construction Regulations, it is a prerequisite to achieve a certain energy demand building code for receiving additional (to basic) financial support through the housing support schemes (see Table 4.2 on the facing page).

Almost all *Länder* have improved U-values over the past years and in some cases have also gone well beyond the minimum standards set forth in the agreement. Upper Austria introduced minimum energy codes (kWh/m^{2}a) for buildings instead of U-values for individual construction components. The latter only have supplemental character in that case.

Experiences show that construction technologies and techniques undergo continuous improvements and can be influenced positively by strict legal standards. A further development of the minimum standards within the existing agreement, therefore, is highly desirable (see below under *planned policies and measures*).
In general, Technical Construction Regulations apply to newly constructed buildings only (except, e.g., change of windows). As long as no obligatory standards for renovation measures exist, thermal standards of the old building stock therefore need to be influenced mainly by other instruments, especially public support schemes for renovation (see M3.1).

M3 Housing support schemes

Implementing entities: 'Länder'
GHG affected: CO_2, HFCs
Type of policy: promotive

Austrian *Länder* administer subsidies of more than € 2 billion annually for housing support programmes. Therefore, a majority of dwellings is constructed or renovated with public support. Around 75 % of financial resources are actually spent for new construction, the rest for renovation of existing buildings. With the largest building stock of the nine Austrian *Länder*, the city of Vienna is different in this regard. In Austria's capital, more than 50 % of available financial resources are spent

Table 4.2: Minimum U-values in Technical Construction Regulations of the *Länder*

Component (selection)	Exterior walls	Roofs	Windows	Exterior doors	Ceiling*
Burgenland	0.45	0.25	1.70	1.7	0.4
Carinthia	0.40	0.25	1.80	1.8	0.4
Lower Austria	0.40	0.22	1.80	1.8	0.4
Upper Austria[1]	0.50	0.25	1.90	1.9	0.45
Salzburg	0.47–0.56[2]	0.26–0.30	2.50	2.5	0.37–0.43
Styria	0.40–0.50[3]	0.20	1.90	1.7	0.4
Tyrol	0.35	0.20	1.70	1.7	0.4
Vorarlberg	0.35	0.25	1.80	1.9	0.4
Vienna[1]	0.50	0.25	1.90	1.9	0.45
"Art. 15a-Agreement"	0.50	0.25	1.90	1.9	0.45

* against unheated space
[1] Limited expressiveness for Upper Austria and Vienna since building-energy codes apply which are more demanding than the sum of U-values for individual components
[2] Values depend on climatic circumstances
[3] Differentiation between one-/two-family houses and larger residential buildings

for renovation of buildings, in most cases for standard improving measures (bathroom, central heating systems, windows, consolidation of flats etc.).

The large amount of public money involved in the housing sector is of significant relevance for heating related energy demand and CO_2 emissions, both in a negative and positive way. On the one hand, housing programmes generally tend to induce construction of larger houses and apartments, also with negative impacts and costs in terms of infrastructure demand and traffic congestion, because it becomes 'affordable' to move out of the cities into the 'green belts'. On the other hand, specific schemes can give relevant incentives for more sophisticated energy solutions, like solar heating systems, optimised thermal insulation or even 'zero-energy-houses'.

M3.1. Thermal insulation of dwellings

Implementing entities: 'Länder'
GHG affected: CO_2, HFCs
Type of policy: promotive

A large proportion of existing dwellings in Austria were built between 1950 and 1980. In those days, the political priority in this regard was the construction of affordable dwellings to meet a continuously rising demand as a consequence of post-war shortages, population growth and changing living standards and patterns. Technical building standards of that period by far did not meet today's requirements in terms of energy efficiency. Reducing energy consumption from heating was not viewed as a priority before the late 1970s. Consequently, thermal standards of a large proportion of Austrian dwellings are very low. Increasingly important renovation measures in this building sector for other than energy-related reasons are to be seen as a chance for major thermal improvements like new windows, insulation of walls and roofs, new efficient heating systems etc.

It is also a consequence of lower demand for new dwellings that most Austrian *Länder* introduced new support schemes for thermal renovation of dwellings over the past years.

The city of **Vienna** spends approximately € 50 million per year for a specific programme focused to improve thermal and energy standards of dwellings from the period 1950-1980 ('THEWOSAN' – Thermische Wohnhaussanierung; Thermal Renovation of Dwellings). Subsidies are differentiated in relation to the quality of measures in terms of reductions in energy demand. It is estimated that this programme will result in a reduction of CO_2 emissions by 350,000 tons per year by 2010.

Further significant amounts of money are channelled towards efficiency raising housing measures in the framework of other Viennese renovation programmes, which focus on general quality improvement of desolate houses and flats. When accompanied by energy efficiency raising measures, higher subsidies apply.

In the *Länder* **Vorarlberg** and **Burgenland** supplemental support is granted for general renovation measures if the energy demand of buildings after renovation reaches less than 80 kWh/m^2. **Upper Austria** also has a similar supplemental subsidy for energy improvements, but buildings even have to reach 65 kWh/m^2 after renovation.

In **Salzburg**, renovation subsidies are differentiated along the improvement of U-values of the most important construction components, i.e. exterior walls, windows and roofs/upper ceilings). The lower the U-values, the higher the subsidy will be, giving special incentives for best-practice thermal renovation.

Lower Austria offers better supporting conditions for renovation if U-values of the provincial technical regulations for new buildings can be achieved after renovation. In **Styria**, renovation subsidies are only granted, if at all, when actual standards of the regulation for new buildings can be guaranteed. In **Tyrol**, renovation measures are supported under the condition of minimum insulation (10 cm for exterior walls and 20 cm for roofs/upper ceilings) without regard to U-values that are achieved.

Finally, in all Austrian *Länder*, singular measures, like windows changes, installation of thermal solar systems or replacement of old and inefficient heating systems benefit from subsidies. Several *Länder* give special incentives for biomass heating systems (e.g. wood pellets) and/or phased out support schemes for new acquisition of fossil fuel heating systems.

Regrettably, no consolidated data is available on the total effects of the measures described in terms of reduction of CO_2 emissions, since many climate change relevant measures are embedded in a bulk of different renovation measures; moreover, evaluation procedures often are insufficient.

M3.2 Support schemes for energy efficient construction and the use of renewable energy

Implementing entities: 'Länder'
GHG affected: CO_2, HFCs
Type of policy: promotive

In the past, public support programmes for construction of new dwellings have had a rather counterproductive total impact on CO_2 emissions, as they have lacked quality standards. During recent years, most Austrian *Länder* have started to introduce specific incentive schemes for energy efficient construction (improved insulation, zero energy houses etc.) and the use of renewable energy sources, such as heating systems based on biomass and solar installations.

Generally, subsidies under the housing support schemes of the *Länder* in the new construction sector are segmented into different components: All *Länder* give *basic* subsidies for new houses built in conformity with existing technical construction standards. Most *Länder* give *supplementary* subsidies, either on social grounds or for specific measures to improve the quality of buildings well beyond legally binding standards. Supplementary supports, differentiated along energy-related specifications, have led to significant decreases in CO_2 emissions from new dwellings since 1995. The schemes have also had a positive impact on the construction industry in terms of technically improved building standards at competitive costs.

With regard to renewable energy, the *Länder* run special support programmes for solar thermal facilities, heating systems based on biomass and the use of heat pumps. In some municipalities, there are additional subsidies for 'renewables' as well as for the connection to district heating systems.

In 1990, **Vorarlberg** was the first among the *Länder* that introduced supplemental support schemes for energy efficient houses and use of renewable energy sources. After the last adaptation of the scheme by 1 June 2001, supplemental support is available under the conditions that

- ▷ yearly heating energy demand is expected to be below 55 kWh/m^2,
- ▷ no construction materials containing fluorinated gases are being used,
- ▷ only certain efficient heating systems, preferably using renewable energy sources, are being installed.

Supplementary support is differentiated in dependency on heating demand and specific other measures and can reach up to 100 % of basic support. In 2000, 60 % of all supported dwellings in Vorarlberg were constructed in an energy-saving way.

Since January 2000, supplementary incentives for houses with a heating energy demand of less than 60 kWh/m^2 have also been granted in **Burgenland**. It should also be noted that the construction of new houses within densely populated city areas or village centres benefits from additional subsidies, in order to limit public costs for infrastructure and reduce regional and local traffic.

In 1998, **Carinthia** introduced a special support scheme for so-called 'Factor 4+' dwellings, which are characterised by low energy demand (expressed by a building code), non-fossil heating systems and the use of wood for roof constructions and windows. Apart from that special scheme, a supplementary support scheme applies for all new residential buildings. Through a differentiation of the subsidies, incentives are given to reach best-practise energy building codes, to install renewable energy heating systems and to use ecologically sound materials.

In **Lower Austria**, a so-called 'Eco Home' support scheme has been applicable since 1998 and was further improved in 2001. Again, the amount of supplemental subsidies depends on energy building codes and ecologically sound heating and hot water systems. In addition, applicants for support are obliged to use materials, which are free from CFCs or HFCs.

Energy-saving dwellings have even been supported with a special scheme in **Upper Austria** since 1993. Building energy codes of less than 65 kWh/m^2 are subject to a supplementary subsidised loan of € 3,634 (ATS 50,000), in case of less than 50 kWh/m^2 the support is even € 7,267 (ATS 100,000). Additional subsidies are granted for the use of thermal solar energy and biomass heating systems. A separate, even more attractive, scheme exists for so called 'passive houses' with a heating energy demand of 15 kWh/m^2 at the highest (subsidised loan of € 14,535 or ATS 200,000). Consultation with an independent energy consultancy is a general prerequisite for support under the housing scheme for one or two-family houses. For larger residential premises, the amount of public support directly depends on the energy code of the building.

In 1994, **Salzburg** introduced an 'energy-points' support system (points for specific measures regarding energy efficiency and the use of 'renewables') and laid a high benchmark for other *Länder* in that regard. The model, which is similar to that of Vorarlberg, combines energy-saving measures, use of renewable energy sources and other ecologically beneficial measures in an integrated way and is among the most successful bonus systems in Austria in terms of CO_2 emissions reduction. To highlight only one effect, the share of biomass heating installations in new dwellings constructed with public support has risen to almost 50 % over the past 5 years.

Other building-related energy-saving measures of the *Länder*

Without being able to make reference to specific measures for the purpose of this communication, it has to be stressed that Austrian *Länder* and many communities are very active in further areas of energy-saving policies. Most *Länder* run governmental energy consultancies. In some *Länder* advisory consultations on energy related issues are a prerequisite for funding from the housing support schemes (e.g. in Upper Austria). Most *Länder* also developed energy accounting systems, which are used for housing support schemes, issuing of energy building codes and for monitoring of energy consumption in public buildings (provincial and municipal) as a prerequisite for energy-saving measures and renovation projects.

M4 Consumption-related heating costs calculation

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

As an act of implementation of the Agreement between the *Länder* and the Federation on Energy-saving (see M.1), a federal Law on Heating Costs Calculation entered into force in 1992, which has been amended several times. The law provides for fair calculation of energy costs in consistency with actual consumption of owners or tenants, when central heating systems are installed in a building. All buildings with central heating have to be equipped with appropriate measuring facilities for individual calculation. The law can be regarded as a major step towards rational and efficient use of energy in buildings with more than three separate entities (apartments, offices. . .).

The scope of law does not automatically apply to buildings built before 1992, which often are not equipped with appropriate measuring instruments for consumption-related heating costs calculation. Instead, costs are calculated on the basis of square metres. In those cases, consumers have no direct incentive to use energy for heating and hot water in an economic way. However, a single tenant or owner of an entity can enforce consumption-related calculation, if s/he can proof that ex-post installation of measuring instruments is economically feasible.

M5 Increased energy efficiency for federal public buildings

Implementing entities: Federation (Ministry for Economic Affairs and Labour)
GHG affected: CO_2
Type of policy: voluntary

Apart from federal and provincial legal instruments and support measures, the Federation in its own building-related energy consumption began from 1980 on, to undertake practical measures aiming at more efficient use of energy and substituting fossil sources. In all public buildings used for purposes of federal governance, energy demand and related environmental impacts have been reduced steadily in relation to space used. It should be noted that federal buildings contribute to 2 % of the total national energy demand for heating and hot water. The measures undertaken not only raise public awareness for energy-saving, but also sum up to considerable reductions in heating energy demand (1980-1999 cumulated: 9.143 GWh) and emissions. In 1998/1999 alone, CO_2 emissions were reduced by 7.1 %, NO_x by 8.1 % and SO_2 by 15.9 %. Among the most effective measures were replacement of old heating systems (partly fuelled with heavy fuel oil) by highly efficient and low emissions systems or district heating. Meanwhile, 50 % of heating energy demand is covered by district heating.

In parallel, the Federation has undertaken regular measures to improve the thermal standards of federal buildings over the past two decades. For renovation measures aiming at higher energy efficiency of exterior building components, € 373 million were spent in the past.

Although federal buildings were transferred to a Federal Estate Company in 2000 and consequently are no longer under the direct administration of the government, measures to reduce energy demand and emissions will continue. To that end, the instrument of 'Contracting' is going to play an increasingly important role in the future (see M6).

M6.1 Third Party Financing ('Contracting') for public buildings

Implementing entities: Federation, 'Länder', and municipalities
GHG affected: CO_2
Type of policy: economic/voluntary

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

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

To highlight a model *Contracting* project, some key figures are given on an energy-savings initiative for federal school buildings in Vienna.

In 1997, two pools of schools, comprising 46 buildings in total, were identified to be eligible for Third Party Financing. During the project's reference year, 1996, € 4,44 million were spent to cover energy demand of these buildings. Electricity demand was responsible for 2/5 of costs or 10 200 MWh, heating demand accounted for 59 800 MWh. For each pool of buildings, one contracting partner was chosen after a European-wide tender. The partners guaranteed a reduction of energy costs by 24.3 % and 21.1 %, respectively. In order to improve motivation and cost awareness of the responsible contacts in schools as well as of students and teachers, schools gained a 20 % share of energy cost reduction during the contract period of 10 years. Afterwards, the total cost reduction accrues to the benefit of the orderer.

From today's perspective, the school project is a clear success. The cost reductions promised by the contractors take place effectively. CO_2 emissions caused directly or indirectly by the schools involved have been reduced by more than 20 %.

The outsourced Federal Estate Company (*Bundesimmobiliengesellschaft*), which is the direct owner of the buildings, clearly signalled interest in further projects of this kind (see also M6.2 under *Adopted Policies and Measures*).

Some *Länder* are also actively interested in reducing energy consumption in public buildings by way of *Contracting*. To give an example, Upper Austria initiated an *Energy Contracting Impulse Programme* as of 1998.

4.2.1.2 Adopted Policies and Measures

M6.2 Third Party Financing (Contracting) for public buildings (cont. from 'Implemented PaM')

Implementing entities: Federation, 'Länder'
GHG affected: CO_2
Type of policy: economic/voluntary

The federal government decided in March 2001 to launch a Programme on Third Party Financing (Contracting) in the field of energy-saving investments for federal public buildings. It is assumed that around 20 % of federal buildings (representing 50 % of heated space in federal buildings) are eligible for classical energy-saving contracting, meaning that measures and investments with relatively short pay-back periods due to energy-savings can be undertaken by a third party (so called 'contractor', e.g. energy planning consultant). Mostly affected are public high schools. In a pilot programme in Vienna energy standards for 46 schools have already been significantly improved.

A further 20 % of federal buildings is planned to be generally renovated within the next 10 years, also comprising thermal insulation measures and replacement of heating systems. Due to high investment costs of thermal insulation with long pay back periods, the latter share of buildings cannot be financed by a third party contractor in classical terms but a differentiated model of 'guaranteed energy-savings' should take place.

The initiative is expected to result in a total reduction of CO_2 emissions by 70–100.000 t p.a. by 2012 in the segment of federal public buildings, which represent around 11 % of total service sector buildings in terms of energy consumption. Since it is likely that the initiative has the potential to accelerate growth in the total contracting market, covering also public buildings e.g. of municipalities and private service sector buildings, a total reduction of emissions by roughly 500.000 t can be expected.

Similar *Contracting Programmes* also take place in the *Länder*, in some cases in direct conjunction with funding schemes (see M6.1 under *Implemented Policies and Measures*). Several new initiatives are planned to improve conditions and raise the acceptance of this relatively new instrument with respect to public provincial and municipal buildings.

M7.1 Promotion of energy-saving measures and renewable energy in housing support schemes

Implementing entities: Federation (framework), 'Länder'
GHG affected: CO_2
Type of policy: revenue sharing

A newly adopted pact on tax revenue sharing between the Federation, the *Länder* and the municipalities gives way for more flexibility with respect to housing support schemes. The Federal Act on Revenue Sharing now explicitly suggests spending parts of the funds for GHG-mitigation measures. In total, the *Länder* receive € 1.78 billion annually from the Federation under the title of 'housing support'. Although, that money can also be spent for other purposes than housing, as indicated above (e.g. for improvement of infrastructure). The GHG mitigation effect from housing support schemes therefore largely depends on specific political intentions followed by individual *Länder*. However, the conferences of the environment *and* finance ministers of the *Länder* governments have declared politically to be willing to spend a relevant part of the money for climate change purposes in order to achieve the targets indicated in the draft *Austrian Climate Strategy 2010* (see M7.2 under *Planned Policies and Measures*).

4.2.1.3 Planned Policies and Measures

M7.2 Further improvement of housing support schemes (cont. from 'Adopted PaM')

Implementing entities: Länder
GHG affected: CO_2*, HFCs*
Type of policy: promotive

It can be seen as an ongoing trend, that housing support schemes of the *Länder* are being improved, paying more attention to energy-saving measures and use of renewable energy sources. In order to accelerate and harmonise these efforts, the Ministry of Environment introduced negotiations with the *Länder* on common minimum energy consumption standards and other ecological requirements as a prerequisite to benefit from housing schemes. A legally binding agreement on the basis of article 15a of the Federal Constitution Act (see above under 4.1.1) between the Federation and the *Länder* is planned in this regard[1]. As these schemes have significant influence on dwelling construction in Austria, strengthened requirements will have a far-reaching impact on the whole construction market. At the same time, construction components which contain fluorinated gases (construction foams, insulation materials, SF_6 in windows) are planned to be phased-out by law (see section 4.2.6).

Promotion of thermal renovation of dwellings

In order to direct more funding to thermal renovation in all Austrian *Länder*, the above-mentioned agreement between the Federation an the *Länder* also focuses on the creation of new and/or improved support schemes in that regard. The agreement will also ensure that public support will only be granted when applicants refrain from using materials containing fluorinated gases (insulation, foams) which is already an established and good-practice in some *Länder*. Pending success of negotiations on the agreement, it is likely that roughly € 200–300 million of funding resources *per year* will be dedicated for thermal renovations over the next 10 years.

M8 Promotion of replacement of old heating systems by renewable energies and district heating

Implementing entities: 'Länder'
GHG affected: CO_2
Type of policy: promotive

[1] Article 15a of the Federal Constitution offers the possibility of legally binding agreements between the Federation and the nine *Länder* in policy areas that are in shared or sole responsibility of the *Länder*. Success depends on the willingness of all partners to coordinate their policies.

Most *Länder* in Austria support the replacement of old heating systems within their housing schemes, although most of these programmes are more targeted towards reducing air pollutants than greenhouse gas emissions. The draft *Austrian Climate Strategy 2010* and the planned agreement between the Federation and the *Länder* (see M7) follow the intention that replacements should only be funded by the public if old fossil fuel systems will be replaced by highly efficient systems based on renewable energy (solar or biomass) or natural gas, when available. Promotion – both in terms of financial support and information campaigns - for the energetic use of biomass in households is important to compensate for rather shrinking market shares in comparison to natural gas and fuel oil. Especially wood pellets technologies have proved to be competitive with fossil fuels, both with respect to fuel prices and handling convenience. In addition, the *Länder* continue to promote the connection with existing or new (often biomass-fired) district heating, which is a specifically successful strategy to mitigate GHG emissions in urban areas or rural communities.

M9 Harmonised energy codes for buildings

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

Austrian *Länder* already reached a technical agreement on a common scheme for an energy code for buildings. Such an instrument, which is also recommended by the so called SAVE directive (93/76/EEC) of the European Community, is expected to give appropriate price signals on the real estate market since energy consumption of houses, apartments and offices become transparent for the consumer. Further progress in this direction is to be expected from the Directive on the energy performance of buildings, which the Commission has proposed recently (COM (2001) 226 final).

The agreement with the *Länder* is necessary due to the jurisdiction situation in building affairs. Unfortunately, it was not possible to reach a political agreement on the building codes until now. Nevertheless, several *Länder* already make use of the instrument, either for public buildings only, or for the whole real estate market, gradually even including renovation projects.

M10 Improvement of technical building standards

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

Technical building regulations are under the jurisdiction of the *Länder* in Austria. Therefore, thermal standards differ from region to region. An agreement between the Federation and the *Länder* (based on Article 15a of the Constitution) dating from 1995 (see also 4.2.1.1 *Implemented Policies and Measures*) comprises harmonised minimum U-values for different building components (exterior walls, windows, doors, roofs etc.). This has been a major step forward, but construction techniques have improved considerably since 1995. That is a reason why the agreement needs to be adapted or replaced by other instruments. An actual attempt to generally harmonise technical building regulations can be seen as a chance to further strengthen minimum thermal standards for buildings. In addition to U-values for different components (walls, windows etc.) preference will be given to energy codes (e.g., heating energy demand in $kWh/m^2 \cdot a$).

M11 Regular inspection of heating systems

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

In compliance with the SAVE-Directive of the EC, the draft *Austrian Climate Strategy 2010* also includes the introduction of compulsory inspections for heating systems on a regular basis in order to control emissions and energy efficiency. Some *Länder* have respective measures already in place or are planning to introduce these in the near future.

Estimated GHG emissions reduction from planned measures, excluding effects of electricity demand side measures: 4 Mt CO_2 p.a.

4.2.2 Energy Supply

Categories of the Common Reporting Format affected: 1A1 (Energy Industries), 1B (Fugitive Emissions from Fuels)

Gases affected: CO_2 (almost exclusively)

CO_2 emissions from energy supply in Austria depend considerably on annual climatic conditions. As a consequence, the share of electricity production from renewable hydropower varied between 65 % and 75 % over the past years, with respective impacts on emissions from caloric electricity generation. At the same time, CO_2 emissions from district heating corresponded to temperature-induced heating energy demand during the winter season.

The period between 1990 and 1999 showed a relatively stable emissions trend, but after adjustment for climatic differentiations, a slightly rising emissions path can be seen. Electricity demand of most sectors is growing and liberalisation of energy markets is expected to cause an acceleration of that trend. At the same time, capacities for new large hydro-power are seen to be at a limit, both in terms of economic feasibility and public acceptance. New strategies, therefore, have to be followed to cut emissions in the mid and long-term future.

The role of renewable energy sources and efficient district heating systems

In 1999, renewable energy sources accounted for 24.03 % of gross domestic energy consumption. Hydropower holds a share of 12 %, wood and bio fuels account for 10-11 %. The relative share of renewable energy sources declined slightly between 1993 and 1998. In 1999 renewables won 1 %-point back, mainly due to an outstanding contribution from hydropower plants. In absolute numbers, energy production from renewables increased over the whole period, from 267 PJ (1993) to 288 PJ (1999). Official data for 2000 are not yet available, but new record figures are expected, due to very good natural conditions for hydropower and – at least for highly comfortable *pellets* heating systems - improving economic conditions for bio energy after price increases in the fossil sector.

Electricity production

A further orientation of the Austrian energy supply system towards renewable energy sources is technically, and due to substantial potentials, possible, even under the assumption of rising energy demand. This will require a combination of various technologies in an inter-connected system of centralised and decentralised plants to meet the different customers' demands. Generally spoken, the liberalised electricity market within the European Union is an advantage in terms of market access for independent power producers. On the other hand, increasing pressure on end consumer prices for electricity can be a market entrance barrier for new technologies, such as wind power, cogeneration from bio fuels and PV. The Austrian Electricity Act responds to that barrier by obliging the provincial governments to fix feed-in tariffs, which cover supplemental costs of electricity production from 'new renewables' (see M12). This policy has led to a noticeable increase in the electricity supply from clean sources such as wind energy in recent years, marking only the beginning of an expected multiplication of output and share in the coming years.

Heat production

The situation is different for bio-energy heating systems without power generation. Tariff policy or new economic instruments, like quota and trading systems, are not applicable in the same way as for electricity from renewables. 'Traditional' investment funding, therefore, has to take place. The use of bio-energy (e.g. chippings) in regional district heating systems has already gained considerable status in Austria. This is to a large extent due to existing public support schemes, granted both by the federal government and the *Länder*, and in many cases co-funded by the European Union. By the end of 2000, 587 biomass district heating systems with a total performance of 730 MW existed, predominantly in rural areas. In 2000 alone, 86 new such systems went into operation. Further 350 so called biomass microsystems were in operation by the end of 2000, especially for heating of building complexes like hotels, swimming baths, schools etc. Federal support for energy from biomass projects amounted to around € 17 million in 2000, supplemented by a further approximately € 15 million from the *Länder* and the EU.

4.2.2.1 Implemented Policies and Measures

M12 Preferential market access for electricity from renewable energy sources

Implementing entities: Federation (framework act), Länder (implementing laws)

GHG affected: CO_2, CH_4

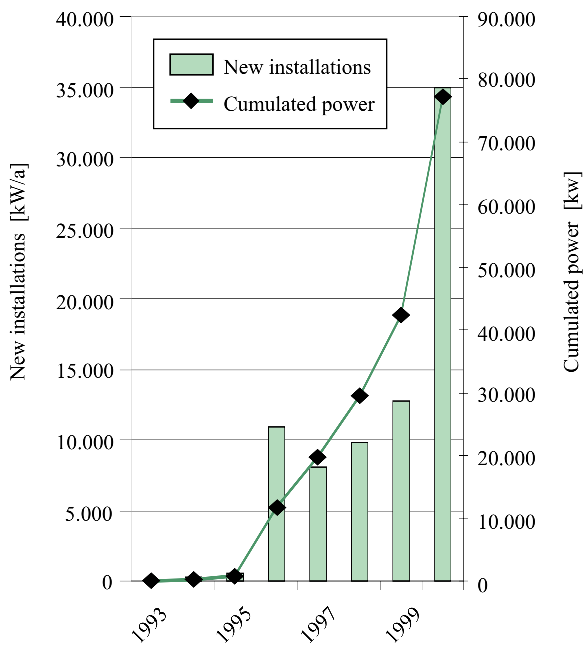


Figure 4.1: Development of wind energy in Austria – new installation per year and cumulated electricity performance (Source: Haas, Berger and Kranzl, 2001)

Table 4.3: Development of renewable energy sources in Austria 1993-1999 (Source: Statistics Austria, 2000)

	1993		1995		1997		1999	
Solar, geotherm., heat pumps	3,964	(0.36 %)	4,737	(0.42 %)	5,716	(0.48 %)	7,033	(0.59 %)
Firewood[1]	84,073	(7.69 %)	82,320	(7.26 %)	81,598	(6.48 %)	77,461	(6.46 %)
Other bio fuels	37,988	(3.47 %)	40,506	(3.57 %)	46,870	(3.93 %)	47,178	(3.94 %)
Wind/photovoltaic	2	(0.00 %)	6	(0.00 %)	80	(0.01 %)	189	(0.02 %)
Sub-total	126,027	(11.53 %)	127,571	(11.26 %)	134,264	(11.25 %)	131,861	(11.00 %)
Hydropower	132,200	(12.09 %)	133,500	(11.78 %)	130,025	(10.90 %)	145,821	(12.17 %)
Burnable waste	8,678	(0.79 %)	9,444	(0.83 %)	11,828	(0.99 %)	10,296	(0.86 %)
Total renewable energy	266,906	(24.41 %)	270,514	(23.87 %)	276,117	(23.14 %)	287,978	(24.03 %)
Total gross domestic cons.	1,093,407	(100 %)	1,133,447	(100 %)	1,193,210	(100 %)	1,198,282	(100 %)

[1] Predominantly (central) heating systems in households.

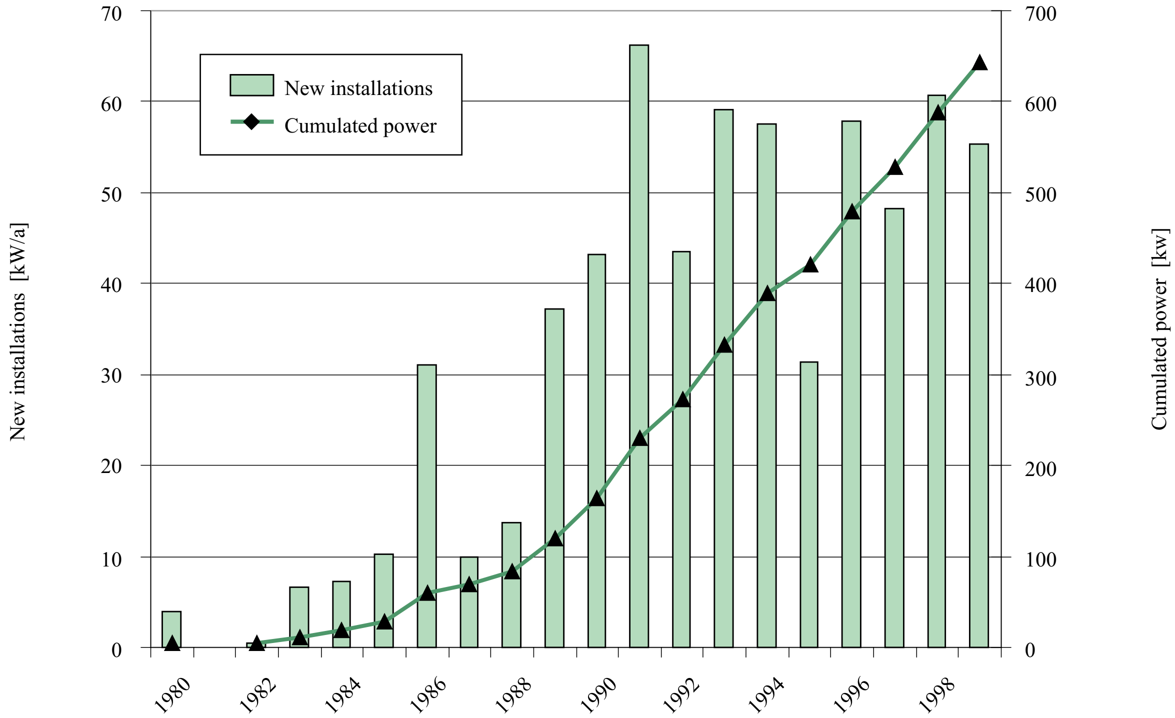


Figure 4.2: Development of district heating from renewable sources – new installation per year and cumulated performance (Source: Haas and Kranzl, 2000; assistance agencies; Lower Austrian Chamber of Agriculture)

Type of policy: economic (regulatory)

The Austrian Electricity Act, which entered into force in February 1999, implements the EU directive on the liberalisation of electricity markets. For an interim period between 1999 and 2001 the market was opened for industrial consumers with sufficiently large demand only. By 1 October 2001, each consumer (also private households), no matter the size of demand, can select an electricity supplier of his or her own choice. In addition, the electricity act has been realised as a chance to pay more attention to environmental concerns in energy supply. Therefore, preferential schemes for renewable energy sources have been given a new basis.

Targets and feed-in tariffs for 'new renewables'

Grid operators have the duty to take over electricity from renewable energy sources generated by independent producers, either industrial or others. A quantified target for so called 'new renewable energy sources' (N-RES, i.e. electricity from wind, solar, biomass, biogas, geothermal energy) was determined at 3 %, to be achieved by supply grid operators by 2005 (as a first step). Due to the amendment of the Austrian Electricity Act in 2000, which is part of the so called 'Energy Liberalisation Act', targets for electricity from renewable sources have been strengthened. In 2007, 4 % of electricity in the grid has to be generated with 'new renewable' sources. The target has to be achieved step-by-step with intermediate targets for 2001 (1 %), 2003 (2 %), 2005 (3 %) and 2007 (4 %).

In 2000, this 'new renewables'-share amounted to approximately 0.6 %, and it is likely that the 1 % share will be achieved in 2001. Those electricity suppliers who are not able to meet the (intermediate) targets will be charged with a compensation duty, which will be earmarked for renewable energy projects. The compensation duty, to be collected by the *Länder*, will be calculated according to the difference between actual net-market prices for electricity and average production prices for 'green-electricity'.

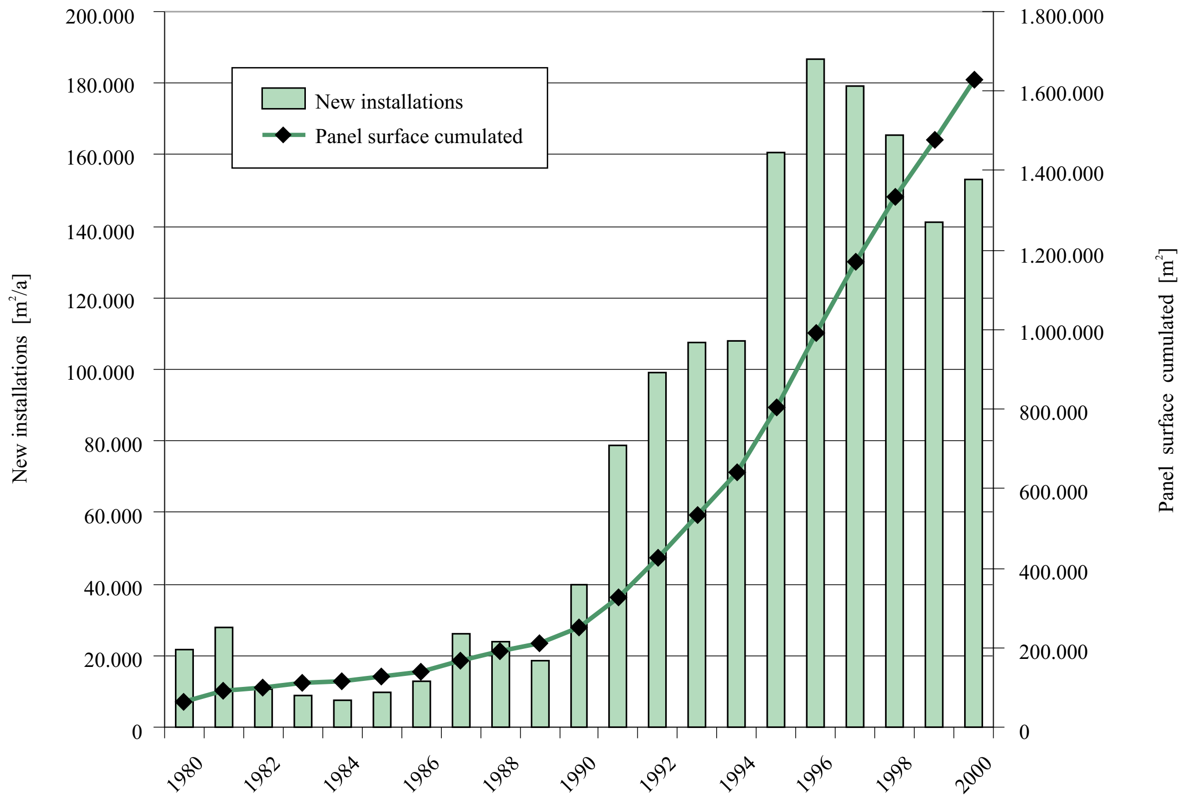


Figure 4.3: Development of solar panels in Austria – new installation per year and cumulated square metres installed, without plastic tube panels (Source: Faninger, 2001)

To make the targets economically attainable, the *Landeshauptmänner* (prime ministers of the *Länder*) have to fix *feed-in-tariffs* according to the production costs of N-RES-electricity and an *extra grid-charge* for recovering the additional costs (resulting from the fixed feed-in-tariffs) to the regional distributors.

'Small hydro'-trading scheme

In addition to targets for so called 'new renewable' energy sources, the Electricity Law from 2000 also sets a quantified target for 'small hydro' up to a peak performance of 10 MW. From the date of entry into force of the law in October 2001, 8 % of electricity delivered to consumers has to be produced in small hydropower plants. That is roughly the actual share of small hydro in the distribution grid in Austria, but under the conditions of rising electricity demand, further investments will be needed to increase power production from that source, in absolute terms. Without legally binding targets, no sufficient economic incentives would be in place, either to revitalise elder small hydro stations or to invest in new ones.

In difference to the feed-in price policy for 'new renewables', a trading scheme for 'small hydro certificates' has been in operation since October 2001 to guarantee compliance with the target in a cost-effective manner.

For the purpose of consumer information, electricity companies and traders have to indicate on the electricity bill the primary energy mix used for the production of electricity they deliver.

In complementary laws of the 9 *Länder* and some Ministerial ordinances, several provisions of the Federal Electricity Act are regulated in more detail.

Table 4.4: Guaranteed net feed-in tariffs for electricity from renewable energy sources in €-Cent/kWh (2001)

	Biomass*	Gas**	Wind energy	Photovoltaic	Geothermal
Burgenland	2.30–9.45	2.30–9.45	2.30–6.54	7.27–14.53	2.30–9.45
Carinthia	5.15–17.44	3.00–9.45	5.74–9.74	54.50–72.67	0
Lower Austria	3.56–12.43	7.27–9.45	3.56–8.87	12.94	3.63–12.43
Upper Austria	2.62–16.77	2.62–15.53	2.62–11.8	55.89–65.33	3.92–9.32
Salzburg	3.06–8.28	3.06–8.28	3.06–8.28	3.06–8.28	3.06–8.28
Styria	4.51–13.52	4.51–13.52	5.31–11.85	36.34	4.43–9.88
Tyrol	5.52–8.28	6.90–8.28	8.28	27.62	8.28
Vorarlberg	3.79–11.13	3.82–11.13	3.82–11.13	11.13	3.82–11.13
Vienna	2.98–12.43	3.58–9.16	3.58–8.50	11.06	2.98–12.43

* Solid and liquid biomass ** Biogas, landfill gas, sewage purification gas

M13 Public support for renewable energy projects and district heating

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

Most renewable energy projects still cannot be realized economically without public support. Climate change response measures in the field of renewable energy and energy efficiency have been supported through federal funding schemes with an annual amount of € 35 million on average between 1997 and 2000. Approximately a further € 20 million have been allocated by the *Länder* and communities for similar purposes under their own schemes, not including energy related support measures within the housing schemes (see M3 and M7).

Federal Environment Fund

The Federal Environment Fund is enabled to fund environment projects with a total budget frame of actually more than € 40 million per year. Over the past years, increasing priority has been given to climate change related projects. In 2000, 70 % of the funding sum was dedicated to projects with direct implications on GHG emissions, and that share will even be extended. For the budget periods 2001 and 2002, the total budgetary frame has been increased to reach € 40 million and € 47 million, respectively, after € 36 million on average during past years. All *additional* funding (i.e. € 15 million for both years) will be channelled for climate change purposes.

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

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

Rural funding schemes for energy from biomass

The Ministry of Environment, the *Länder* and the European Union also provide funding for rural biomass energy projects. Total public funding for those projects, like district heating from wood chippings, biogas CHP or individual biomass heating systems amounted to roughly € 25 million annually over the past years.

The *Länder* receive a share of 11,835 % of the energy tax revenue (electricity and gas) that is to be spent for these and other environmental purposes. Since the federal electricity tax was raised by 100 % in mid 2000, *Länder* now receive additional € 25 million per year for relevant support schemes, giving more flexibility to step-up resource allocation for renewables and district heating. For instance, Lower Austria announced in 2001 that it would quadruple provincial funding for biomass district heating from € 1.45 to € 5.8 million annually.

Meanwhile, biomass district heating has achieved a relevant share in energy supply (see also page 56).

Table 4.5: Climate change related funding under the Federal Environment Fund, 1997-2000

Type of project	Number of projects	Subsidies in total (€)	Average per year (€)
Biomass district heating	24	10,681,670	2,670,418
Biogas use	14	864,224	216,056
Biomass central heating	594	26,628,286	6,657,071
Landfill gas use	3	348,628	87,157
Entrepr. Energy-saving	108	9,564,450	2,391,112
District heating (conventional)	201	1,385,775	346,444
Thermal renovation of buildings	91	3,896,666	974,167
Geothermal energy	5	3,821,734	955,433
Photovoltaic energy	20	133,852	33,463
Thermal solar energy	590	4,105,084	1,026,271
Small hydropower	93	10,106,400	2,526,600
Wind power	57	3,858,241	3,464,560
Total	1,800	85,395,009	21,348,752

Another effective measure for reducing greenhouse gas emissions in the agricultural context is the utilisation of biogas in CHP-devices. The technology allows avoiding methane emissions from livestock to a large extent and – as a 'double dividend' - fossil fuels can be substituted. However, economically feasible potentials are rather limited. Improved feed-in conditions for 'green' electricity (see 'Implemented PaMs') could have the potential to accelerate the rather slow development until now. In 1999, approximately 100 agricultural biogas CHP systems were in place.

Improved coordination of climate change-related funding schemes

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

M14 Energy tax rebates for combined heat and power production (CHP)

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

Austria's energy taxation system exempts 'input'-fuels for power production from mineral oils and natural gas taxes in order to avoid double taxation due to the 'output'-tax (= consumption tax) on electricity. On the contrary, heat from (sole) heating plants is taxed indirectly by the taxes on input-fuels. Accordingly, for combined heat and power, only a share of input fuels is exempted from taxes. In order to give incentives for heat production from cogeneration, efficient cogeneration plants benefit from tax rebates within the mineral oils and natural gas tax since 1996. Plants with a minimum

electricity performance of 44 % are exempted from taxes on 'heat share' of energy output.

4.2.2.2 Adopted Policies and Measures

M15.1 Preferential framework conditions for combined heat and power production (CHP)

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

Within the Federal Electricity Act, the *Länder* are entitled to oblige net-operators to feed in electricity from combined heat and power ('cogeneration') at macro-economically reliable prices. Such preferential conditions are allowed to be granted until the end of 2004.

4.2.2.3 Planned Policies and Measures

M15.2 Preferential framework conditions for combined heat and power production (CHP) (cont. from 'Adopted PaM)

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

The European Commission is also planning an initiative to double the share of electricity from combined heat and power in the European Union from actually 9 % to 18 % by 2010. A draft directive in that respect is scheduled to be adopted by 2002.

M16 Further development of targets for renewable energy sources and implementation of the EU directive on renewables

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

The recently adopted EU Directive on Electricity Production from Renewable Energy Sources sets indicative targets for each Member State for the year 2010. According to that legal act, Austria has to set an indicative national target that takes into account the reference value laid down in the directive, equivalent to an increase of the share of electricity from renewable energy sources from 70 % in 1997 to 78.1 % in 2010. The figures include large hydro as well as a broader definition of the term 'biomass' and are, therefore, not directly comparable with 'new renewables' targets from the Electricity Act. Given an annual increase of electricity demand of 1.6 %, according to latest analysis ('Energy Forecasts and Scenarios until 2020', WIFO 2001), the target would be equivalent to additional 13 - 14 TWh electricity from renewable energy sources by 2010 compared to around 39 TWh supplied by all renewables in 1997. However, Austria states in a footnote to the directive that 'the reference value of 78.1 % would be a realistic figure, on the assumption that in 2010 gross national electricity consumption will be 56.1 TWh'. If this assumption occurs, meaning that electricity demand remains at its 1997 level, there would be a need for an additional 4.8–5 TWh, only in electricity production from renewables by 2010.

The directive, which also sets framework conditions for the establishment of mutually recognised electricity labelling systems, has to be implemented by Member States by the end of 2003. Depending on the development of electricity consumption in Austria, it is likely that further efforts will be needed to get in compliance with the directive. This would require a forward projection and adequate adaptation of existing targets for renewables in the 'Energy Liberalisation Act'.

However, the targets will only be in reach when supplementary efforts will be made to slow down the growth in electricity demand. Measures to that end are described in the draft *Austrian Climate Strategy 2010*, e.g. contracting initiatives, energy consulting, 'green public purchasing' etc. (see section 4.2.1).

Supplementary to the directive on electricity from renewable sources, the European Commission has also announced its intention to prepare draft directives on the promotion of bio fuels and an initiative on the promotion of heat production from renewable energy sources.

M17 Stepped-up public support for renewable energy and district heating projects

According to the draft *Austrian Climate Strategy 2010*, public support schemes for renewable energy and district heating projects need to be stepped-up substantially over the coming years in order to achieve Austria's Kyoto target under the EU burden-sharing agreement. The federal government is, therefore, planning to reserve more federal money for tailor-made schemes like the Federal Environment Fund and the rural biomass programme. Budgetary commitments will be made in compliance with the zero-deficit target of the federal government and after careful evaluation of the effectiveness of current climate change, related subsidies in conjunction with further pending decisions with respect to an appropriate mix of instruments such as fiscal measures, national emissions trading and a national programme on Joint Implementation and the Clean Development Mechanism.

M18 Green electricity purchasing for public buildings

Implementing entities: Federation, 'Länder' and municipalities
GHG affected: CO_2
Type of policy: contractual

Clear and reliable electricity labelling, which makes visible to the consumer the different sources of electricity delivered, is a prerequisite for green electricity purchasing. Labelling systems are due to enter into force and some (new) suppliers explicitly advertise high shares of renewables in their energy-mix.

A green electricity purchasing policy of relatively large electricity consumers, like public services, could have considerable impact on the green electricity market. The draft *Austrian Climate Strategy 2010*, therefore, advises public entities (*Länder*, municipalities, Federal Real Estate Company etc.) to buy green electricity on the open market. After the amendment of the Federal Electricity Law, electricity suppliers and brokers are obliged to issue the primary energy mix of delivered electricity on the account.

M19 Voluntary agreements

Implementing entity: Federation
GHG affected: CO_2 (predominantly) and other gases
Type of policy: negotiated agreement, economic

Voluntary agreements between the government and (parts of) energy industries, allowing for a more flexible and cost-effective achievement of targets, are under consideration. These could aim at clearly defined emissions limitations, being also a prerequisite for the establishment of an emissions trading scheme, which is currently under discussion (see also *Cross-cutting Policies and Measures*').

Estimated GHG emissions reduction from planned measures in the Energy Supply Sector: 2 Mt CO_2-equivalent p.a.

4.2.3 Waste Management

Categories of the Common Reporting Format affected: 6, 1A1, 1A4
GHG affected: CH_4, CO_2

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

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

Waste management, namely waste incineration, also has significant influence on CO_2 emissions, both in a positive and negative way. Combustion of plastics (and co-firing of fossil fuels) causes additional CO_2 emissions, but it avoids long term CH_4 emissions from organic carbon. When the incineration plant is equipped with CHP technology, waste incineration also avoids large quantities of CO_2 emissions in other sectors (households, energy industry). On condition of energy efficiency and other high technical standards, which reduce 'traditional' pollutants to an absolute minimum (environmental impact assessment!), incineration seems to be the environmentally most attractive way of residual waste[2] treatment.

4.2.3.1 Implemented Policies and Measures

M20 Waste Management Act 1990

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

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

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

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

Consequently, Austrian waste management policy follows as leading principles:

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

These principles are also in line with Council Directive 75/442/EEC on Waste, although most Austrian standards, implemented by regulations, go beyond those at the community level. This does not

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

necessarily cause legal conflicts, as far as domestic provisions do not distort competition in the common market. The Waste Management Act is implemented through several regulations. The most important of these in terms of potential GHG reductions is the Landfill Regulation.

M21 Landfill Regulation 1996

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

The Landfill Regulation is one of the most important instruments for implementing overall targets of the Waste Management Act (see M20). The regulation also implements Council Directive 99/31/EC on Landfills.

The leading principles of the Landfill Regulation are:

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

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

The Landfill Regulation entered into force in 1996 but central parts of the regulation will not be implemented before 2004 (see 'Adopted Policies and Measures').

M22 Landfill Charge Act 1989 ('Clean-up of Contaminated Sites Act')

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

Leading principles:

- ▷ Disposal of waste on landfills (domestic or abroad) is subject to a charge
- ▷ Rate of charge depends on type of waste
- ▷ Charge raised step by step between 2001 and 2006
- ▷ Supplemental charges for disposal on landfills without gas recovery
- ▷ Revenue of charge earmarked for clean-up of contaminated land

The effectiveness of Austrian waste policies and specifically the Landfill Regulation (see M21) is directly supported by the landfill charge. The charge for residual waste currently is € 43.6 (ATS 600) per tonne, and will be raised to € 65 (ATS 900) by 1 Jan 2004. A supplemental charge of € 29 (ATS 400) applies when the landfill is not equipped with a landfill seal, and another € 29 (ATS 400) for landfills without landfill gas recovery of current technical standard. On 'worst case' landfills, which rarely exist anymore, the charge can, therefore, total up to € 100 (ATS 1,400) per tonne (€ 123 or ATS 1,700 as of 2004).

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

4.2.3.2 Adopted Policies and Measures

M23 Expansion of treatment capacities other than landfilling

Implementing entities: 'Länder', municipalities
GHG affected: CH_4, CO_2 (implicit)
Type of policy: regulatory

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

Implicit impact of the landfill regulation on incineration

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

M24 Promotion of waste recovery and R&D

Implementing entities: Federation, Länder, communities
GHG affected: CH_4, CO_2
Type of policy: voluntary agreements, information, education, research & development

Experience has shown that ecologically and economically viable recovery reaches its limit when the input required for the collection, cleaning and treatment of waste entails a greater quantity of emissions or other environmental contamination than would be generated by the use of primary materials. Therefore, it is especially important to place more emphasis on long product life and ease of repair with respect to material goods and plants of all types, and to use renewable raw materials preferentially in production. This applies not only to the use of material resources but also to the energy resource input. The recycling and thermal recovery of organic waste from renewable raw materials (in particular wood) will be of increasing importance in the future.

Active support of companies is necessary for the further intensification of the management of recoverable waste. In 1996, the then Federal Ministry of Environment, Youth and Family Affairs, together with its partners, launched a pilot project for a recycling network in Upper Styria. Management consulting sessions were carried out in over 30 production companies in order to identify recycling potential and methods and thus, establish a functioning recycling network. Since then, these consultation activities have led to the formation of a recycling information centre, which, so far, works at the university level, but will be outsourced. Some of the economic relations established in 1996 are still firmly upheld; at the moment, intensive networking is underway with respect to waste lacquers, granite residues and pallets. For logistic planning, GISs are used in addition to economic modelling in order to optimise the material flows.

Effective recovery exchanges require a sufficient supply of information on what is available in the field. Otherwise, they remain largely unused. The actual problem is obviously not a lack of suitable recovery options but the lack of referral and consulting activities, as well as the need to overcome communication barriers. Establishing regional and/or waste-specific 'recycling agencies' could provide help. For these reasons, a so-called Recycling Exchange for the Construction Industry was established for the construction sector at the ÖBRV; since 1998, the Exchange has been managing information on the supply and demand of demolition and construction waste and excavated soil.

M25 Efficient energy recovery from waste

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

High energy efficiency of waste incineration plants could even result in further GHG mitigation effects, when taking into account energy induced CO_2 emissions from other sectors. Therefore, incineration plants are to be subsidised under the new guidelines for the Federal Environment Fund on condition that energy from organic material is efficiently recovered. District heating grids should be extended in parallel and in conjunction with space planning measures.

M26 Other programmes to launch waste prevention and recovery

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

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

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

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

4.2.3.3 Planned Policies and Measures

M27 Definition of technical state of art for mechanical-biological treatment of waste

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

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

Estimated GHG emissions reductions from adopted and planned measures in the Waste Management Sector: 1.1 Mt CO_2 equivalent p.a.

4.2.4 Transport

Categories of the Common Reporting Format affected: 1A3 (Transport)
GHG affected: CO_2, N_2O

Different from other sectors with more or less stable or falling emissions trends since 1990, the transport sector in Austria shows an extraordinary growth without signs of a fundamental change in sight. Since 1990, CO_2 emissions from mobile sources have been growing by 30 % from 13.6 Mt to 17.6 Mt in 1999.
Transport induced emissions of N_2O also increased sharply over the period from 0.3 Mt CO_2 equivalent to 0.6 Mt, mainly caused by the compulsory use of catalytic converters for clean air reasons.

Emissions trends in the transport sector depend on a variety of different driving forces, among them the economic development, changing living patterns, the opening and expansion of the EU towards the east and infrastructure needs and developments. Today, private traffic is responsible for around 55 % of total transport emissions. Although private mobility still continues to rise, a stabilisation of emissions from private transport can be expected between 2005 and 2010 due to continuous improvement of fuel economy. This is not the case for business transport, giving rise to the expectation that emissions from lorries will be equal to or even higher than those of passenger cars by 2010 in the business-as-usual scenario.

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

4.2.4.1 Implemented Policies and Measures

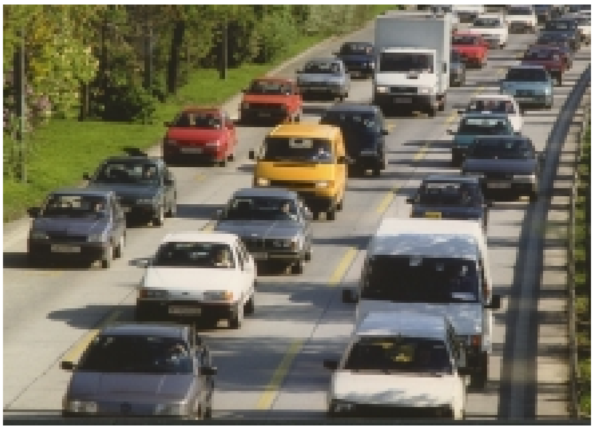
M28 CO_2 labelling and other measures to reduce emissions from passenger cars

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

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

The labelling scheme is one element of an EU strategy to bring down average CO_2 emissions from new passenger cars to 120 g/km (corresponding to an average fuel consumption of about 5 litres/100 km or 20 km/l) by 2010 at the latest, adopted by the Council of Ministers and the European Parliament. In 1999, the average level of CO_2 emissions from newly registered cars in Europe was approximately 176 g/km. The most important step towards that ambitious target was the conclusion of agreements between the European Commission and European, Japanese and Korean associations of car manufacturing industries (ACEA, JAMA and KAMA), covering more than 95 % of the European market for passenger cars. According to these agreements, average CO_2 emissions from newly registered cars will not be higher than 140 g/km by the year 2008. That still leaves a gap of 20 g/km, which has to be bridged by supplementary measures.

Apart from the labelling scheme, the Commission is also considering a common European framework for fiscal measures to reduce CO_2 emissions from passenger cars, covering fuel taxes (EU minimum rates already apply), registration and circulation taxes. To that end, possible ways and options are under scrutiny; taking into account already successfully implemented fiscal measures in several Member States.



M29 Fuel consumption based registration tax

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

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

M30 Road tolls

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

In 1996, a toll for private car use on highways was introduced. The base for the toll is the time-frame use. A one-year 'vignette' was introduced at a fare of € 40 (ATS 550) and raised to € 73 (ATS 1,000) in 2001. According to original plans, a mileage-based toll should replace the 'vignette', being more effective from an environmental *and* economic point of view. From today's perspective, a mileage-based toll is scheduled to enter into force for trucks from 2004. The system will be technically open for extension to passenger cars in a second phase.

M31 Vehicle tax adaptation in 2000

Implementing entity: Federation
GHG affected: CO_2, N_2O
Type of policy: fiscal

Amendments of taxation laws in 2000 also led to a sharp increase of circulation taxes for passenger cars and motor-bicycles by 50 % on average. A considerable effect on fuel consumption can be expected from the measure as vehicle tax rates are based on engine power, which is both an indicator for traffic safety and fuel consumption. In conjunction with the consumption-related registration tax and the CO_2-labelling for passenger cars, the measure will have relevant impact on consumers' purchase choice.

M32 Rail infrastructure, regional and urban public transport investments

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

Expanding exchange of goods and passengers within the European internal market and the extension of the EU towards the east implies the need for adaptation of Austrian transport infrastructure. Major investments have been undertaken in past years in order to be prepared to meet future transportation needs in a sustainable manner.

Current and Future Investments in rail and urban public transport

A main objective of Austria's traffic policy is to improve the rail and the urban transport to increase capacity, speed and service quality. For the national rail network, a fund amounting to € 10.39 billion exists. This fund is based on the national budget and on the revenues from infrastructure tolls paid by the rail operators. Important infrastructure projects for the next 10 years are:

- A new high speed line Vienna–St.Pölten.
- Further upgrading measures between the cities of St. Pölten and Attnang-Puchheim to improve rail capacity and speed in the Danube corridor. The travel time by *Intercity*-train from Vienna to Salzburg should be reduced from today more than 3 hours to around 2 1/2 hours.
- Improvement of the two important alpine corridors *Tauern*- and the *Inntal-Brenner* axis
- Projects along the *Pontebbana* corridor from the Czech republic via the Vienna region to Italy. Especially the new *Koralmtunnel* between Graz and Klagenfurt will significantly reduce travel time from the Vienna Region and Graz to Carinthia and Italy. The accessibility of Graz on rail will be very much improved by this project.

In the framework of the *Austrain General Transport Plan* the projects still to be scheduled are analysed and ranked according to priority categories. The *General Transport Plan* will be published at the beginning of 2002,

Combined Transport

Austria's transport policy is very successful in promoting Combined Transport (CT). In 2000, the *OeBB* (Austrain Federal Railways) carried 21.8 million tons in CT on rail. 11.4 million tons were transported in unaccompanied CT (Containers, swap bodies...) and 10.4 million tons with the *Rolling Road*, which carries lorries and their drivers. For 2001 more than 25 million tons are forecasted. In Wien Inzersdorf and in Wien Freudenau, two additional CT terminals are planned. Freudenau will also include the trans-shipment from inland waterway navigation to rail and road. Both terminals will improve the accessibility to CT for the clients in the Vienna Region. In Werndorf near Graz a new CT-Terminal is already under construction.

Austria's federal transport policy also focuses on the introduction of the Danube inland waterway in CT chains. Therefore, a logistic company specialised in the inland waterway – called *Via-Donau* – was founded with the support of the Federal Ministry of Transport, Innovation and Technology. *Via-Donau* has already arranged scheduled feedership services between Deggendorf in Germany and Budapest, stopping also in Austrian inland waterway ports.

Regional and urban transport

Not only international transportation needs are challenging for transport policies, but also regional and local developments. New living patterns and mobility demands cause increasing pressure on regional transport infrastructure, especially in suburban areas (commuter and regional business transport). Regular improvement and expansion of regional and local public transportation systems is, therefore, required. Austrian *Länder* and cities are obliged by the Federal Act on Revenue Sharing to earmark approximately € 170 million annually from mineral oils and energy tax revenues for public transportation investments and subsidies. *Länder* and municipalities give further contributions from general budgets for these purposes, depending largely on local and regional needs and circumstances. The construction of the Vienna underground network is also supported by the federal government.

M33 Improvement of fuel quality and promotion of 'bio-diesel'

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

European Community Directive 98/70/EC from 13 October 1998 on the quality of petrol and diesel was implemented in Austrian law by way of a regulation in 1999. The EU directive/national regulation aims at a substantial reduction of polluting substances in fuels within the time frame 2000–2005. Apart from air quality objectives, the envisaged reduction of sulphur content of petrol and diesel is of specific importance for fuel consumption reduction and, therefore, is of high relevance for implementation of the agreements between car manufacturers and the European Commission on average fuel consumption of new cars (see M28). However, it already seems clear that reductions foreseen in the '98 directive will not be sufficient to meet the goals. Consequently, the Commission made a proposal for a further strengthening of the 2005 target, aiming at long-term sulphur contents below 10 mg/kg. The target in force for 2005 is 50 mg/kg.

The 1999 regulation on fuel quality also paved the way for a broader use of 'bio-diesel' in passenger cars, busses or lorries. Adding up to 3 % pure 'bio-diesel' (e.g. from rape or sun flower oil-seeds) still is in accordance with the standardized specifications of conventional diesel. Car-manufacturers also issue certificates of non-objection for using pure bio-diesel for most types of new diesel cars on the market. Pure bio-diesel, offered at a lot of Austrian petrol stations, is competitive with conventional diesel due to exemption from mineral oils tax and temporarily high prices for imported crude oil or refinery products.

M34 Model projects and programmes for environmentally sound mobility

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

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

Mobility management for large events

Three pilot projects for environmentally sound and congestion-free transport solutions for large events

(Wieselburg Fair 1998, Nordic Ski World Cup in Ramsau 1999, International Gardening Fair, Graz 2000) have been carried out by the Ministry of Environment in the Framework of the implementation of the National Environment Plan and the Climate Change Campaign of the Government. The share of visitors travelling by private car could be held at only 30 % in average, others travelling by bus, train, shuttle services or bicycle. The applied mobility management concepts were broadly welcomed by visitors (e.g. 99 % of visitors at the International Gardening Fair praised the mobility concept as 'good' or 'very good').

'Car free' tourism communities

The project is being carried out cooperatively by Federal Ministries (FMAFEW, FMTT, FMEAL), *Land* Salzburg and the model communities Bad Hofgastein and Werfenweng (both skiing resorts as well as summer tourism destinations in Salzburg) with financial support of the European Union. The pilot project follows different policy objectives in the fields of environment, transport, tourism and technology, as formulated, for example, in the National Environment Plan, the EU Environment Action Programme or the Alps Convention. Locally, the model projects follow an improvement of living quality for inhabitants and guests by reducing transport-related environmental impact (air quality, congestion, noise, safety...). A broad variety of local measures and initiatives, ranging from improved environmental sound transport connections (both for journey to the destination and local/regional transport) and baggage/shuttle services to the availability of alternative vehicles in the communities (e.g. rental service with electric cars, scooters and bikes, car-sharing etc.) and electronic travel information systems which cover all modes and regional/interregional services of transport. The high acceptance of the concept can be illustrated by the remarkable growth in overnight accommodations (+11 % in the affected communities compared with 2.5 % in the average of the *Land* Salzburg).

Mobility management for business

Five pilot projects with companies and public institutions, carried out by the Ministry of Environment in Cooperation with the Austrian Chamber of Commerce, showed large potential for traffic avoidance and reallocation for employees' everyday travel to work and other business-related transport demands. The model projects not only showed positive environmental outcomes but also economic advantages for companies and employees (e.g. 'jobtickets' for public transport, less need for creation of parking facilities etc.). In order to promote a broader application of sound mobility partnerships for business and employees, measures in this field can also be supported under the Federal Environment Fund after an amendment of the relevant law in 2000.

MOVE – Mobility And Transport Technology

'*MOVE*' is a technology stimulation programme, lasting several years, designed and financed by the Ministry of Transport, Innovation and Technology. It supports the development of an efficient and innovative transport system which is key for securing the mobility needs of individuals as well as the economy.

MOVE promotes research and development projects in the field of transport and mobility by funding pilot projects capable of triggering innovation in the transport system.

According to the Innovation and Technology Fund's (ITF) guidelines, the following activities can be funded:

- ▷ Projects in economic basic research;
- ▷ System and feasibility studies;
- ▷ Applied R&D projects and pilot schemes of innovative procedures, products, services and systems solutions;
- ▷ Networks and interactive information platforms designed for technology transfer.

The proportion of funding quotas (10 % bonus for small and medium-sized enterprises) and private investments is strictly in line with the relevant EU guidelines. For *MOVE* and its programmes, approximately € 2.9 million are budgeted annually.

Innovative Mobility Services

The Ministry of Transport, Innovation and Technology promotes the development and market penetration of customer-oriented and ecologically sound mobility technologies as well as new services combining public and individual transport.

TAKE ÖV – telematic application for public transport

A central aspect of *TAKE ÖV* are customer-tailored telematic applications as a predominant key to increase the attractiveness of public transport. A close co-operation between technology and system providers, public transport services and customers triggers innovation and development.

M35 Model projects for environmentally sound logistics

Implementing entity: Federation (Ministry of Transport, Innovation and Technology)
GHG affected: CO_2
Type of policy: information, education, R&D

Logistic Austria Plus

Logistic Austria Plus increases the economic efficiency of logistic systems. The optimisation of transport chains, the minimization of costs and the improvement of schedule reliability increase the competitiveness of Austria's enterprises. *Logistic Austria Plus* has a clear emphasis on intermodal transport with the overall aim to shift traffic to environmentally friendly transport modes.

Subprogramme 'Green Logistics'

Green Logistics – as one out of four thematic key actions of *Logistic Austria Plus* – has been set up to combine the goals of socio-economic and environmental policies and promote intelligent cross-modal logistic solutions. To meet these objectives the Austrian Ministry of Transport, Innovation and Technology launched a 2-step call for proposals, which closed in December 2000. Consortia of private commercial and industrial organisations, universities and other research institutions, public authorities, as well as individual participants were invited to submit proposals.

Via Donau – revitalization of inland navigation

Via Donau is a technology and logistics company of the Ministry of Transport, Innovation and Technology founded in 1999 to realize transport technology and economic goals. It is a competent partner in inland navigation transport and the logistics sector, standing for:

- Developing high quality transport and logistics on the Danube;
- Carrying out technological projects for freight transport on the Danube;
- Public relations and lobbying for the Danube as an important waterway;
- Integration of the Danube waterway in the Trans-European Transport Network.

Pilot Programme Waterway Danube

Under the *Via Donau* programme, approximately € 1 million per year will be spent on stimulating combined water/rail transport by funding the shipment of containers. Furthermore, studies, logistic concepts and other activities, which are in line with the guiding principle of intermodality, can be co-funded up to 50 %.

Combined Freight Transport Programme (1999-2002)

This programme focuses on supporting the construction or retrofitting of terminals, handling and loading equipment and other innovative technologies and systems (like information and communication technologies) for facilitating combined freight transport. Moreover, the programme allows for the funding of feasibility studies in the area of terminal technologies and for special training in the field of combined freight transport.

The funding is issued in the form of grants up to 30 % (maximum € 1.45 million) of overall expenditures. In the case of transportation equipment, 100 % of the estimated additional costs in comparison to the conventional equipment will be funded. For feasibility studies and training programmes, funding is foreseen up to 50 %. The overall budget for the combined freight transport programme includes € 2.9 million per year.

4.2.4.2 Adopted Policies and Measures

M36 Mileage-based toll for lorries

Implementing entity: Federation

GHG affected: CO_2
Type of policy: fiscal

Continuously rising commercial traffic and road transport is mainly responsible for the upward trend in transport CO_2 emissions. One of the reasons is that external costs of road transport are not reflected in the prices for road use. For transit trucks operating between EU countries (esp. between Germany and Italy) a so-called 'eco points' system applies since Austria became a member of the European Union in 1995. According to the Accession Treaty between Austria and the Union, the transit traffic system will be effective until the end of 2003 and has to be replaced by an ecologically effective but non-restrictive system for the time following. Although the eco-points system provides for a significant reduction of NO_x-emissions from trucks, the overall costs structure and the economic activity within the internal EU market clearly stimulates cross-boarder road transport. Austrian road-use duties for trucks had to be reduced dramatically after EU-accession for the sake of convergence with internal market law.

Transport prices reflecting costs of environment damage and health effects, therefore, are one of the leading targets of Austrian transport policies, both on a national and European level. Accordingly, a non-discriminatory mileage based highway toll for lorries and trucks with a total weight of at least 3.5 tons will be introduced as early as possible, but not later than 2004. The respective federal law has already been adopted by parliament (*Bundesstraßenfinanzierungsgesetz*). A public call for tenders for the installation of an electronic system, which has to be compatible with systems planned in other EU member states (esp. Germany), was placed in spring 2001.

The existing timely based 'vignette', which has to be purchased for highways use with vehicles with a total weight of up to 12 tons, will be partly replaced by the electronic mileage-based system. Lorries with a total weight between 3.5 and 12 tons will be charged under the new system, whereas for passenger cars the 'vignette'-system will continue to apply. By January 2001, the vehicle tax for lorries (above 3.5 tons), which has already been one of the highest in the EU, was increased by a further 50 % on average. For lorries, this measure will only be effective until the introduction of the mileage based toll. By then, the rates will be reduced to the amounts that were effective at the end of 2000.

4.2.4.3 Planned Policies and Measures

M37 Promotion of energy efficient and alternative motor concepts

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

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

M38 Public awareness-raising measures

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

Measures focused on raising public awareness with regard to climate-friendly modes of mobility constitute an integrative part of policies and measures in the traffic and transport field. The new law on passenger car's labelling was mentioned above (M28, under *Implemented Policies and Measures*. Further measures of the Federation, the *Länder* and municipalities, such as regional centres for mobility management, education and training schemes, information on economic driving ('ecodrive'), labels on transport intensity of food products etc., are in a planning stage. Model projects of federal ministries, as described under *Implemented Policies and Measures*, will be carried on.

M39 Improvement of transport logistics

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

A significant reduction of emissions from trucks can be achieved by means of improved logistic management and infrastructure measures. It is likely that already existing incentive schemes of the Ministry of Transport, Innovation and Technology, as described under *Implemented Policies and Measures*, will be expanded over the coming years.

M40 Further internalisation of externalities from road transport

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

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

Also for passenger cars, the draft *Austrian Climate Strategy 2010* faces the necessity of reflecting external costs in a manner, that taxes and duties should be based predominantly on mileage and fuel consumption. Taxes on fuels and road use should, therefore, be increased and/or differentiated in a way that better reflects impact on the environment. In a medium-term perspective, mileage-based road tolls for highways, consequently, should be introduced for all vehicles.

Fuel taxes in Austria need to be further developed step-by-step in a coordinated way with neighbouring countries and in accordance with tax rates laid down in mineral oil tax directives of the EU. The existing Fuel Consumption Duty, which is designed as a sales tax, should also be further differentiated in the future in order to put cars with high petrol or diesel consumption in a more disadvantageous position, whereas highly efficient cars already now benefit from low tax rates.

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

M41 Promotion of walking and cycling

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

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

M42 Improvement of spatial planning

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

Spatial planning is under the jurisdiction of the *Länder*, although guiding principles and recommendations are formulated in *Spatial Planning Concepts* from the Austrian Spatial Planning Conference, which are updated every 10 years. The Federal Chancellery chairs the Spatial Planning Conference; all regional entities (Federation, *Länder*, municipalities) are members of the institution. The new *Spatial Development Concept 2001* is due to be adopted by the end of 2001. Environmental aspects, such as sustainable transport and careful use of natural resources, will be given more attention than in previous concepts.

There is broad consensus among stake holders that spatial planning strategies and laws of the *Länder* need more coordination in order to reduce traffic inducing structures, such as shopping and leisure centres in sub-urban areas ('on the green lawn') or scattered settlements with high infrastructure costs and limited access for public transport services.

The draft *Austrian Climate Strategy 2010* makes several suggestions for better integration of climate change issues in spatial planning instruments, e.g. defining environmental and climate change targets as high priorities in the spatial planning laws of the *Länder*; creation of legal prerequisites for interregional costs/benefit adjustment; promotion of sufficient density and multi-functionality of settlements; creation of model-settlements for 'car free living', etc.

M43 Traffic management and speed limits

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

Congestion, especially in urban areas, causes high macroeconomic costs and is an increasingly relevant source for avoidable CO_2 emissions from transport. Telematic technologies can contribute significantly to congestion avoidance. The Federal Ministry for Transport, Innovation and Technology is, therefore, promoting key technologies in that respect.

Speed limits on highways have also proven to be very effective in terms of fuel consumption reduction but also with respect to traffic safety and noise reduction. Electronically controlled and situation adaptive speed limits also have some potential for congestion avoidance.

Also pricing differentiations within the scheduled electronic road toll for trucks on a regional and timely basis can effectively contribute to congestion avoidance and, therefore, warrant serious consideration.

The Austrian Federal Ministry for Transport, Innovation and Technology has accepted the challenges of transport and transport-related technology policy and is launching forward-looking measures to create an innovative transport sector. Building upon some of the already existing successful initiatives of the ministry, FMTT is currently developing a multi-annual research and technology programme that shall be both tuned to the national strengths in transport research and industry and strategically positioned in the light of current international developments in transport and technology policy. The development of intelligent systems solutions, making efficient use of the innovative potential of new technology, is key for the creation of cost-effective, safe, environmentally friendly and user friendly transport systems and services. This programme, which mainly is based on implementing a multi-modal traffic telematic infrastructure, will be funded up to € 58 million.

Expected GHG emissions reduction from planned policies and measures in the Transport Sector: 3–4 Mt CO_2 equivalent p.a.

4.2.5 Industry

Categories of the Common Reporting Format affected: 1A2 (Manufacturing Industries and Construction), 2 (Industrial Processes)
GHG affected: mainly CO_2[3]

The industry sector has been very successful in decoupling production output and energy demand over the past two decades. CO_2 emissions decreased from around 25 Mt to 20 Mt between 1980 and 1990 and were kept stable during the 1990s. Data include emissions from industry's own electricity production.

Policies and measures for the manufacturing industry, therefore, aim at supporting a continuation of efforts undertaken by companies. A mix of promotive and economic instruments is envisaged in order to make sure that industry is able to cut emissions in a cost-effective way, also making profit from 'first-mover'-advantages in international competition.

4.2.5.1 Implemented policies and measures

M44 Promotion of energy efficiency measures and renewable energy projects

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

Energy-saving measures and the use of renewable energy sources in industry gain public support under the scheme of the Federal Environment Fund. Around 200 industrial projects with climate change mitigating effects were supported between 1996 and 1999. Specific attention was given to thermal solar energy, district heating from industrial boilers, biomass boilers and cogeneration (bio fuels or natural gas).

M45 Implementation of the IPPC Directive

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

Although not perceived originally as an instrument for climate change mitigation, the EU Directive on Integrated Pollution Prevention and Control (IPPC), which lays down common principles and rules on granting permits for new and existing industrial installations, foresees in article 3 the obligation for operators to use energy efficiently. The directive was implemented in national law in 2000 by amendments of the *Gewerbeordnung 1994* (BGBl. I Nr. 88/2000) and other material laws (water protection, waste management etc.). However, the European Commission is actually considering to propose an amendment to the directive in order to specify energy efficiency requirements for individual sectors.

M46 Energy concepts for energy intensive branches

Implementing entities: Länder
GHG affected: CO_2
Type of policy: promotive/awareness raising

In close cooperation with industry representing organisations, several *Länder* have worked out energy concepts for energy intensive branches. These studies show economic potential for energy-savings and offer possible and practical solutions.

4.2.5.2 Planned policies and measures

M47 Energy efficiency programme

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

[3] In difference to other countries Austrian industry emits only small quantities of N_2O emissions; fluorinated gases (HFC, PFC, SF_6) are covered under a separate section, due to cross-cutting character of measures

The producing sector in Austria successfully managed to decouple energy demand and product output growth over the past decades. Since the mid-1970s CO_2 emissions from the sector have remained relatively stable. To achieve further emissions reductions, an energy efficiency programme will be launched over the next years, comprising benchmarking, best practise diffusion and energy auditing as its central parts.

M48 Promotion of energy efficiency and renewable energy projects

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

In continuation of successful programmes in the framework of the Federal Environment Fund, further public support will be given for installation of industrial co-generation plants, increased use of renewable energy sources and energy-saving measures (see also sector energy supply). The step-by-step increase of the annual budgetary frame for environment funding and a strengthened focus on climate change mitigating measures are expected to result in significantly higher GHG emissions reductions in the industrial sector than in the past.

M49 Voluntary Agreements and flexible instruments

Implementing entities: Federation, EU
GHG affected: CO_2
Type of policy: voluntary/negotiated agreements, economic

Voluntary agreements and other economic instruments should be in addition to measures in the industry sector as laid down in the draft *Austrian Climate Strategy 2010*. The application of project based flexible mechanisms of the Kyoto Protocol (Joint Implementation and Clean Development Mechanism) could play a key role as a cost effective measure in industry's strategy to reduce GHG emissions. The Austrian government is on the way to adopt a JI- and CDM-Programme, which aims to provide a facilitative framework for companies undertaking GHG-mitigation projects in other countries.

The European Commission has recently initiated a legislative process towards an EU framework for Emissions Trading. In parallel, preparations for a national scheme, which must be compatible with a future EU framework, will be continued. Agreed targets ('caps') are generally seen as a prerequisite for an effective trading scheme. Discussions with industry representing organisations on possible ways of agreements have been initiated. Moreover, the role of the European Union with respect to 'Voluntary' or 'Long Term Agreements' needs to be further investigated. There are goods arguments, for instance, that the EU should play an important role when it comes to *product related agreements*, focusing on GHG emissions caused from product use. Agreements between the Commission and the three most important car manufacturers for the European market on a significant reduction of CO_2 emissions from newly registered passenger cars by 2008 are a good example in this respect.

Estimated GHG emissions reduction from planned measures for industry: 1.25 million t CO_2 equivalent p.a.

4.2.6 Agriculture and Forestry

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

Agricultural and forest production is on the one hand directly affected by climatic changes and therefore might need to develop adaptation strategies (see chapter 6). Nevertheless, agriculture and forestry can play a future key role as suppliers of renewable energy sources and other sustainable raw materials. 17 % of Austrian households use bio energy in individual heating systems. In addition, several hundred agricultural district heating plants running with bio fuels (wood chippings, straw etc.) are a clear indication that the agriculture and forestry sector is an emerging partner in the energy market. Public promotion for renewable energy projects highlights the political efforts to support and accelerate that process.

On the other hand, the agriculture and forestry sector is affected by climate change as a source of greenhouse gases. Agricultural production contributes to climate change especially with methane and N_2O-emissions. CO_2-emissions from agriculture are statistically covered by other sectors in the emissions inventory, especially transport (off-road vehicles; 1A3) and 'other energy sectors' (1A4).

4.2.6.1 Implemented Policies and Measures

M50 Extension of ecological farming

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

In the agricultural sector use of mineral fertiliser (nitrogen, phosphate, potassium) continues to decrease due to measures administered under the Austrian Programme for Environmentally Compatible Agriculture (*Österreichisches Programm für umweltgerechte Landwirtschaft, ÖPUL*), which is co-financed by the EU, and because of structural changes in the general economic framework. Meanwhile, an improved *ÖPUL II*-programme is in force after in-depth evaluation of the ecological effects of the first programme period. At the same time, the share of organic farming increased substantially until the late 1990s. Rising consumers' demand for food products from organic farming also backed that development.

In 1999, about 20,000 organic farms existed in Austria, representing about 10 % of farmland. The Federation, *Länder* and the EU gave compensation payments to organic farmers at a value of € 64 million in 2000.

M51 Cultivation of oil-seed crops

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

Oil-seeds from rape and sun flower are also used as substitutes for mineral oil products (diesel). Oil-seeds acreage was around 7 500 ha for this purpose in 1999 and 2000, after 3 000 ha on average between 1997 and 1998. To support the development, liquid bio fuels have been entirely exempted from mineral oils taxes.

4.2.6.2 Adopted and Planned Policies and Measures

M52 Further enforcement of measures to reduce methane and N_2O emissions

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

A lot of measures within the agricultural environment programme contribute directly or indirectly to GHG emissions reductions (e.g. manure management, limitation of livestock density, and reduced use of mineral fertilisers). These measures will be given even more emphasis in the second programme period. As an accompanying measure, 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 service facilities are recommended to offer 'biological' meals and products in restaurants (e.g. in schools, hospitals etc.). Some *Länder* and communities consider introducing obligatory quotas for calls for tender in this respect.

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

M53 Maintenance and extension of vital forests

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

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. As a result – and of course also due to natural conditions – Austria is one of the European countries with the highest density of forests. Today, nearly 47 % of the country is covered with forests. Forest inventories showed a steady, but uneven, increase of forest-covered areas after the Second World War, but with a clear tendency towards stabilisation toward the end of the last century, due to natural and human-induced limitations (mountain areas, settlements, agricultural and touristic use...).

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. That implies a continuation of the well-proven sustainable management as well as improved protection of forests from air pollutants, reduction of damage from deer and cattle and specific measures to preserve and increase biological diversity. Specific adaptation strategies have to be initiated in regions with decreasing precipitation and rising temperatures, especially in the north-eastern parts of Austria, where specific forests already show significant stress symptoms.

GHG removals by sinks in the forestry sector: Uncertain, due to unknown future development of wood markets and increased use of biomass as a renewable energy source

4.2.7 Fluorinated Gases

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

Emissions of fluorinated gases showed an uneven trend during the past decade. Ozone layer depleting 'Montreal gases' are on a clear phase-out track, while other gases, covered by reduction targets in the Kyoto Protocol due to high global warming potentials, are expected to emerge as ozone layer-friendly substitutes. This is specifically the case for HFC emissions, which increased steadily between 1990 and 1999, without a trend reversal in sight for coming years, without additional measures. A sharply decreasing trend was observed for PFCs, which stabilised at a low level. SF_6 emissions showed an up and down trend, without serious expectations of a considerable increase in the future.

The three 'Kyoto F-gases' together make a share of around 2 % of total greenhouse gas emissions and are expected to reach 3–4 % in 2010 in the business-as-usual scenario.

4.2.7.1 Implemented Measures

M54 Phase-out of ozone layer depleting substances under the Montreal Protocol

Implementing entity: Federation
GHG affected: 'Montreal Gases'
Type of policy: regulatory

Austria has entirely fulfilled its obligations to phase out ozone layer depleting substances, as specified in the Montreal Protocol.

4.2.7.2 Planned Policies and Measures

M55 Regulation on phase-out of HFCs and SF_6

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

In spring 2001, the Federal Ministry of Environment started a consultation procedure with respect to a draft regulation on reducing and phasing-out, respectively, the use of HFCs and SF_6 in all relevant applications on the basis of the Federal Chemicals Act. That measure will be the most important step of the Austrian government's strategy to mitigate or avoid future GHG emissions from fluorinated gases. Without the regulation, emissions were expected to grow by about 50 % by 2010, mainly due to increased use of HFCs as a substituting substance for ozone layer depleting CFCs (e.g. for cooling or insulation materials).

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

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

The European Commission has to be notified of the measure, as a ban of certain products from the domestic market could constitute an infringement of the European Internal Market principles. However, according to the ruling practice of the European Court of Justice (ECJ), barriers to a free circulation of goods are respected when justified by sake of protection of the environment *as far as* European legal acts are pending. Experiences of the past showed that the European Commission often initiated a European legislative process in order to harmonise product related environment protection measures and policies of individual member states in order to avoid a fragmented market. Therefore, member states can indirectly increase pressure on the Commission to come forward with proposals, which safeguard high environment protection standards throughout the whole Union. With respect to applications for fluorinated gases, the Commission has already indicated to consider proposals for regulatory measures.

M56 Public procurement and support measures

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

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

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

The planned agreement between the Federation and the *Länder* on common environmental standards for housing support schemes (see above M7) also foresees a ban of fluorinated gases.

M57 Avoidance of leakage

Implementing entities: Federation (Ministry of Environment)
GHG affected: HFC, PFC, SF_6
Type of policy: voluntary agreement, research

It is planned to come to voluntary agreements with certain business sectors, especially in the field of business cooling systems, aiming at reducing leakage to an absolute minimum, reducing demand for refrigerants per system and installation of collection facilities for refrigerants as a prerequisite for recycled use.

Expected GHG emissions reduction from planned policies and measures for fluorinated gases: 1.2 Mt CO_2 equivalent p.a.

4.2.8 Cross-cutting Policies and Measures

4.2.8.1 Implemented measures

M58 Energy related taxes and earmarking for climate change related measures

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

Austria introduced an energy tax on electricity and natural gas in 1996. Consequently, most fossil fuels (except coal) and electricity are covered by energy-related taxes, since heating oil and transport fuels are taxed on an EU-wide common basis.

In June 2000, the electricity tax was raised by 100 % in order to compensate for demand-driving electricity price-cuttings. The latter is a consequence of the electricity market liberalisation since 1999.

The *Länder* gain a share of 11.835 % of the revenues from taxes on electricity and natural gas, which has to be earmarked for energy saving and other environmental projects. That amounted to roughly € 50 million annually during past years. From 2001 onwards, the *Länder* can make use of additional € 25 million for climate change related projects as a consequence of the increased revenues from electricity tax.

4.2.8.2 Planned Policies and Measures

M59 GHG Emissions Trading Scheme

Implementing entity: Federation
GHG affected: CO_2 (predominantly) and other gases
Type of policy: economic

Under the guidance of the Federal Ministry of Environment, efforts are undertaken to establish an Emissions Trading Scheme in coherence with a recent EU-wide initiative. In this regard, one study, commissioned by the ministry, was published in spring 2000; a more in-depth follow-up study is under preparation.

The trading scheme under consideration should cover industry, electricity and heat suppliers, as well as other sectors with relevant and measurable energy consumption. Negotiated agreements between the relevant sectors and the government are generally seen as a prerequisite for entry into the trading scheme. A national trading scheme will be carefully designed to allow interlinkages with a future European trading scheme in order to create an effective, volatile and non-distorting market. Options in this regard are under scrutiny both on a national and European/international level.

4.3 Policies and measures no longer in place

Agreement between the Federation and the *Länder* on measures to reach the 'Toronto-Target'

As a consequence of changing circumstances after the adoption of the Kyoto-Protocol in December 1997 and the following 'Burden-Sharing-Agreement' between the 15 Member States of the European Union in June 1998, negotiations on an agreement between the Federation and the *Länder* on the basis of Article 15a of the Federal Constitution Act did not lead to an adoption (former measure 5.3.1.7 of the Second National Climate Report). The Ministers of Environment and Finance came to the conclusion that new conditions required a reassessment of policies and measures with respect to adequacy and costs involved. On the basis of the study 'Kyoto Options Analysis', issued by *Kommunalkredit Austria AG* in November 1999, a new draft programme (*Austrian Climate Strategy 2010*) was prepared in close cooperation between federal ministries, *Länder* and other stakeholders.

Change of conditions after the electricity market liberalisation

Some electricity-related measures described in the second communication lost relevance over the past years as a consequence of the electricity market liberalisation. That applies, for example, to electricity tariff reforms (measure 5.3.1.9) or Least-Cost-Planning Concepts (measure 5.3.1.14).

Meanwhile, EU directives on electricity and gas market liberalisation have been implemented in national law, following a different, non-regulatory approach with regard to consumers' free choice of supplier and price setting. Although the tendency of shrinking prices for electricity has consumption-driving effects under normal economic conditions, liberalisation also can be seen as a beneficiary framework condition for efficiency raising measures in the electricity sector. Implementation of the liberalisation directives in Austria also showed that environmental necessities can be sufficiently reflected and that independent power producers, either industrial or small producers in the 'renewable sector', can even be given a stronger role than before, as long as they have unrestricted access to the grid at economically fair conditions.

Table 4.6: Policies and Measures — Summary Table. (Estimated mitigation effect in 2010, in million tons CO_2 equivalent)

No.	Name of Policy or Measure	Objective and/or activity affected	GHG affected	Type of instrument	Status	Implementing entity/entities	Estimated effect
	1 Energy demand						
M1	Agreement between Federation and *Länder* on energy-saving	Energy-savings in buildings, heating installations and electricity consumption	CO_2	regulatory (framework legislation)	Implemented	Federation and *Länder*	n.q.
M2 + M10	Minimum thermal standards for buildings	Energy-savings in buildings	CO_2	regulatory (implementation)	implemented / planned	*Länder*	0.5 Mt (0.2–0.3 impl.)
M3 + M7	Housing support schemes	Energy-savings in dwellings (new and renovation)	CO_2, HFC	promotive	implemented / adopted / planned	*Länder*	2–2.5 Mt (0.5–1.0 impl./adop.)
M4	Consumption-related heating costs calculation	Energy-savings in buildings	CO_2	regulatory	implemented	Federation	0.1 Mt
M5	Energy efficiency in federal public buildings	Energy-savings in public buildings	CO_2	voluntary	implemented	Federation	0.05 Mt
M6	'Contracting' for public buildings	Energy-savings in public and private sector buildings	CO_2	economic / voluntary	implemented / adopted / planned	Federation, *Länder*, municipalities	0.5 Mt (0.1 impl./ adop.)
M7	*see M3*						
M8	Replacement of old heating systems	Energy-savings in buildings by improvement of heating energy supply	CO_2	promotive	implemented / adopted / planned	*Länder*, municipalities	2.0 Mt (0.5 impl./ adop.)
M9	Harmonised energy codes for buildings	Transparent and comparable declaration of energy consumption of buildings	CO_2	economic / information	planned	Federation, *Länder*	n.q.
M10	*see M2*						

Table 4.6: (continued)

No.	Name of Policy or Measure	Objective and/or activity affected	GHG affected	Type of instrument	Status	Implementing entity/entities	Estimated effect
M11	Regular inspection of heating systems	Energy-savings in buildings by efficiency-raising of heating systems	CO_2	regulatory	implemented / adopted / planned	*Länder*	0.3 Mt (0.1 impl./ adop.)
	2 Energy Supply						
M12	Preferential market access for 'green electricity'	Raising share of renewable energy sources in electricity supply	CO_2, CH_4	economic (regulatory)	implemented	Federation (framework), *Länder* (executing laws)	0.5 Mt
M13	Public support for renewable energy projects and district heating	Raising share of heat production from renewable energy sources and CHP	CO_2, CH_4	promotive	implemented	Federation, *Länder*, EU	0.7 Mt
M14	Energy tax rebates for CHP	Promotion of combined heat and power production (natural gas and diesel)	CO_2	fiscal	implemented	Federation	n.q.
M15	Preferential framework conditions for CHP	Promotion of combined heat and power production by granting improved feed-in conditions or setting obligatory quota	CO_2	economic / regulatory / promotive	framework law implemented; executing laws planned	Federation (framework), *Länder* (executing laws) EU (future targets)	0.5 Mt
M16	Further development of targets for 'green electricity'	Raising share of renewable energy sources in electricity supply	CO_2, CH_4	economic (regulatory)	planned	Federation (framework), *Länder* (executing laws)	0.2–0.5 Mt
M17	Stepped-up public support for GHG mitigation projects	Promotion of heat supply from renewable energy, energy efficiency measures etc.	CO_2	promotive	planned	Federation	1.5–2 Mt
M18	'Green electricity' for public buildings	Raising share of electricity production from renewables through purchase power of public entities	CO_2	economic	adopted / planned	Federation, *Länder*, municipalities	n.q.

Table 4.6: (continued)

No.	Name of Policy or Measure	Objective and/or activity affected	GHG affected	Type of instrument	Status	Implementing entity/entities	Estimated effect
M19	Voluntary agreements	Cost efficient GHG reductions in energy industry	CO_2	voluntary / negotiated	planned	Federation	n.q.
	3 Waste Management						
M20	Waste Management Act 1990	Framework law regulating waste management – minimisation of environmental impacts	CH_4, CO_2	regulatory	implemented	Federation (framework), *Länder* (executing laws)	n.q.
M21	Landfill Regulation 1996	Minimisation of waste landfilling	CH_4	regulatory	implemented / adopted	Federation (framework), *Länder* (executing laws), municipalities	0.9 Mt
M22	Landfill Charge Act 1989	Reduction of disposal of waste on landfills; earmarking of revenue for clean-up of contaminated land	CH_4	regulatory / fiscal / economic	implemented	Federation	n.q.
M23	Expansion of waste treatment capacities other than landfilling	Banning disposal on landfills by 2004/2008; expanding share of other capacities, e.g. energy efficient incineration	CH_4, CO_2	regulatory	planned / adopted	*Länder*, municipalities	1.1 Mt for measures M24–M28 (0.3 adop.)
M24	Promotion of waste recovery	higher share of waste recycling	CH_4, CO_2	voluntary, information, education, research	implemented / adopted / planned	Federation, *Länder*, municipalities	n.q.
M25	Efficient energy recovery from waste	energy recovery from waste incineration (CHP)	CH_4, CO_2	promotive	adopted	Federation	n.q.
M26	Other programmes to launch waste prevention and recovery	prevention of waste; higher share of energy recovery / recycling	CH_4, CO_2	voluntary, information, research, promotive	implemented / adopted / planned	Ministry of Environment, *Länder*	n.q.

Table 4.6: (continued)

No.	Name of Policy or Measure	Objective and/or activity affected	GHG affected	Type of instrument	Status	Implementing entity/entities	Estimated effect
M27	Technical state of art for mechanical-biological treatment of waste	Better investment security for operators of waste treatment sites with respect to technical standards	CH_4	standardization	planned	Federation	n.q.
	4 Transport						
M28	Reduction of emissions from passenger cars	Raising market share of advanced engine technologies with low fuel consumption	CO_2	voluntary / information	implemented	Federation, EU	0.5 Mt
M29	Fuel consumption levy	Fiscal incentive for low fuel consumption vehicles	CO_2	fiscal	implemented	Federation	n.q.
M30	Road tolls	Internalisation of external costs for use of highways	CO_2	fiscal	implemented	Federation	n.q.
M31	Vehicle tax adaptation 2000	Internalisation of external costs, especially for strong engines	CO_2	fiscal	implemented	Federation	n.q.
M32	Rail infrastructure and public transport investments	Changing modal split to the benefit of rail/public transport	CO_2	public investments and promotion	implemented / adopted / planned	Federation, *Länder*, municipalities	0.3 Mt (0.1 impl./ adop.)
M33	improvement of fuel quality and promotion of 'bio-diesel'	GHG emissions reduction through fuel improvement and renewable energy sources	CO_2	regulatory / fiscal	implemented / planned	Federation	0.1 Mt (0.05 impl.)
M34	Model projects and programmes for environmentally sound mobility	Model projects with the aim to raise public awareness and to demonstrate new technologies	CO_2	information / education / demonstration / research	implemented	Federation, *Länder*, municipalities	n.q.
M35	Model projects and programmes for environmentally sound logistics	GHG emissions reductions in transport sector by logistic support and avoidance of insufficient transportation		promotion / information / demonstration / research	implemented	Federation	n.q.
M36	Mileage based toll for lorries	Internalisation of external costs of road transport	CO_2	fiscal	adopted	Federation	0.3 Mt

Table 4.6: (continued)

No.	Name of Policy or Measure	Objective and/or activity affected	GHG affected	Type of instrument	Status	Implementing entity/entities	Estimated effect
M37	Promotion of energy efficient and alternative motor concepts	Reduction of fleet fuel consumption	CO_2	promotive	planned	Federation, EU	0.1 Mt
M38	Public awareness raising measures	Reduction of individual private traffic	CO_2	information, education	adopted / planned	Federation, *Länder*	0.3 Mt (0.1 adop.)
M39	Improvement of transport logistics	Avoidance of inefficient and unnecessary transportation of goods, aiming at total reduction of road transport	CO_2	promotive, information	implemented / adopted / planned	Federation, *Länder*	0.7 Mt (0.2 impl./ adop.)
M40	Further internalisation of costs	Internalisation of external costs of road transport / private traffic	CO_2	fiscal	planned	Federation	n.q.
M41	Promotion of walking and cycling	Shifting modal split, improving living conditions and safety	CO_2	promotive, information, education	implemented / adopted / planned	(Federation), *Länder*, municipalities	0.3 Mt (0.1 impl./ adop.)
M42	Improvement of spatial planning	Avoidance of traffic-inducing settlement structures	CO_2	planning / regulatory	planned	*Länder*	0.3 Mt
M43	Traffic management and speed limitation	Avoidance of congestions; promotion of economic driving	CO_2	information / regulatory / fiscal	implemented / planned	Federation, *Länder*	0.3 Mt (impl. n.q.)
	5 Industry						
M44	Promotion of energy efficiency and renewable energy	Energy-savings and increasing share of renewables in industry	CO_2	promotive	implemented	Federation	0.2 Mt
M45	Implementation of the IPPC directive	Energy-savings and efficiency raising measures in industry	CO_2	regulatory	implemented	Federation, (EU)	n.q.
M46	Energy concepts for energy intensive branches	Evaluation of energy-saving potentials in industry	CO_2	conceptual, consultative	implemented	*Länder*	n.q.
M47	Energy efficiency programme	Promotion of economic energy-saving in industry	CO_2	consultative, promotive	planned	Federation	0.5 Mt

Table 4.6: (continued)

No.	Name of Policy or Measure	Objective and/or activity affected	GHG affected	Type of instrument	Status	Implementing entity/entities	Estimated effect
M48	Promotion of energy efficiency and renewable energy	Energy-savings and increasing share of renewables in industry	CO_2	promotive	planned	Federation	0.3 Mt
M49	Voluntary agreements and flexible instruments	Cost efficient GHG reductions in industry	CO_2	voluntary/ negotiated agreements, economic	planned	Federation	1.0–2.0 Mt
	6 Agriculture and Forestry						
M50	Extension of ecological farming	Protection of rural environment (soil, water, natural and cultural habitate); production of high quality food	CH_4, N_2O	promotive	implemented	Federation, *Länder*, EU	n.q.
M51	Cultivation of oilseed crops	Extension of crops for production of bio-fuels	CO_2	promotive, fiscal	implemented	Federation, *Länder*	n.q.
M52	Further enforcement of measures to reduce methane and N_2O emissions	Protection of rural environment with more specific focus on GHG mitigation	CH_4, N_2O	promotive	adopted	Federation, *Länder*, EU	n.q.
M53	Maintenance and extension of vital forests	Maintaining biodiversity, productivity, regeneration capacity and vitality of forests	CO_2	research, information, regulatory	implemented / adopted / planned	Federation, *Länder*	n.q.
	7 Fluorinated Gases						
M54	Phase-out of Montreal gases	Protection of the ozone-layer	'Montreal gases'	regulatory	implemented	Federation	n.q.
M55	Partial phase-out of HFCs and SF_6	Substantial reduction of emissions of gases with high GWP	HFC, SF_6	regulatory	planned	Federation	0.8 Mt
M56	Public procurement and support measures	Substantial reduction of emissions of gases with high GWP	HFC, SF_6	promotive, public procurement	Implemented / adopted / planned	Federation, *Länder*	0.1 Mt (0.05 impl./ adop.)

Table 4.6: (continued)

No.	Name of Policy or Measure	Objective and/or activity affected	GHG affected	Type of instrument	Status	Implementing entity/entities	Estimated effect
M57	Avoidance of leakage	Substantial reduction of emissions of gases with high GWP	HFC, SF_6	voluntary, research	planned	Federation	0.3
8 Cross-cutting PaMs							
M58	Energy related taxes	Revenue-raising with positive side-effect of potential GHG reductions	CO_2	fiscal	implemented	Federation	0.3
M59	GHG emissions trading	Cost-effective GHG emissions reductions for large stationary emitters	CO_2	economic	planned	Federation	n.q.

Chapter 5

Projections and the Total Effect of Policies and Measures

Two approaches are taken to develop projections of greenhouse gas emissions and to calculate the total effect of policies and measures. On the one hand, the estimated development according to the draft *Austrian Climate Strategy 2010* is shown, which is based on expert judgements for the year 2010. On the other hand, projections for the period 2000–2020 have been developed based on the energy model calculations. Both approaches show quite similar results.

The increase in greenhouse gas emissions cannot be stopped completely with implemented and adopted measures. Additional measures will lead to a considerable decrease of emissions from 1999 to 2010 and to further reduction until 2020. The aggregate effect of implemented and adopted policies and measures is estimated at 4–5 million tons CO_2 equivalent for the year 2010, the effect of planned measures is about 14 million tons for the year 2010.

5.1 Projections

Projections and scenario-based planning have become valuable tools for many areas of policy-making and commercial activities. Development of projections regarding energy use for energy policy has a rather long tradition in Austria, as the energy sector was rather tightly controlled by the Federal Government and the Länder throughout the second half of the 20th century.

Sometimes, participants in public discussions are tempted to misinterpret economic scenario calculations as some kind of fortune-telling. It must be kept in mind that models are an imperfect reproduction of reality and may have limitations with respect to a detailed representation of those (sub)sectors of economy which are relevant for greenhouse gas emissions. Projections are closely tied to assumptions and trends on which they are based, that key input data have to be selected by experts and that these selections will always be influenced by contemporary common opinions and insights. Some parameters or effects of some policy options cannot be quantitatively estimated in a reliable manner. Last but not least, there are externally caused parameter changes or even shocks, which are considered as 'completely improbable' at the time of projection development. Such changes do not usually have infinite improbability though (Douglas and Adams, 1979) and will, therefore, happen sometimes, but cannot reasonably be taken into account.

When comparing the results of projections shown in the National Communications of different countries, the gentle reader should keep in mind that uniform rules for greenhouse gas projections do not exist. Projections have been developed at different points in time with different expectations of economic development; models may rely on quite different principles and input parameters may have been estimated quite differently by different experts.

In spite of these shortcomings, scenarios remain important instruments for preparing decisions, if the input parameters and the scope and limits of the underlying model are taken into account. In the following sections, the results of the projections with respect to energy use and greenhouse gas emissions are presented. Information, which is necessary for proper judgement of the results, like model description and important input parameters, is shown beneath.

5.1.1 Approach for Projections

For Austria's draft National Climate Strategy, efforts have been undertaken to estimate the development of greenhouse gas emissions according to implemented and adopted measures and the effect of planned measures. The figures from the National Climate Strategy are based on expert judgements and available for the year 2010 (FMAFEW, 2001).

In addition, model calculations have been performed, which provide 'With Measures' scenario and a 'With Additional Measures' scenario. The 'With Measures' scenario comprises implemented and adopted policies and measures, the 'With Additional Measures' takes into account planned policies and measures as well. Energy projections have been developed by the Austrian Institute of Eco-

Table 5.1: Projection of GHG emissions according to the draft National Climate Strategy (in Tg CO_2 equivalent)

	Emissions 1990	1995	1999	With Mea. 2010	With Add. 2010
Energy demand (CO_2+N_2O+CH_4)	13.83	15.34	13.40	14.0	10.0
Energy supply (CO_2)	14.52	13.27	14.03	15.5	13.5
Waste (CH_4+CO_2)	6.24	5.79	5.33	4.8	3.7
Transport (CO_2+N_2O)	13.90	16.0	18.23	21.0	17.3
Industry (CO_2+N_2O)	20.40	19.93	20.81	20.5	19.25
Agriculture (CH_4+N_2O)	5.59	5.15	4.96	4.8	4.3
HFCs, PFCs, SF_6	1.49	1.74	1.63	3.0	1.8
other (incl. solvent use)	0.98	0.8	0.85	0.8	0.8
Total	76.94	78.04	79.22	84.4	70.65

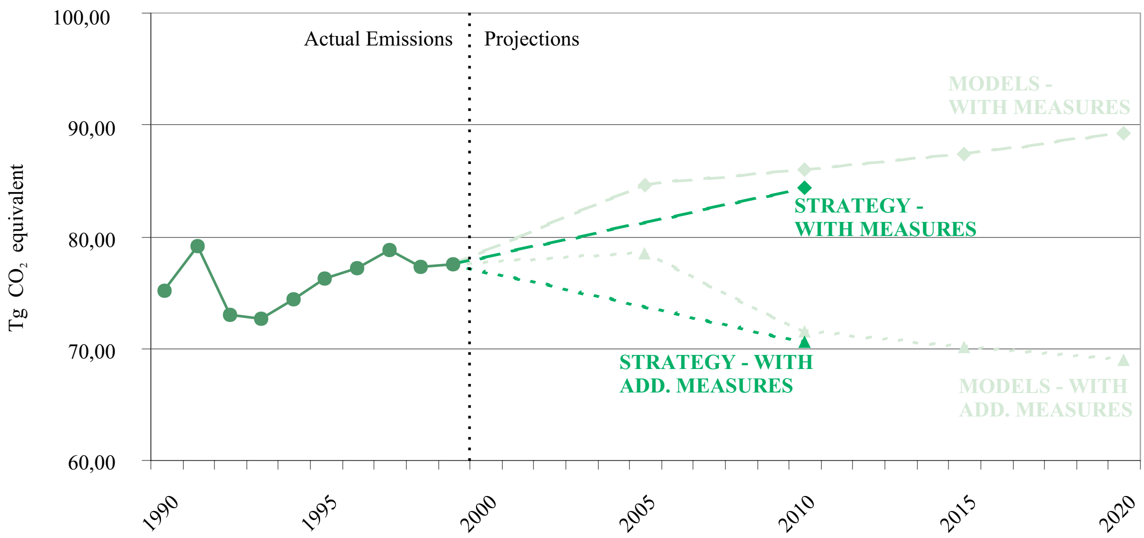


Figure 5.1: Summary of projection results

nomic Research (Kratena and Schleicher, 2001). Energy data have been used as input for the emission projections for CO_2, CH_4 and N_2O calculated by the Austrian Research Centers Seibersdorf (Orthofer and Gebetsroither, 2001). Projections of the emissions of HFCs, PFCs and SF_6 were taken from a survey on the use of these substances (Werenskiold and Unterberger, 2001).

According to the projections of the National Climate Strategy, a 6 % increase of greenhouse gas emissions by 2010, compared to 1999, can be expected with implemented and adopted measures. The model calculations show a slightly higher increase from 1999 to 2010 of about 9 % and a further increase from 2010 to 2020 of 4 % in the 'With Measures' scenario. Additional measures will lead to a 10 % decrease from 1999 to 2010; the model calculations show a further decrease of 4 % by 2020.

5.1.2 Projections according to the draft National Climate Strategy

In the framework of a consensual process which lasted several months, to formulate a National Climate Strategy towards the Kyoto target under the EU burden sharing agreement, regularly up-dated experts' judgements have been utilized to determine the expected development of greenhouse gas emissions according to the structure of the draft strategy. The sectoral differentiation is shown in Table 5.1 on the preceding page and corresponds to the structure of Chapter 4. The latest experts' judgement also reflects the outcome of the recently released energy projections of the Austrian Institute of Economic Research (Kratena and Schleicher, 2001).

5.1.3 Model calculations

Model calculations are based on different methods for different sectors. Emissions from the energy sector have been derived from the use of a macroeconomical and an energy model of the Austrian Institute for Economic Research, which are based on a sectoral structure different to the IPCC sectors. The total result represents approximate emissions included in IPCC sector 1. Data for IPCC sector 2 combine process emissions covered by the analysis of the Austrian Research Centers Seibersdorf (ARCS) and an expert judgement for fluorinated gases. Projections for agriculture (IPCC sector 4) and waste (IPCC sector 6) have been calculated by ARCS.

Energy

Emissions from energy (IPCC sector 1) will clearly increase in the 'With Measures' scenario; additional measures will allow thorough energy savings in this sector.

For details see Table 5.2 on the facing page and Figure 5.2.

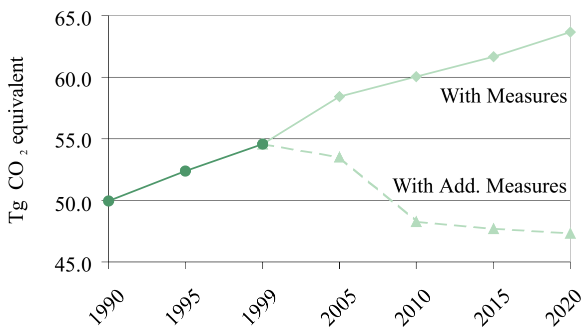


Figure 5.2: Model results – Energy

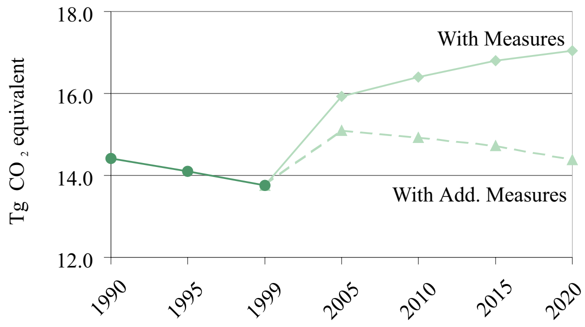


Figure 5.3: Model results – Industrial Processes

Industrial Processes

A pronounced short-term increase of emissions from industrial processes (IPCC sector 2) is expected in both scenarios. In the 'With Measures' scenario, a further slight increase from 2005 to 2020 is expected due to rising emissions of HFCs. The 'With Additional Measures' scenario lets expect decreasing emissions after 2005.

For details see Table 5.3 on the facing page and Figure 5.3.

Waste

Greenhouse gas emissions from waste (IPCC sector 6) are mainly caused by methane. Implemented measures will keep emissions below current levels in the year 2010; additional measures will lead to a significant decrease.

For details see Table 5.4 on page 94 and Figure 5.4.

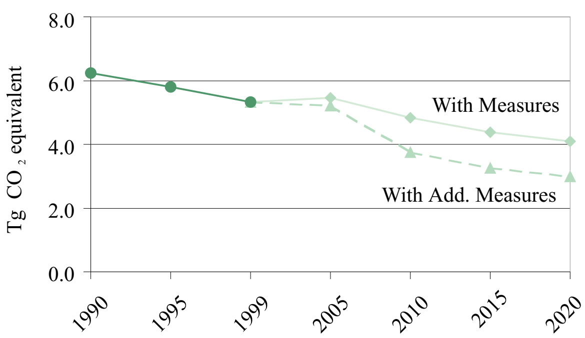


Figure 5.4: Model results – Waste

Table 5.2: Projections of GHG emissions from sector 'Energy' (IPCC sector 1) according to model calculations

	Emissions			With Measures				With Add. Measures			
	1990	1995	1999	2005	2010	2015	2020	2005	2010	2015	2020
	in Tg (CO_2) / Gg (CH_4, N_2O)										
CO_2	48.82	51.06	53.32	57.23	58.85	60.43	62.44	52.38	47.26	46.72	46.38
CH_4	24.65	22.72	18.61	19.00	18.59	18.16	17.80	17.47	15.35	14.40	13.52
N_2O	1.89	2.76	2.74	2.60	2.66	2.71	2.75	2.45	2.28	2.23	2.14
	in Tg CO_2 equivalent										
CO_2	48.82	51.06	53.32	57.23	58.85	60.43	62.44	52.38	47.26	46.72	46.38
CH_4	0.52	0.48	0.39	0.40	0.39	0.38	0.37	0.37	0.32	0.30	0.28
N_2O	0.59	0.86	0.85	0.81	0.82	0.84	0.85	0.76	0.71	0.69	0.66
Total	49.93	52.39	54.56	58.44	60.06	61.65	63.67	53.51	48.29	47.72	47.33

Table 5.3: Projections of GHG emissions from sector 'Industry' (IPCC sector 2) according to model calculations

	Emissions			With Measures				With Add. Measures			
	1990	1995	1999	2005	2010	2015	2020	2005	2010	2015	2020
	in Tg (CO_2) / Gg (CH_4, N_2O)										
CO_2	12.75	12.19	11.94	13.38	13.20	12.89	12.44	13.35	13.16	12.83	12.36
CH_4	0.14	0.16	0.14	0.21	0.22	0.23	0.24	0.20	0.20	0.20	0.21
N_2O	0.60	0.55	0.58	0.60	0.63	0.65	0.68	0.58	0.60	0.61	0.62
	in Tg CO_2 equivalent										
CO_2	12.75	12.19	11.94	13.38	13.20	12.89	12.44	13.35	13.16	12.83	12.36
CH_4	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00
N_2O	0.19	0.17	0.18	0.19	0.19	0.20	0.21	0.18	0.18	0.19	0.19
HFCs	0.00	0.55	0.87	1.70	2.39	3.09	3.78	1.02	1.15	1.28	1.41
PFCs	0.96	0.02	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
SF_6	0.52	1.18	0.73	0.63	0.58	0.58	0.58	0.51	0.40	0.40	0.40
Total	14.42	14.10	13.75	15.93	16.40	16.80	17.04	15.10	14.93	14.73	14.39

Agriculture

Methane emissions from agriculture (IPCC sector 4) are expected to decrease because of a reduced number of cattle. Effects from reduced fertilizer use and improved manure management are, however, not shown in the scenario calculations due to methodological problems.

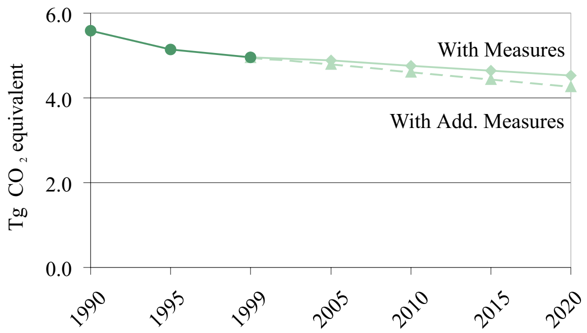


Figure 5.5: Model results – Agriculture

For details see Table 5.5 on the next page and Figure 5.5.

Total Emissions

The summary of all sectors shows that emissions are expected to rise from 79 Tg CO_2 equivalent in 1999 to 86 Tg in 2010 and 89 Tg in 2020 in the 'With Measures' scenario. The 'With Additional Measures' scenario shows a considerable decrease to about 72 Tg in 2010 and a further decrease to 69 Tg in 2020. Emissions of CH_4 show a decrease in both scenarios, whereas CO_2 and N_2O can be reduced only with additional measures.

Table 5.4: Projections of GHG emissions from sector 'Waste' (IPCC sector 6) according to model calculations

	Emissions			With Measures				With Add. Measures			
	1990	1995	1999	2005	2010	2015	2020	2005	2010	2015	2020
	in Tg (CO_2) / Gg (CH_4, N_2O)										
CO_2	0.04	0.12	0.12	0.32	0.50	0.59	0.63	0.39	0.50	0.59	0.63
CH_4	295.37	270.04	247.74	244.34	206.05	179.78	164.44	228.72	154.58	126.92	111.73
N_2O	0.01	0.01	0.01	0.02	0.04	0.04	0.05	0.03	0.04	0.04	0.05
	in Tg CO_2 equivalent										
CO_2	0.04	0.12	0.12	0.32	0.50	0.59	0.63	0.39	0.50	0.59	0.63
CH_4	6.20	5.67	5.20	5.13	4.33	3.78	3.45	4.80	3.25	2.67	2.35
N_2O	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Total	6.24	5.80	5.33	5.46	4.84	4.38	4.10	5.20	3.76	3.27	2.99

Table 5.5: Projections of GHG emissions from sector 'Agriculture' (IPCC sector 4) according to model calculations

	Emissions			With Measures				With Add. Measures			
	1990	1995	1999	2005	2010	2015	2020	2005	2010	2015	2020
	in Tg (CO_2) / Gg (CH_4, N_2O)										
CO_2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CH_4	217.43	196.54	187.85	185.10	179.60	174.50	169.56	181.59	173.50	165.85	158.59
N_2O	3.31	3.27	3.27	3.23	3.19	3.17	3.14	3.20	3.15	3.10	3.05
	in Tg CO_2 equivalent										
CO_2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CH_4	4.57	4.13	3.94	3.89	3.77	3.66	3.56	3.81	3.64	3.48	3.33
N_2O	1.03	1.01	1.01	1.00	0.99	0.98	0.97	0.99	0.98	0.96	0.94
Total	5.59	5.14	4.96	4.89	4.76	4.65	4.53	4.81	4.62	4.44	4.27

Table 5.6: Projections of total GHG emissions according to model calculations

	Emissions			With Measures				With Add. Measures			
	1990	1995	1999	2005	2010	2015	2020	2005	2010	2015	2020
	in Tg (CO_2) / Gg (CH_4, N_2O)										
CO_2	62.13	63.75	65.78	70.93	72.54	73.91	75.51	66.12	60.92	60.14	59.37
CH_4	537.58	489.46	454.35	448.65	404.46	372.67	352.04	427.99	343.63	307.36	284.05
N_2O	6.56	7.34	7.35	6.46	6.52	6.57	6.62	6.27	6.06	5.98	5.85
	in Tg CO_2 equivalent										
CO_2	62.13	63.75	65.78	70.93	72.54	73.91	75.51	66.12	60.92	60.14	59.37
CH_4	11.29	10.28	9.54	9.42	8.49	7.83	7.39	8.99	7.22	6.45	5.96
N_2O	2.03	2.27	2.28	2.00	2.02	2.04	2.05	1.94	1.88	1.85	1.81
F-gases	1.48	1.74	1.63	2.36	3.00	3.70	4.39	1.56	1.58	1.71	1.84
Total	76.94	78.04	79.22	84.72	86.06	87.47	89.34	78.62	71.60	70.16	68.98

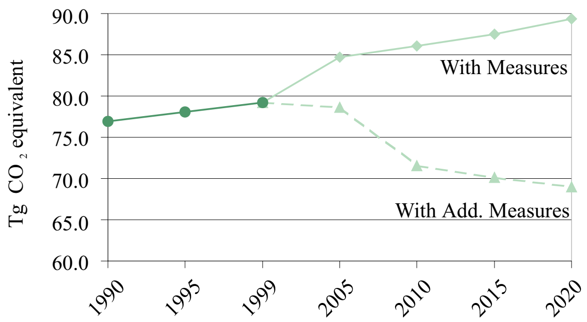


Figure 5.6: Model results – Total

For details see Table 5.6 on the facing page and Figure 5.6.

5.1.4 Summary of Projection Results

Expert judgements of the draft National Climate Strategy and model calculations show comparable trends (see also Fig. 5.1 on page 91). Total greenhouse gas emissions are expected to be in the range of 84 to 86 million tons in 2010 with implemented and adopted measures and to be substantially lower (around 71 million tons) with planned measures.

5.2 Assessment of Aggregate Effects of Policies and Measures

Chapter 4 shows a comprehensive listing of policies and measures contained in the National Climate Strategy 2010. 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 caused some difficulties for coherent monitoring and evaluation of the effects of policies and measures. That is due to a lack of complete and comparable information on policies and measures and also due to the fact that many measures were undertaken, primarily for other environmental, social or economic needs and that GHG mitigation had been a positive, but rarely measured and evaluated, side effect.

For these reasons, the development of a 'Without Measures' scenario likewise to the 'With Measures' and 'With Additional Measures' scenarios proved difficult. Choice of important parameters with respect to the measures would have had to be based on expert judgements rather than on reliable data for the 1990s. Given the fact that such a scenario could only give a vague assessment of past measures and would be of little use for current and future decisions, costly scenario calculations were not considered in that case. The aggregate effect of *implemented and adopted* policies and measures is therefore derived from the sum of potentials of the individual measures, which are based on expert judgements according to the draft National Climate Strategy. It amounts to 4–5 million tons for all greenhouse gases in 2010 and to 4–6 million tons in 2020. For details see Table 5.8 on the next page.

The effect of *planned* policies and measures has been judged in the draft National Climate Strategy for the year 2010 as 13.8 million tons for all greenhouse gases. Another approach to derive the total effect of planned policies and measures is to take the difference of the 'With Measures' and the 'With Additional Measures' scenario from the model calculations. The model calculations, which take into account the policies and measures described in the draft National Climate Strategy, show a quite similar effect for the year 2010 as the draft strategy and 40 % more reductions for the year 2020. The total effect is heavily based on CO_2 emission reductions; other gases contribute about 1/5 of the total effect. For details see Table 5.7.

Both the *planned* policies and measures of the draft strategy and the 'With Additional Measures' scenario of the model calculations indicate that the

Table 5.7: Aggregate effect of planned policies and measures

	2005	2010	2015	2020
	in Tg (CO_2) / Gg (CH_4, N_2O)			
CO_2	4.81	11.63	13.77	16.14
CH_4	20.66	60.83	65.31	68.00
N_2O	0.18	0.45	0.59	0.77
	in Tg CO_2 equivalent			
CO_2	4.81	11.63	13.77	16.14
CH_4	0.43	1.28	1.37	1.43
N_2O	0.06	0.14	0.18	0.24
HFCs, PFCs, SF_6	0.80	1.42	1.99	2.55
Total	6.10	14.47	17.31	20.35

Table 5.8: Aggregate effect of implemented and adopted policies and measures

	1995	2000	2005	2010	2015	2020
	in Tg (CO_2) / Gg (CH_4, N_2O)					
CO_2	n. q.	2.55	3.1–4.1	3.1–4.1	4.1–5.1	4.1–5.1
CH_4	n. q.	21.4	42.9	42.9	42.9	42.9
N_2O	n. q.	n. q.	n. q.	n. q.	n. q.	n. q.
	in Tg CO_2 equivalent					
CO_2	n. q.	2.55	3.1–4.1	3.1–4.1	4.1–5.1	4.1–5.1
CH_4	n. q.	0.45	0.9	0.9	0.9	0.9
N_2O	n. q.	n. q.	n. q.	n. q.	n. q.	n. q.
F-gases	n. q.	n. q.	n. q.	n. q.	n. q.	n. q.
Total	n. q.	3.0	4.0–5.0	4.0–5.0	4.0–6.0	4.0–6.0

(n. q. = not quantified)

actual approach is appropriate to show demonstrable progress in greenhouse gas mitigation by 2005 and to follow Austria's Kyoto target under the EU burden sharing agreement. The remaining gap of around 3-3.5 Mt CO_2 equivalent between expected emissions during the commitment period 2008-2010 and the assigned amount of 67.2 Mt CO_2 equivalent should be bridged by utilising the project-based flexible instruments of the Kyoto Protocol.

5.3 Methodology

Emissions from the energy sector are projected with the modelling framework of the Austrian Institute for Economic Research. The framework comprises the energy model DEDALUS and the macroeconomic multisectoral model MULTIMAC. Resulting figures for energy demand in the Austrian economy are split according to the subsectors of the Austrian greenhouse gas emission inventory and emissions are calculated in accordance with inventory methodology. Emissions for the other sectors are again calculated based on emission factors from the Austrian greenhouse gas inventory. Activities are derived from the Austrian Carbon Balance Model and adjusted to economic data from the energy model.

5.3.1 Emissions from Fuel Combustion

The model used for the projections starts with demand for energy services and investigates the resulting flows for energy from final consumption to gross energy flows.

The design of the model provides a tool for evaluating the following policy options:

- ▷ The impact of changes in energy prices, in particular those that are driven by the price of crude oil, on the demand for energy services and the mix of energy flows.
- ▷ The substitution of energy flows by more and improved capital, as in the case of the thermal quality of buildings and the fleet of cars for transport.
- ▷ The opening of energy markets to renewables by stimulating the relevant technologies and integrating them into existing markets for electricity and heat.

This structural design of the model enables the evaluation of a number of innovative policy options:

- ▷ The elimination of redundant energy services, in particular in transport, by an integrated systems perspective.
- ▷ The Impact of a program that aims at increasing the renovation rate for existing buildings with emphasis on energy efficiency investments.
- ▷ The changes in the modal mix of transportation by providing incentives for zoning regulation and public transport.

The structure of the energy-economy-environment (E3) modelling framework is as follows: The energy model DEDALUS is integrated into the macroeconomic multisectoral model of the Austrian economy MULTIMAC III. The output of DEDALUS determines the energy sector variables, which is the energy-economy link. The outcome of the macroeconomic multisectoral model (GDP, output by industries, capital stock for different energy-relevant purposes) determines together with fully exogenous influences (energy prices, technology diffusion for renewables and district heating, transport equipment, demography, etc.) the energy use and CO_2 emissions, which constitute the remaining environmental link.

DEDALUS (Kratena 1999a, 1999b; Kratena and Schleicher 1999, 2000, 2001) consists of an econometric model for final energy demand of 13 sectors of the Austrian economy and an input-output-model of energy transformation with varying technical coefficients. This model describes the Austrian energy system in sufficient detail to derive emission paths of 13 sectors and the energy-transforming processes. For the energy use of households and the service sector within the 13 sectors, the analysis is extended to energy service indicators and explicit (embodied) efficiency of the capital stock. This allows the treatment of embodied and induced technical change, which is characterized as an isoquant between capital costs and energy flow potential of capital goods.

MULTIMAC III (Biffl and Kratena, 2000) is input-output based at a medium aggregation level of 32 industries and combines econometric functions for goods and factor demand, prices, wages and the labour market with the input-output accounting framework. In that sense, MULTIMAC III is oriented along the same lines as other large scale macroeconomic input-output-based models like the INFORUM model family (Almon, 1991) and the European multiregional model E3ME (Barker et. al., 1999). Compared to these fully specified models, MULTIMAC III has important shortcomings in the modelling of external trade, where exports are fully exogenous and only import functions exist. MULTIMAC III shares with the two mentioned models the emphasis on econometrics, i.e. on parameter values derived by using historical data in statistical methods opposed to the CGE philosophy of restricting parameters and calibrating for some base year.

MULTIMAC III tries to combine the advantages of econometric techniques with consistent microeconomic functional forms and uses specifications derived from well-known microeconomic concepts. In general the functional forms chosen in MULTIMAC III from microeconomic theory are those with a minimum of necessary a priori restrictions. MULTIMAC III consists of three main blocks for factor demand, goods demand and the labour market. In between these model blocks, some small model elements are built in for the intermediate demand prices and for income generation. Input-output analysis plays an important role on the price side as well as on the goods demand side and in both cases the phenomenon of changing input-output structures is dealt with.

Results of the energy projections are used by the Austrian Research Centers Seibersdorf to derive emission projections for CO_2, CH_4 and N_2O (Orthofer and Gebetsroither, 2001). As the economic sectors of energy model do not correspond to the IPCC sectoral structure, however, fuel consumption has to be assigned to the IPCC sub-sectors (a fact which leads to some additional uncertainty in the resulting emission projections). Calculation of emissions is done according to the emissions factors of the Austrian greenhouse gas emission inventory.

5.3.2 Emissions not related to Fuel Combustion

Emission scenarios for the agriculture, industrial processes and waste sectors are in principle based on the Austrian Carbon Balance Model (ACBM). ACBM is a model that reflects the dynamic behaviour of the carbon cycle in Austria with the aim of establishing a full carbon accounting for that country. In contrast to the energy projections, the model uses carbon fluxes and carbon pools rather than activities and emission factors. It takes into account the interdependencies between and within the individual subsystems (agriculture, industrial production, waste management, lithosphere and atmosphere). Different scenarios have been calculated (Orthofer et al., 2000).

For the current projections, the results of the ACBM scenarios had to be partially adapted according to results of the energy projections (e.g.

activities in the industry sector) and to the latest expert judgements (e.g. development of livestock). The emission figures are based on emissions factors from the Austrian greenhouse gas inventory. This leads to some limitations regarding the assessment of policies and measures. Reduced fertilizer consumption in agriculture, for instance, cannot be properly taken into account, as the development of new emission factors would be necessary in that case.

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

5.3.3 Differences to the Second National Communication

The projections contained in the Second National Communication show a 6 % decrease of CO_2 emissions for 2010 compared to 1990 in the 'With Measures' scenario, whereas the latest model-based projections indicate a 17 % increase for the same period. The main reason why the rather optimistic perspectives for the projections of the Second National Climate Report to date did not materialise concerns the fundamental changes in the prices of energy. Because of cheap crude oil and falling electricity prices for many customers, energy markets provided hardly any signals for switching to more energy efficient technologies. Price competition for industrial customers even caused the closing of cogeneration units that are highly recommended from an energy efficiency point of view.

The more conservative projections made for the Third National Climate Report emphasize this point. Unless a broad public awareness emerges that switching to an economy that pays careful attention to the elimination of redundant energy services, substitutes energy flows for more capital with higher quality, and shifts from fossil fuels to renewables, the baseline projections indicate a further increase in energy demand. In addition, however, the scenarios investigated reveal the considerable advantages of low energy strategies, not only for GHG emissions but also for conventional economic indicators such as GDP growth, employment, and even public budgets.

Furthermore, it needs to be mentioned that the modelling environment, which is used for the model-based projections, exhibits a number of substantial refinements compared to the model used for the Second National Communication:

- ▷ The sectoral disaggregation was expanded both for the energy sector and other economic activity by applying a multisectoral integrated input-output framework;
- ▷ Emphasis was given to role of induced and embodied technological change by taking into account the flow-stock relationships for providing energy services in housing and transport;
- ▷ Special attention was given to direct and cross price effects and the dynamics of price changes.

Emissions are not calculated directly within the sectoral structure of the energy model as for the Second National Communication, but are based on the methodology and emission factors of the Austrian greenhouse gas inventory.

5.3.4 Sensitivity Analyses

Small differences in key input parameters may have considerable impact on the resulting emissions; sensitivity analyses allow for a quantitative estimation of these impacts. For the energy projections, two effects have been quantitatively estimated: A change in the utilisation of renewable sources of energy and a different assumption regarding the relation of domestic production to energy imports.

With respect to biomass in production and households, the 'With Measures' energy scenario is based on the assumption that existing trends will continue; increases are expected for biomass in district heating and for other sources of renewable energy (Haas et al., 2001). If all assumptions in favour of an increase in the use of renewable energy sources are abandoned, consumption of fossil fuels for electricity and heat generation as well as CO_2 emissions are considerably higher in the year 2010:

Coal, oil, gas:	+ 21 PJ (+11 %)
Sectoral CO_2:	∼ + 9 %
Total CO_2:	∼ + 2 %

Electricity exports have exceeded imports in Austria in the past. For the 'With Measures' energy scenario, a moderate shift to net imports due to effects of liberalisation has been assumed (2 % of domestic consumption in 2010). If, however, the whole increase in electricity demand were met by imports instead of increased domestic production, imports would be at 11 % of domestic consumption in 2010 and thus lead to considerably lower CO_2 emissions compared to the 'With Measures' scenario:

Sectoral CO_2:	∼ – 18 %
Total CO_2:	∼ – 4 %

The number of cattle is a key figure with respect to the emissions of agriculture. Lower numbers bring about lower emissions of CH_4 from enteric fermentation and manure management. 10 % more meat consumption in 2010 compared to the 'With Measures' scenario would therefore have some impact worth mentioning:

Sectoral CO_2-eq:	+ 6.4 %
Total CO_2-eq:	+ 0.4 %

In the waste sector, CH_4 is emitted from landfills; reduced depositing would lead to lower emissions. A 10 % reduction in waste deposition compared to the 'With Measures' scenario would lower CH_4 emissions in 2010:

Sectoral CO_2-eq:	– 6.8 %
Total CO_2-eq:	– 0.4 %

5.3.5 Key Variables and Trends

Information about key input parameters for the models is necessary to allow for an interpretation of the results, just as knowledge about the economical and mathematical foundations of the model itself. Table 5.9 lists figures for some of the parameters. However, it must be kept in mind that this kind of information cannot replace thorough analysis of the modelled scenarios. Some characteristic results of the scenario calculations are shown for easier understanding of the emissions trends. The figures relate to the 'With Measures' scenario. Parameters, which are input for the models, are printed in **bold**.

Table 5.9: Key parameters for the models calculations

	1990	1995	2000	2005	2010	2015	2020
GDP growth [%]	+4.6	+1.5	+3.9	+2.1	+2.0	+1.9	+2.0
Oil price Brent [€(1990)/bbl]			24.9	16.5	16.5	19.7	22.5
Population [million pers.]	7.73	8.05	8.11	8.17	8.21	8.25	8.30
Electricity import/exp. ratio [%]			-2.6	+2.6	+2.0	+2.0	+2.0
Number of dwellings [million]	2,97		3.26	3.36	3.44	3.51	3.59
Private cars [million]	2.99	3.59	4.03	4.40	4.77	5.10	5.37
Energy prices [% of 2000 price]							
fuel oil			100	78	76	79	84
electricity			100	92	102	103	106
gasoline			100	86	84	86	89
Final energy consumption [PJ]	833	880	945	1,010	1,049	1,085	1,121
Steel production							
activity [1000 tons]	3,922	4,529	5,366	5,502	5,502	5,447	5,393
energy efficiency [%]		+18 %			+10 %		
cattle [1,000 head]	2,584	2,326	2,156	2,092	2,010	1,941	1,875
municipal waste deposition in landfills [1000 tons]	4,115	3,529	3,640	3,463	2,700	2,147	1,783

Chapter 6

Climate Change Impacts and Adaptation

Austria consists to a considerable extent of alpine and hilly regions. This situation has significant consequences for the vulnerability to possible climate change impacts: Changes in precipitation patterns and degradation of mountain permafrost, for example, can affect the frequency of natural hazards such as landslides and mudslides. Reduced snow cover in winter, due to increased temperatures, would severely affect winter tourism. Alpine ecosystems are rather sensitive to environmental changes. Projections of climate changes are, however, difficult to obtain and rather uncertain for mountain environments due to the limitations of current climate models.

With respect to adaptation, some measures have to be pointed out, which primarily serve the purpose of reducing other environmental risks, but which are also beneficial for adapting to a climatic change. Among these are measures for avalanche, erosion and torrent control, which have a long tradition in Austria.

6.1 Expected Impacts of Climate Change

The year 2000 was the second warmest year of the 20th century in East Austria, partially even the warmest since the beginning of temperature recordings in 1775. Thus the trend of increasing temperatures, which has been observed in the last 20 years, continues. A similar development has not occurred during the last 1000 years in Austria; observed changes are even coming close to the maximum temperature fluctuations during the last 10,000 years. It must be noted, however, that the last 10,000 years represent an era of relatively uniform weather conditions and of small variations compared to previous periods of climate history.

Any changes in temperature and other climate factors may have manifold effects on the inanimate and living environment as it is known to our generations. Thus changes of landscape, negative impacts on food and energy supply, increased risk potential for human settlement areas with respect to natural disasters and dramatically reduced income from tourism may occur. Therefore, it is of the utmost importance to gain enough insight how climate changes can impair the biosphere, the geosphere and mankind. Profound knowledge of climate change impacts will allow for the implementation of adaptation measures, at least in some of the above-mentioned areas.

The approach taken to present climate change effects in the following section is a dual one: Scientific findings of the international research community, which are relevant to the Austrian situation, are complemented by research projects which have been performed in the Austrian context. Data presented in the previous National Communications are updated and supplemented by the latest results.

6.1.1 Impacts on Physical Systems

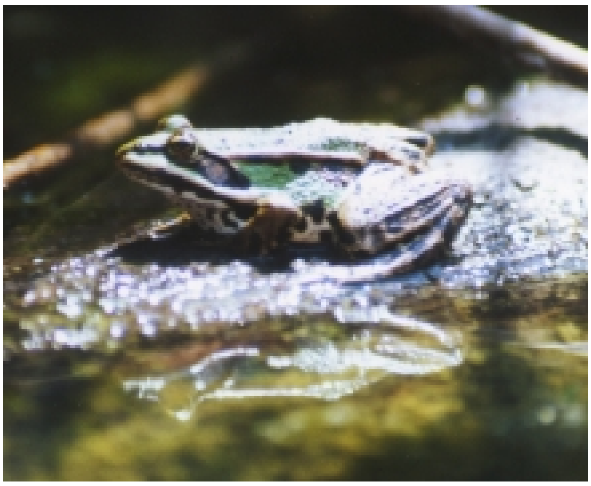
6.1.1.1 Hydrology

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

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

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



So far, there is no detailed assessment of possible climate change impacts on hydrology and water resources for the whole of Austria. In a first attempt, Kuhn *et al.* (1992) discuss possible linkages between climate and hydrology in a general way, thereby taking Austria's specific topography into account (FMEYF, 1994). Several Austrian studies focus on catchments and their possible reactions to a changing climate at the basin scale, employing a range of approaches and hydrological models (Haiden and Schultheis, 1995; Nachtnebel *et al.*, 1996; Nachtnebel *et al.*, 1999; Bogardi *et al.*, 1996). Instead of using GCM outputs like temperature and rainfall, a down-scaling approach (Bardossy and Plate, 1992; Matyasovszky *et al.*, 1994) was applied, integrating regional characteristics to obtain higher spatial resolution.

6.1.1.2 Mountain Cryosphere

The effects of temperature and precipitation changes on glaciers' behaviour are complex and vary by location. Haeberli (1994) indicates that alpine glacier and permafrost signals of warming trends constitute some of the clearest evidence available concerning past and ongoing changes in the climate system.

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

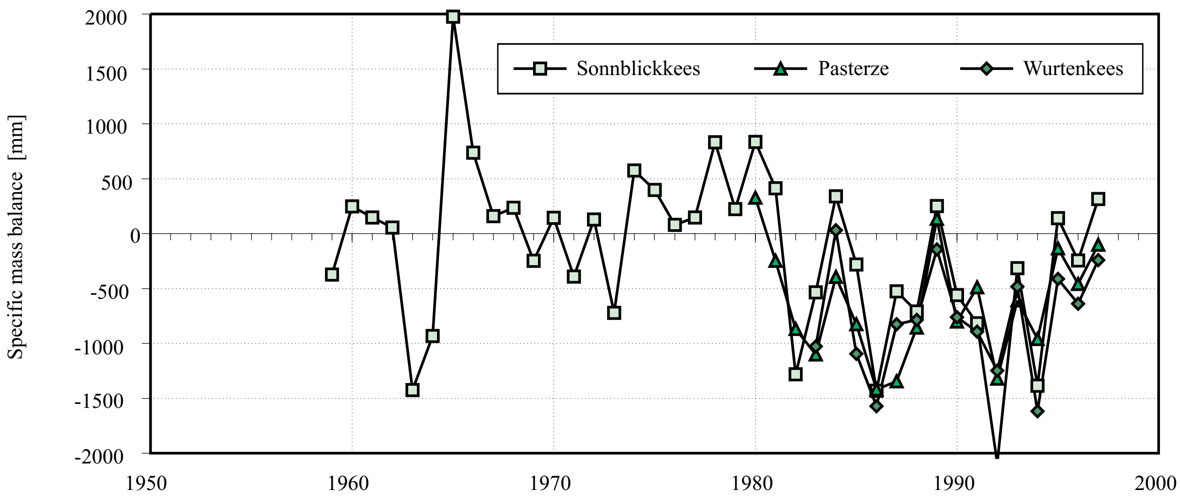


Figure 6.1: Mass balance development of three Austrian glaciers in the central eastern Alps within recent decades. Since 1980, the glaciers lost mass nearly every year. (Schoener *et al.*, 2000)

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 snow fall. An example for the mass balance development within the last decades is shown in figure 6.1. The mass balance is easiest to visualize by the concept of an equilibrium line that separates regions of net gain above from those of net mass loss below the line. The equilibrium line altitude of Austrian glaciers goes up by 100 m if either accumulation decreases by 400 mm of water equivalent or temperature increases by 0.8°C.

During recent years even large areas have been affected, at altitudes that had been considered “safe” at first glance. The ice cover on the steeper slopes surrounding the main glacier bodies is thinner than the latter and thus subject to rapid wastage and disappearance. This implies that many Austrian glaciers are reduced in size at both lower and upper ends. Researchers at the University of Innsbruck are involved in the second Austrian glacier inventory (see Table 8.7 on page 152). This inventory will give a quantitative description of the changes within the last 30 years and can be related to climatological conditions.

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 extremely limited.

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

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).

Often the question concerning an increase of catastrophes due to climatic change is posed. The possibility that an increase of temperature on the earth's surface is accompanied by effects on meteorological phenomena (wind, precipitation) is very likely, but statistical confirmation of deterioration of effects of damage events is not possible at the moment due to a lack of information on absolute frequency (BUWAL 2001).

6.1.1.5 Avalanches

More than 5,800 avalanche catchments threaten permanently settled areas in the Austrian part of the Alps. Historical and present avalanche catastrophes are studied to assess a range of parameters and characteristic extreme values such as date of incidence, runout length and damage in order to provide support in planning future protection measures (hazard zoning, etc.). According to Austrian avalanche reports that have been published regularly since 1967/68, 764 persons had been killed by avalanches until 1995/96. About 78 % of winter 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. However, this is no guarantee as can be seen by the disastrous avalanche from Galtür 1999, where 38 people were killed in their houses.

Avalanches, especially large damage avalanches, are consequences of extreme weather conditions, especially of intensive long-lasting snowfall in combination with extreme snow transport or warming and rain up to high altitudes. Therefore, assessment of avalanche activity based on mean change of definite climatologic parameters is very difficult. Fliri (1992) expects the danger potential of avalanches in high-altitude valleys to increase with increasing temperatures.

Interpretation of a mean climatic change concerning change in avalanche frequency is very uncertain. Contrary to glaciers, avalanches are not indicators for climate. By assumption of a positive trend of temperature and a more or less distinct increase of mean precipitation, some conclusions can be drawn:

- ▷ Spatial and temporal extension of snow cover could be reduced in regions at low altitudes. This does not, however, lead to fewer damage avalanches because extreme weather conditions may occur under these circumstances, too.
- ▷ Earlier soaked snow cover as a consequence of higher temperature might cause wet-snow-ground-avalanches earlier than up to now, but the number of damage wet-snow-ground-avalanches over the year will remain constant.
- ▷ Higher average temperatures during precipitation periods may also cause earlier settlement of snow cover and therefore critical situations can be defused earlier and more often.
- ▷ Expected increase of 3-day heavy rain events might cause an increase of avalanche events, especially in high altitudes.

6.1.2 Impacts on Ecological Systems

6.1.2.1 Ecophysiological Processes

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

6.1.2.2 Vegetation Migration

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

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

In addition to the impact of climatic change on the altitudinal vegetation distribution, interferences with latitudinal vegetation changes have to be taken into account. Deep valleys that split mountain systems into isolated 'island subsystems' constitute migration barriers. They may prevent species concentrated in specific, high-altitude refugia 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 south-eastern 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 is a number of ecosystem models currently available that can be used to test the sensitivity of a particular ecosystem (e.g., CENTURY, TEM, BIOME, PICUS,). In climate impact research two different model approaches are used to evaluate the impacts of changing climate: The gap-models (Shugart 1998, Lexer *et al.*, 2000) and the mechanistic ecosystem models (Running and Gower, 1991; Hasenauer *et al.*, 1999).

The gap-models use statistical relationships to simulate the interaction of different species within the patches. These models are driven by monthly input data and can make multi-century simulations and are used to investigate the potential species distribution within the patches. 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. Lexer *et al.* (2000) used 3 different climate change scenarios. From these simulation results, it might be 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 climate change impacts might increase substantially.

The mechanistic ecosystem models calculate the net primary production (NPP) of forests. In general, these models require daily input data and as a result, they are able to simulate the effects of short time events (e.g. moderate try spells) to forest growth. Austrian scientists (Hasenauer *et al.*, 1999) used such a model to simulate the 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. Attempts will be made to use this validated model for advanced climate impact studies.

Since 1961 basic data on structure and development of the Austrian forests have been compiled within the Austrian Forest Inventory program. Results show a continuous increase in forest area, growing stock and annual increment as well as in the damage of forest stands in protection forests (FMAF, 1995a; 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 to 1990. The last 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 in these results (Hasenauer, 2000).

There are a number of forest-growth models that have been employed in studies aiming at accounting the carbon budget of Austria's forests (Halbwachs *et al.*, 1994, 1995; Jonas and Schidler, 1996; Ruppert *et al.* 1996) or of plantation systems, thereby taking into account biomass utilization strategies (Marland *et al.*, 1995, 1996; Schlamadinger *et al.*, 1995, 1996; Schlamadinger and Marland, 1996a, b, Orthofer *et al.*, 2000). So far, the primary focus of model applications, however, has been on the evaluation of different forest management or bio energy strategies under current climatic conditions and not on the investigation of a CO_2-stimulated growth.

6.1.2.4 Alpine Protection Forests

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

The limits of life as well as the influence of temperature on the growing conditions of the most important tree species in the Austrian mountain regions have been a main focus in Austrian research within recent 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.

However, at the time of the upward shift the composition and structure of forest communities will also change. Spruce, with approximately 61 %, the most abundant and important species in Austria would be reduced, particularly in lower regions in favour of oak and other deciduous tree species.

Among different air pollutants, ozone reaches exceptionally high (day and night) peak values, especially at the altitude of the timberline and above, the region of the formerly deforested *combat zone* (FEA, 1996; FMAF, 1996; Loibl, 1995, 1996; Loibl and Smidt, 1996; Schneider *et al.*, 1996). Vegetation reacts adversely to high ozone concentrations through disturbed photosynthetic activity. At the altitude of the timberline, the ozone concentrations can exceed an eight-fold level, the critical level for the protection of forests. This bioclimatic situation, which is primarily affected by traffic exhaust gases, reveals an alarming development in regard to the state of mountainous forests. Transport processes across, or convective processes in the Alps affect the deposition of particles, and together with increased short-wave radiation at higher altitudes, contribute to the production of ozone. This implies serious long-term consequences (Türk, 1996; Mayer, 1992; Wotawa and Kromp-Kolb 2000).

6.1.3 Impacts on Socio-economic Systems

6.1.3.1 Mountain Agriculture

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

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

ity. Species and intensities of plant diseases may change.

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

6.1.3.2 Hydropower

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

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

6.1.3.3 Commercial Timber Activities

Commercial utilization of mountain forests can be negatively affected directly and indirectly by climate change. Direct effects include problems in regeneration and lower seedling survival. Indirect effects relate to losses caused by fire, insects and diseases. The indirect effects depend on the influence of climate on the disturbance agents themselves. Warming in winter, e.g., may allow destructive insects and pathogenic fungi to survive at higher latitudes and altitudes than at present, enabling subtropical or warm-temperate pests and pathogens to invade vegetation from which they are now excluded (Dobson and Carper, 1992; Schopf, 1997).

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

6.1.3.4 Tourism

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

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

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

6.1.3.5 Property Loss and Insurance

Within financial services, the property insurance industry is most likely to be directly affected by climate change since it is already vulnerable to extreme weather events. The cost of weather-related disasters to insurers, in particular due to damage by windstorms, floods and hail, has risen rapidly since 1960 (Berz, 1996, Jakobi, 1996a, 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).

Yet, the past insurance record of extreme events induces an increasing number of insurance companies to join the environmental declaration originally signed by 17 insurance companies at the UN in Geneva in November 1995 (Jakobi, 1996b; ACCC, 1996). The signatories of this declaration explicitly acknowledge the principle of sustainability and the precautionary principle as integral parts of the overall economy.

6.1.3.6 Human Health

Presently, climate change-induced impacts on human health are of no great concern to WHO-Europe. Relatively little research has yet been done in Europe to investigate such effects. However, various impacts may also strike central and northern Europe. Due to extensive 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).

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

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.

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

6.2 Vulnerability Assessment

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

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

Austrian-specific research about climate chance impact and especially vulnerability assessment was compiled in a summary report by the Austrian Academy of Sciences (ÖAW, 1992, 1993). In neighbouring countries interdisciplinary multiyear research programmes have been launched (e.g. BAYFORCLIM in Bavaria and the NFP-31 in Switzerland), the results of which are also of relevance for Austria. A comprehensive updated vulnerability assessment for Austria as a whole currently does not exist. Vulnerability assessment, as expressed below, can only be stated by individual research disciplines.

In addition, attempts are being made by Austria's Federal Ministry of Education, Science and Culture to gather the scientific expertise that is available in the area of climate impact research on a national level and to set up an *Austrian Climate Programme,* including a *Coordination and Information Centre for Climate and Climate Impact Research.*

6.2.1 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 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.

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 originates 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.

Recent impact studies (Nachtnebel *et al.*, 1999; Kuhn, 1999) showed no dramatic decrease in annual water runoff. The most important changes are the changes in the seasonal runoff pattern. But this result highly depends on the used climate change scenario.

6.2.2 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) and the mean equilibrium line altitude of Austrian glaciers was approximately 100 m lower than today's (approximately 2,700 m above sea level; regionally dependent on the amount of precipitation and the geographical, i.e., north-south exposition; compare also Fig. 6.2). Therefore, Austrian glacier areas most endangered by a continued warming are those in mountain ranges with peak altitudes slightly above present equilibrium lines.

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

- ▷ Climate conditions will have important consequences for the winter tourism industry, which accounts for 4 % of Austria's GNP.
- ▷ With an increase of temperature, the number of 'good' seasons will decrease, and a further

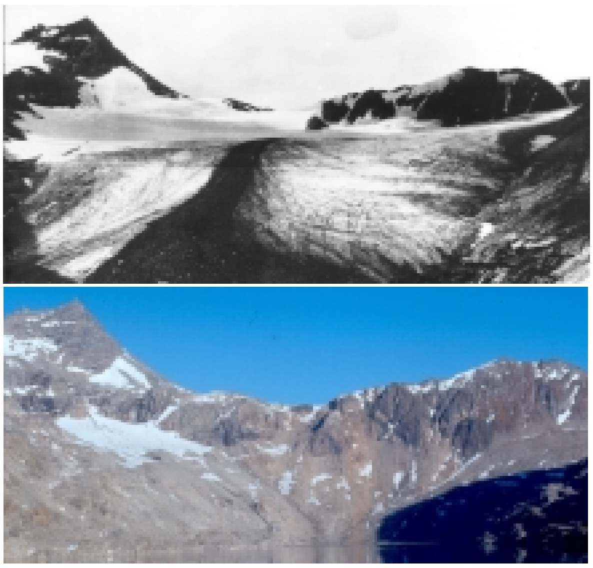


Figure 6.2: Glacier change – Wurtenkees (Hohe Tauern, Austria) in the years 1896 (top) and 2001 (bottom)

concentration of winter tourism in the midwinter months of January and February may take place.

- ▷ Lower-situated tourist resorts are disfavoured relative to those higher up.

6.2.3 Ecosystem Responses

6.2.3.1 Vegetation Migration

From finalised and ongoing research studies (Pauli *et al.*, 1996) the important conclusion can be drawn that even a moderate warming induces migration processes. The example from the limits of plant life at high alpine summits is of general importance and suggests that global warming is already having a significant effect on alpine plant ecology. Upward migration may therefore cause disastrous extinctions in these environments.

6.2.3.2 Forest Growth

In most areas of Austria, precipitation is not a limiting factor. However, at the eastern and southeastern 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, grazing, and profit oriented wood production by promoting fast growing coniferous stands. It is expected that potential climate change (temperature increase/changes in precipitation patterns) may directly effect these forest ecosystems as well as indirectly by favouring insect outbreaks and/or fungi infections (Hasenauer, 2000).

A positive aspect is stated by Patzelt (1999): In some regions of the Eastern Alps better growth of natural regeneration at the timberline and higher regions can be observed. According to Lexer (in: Sprenger 2001) a higher scope for silviculture in high altitudes can be expected if the current warming trend continues.

In estimating the future of the Alpine protection forests, increasing air pollution must also be taken into account. During the last few decades, different air pollutants (especially ozone) have led 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 average, while Tyrolean production forests reveal a damage rate of only 30 %. The average damage rate for the entire Austrian forest amounts to 33 % with approximately 7 % of the trees damaged more seriously (FMAF, 1996).

Depending on the site quality of mountainous highlands, reforestation of a damaged forest may require 300–1,000 years (Mayer, 1992). In the case of Tyrol, Heumader (1987) expects, for only half of the 12,000 ha of inclined forested area, technical control measures (like snow bridges) worth some € 1.45 billion (ATS 20 billion), and a reforestation time of about 200 years.

6.2.4 Extreme Events and Geomorphological Processes

Heavy precipitation episodes often have significant impacts on natural and socio-economic environments. There are generally major economic consequences related to mudslides and flooding. The degradation of mountain permafrost is an additional consequence of persistently high temperatures which can lead to slope instabilities that

threaten settlements and communication routes (Beniston, 2001).

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

In Austria, 74 % of all communities are endangered by torrents and avalanches. In some provinces (Carinthia, Vorarlberg, Salzburg, Tyrol) the area threatened by such events amounts to 80 % and more of the total (FMAF, 1996). In the Länder Tyrol and Vorarlberg, which cover about one fifth of Austria, the documentation of flood-, mudflow-, and landslide events comprised about 1000 events relevant for settlements and infrastructure in 1999, among them 576 avalanche events, 197 landslides, 31 mudflow events, 129 torrent events and 12 rock falls (Reiterer, 2000; Neuner, 2001). The documented damages reach a volume of several 100 Mio ATS.

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 a per-event average of 10,000 m^3 (except for the provinces of Lower Austria and Styria) (Andrecs, 1995).

Increasing exploitation of mountainous regions by settlements, traffic infrastructure and tourism in recent decades has also increased disposition for damages. However, damages by avalanches have always remained at a similar level. An explanation might be that in the same time period (beginning about at 1950) technical and planning measures (construction works, artificial release, closing of roads, hazard zoning) have continuously increased. It can be assumed that from the middle of the 1980s, these defense measures significantly reduced the probability of catastrophic avalanches.

Protective effects of woodland are beyond doubt. Concerning future developments, it must be stated that Austria has a disproportionate number of protection forests that are too old. Resources with regard to finance and staff for the conversion of these stands are lacking. At the same time, pressure on development of avalanche and torrent catchments is rising, especially at the timberline region and the areas above. As a consequence, runoff from these areas is constantly increasing (Markart *et al.*, 2000).

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 puts priority on the mitigation of greenhouse gas emissions. It should be pointed out, however, that Austria continues to implement a set of adaptation measures that, on the one hand serve the purpose of reduction of other environmental risks, but which are also beneficial for adapting to a climatic change, on the other hand.

6.3.1 Potential of Adaptation

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

- Highly managed systems, 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 Forest Ecosystems

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

Both natural conditions and anthropogenic interference influence the adaptive capacity of forests. An important issue is genetic diversity of forests, which allows for intra-specific adaptability: More genetic variants within a tree population increase its genetic adaptability to environmental stress. The genetic diversity of Austria's tree populations is mainly due to the size and number of refugial populations during glacial periods, to the number of pathways and interplay during recolonisation and, finally, to man-made influence of past deforestation and present-day forestry. As these factors have or have been varied for different tree species, genetic adaptability to environmental changes must be different among populations. Broadening the genetic diversity can be achieved by enhancing natural regeneration in more or less natural forest plant communities and by mixing appropriate seed lots where artificial reforestation is necessary. Also, artificial establishment of satellite tree populations is a conceivable measure. Such populations have genetic compositions which make them well adapted to environmental conditions in future decades. The ability to respond to environmental stress also depends on the (natural or man-made) species composition. Only after the extent of environmental changes has exceeded the genetic adaptability of the individual species does the situation call for the adaptive capacity of the ecosystem.

Forestry can take advantage of the ability of self-regulation or self-stabilization of forest ecosystems by tolerating or advancing natural dynamics and thus contribute to the reduction of the risk potential. As interferences form part of the overall dynamic process, they can be used to improve and enrich the structure of forests for the purpose of a high biodiversity. The measures classified under the term of *nature-conforming forestry* are equally oriented to the natural dynamics of forest ecosystems. Typical examples are the integration of natural succession in the regeneration of forests or the use of self-differentiation in forest tending.

Forest ecosystems which correspond to nature as regards their species composition and dynamic processes, will have a higher adaptive potential than substitute communities which are not suited for the habitat and the stability thereof is, therefore, already endangered under today's climatic conditions. The study of hemeroby (Koch *et al.*, 1997; Grabherr, 1997) indicates that, in general, the degree of the naturalness of Austria's forests is comparably high and that the diversity of Austrian forest communities corresponds to the typical proportions in that field. Two thirds of the forest-covered areas clearly show elements of the natural forest community. 25 % of Austria's forests are natural or nature-conforming, which is a European peak value.

As considerable uncertainties with respect to the best strategies for the different forest areas in Austria exist, research is an important part of the activities directed towards adaptation measures. A project about climate change effects on forests in the east of Austria has resulted in recommendations on how to mitigate the effects of climate change, which are very much based on the expertise and knowledge of forest managers. Austrian researchers also participate in European efforts to develop adaptive forest management strategies. (For details see Chapter 8, Table 8.5 on page 145).

6.3.3 Avalanche, Erosion and Torrent Control Measures

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

6.3.3.1 Torrent and Avalanche Control

Since 1884, the lawful basis for precautions has existed for drainage of rivers in mountainous areas and for prevention measures against formation or damaging release of certain avalanches (RGBl. 117/1884). These tasks for protection against torrents, avalanches, erosion and rock falls are performed by the Federal Service for Torrent and Avalanche Control. This service represents the only task force in Austria, which performs qualified support-actions and protection-measures in a disaster situation and which is permanently ready for action (Schmidt, 2001). The general tasks are:

- Prevention against natural dangers in the sense of a lasting nature-area- and culture-area-planning, -forming and -maintenance under the purpose of the damage-defense as well as damage-minimization;
- Risk-management by process-based link of natural-dangers - and potential of resource use with the ultimate goal of a preventive country-utilization-control;
- Water-protection-strategies in the catchments (management strategies, technical and biological measures) under consideration of hydrological, geological and nature-spatial aspects, (Mayer, 2001).

Within the Federal Service for Torrent and Avalanche Control, the Centre for Geology and Risk-management deals with the documentation of nature-spatial processes, their evaluation and finally the recognition of danger potentials. Main tasks include transformation of the danger potentials into danger-maps, preparation of bases for decisions in risk-management (especially for erosion-processes) and the preparation of the bases for operative use. The Centre for Simulation-Technology enforces the avalanche-simulation and, in future, will also enforce the hydrological modelling. Avalanche-simulation-models represent essential instruments for the assessment and rework of hazard zone maps which are already used in practise. Simulation results are used for judgment of possible floods in alpine torrent-catchments and for calculation of the possible sediment discharge during extreme-events.

6.3.3.2 Natural Danger Research and Event Documentation

The Institute for Avalanche and Torrent Research at the Federal Forest Research Station enforces research on natural dangers and disasters in cooperation with its partners in research and practise. For example, examinations on the effects of the decline of many alpine glaciers, which occurred in recent decades, on runoff behaviour and sediment transport will be started.

The documentation of avalanches, floods, mudflow events or landslides is a basic requirement for hazard zone mapping, planning and performance of preventive measures. Documentations help to extend very short-term "human memories" and also to make knowledge about natural disasters and catastrophes available for future generations, as a base for land use, environmental planning and preventive measures (Reiterer 2000). Therefore, this documentation will especially serve as a basis to allow for conclusions on the frequency of damage events due to climatic change.

The Federal Service for Torrent and Avalanche Control is supported in documentation and evaluation of events by the Institute for Natural-dangers and Engineering Forestry at the University of Agricultural Sciences Vienna. The regional administrative bodies, especially local communities, perform qualitative and quantitative recording of events as well. Digital avalanche-maps provided by the federal torrent and avalanche control service serve as basic information for environmental planning for the communities.

6.3.3.3 Improvement of the protective forest function

In the framework of the protection against dangers caused by torrents, avalanches and erosion dangers, particular attention is paid to functional forest improvement. The mountain forest belt is crucial for the prevention of the natural dangers cited above. Permanent settlement in mountain valleys without protective mountain forests would not be possible.

Enormous efforts to protect critical areas against lying fallow are made by the mainly agricultural landowners during their land and forestry management. In addition, nearly 550 redevelopment projects on an area of approximately 110.000 ha are currently supported by public funds. The priority ranking takes place on the basis of concepts of forest protection of the countries. Besides the functional improvement of the mountain forest belt, the redevelopment projects also include afforestations above the current timberline as well as the improvement of agriculturally used areas of Alpine pastures with respect to its protective function. The implementation of measures is mostly done by the forest-owners, due to the property structure, especially by mountain farmers.

Financial means for the described technical and biological precaution measures are provided a. o. by the federal government (61 %) and the Länder (20 %). At the federal government level, measures are proportionally financed by the Austrian Fonds for the Protection of Natural Disasters and the 'Green Plan' (support in accordance with section X of the forest-law 1975) (Knieling, 2001).

6.3.3.4 Systems for Crisis Management

The development of crisis-management systems under inclusion of numerical models represents another main focus of current work. Such a concept was already successfully used during the ski world-championship in St. Anton am Arlberg in February 2001 (Sailer, 2001a, b).

The system is based on the analysis of documented events as well as the generalisation of different disaster scenarios. The preparation of a sound security-plan, taking into account all different areas of responsibility, serves as an essential prerequisite for fast and efficient rescue-measures in the case of a disaster situation. Tasks and activities of all concerned organisation units are established and documented as well as evaluated in regular intervals.

6.3.3.5 Hazard Zone Mapping

The consequences of a possible climate-change show the need for the Federal Service for Torrent and Avalanche Control to enforce a new evaluation of the risk potentials on the one hand and to influence settlement-development by instruments for environmental planning, like hazard zone maps, on the other hand.

The preparation and re-evaluation of hazard zone maps is done by the Federal Service for Torrent and Avalanche Control. Concerned communes may give their views on the draft, which is examined by a commission afterwards and approved by the Federal Minister of Agriculture and Forestry, Environment and Water management. Hazard zone maps are then incorporated into the environmental planning laws of the Länder.

Chapter 7

Financial Resources and Transfer of Technology

Austria has contributed to the Global Environment Facility, which was set up to tackle global warming and other environmental problems in developing countries, since the beginning. With respect to bilateral support, it is important to note that projects of the Austrian official development assistance generally have to comply with the target of environmental sustainability; climate change related projects are focused on small-scale hydro power, solar energy and protection of rain forests. Efforts for the transfer of environmentally sound technology are undertaken in the framework of relevant institutions and initiatives (IEA, CTI). It is important to note that technology transfer also occurs as part of assistance projects where it is not the only objective.

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, after restructuring in 1994, continued for an indefinite period. Its objective is to help developing countries and, to some extent, countries with economies in transition (Central and Eastern Europe and former CIS) to cope with four major environmental problems of basic and world-wide importance:

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

With regard to the UNFCCC, GEF supports developing countries in fulfilling the common but differentiated responsibilities for the protection of the global climate system. GEF is an administrative umbrella, which receives financial resources from a variety of funds, the main source being the Global Environment Trust Fund (GET), also referred to as the 'Core Fund'.

Austria has provided financial support for the GEF since the beginning; the Austrian participation in the GEF has been financed in addition to existing commitments and payments to other international finance institutions and has, therefore, to be called 'new and additional'. During the pilot phase Austria contributed a comparatively large share to GET (about US$ 35 million or about 2.7 %) in order to underscore its interest in international measures for the protection of the environment. For the first replenishment of the GET Austria contributed US$ 20 million. In addition, Austria contributed financial resources for a bilateral GEF Consultant Trust Fund. From 1997 to 2000, Austria provided about US$ 10 million, see Table 7.1.

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

	1997	1998	1999	2000
	Contribution (millions of US$)			
GEF	4.079	2.247	2.099	1.879

7.2 Developing Countries Particularly Vulnerable to Climate Change

There is no clear definition of countries that are particularly vulnerable to climate change. It is obvious, however, that countries with low gross domestic products, for example, resulting in a serious dependence on domestic food production, are particularly vulnerable to climate change with respect to their agriculture and the danger of famine. Countries in arid climates or alpine regions rely on a sensitive balance of their ecosystems and their agriculture; countries in regions prone to natural disasters such as hurricanes will suffer severe losses in infrastructure and resources the more frequently disasters occur.

Due to the size of the country and its limited resources, Austria's ODA is focused on several priority regions in Africa, the Himalayas and Central America with a large share of least developed countries. In 1999, 43 % of the programme and project aid were granted to least developed countries, 21 % to low income countries and 17 % to lower middle income countries. Countries like the Cap Verde Islands, Burkina Faso or Tanzania in Africa with limited water resources or Bhutan and Nepal, where a large part of the territory lies 1000 metres above sea level and higher, are probably particularly vulnerable to climate change. However, a differentiation between countries, which are particularly vulnerable or less vulnerable, is difficult. Therefore all assistance projects are described in the following section.

7.3 Provision of financial resources

Projects of the Austrian official development assistance have to comply with the target of environmental sustainability. A considerable share of projects has environment protection as a main or significant additional target. With regard to climate change, bilateral efforts have been concentrated in the areas of small scale hydropower, solar energy and protection of rain forests.

7.3.1 Bilateral financial contributions

Assistance to developing countries with respect to measures to protect the global climate system and to support adaptation to the adverse effects of climate change is granted primarily within the framework of the Austrian official development assistance (ODA). Programme and project aide from the Federal Ministry for Foreign Affairs amounted to US$ 212 million in 1997–1999[1], which was about 15 % of total Austrian ODA. Further project-based support was granted by other ministries, Länder, municipalities and Austrian NGOs. US$ 292 million were contributed to the EU development assistance funds by Austria during this period.

ODA projects in general have to comply with several basic targets, namely democracy and human rights, prevention of conflicts, combating poverty, social development of the economy, gender equality and preservation of the natural environment. Therefore, environmental sustainability should be taken into account in the examination and approval of projects, even if the main target of many projects lies in different areas. In 1999, about 8 % of financial resources for programme and project aid were granted for projects which had environment protection as a main target, and 22 % for projects which had environment protection as a significant additional target.

With regard to Climate Change related projects, the Austrian Federal Ministry for Foreign Affairs has since 1997 concentrated its bilateral efforts in three different areas:

(1) small scale and micro hydro power plants (consulting, construction and rehabilitation) as well as education and training in the energy sector,
(2) solar energy and energy efficiency in rural areas,
(3) protection of rainforests.

With regard to (1), projects in Nepal and Bhutan have to be mentioned. The Namche Bazaar hydropower plant, 600 KW in Nepal was finished in 1996. The project had been particularly challenging when a glacier lake outbreak caused a vast flood, destroying a newly-erected building and power generating unit in 1985. A number of accompanying measures became necessary since completion of the power plant, and different training programs were added. Expenditures for these accompanying measures and training programs in the years 1997–2000 were US$ 0.48 in grants. In Bhutan, preparations and planning for the construction of two hydropower plants, in Baso Chu and Rang Jung, started in 1995. Expenditures involved in the years 1997–2000 were US$ 14.19 million in grants and US$ 12.96 million in loans. For details see tables 7.2–7.5.

Planned, however not yet started, are activities in support of the construction, operation and management of micro power plants in Ethiopia. A first feasibility study will be carried out by the end of 2001.

With regard to (2), a project for the use of solar thermal energy in Zimbabwe has been started. Firewood is the most important source of energy in rural areas in Zimbabwe, which is one of the

[1]Amounts given in this chapter in US$ were converted from ATS using the exchange rate at the end of the years. In cases where international payment obligations relate to US$, those figures were used directly.

Table 7.2: Bilateral financial contributions related to the implementation of the Convention 1997 (millions of US$)

Recipient country	Mitigation		
	Energy	Transport	Forestry
Brazil			0.31
Bhutan	3.13		
Cameroon			0.22
Columbia			0.02
Cuba			
Guatemala			0.05
Nepal	0.13		
Nicaragua			
Panama			0.08
SADC region		0.28	
Zimbabwe			
Total	4.22		

Table 7.3: Bilateral financial contributions related to the implementation of the Convention 1998 (millions of US$)

Recipient country	Mitigation		
	Energy	Transport	Forestry
Brazil			0.20
Bhutan	2.10		
Cameroon			0.13
Columbia			0.30
Cuba	<0.01		
Guatemala			0.04
Nepal	0.32		
Nicaragua			1.29
Panama			0.10
SADC region		0.22	
Zimbabwe	0.04		
Total	4.74		

reasons why the country's forest area is being reduced by 2 % annually. Solar thermal energy systems proved to offer a sustainable alternative to reduce firewood consumption for the creation of hot water. With the support of Austrian Development Co-operation, more than 200 thermo-siphon systems have been locally produced so far and an education programme at the Technology Centre of the University of Zimbabwe has been set up. Expenditures involved in the years 1998–2000 were US$ 0.21 million in grants.

In Cuba, the use of solar energy for health centres and hospitals has been supported. Most of Cuba's rural health centres are not connected to the national electricity grid and rely on diesel generators for electricity supply. Austria financed the installation of photovoltaic systems for several surgeries and hospitals and the production of a solar energy textbook for educational purposes. Expenditures in the years 1998–2000 were US$ 0.05 million in grants.

With regard to (3), forest protection and sustainable forest management have played an important role in Austrian Development Co-operation since the Rio conference in 1992. From 1993 to 1996, in the framework of a special initiative, US$ 18 million were dedicated for the conservation of tropical rainforests. From 1997 onwards, projects in Brazil and Columbia received particular attention.

In the Northwest of Brazil, in the river basin of the Upper Rio, Negro indigenous communities are strengthened in order to support the conservation and sustainable use of a forest area of 110.000 km^2. Expenditures from 1997 to 2000 were US$ 0.66 million in grants. For details, see tables 7.2–7.5. For the years 2001-2003, a further US$ 0.41 millions in grants are planned.

In the Columbian Amazon Lowland, Austria is complementary to Denmark and the European Commission supporting COAMA, a network of NGOs. The network aims at enabling the local indigenous communities to actively take part in political processes and at enabling them to effectively protect their land, their culture and their traditional rights. Expenditures in the years 1997–2000 were US$ 0.51 million in grants. For details, see tables 7.2–7.5. For the years 2001–2003, a further US$ 0.61 million in grants are planned.

In a similar basic approach and with similar aims, capacity building of local communities for the conservation of tropical forest resources – forest communities in Cameroon were supported. Expenditures in the years 1997–2000 were US$ 0.50 million in grants.

In Nicaragua's Southwest, tropical rainforests are threatened by the continuous immigration of peasants in search for land. Austria is supporting local NGO's in their efforts to improve the peas-

Table 7.4: Bilateral financial contributions related to the implementation of the Convention 1999 (millions of US$)

Recipient country	Mitigation		
	Energy	Transport	Forestry
Brazil			0.10
Bhutan	3.55		
Cameroon			0.12
Columbia			0.12
Cuba	0.04		
Guatemala			
Nepal	<0.01		
Nicaragua			0.65
Panama			
SADC region		0.01	
Zimbabwe	0.13		
Total	4.72		

Table 7.5: Bilateral financial contributions related to the implementation of the Convention 2000 (millions of US$)

Recipient country	Mitigation		
	Energy	Transport	Forestry
Brazil			0.05
Bhutan	5.41		
Cameroon			0.03
Columbia			0.07
Cuba	0.01		
Guatemala			0.03
Nepal	0.03		
Nicaragua			0.58
Panama			
SADC region		0.39	
Zimbabwe	0.04		
Total	6.64		

ant's livelihood situation and create awareness of the problematic environmental situation caused by the forest destruction. The stabilisation of the settlement boundary and a sustainable management of the buffer-zone between that boundary and the remaining intact forest areas are the long-term goals of these efforts. Expenditures for the years 1998–2000 were US$ 2.52 million in grants. For details, see tables 7.2–7.5. For the year 2001, a further US$ 0.74 million in grants are planned.

Similar to above, Austria co-financed an integrated development project aiming at a consolidation of settlements and conservation of tropical rainforests in the Petén region in Guatemala. Expenditures for the years 1997–2000 were US$ 0.12 million in grants.

In two cases in Panama, Austria supported the demarcation of indigenous territories: The Comarca Embera and the Comarca Kuna Yala. Both projects were completed in the year 1998. Expenditures for the years 1997–1998 were US$ 0.18 million in grants.

Outside the four main areas of UNFCCC-relevant bilateral aide, a particularly interesting project of co-operation in the field of transport is noteworthy, the support to SADC railways. Since the 1960's investments in the railway networks in Africa were very low if compared to road network development and other forms of public transport. In order to assist SADC railways to improve their services, Austria financed several maintenance and training programmes throughout the last decade. Expenditures for the years 1997–2000 were US$ 0.9 million in grants. For details, see tables 7.2–7.5.

A reforestation program in Pakistan aims at the prevention of erosion by means of protective forests and hedges. Although this is an adaptation measure to counteract increased erosion and landslides, which are important consequences of increased extreme weather events caused by climate change, especially in mountainous regions, it may be more adequate to report these activities in the context of the Convention to Combat Desertification. The relevant financial contributions are, therefore, not listed in the tables.

7.3.2 Multilateral financial contributions

Financial contributions to multilateral institutions and programs are shown in table 7.6 on the next page. The contributions listed there constitute the participation of Austria in capital increases and replenishment efforts, respectively, according to the needs of each of these institutions; therefore, these contributions cannot be specifically attributed to the implementation of the Convention. Such attribution has to be done at the level of each of the

Table 7.6: Financial contributions to multilateral institutions and programmes

Institution or programme	1997	1998	1999	2000
	Contribution (millions of US$)			
Multilateral institutions:				
1. World Bank	0	0	0	0
2. International Development Association	49.122	47.188	39.966	46.326
3. International Finance Corporation	1.761	0	0	0
4. Multilateral Investment Guarantee Agency	824	0	0	538
5. Consultative Group for International Agricultural Research	1.500	1.500	1.500	1.500
6. African Development Bank	0	0	0	359
7. African Development Fund	8.002	10.535	8.588	3.874
8. Asian Development Bank	115	125	111	112
9. Asian Development Fund	12.931	13.475	9.295	6.765
10. European Bank for Reconstruction and Development	2.476	3.951	6.442	8.115
11. Inter-American Development Bank	391	933	493	643
12. Fund for Special Operations	587	747	50	607
13. International Fund for Agricultural Development	1.027	1.171	1.228	1.314
Multilateral scientific, technological and training programmes:				
1. UNIDO Cleaner Production Centers	see text			
2. Consultative Group on International Agricultural Research	1.399	1.626	1.416	

institutions in accordance with the activities they have financed.

In addition, the Austrian contribution to UNIDO's Cleaner Production Centres (CPC) programme has to be mentioned. It aims at the creation of national capacities to promote the application of cleaner production technologies, among other things, to improve energy efficiency and the utilisation of renewable energy. Expenditures for CPCs a. o. in Nicaragua and Uganda in the years 1994–2000 were about US$ 2.20 million.

7.4 Activities Related to Transfer of Technology

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

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

As a member country of the International Energy Agency (IEA) from the outset, Austria has been co-operating for about 25 years with other OECD members (now 25, Korea joined this year) in the framework of the energy technology and R&D collaboration programme. One of the basic aims of the IEA outlines this co-operation as follows: "... to promote rational energy policies in a global context through co-operative relations with non-member countries, industry and international organisations".

Accordingly, this programme also facilitates co-operation, one of the fundamentals of any successful technology transfer, between member and non member countries. Especially some of these non-member countries – economies in transition – are expecting a dramatically growing energy demand and therefore will face a lot of social, ecological and economic challenges.

Austria currently participates in 11 Implementing Agreements, 9 of which deal with 'climate-friendly' technologies or measures, e.g. in the areas of solar energy[2]; biomass[3]; wind energy[4]; demand side management[5] and hybrid and electric vehicles[6]. Public funding of about 10 Mio ATS annually gives Austrian researchers access to many highly relevant fields of energy-related R&D.

As an example for co-operation with non member countries, Austria and Mexico work together in the field of solar assisted air conditioning of buildings (Task 25) in the solar heating and cooling programme. In the bio energy programme, where an Austrian energy expert holds the position of a chairman, Brazil joined to co-operate.

The IEA Working Party on renewable energy (REWP) regularly invites non-member countries for discussion on common efforts. Mexico, Ecuador, India, China, and Morocco exchanged their views with the REWP. The REWP is also in close contact with financial organisations like the Global Environmental Facility (GEF). Undeniably, most of the non-member countries will also need financial support to redirect their energy systems to more sustainable grounds.

7.4.2 Austria's participation together with non-EU member countries in the 5th Framework Program for Research & Development of the EU

Austria's participation in climate change projects within the 5th Framework Program for R&D was quite successful according to PROVISO, a database that was established by the Austrian Ministries for Transport, Innovation and Technologies as well as Education, Science and Cultural Affairs. Until April 2001 9 of 47 transmitted project proposals were retained successfully. Most partners in these projects come from EU-member states, however the number of non-EU member states, primarily candidate countries, is constantly growing. Furthermore, Austria is also involved in climate change projects with countries like Israel, Georgia and Russia.

[2] see http://www.iea-pvps.org, http://www.iea-shc.org
[3] see http://www.ieabioenergy.com
[4] see http://www.afm.dtu.dk/wind/iea/
[5] see http://dsm.iea.org
[6] see http://www.ieahev.org

7.4.3 Climate Technology Initiative

Austria is one of the founding members of the Climate Technology Initiative (CTI, http://www.climatetech.net), which is a multilateral initiative of 23 IEA/OECD countries and the European Commission with the mission of promoting the objectives of the United Nations Framework Convention on Climate Change (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. CTI/industry joint regional seminars on technology diffusion to broaden understanding of information and tools necessary to increase regional penetration of climate-friendly technologies and regional technology training courses, where trainees are provided with hands-on exposure to environmentally sound technologies, along with instructional guidance materials.

Austria as a country with high environmental standards and a progressive environment technology and with a high share of nearly 25 % renewable energy sources will support this initiative.

7.4.4 Further Initiatives

A workshop on ***F**inancing **S**ustainable **T**ransport Infrastructure and Technology* was held in Vienna, Austria, on 25/26 January 2001. More than 120 participants from more than 30 countries, primarily Central and Eastern Europe as well as the Newly Independent States, discussed strategies to shape the transport system of the above-mentioned region towards sustainability with experts from the world's leading international financing institutions such as the World Bank or the European Investment.

The FIST workshop investigated instruments to furnish investment programs with incentives towards sustainable transport systems. This workshop was organised by the Central European Initiative (CEI), sub group on Environment and Transport, UNDESA, the Austrian Ministry for Transport, Innovation and Technology, the Austrian Ministry of Agriculture, Forestry, Environment and Water Management and E.V.A., the Austrian Energy Agency. For the participants from Eastern European countries as well as the NIS, the travel and lodging costs were reimbursed by the Austrian government. The findings of the FIST workshop were presented by Austria as an input paper for the Commission on Sustainable Development (CSD) 9th Session on 'Energy and Transport'.

Austria has supported the European-Asian environmental technology centre in Bangkok since its foundation in 1999. Austria provided financial support for the infra-structure of the centre of about US$ 35,000 and financed the participation of an Austrian expert at the centre.

7.4.5 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 from the project organiser.

Table 7.7 on pages 124 to 128 will present some examples of the technology transfer aspects of aforementioned projects and of further initiatives. The listing is not at all exhaustive, since the ability to collect information on projects that are relevant to technology transfer is limited, especially as far as the private sector is concerned. Projects that are mentioned in the previous section are primarily supported by the program and project aid of the Federal Ministry for Foreign Affairs; the other projects are supported by Austrian NGOs, Länder, private initiatives and ODA. More detailed information on some of the projects and their supporters can be found in the brochure "Energy Technologies for a Sustainable Development", which is available online (http://gpool.lfrz.at/gpoolexport/media/file/unidc3brosch.pdf).

Table 7.7: Selected projects that promote practicable steps to facilitate and/or finance the transfer of, or access to, environmentally sound technologies

Project/program title: Small hydropower plant Namche Bazar

Purpose: Supply of energy from renewable sources for the Thame valley in order to improve health and living 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
Nepal	Energy supply	> US$ 5 million	1988–1998

Description: The 600 kW power plant Namche Bazar (at an altitude of 3800 m above sea level!) is designed to work in isolated mode – only the respective amount of energy that is actually required is generated. It currently supplies electricity to about 620 households. A young local Sherpa team was intensively trained on electricity in Kathmandu as well as at the power plant itself, where training was provided by Austrian engineers. Since 1999, the plant has been operated by the local team; no technical support from Austria is on site any longer. The local electricity company is managed by elected representatives of the local user groups; tariff structure is graded according to social aspects. (http://www.ecohimal.or.at/03englis.htm)

Indicate factors that led to project's success: Adequate training of local staff and de-centralised management structure on the site.

Technology transferred: Small hydropower plant and relevant know-how

Table 7.7 – continued

Project/program title: Hydropower plants Baso Chu and Rang Jung

Purpose: Supply of energy from renewable sources for Bhutan in order to improve health and life standard of the population; reduction in the consumption of fire-wood in order to safeguard forests and avoid deforestation

Recipient country	Sector	Total funding	Years in operation
Bhutan	Energy supply	> US$ 15 million	since 1995

Description: Hydropower plants with a capacity of 2.2 MW and 22 MW have been planned and installed and are being installed respectively in Bhutan. Work is carried out by local contractors. Austrian technology for electrical and mechanical equipment is used.

Indicate factors which led to project's success:

Technology transferred: Hydropower plant.

Project/program title: Solar energy for Cuba

Purpose: Supply of energy from renewable sources for doctors' surgeries in remote areas

Recipient country	Sector	Total funding	Years in operation
Cuba	Energy supply	> US$ 0.2 million	1998

Description: Only part of doctors' surgeries in rural Cuba are connected to the electric grid. For several doctors' surgeries, 400 W photovoltaic systems were installed to provide electricity for lighting and medical equipment. A hospital was equipped with a 2 kW photovoltaic system. Provision of proper information about maintenance of the systems and efficient use of electricity was an important part of the project. Furthermore, a textbook about the use of solar energy was prepared for use in schools and secondary technical colleges. (http://www.cubasolar.cu)

Indicate factors which led to project's success:

Technology transferred: Photovoltaic systems and information related to use of solar energy

Project/program title: Solar drying systems for crops

Purpose: Improvement of the quality of dried food through the use of an indirect solar drying system

Recipient country	Sector	Total funding	Years in operation
Burkina Faso	Agriculture	about US$ 0.2 million	1998

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

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

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

Table 7.7 – continued

Project/program title: Solar thermal energy in Zimbabwe

Purpose: Use of solar energy in order to reduce the consumption of fire-wood, as the countries forest area is currently being reduced by 2 % annually and is increasingly suffering from erosion.

Recipient country	Sector	Total funding	Years in operation
Zimbabwe	Energy supply	US$ 0.22 million	1997–2000

Description: The main aim of the project was to develop a solar energy system for generating hot water, which can be produced using locally available materials. An extensive education programme has been set up in co-operation with the Development Technology Center of the University of Zimbabwe to train students in solar technology and to grant manufacturers the required practical training necessary to produce the solar systems. In addition, experts at the University of Zimbabwe have created the basis for further development and optimisation of the concept. Up to now, 200 thermo-siphon solar systems have been constructed. (http://www.aee.at/verz/english/zimbabwe.html)

Indicate factors that led to project's success: Financing of basic equipment and adequate training of local skills. The project is, however, impaired by the severe economic crisis, which makes delivery of materials difficult.

Technology transferred: Know-how about solar thermal systems

Project/program title: Biomass project in Nicaragua

Purpose: Development of concepts of sustainable energy production, biological wastewater treatment, municipal waste management and agricultural efficiency

Recipient country	Sector	Total funding	Years in operation
Nicaragua	Energy supply		1996–2000

Description: The Biomass Project, located at the National University of Engineering Sciences in Managua, Nicaragua and funded by the Austrian Government, is a research and development co-operation project related to questions of sustainable energy production, biological wastewater treatment, municipal waste management and agricultural efficiency. One part of the project was to examine an extraction and trans-esterification process to transform the raw oil of physic nut (Jatropha Curcas L., a tropical oil seed), into Curcas Oil Methyl Esters. These can be used as fuel in any diesel engine or diesel burner, mostly without any further adaptations. 1000 hectares of previously degraded and idle agricultural land have been converted into physic nut plantations in Nicaragua and are managed by small holders and co-operative farmers. A modern analytical laboratory and a pilot plant have been established. (http://www.ibw.com.ni/~biomasa/)

Indicate factors that led to project's success: Close co-operation of Nicaraguan and Austrian scientists and engineers is the heart of the project. The biofuel part, however, suffers from the development of fossil fuel prices, which makes the production of diesel from physic nut uneconomical at the moment.

Technology transferred: Biofuel and biogas production, waste and wastewater treatment.

Table 7.7 – continued

Project/program title: Solar energy for African hospitals

Purpose: Providing electricity and/or hot water from renewable energy sources, substitution of diesel generators and creating reliable energy supply

Recipient country	Sector	Total funding	Years in operation
Uganda/Tanzania/Zimbabwe	Energy supply	about US$ 0.8 million	since 1997

Description: Hospitals in rural Africa usually rely on diesel generators for electricity and on coal or firewood for hot water. Several hospitals have been equipped with photovoltaic systems to provide electricity for lighting and equipment and/or solar collectors for hot water (laundry and personal hygiene). The work has been done partly in the course of the renovation of the buildings. (http://www.sustainable-energy.org/MainIssues/technic.htm; http://www.aee.at/verz/artikel/entw20.html, in German only)

Indicate factors which led to project's success: Keeping the systems easy to handle and maintain, using part of local origin where possible. Participation (and enthusiasm) of concerned local inhabitants and technicians

Technology transferred: Photovoltaic systems and solar thermal systems

Project/program title: Himalayan solar school

Purpose: Cost-effective space heating for a school building

Recipient country	Sector	Total funding	Years in operation
India (Ladakh)	Domestic heating	US$ 0.03 million	1998–2000

Description: The village Lingshed lies at an altitude of 4000 m above sea level and in an extremely isolated location, four days' march away from any road and completely cut off in winter. A village school was built according to the principles of passive utilisation of solar energy. All rooms can be heated passively by solar irradiation. The building was constructed by the inhabitants of Lingshed, supported by an Austrian Architect and friends. As far as possible, locally available building materials were used. Additional experiences with solar energy use (green house, solar cooker) have been started. (http://www.lingshed.org)

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

Technology transferred: Principles of solar building (space heating by solar irradiation)

Table 7.7 – continued

Project/program title: Clay ovens for use in developing countries

Purpose: Optimisation of oven technology in order to reduce the consumption of firewood

Recipient country	Sector	Total funding	Years in operation
	Residential heating		since 1999

Description: Austrian stove fitting technology is actually leading on a global scale and offers future-oriented perspectives in this field. Taking into account the situation of countries like Zimbabwe, where high demand for firewood leads to an annual reduction of forest area by 2 %, a research project targeting the optimisation of oven technology has been conducted. Prototypes have been developed, which meet all requirements (cooking, baking, hot water and heat storage), reducing firewood consumption by 75 % compared to open fire places and cause much less air pollution. These ovens can be built by local craftswomen. Initiatives for the diffusion of the technology in Africa have been initiated.

(http://www.forschungsforum.at/e/2_00.htm)

Indicate factors which led to project's success:

Technology transferred: Energy efficient technology for wood-fired ovens

Project/program title: Silicate technology for sustainable use of water reserve

Purpose: Reforestation with low water consumption in arid zones

Recipient country	Sector	Total funding	Years in operation
Senegal, Mauretania	Forestry		since 1998

Description: An optimal water and nutrient storage capability of soils is important, especially in arid zones. A plant substratum has been developed by the Austrian State Research Institute for Silicate Technology that is capable of storing up to 50 litres of water per kg. Granular materials like gravel or sand are coated with the substrate and mixed with soil, thus generating a solid soil structure with high air and water storage capability. Field experiments have been performed to stabilise a shifting sand dune in Mauretania and for reforestation in the Sahel region in Senegal, showing increased growth with an 80 % reduction of required water (http://www.sanoway.com).

Indicate factors which led to project's success:

Technology transferred: Optimised plant substratum leading to reduced irrigation demand

Chapter 8

Research and Systematic Observation

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. Rather heterogeneous meteorological patterns in the alpine regions have also brought about a dense network of observing stations for meteorological and hydrological parameters; Austria's instrumental time series are among the longest in existence.

8.1 General Policy on Research and Systematic Observation

Three federal ministries hold a central position in co-ordinating and financing research in Austria. The Federal Government directly finances the basic infrastructure of universities, and – fully or partly – of Fachhochschulen, extra university research institutions, and bottom-up oriented science funds. 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

Public authorities, as the federal ministries and provincial governments, bear responsibility for research issues within their own areas of competence. A central position in co-ordination, administration and financing of research hold the Federal Ministry of Education, Science and Culture and the Federal Ministry of Transport, Innovation and Technology. The former focuses on university research and teaching, providing the financial basis for the university research; the latter is a. o. responsible for a large proportion of extra-university research institutions and the research funds.

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 University Organisation Act (Universitätsorganisationsgesetz). The Research and Technology Funding Act sets up two separate, 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 University Organisation Act defines the set-up and structures of Austrian universities and their scope of autonomy with regard to staff and financial matters.

8.1.2 General Strategy

The 'Council for Research and Technology Development', 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. The Council prepares the research strategy for Austria and guidelines for setting priorities.

The international research relations are naturally but not exclusively oriented towards the EU's framework programmes and the emerging 'European Research Area'. The latter aims at creating a 'single market' without borders for research and technology within the EU. This will thoroughly redesign the research environment in Europe. Research institutions will have to develop integrated and longer-term strategies on how to find their place regarding international development and scientific or industrial competition. On the other hand, national funding will keep its important role as it has to maintain the vital basis for competitive research institutions, and to cover themes of national interest.

An increase in the research expenditure to 2.5 % of the gross domestic product shall be achieved by 2005 by raising especially the share of business enterprises in the total of R&D financing. Stimulation measures for increasing R&D activities will aim at a better participation of small and medium enterprises, establishing of innovation management capacities and funding regional, national and international innovation networks, as well as integrating the activities with programmes at a European level.

8.1.3 Funding

Within the last two decades, Austria has seen a continuous increase in real investments in research and development and – though with some delay when compared with similar industrialised countries – a considerable extension of university and extra-university infrastructures and great increases in the personal resources invested in research. Among the EU member states, Austria currently ranks within the mid-field of the national economies, with a research expenditure amounting to about 1.8 % of the gross domestic product. For the year 2000, the expenditure on research and development is estimated at about € 3,634 million (ATS 50,000 million). 38 % of the expenditure is contributed by the public sector, which is high, compared to the EU average. In contrast to most other OECD countries, only civilian research work is financed from public funds in Austria.

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

The Austrian Science Fund was set up as a bottom-up oriented instrument for basic research funding in 1967. About 90 % of the subsidy applications come from university staff. Funding is provided for individual research projects, programmes, publications, grants, and awards. Applications for subsidies are subjected to stringent international peer-review. The total budget spent in 2000 was around € 85 million (ATS 1,170 million).

The Austrian Industrial Research Promotion Fund, founded in 1967, is a bottom-up funding instrument which stresses the 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. Since Austria's business structure is essentially characterised by small and medium-sized enterprises with clusters of certain product groups and production processes, the FFF has initiated special programmes for the reinforcement of specific strengths of Austria's economy. In 2000 funds amounted to about € 254 million (ATS 3,500 million).

The Innovation and Technology Fund, installed as a top-down instrument by the Federal Government in 1987, supports national and international research and development projects within the framework of strategic programmes with special research targets. Projects carried out in co-operation between enterprises and university and extra-university research institutions within temporary programmes with special research targets, are grouped, with respect to subject and organisation, into key actions.

8.1.4 Environmental Issues

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

Environmental issues are part of the key areas of research commissioned by the Federal Ministry of Education, Science and Culture and the Federal Ministry of Transport, Innovation and Technology, the Federal Ministry of Agriculture, Forestry, Environment and Water Management, and the Länder.

The purpose of this funding instrument is to provide the Governments with scientific and technical advice. These key areas need additional stimulation with public money, as neither private nor university activities sufficiently cover them. Funding focuses on well-defined, interdisciplinary fields of research of great interest to the public. Examples of such key areas are 'future-oriented energy and environmental technologies' (efficient use of energy, renewable energies, cleaner production), 'Sustainable Development of Austrian Man-dominated Landscapes and Regions' (targeted at reduction of the flow of anthropogenic material, optimised relationship between quality of life and biodiversity, and promotion of biodiversity development options), 'remote sensing for environmental monitoring'.

The Federal Ministry of Education, Science and Culture finances the 'Austrian Network for Environmental Research'. The main objective of the network is the promotion of international research activities and the support of environmental scientists. The network functions as an interdisciplinary think-tank for developing future-oriented concepts and international research cooperation and fulfils a vital role in the close cooperation of research politics, scientific program conception and organisation that is necessary for developing a successful international research agenda. It functions as a consultant for the ministry concerning specific concepts, strategies and international lobbying activities. The network currently consists of the following nodes: 'Biodiversity Research', 'Climate, Climate Change and Atmospheric Environment Research', 'Austrian Landscape Research', 'Ecosystem Research and Environmental Monitoring', 'Long-term Ecological Research Austria', 'River Ecology – Assessment of Ecological Integrity of Rivers', 'Social Economic Environmental Research', 'Tropical Forest Research / ANN–ETFRN'.

The Austrian National Committee on the Global Change Programmes is hosted by the Austrian Academy of Sciences and is dedicated to establishing contacts with, and to funding Austrian contributions to the Global Research Programmes IGBP, WCRP and IHDP.

The Innovation and Technology Fund supports national and international research and development projects within the framework of strategic programmes with special research targets. Several research targets were focused on environmental issues, such as 'transport technologies' and 'energy technologies'. In 2000, a five-year program on 'technologies for sustainable development' with the subprograms 'building of tomorrow' and 'factory of tomorrow' was established.

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 Austrian Academy of Sciences, the Federal Environment Agency, the Hydrographical Central Bureau, institutes of the Federal Ministry of Agriculture, Forestry, Environment and Water Management, the Austrian Research Centers Seibersdorf, and Joanneum Research, as well as the environmental departments of the provincial governments.

Regarding research and systematic observation in the area of global change, the importance of funding by public authorities needs to be mentioned. An analysis of more than 100 projects in the field of climate change and air quality, which have been funded during recent years, showed a share of more than 50 % of the projects funded by federal ministries, whereas the rest was equally contributed to by the federal provinces and local authorities, by EU funds and the research institutions themselves. Business sector contributed to about 3 % of the projects.

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. With respect to mitigation technologies, biomass and solar energy are of special interest for Austrian researchers. It needs to be mentioned that several projects are supported within the 5^{th} Framework Programme on RTD of the EU.

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 orography, especially the Alps. Precipitation and chemical climatology have attracted a number of research groups. This basic research is of course not only of interest for climate studies, but has other meteorological and also interdisciplinary aspects.

For examples of research projects and activities in which Austria has been particularly active, consult Table 8.3 on page 139.

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 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 true, e.g., for prediction activities based on statistical analyses linking regions or scenarios, but some efforts are also being undertaken to establish a limited area model in climate mode for Austria.

For examples of research projects and activities in which Austria has been particularly active, consult Table 8.3.

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: forests, water, glaciers, etc. Most of these studies look into the effects of a climatic change on the Alpine region, since its climate is very specific, due to the elevated and complex topography and also very sensitive to minor shifts in the general circulation, including to the paths of cyclones. This is one of the reasons why regionalisation is discussed intensively in Austria as a priority in climate research. Some studies are examining impacts on the low-lying east of Austria, where agriculture plays a vital role. In this area, water shortages could lead to difficulties in the future.

For examples of research projects and activities in which Austria has been particularly active, consult Table 8.4 on page 141.

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

One node of the 'Austrian Network for Environmental Research' is responsible for 'Human Dimensions of Global Environmental Change'. This node is devoted to fostering interdisciplinary research in this crucial area, originating primarily from the fields of social and political sciences, economics, and the humanities.

Austrian research in this field is mainly directed towards two major topics. These are: the estimation of costs and benefits (in economic as well as social respect) caused by the introduction of technologies for energy supply from renewable sources, and the development of regional response options aiming at reducing greenhouse gas emissions from energy generation.

Regional response options particularly aiming at reducing greenhouse gas emissions are currently an integral part of most regional and local development plans. There is a definite demand-side pressure for research in this field, as almost 400 Austrian municipalities and eight Länder have joined the Klimabündnis, dedicating themselves to halving their CO_2 emissions by 2010.

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

In order to help develop a suitable strategy for the further promotion of renewable energy sources in Austria with a special consideration of the EU's White Paper on Renewable Energies and of the EU Campaign for Take Off (CTO), different scenarios were investigated.

For examples of research projects and activities in which Austria has been particularly active, consult Table 8.5 on page 145.

8.2.5 Research and Development on Mitigation and Adaptation Technologies

Austria has a long research tradition concerning energy technologies based on renewable sources and holds competitive positions in the fields of biomass utilization and solar energy technologies. In the first field, research is mainly directed towards biomass utilization in small and medium (up to 50 MW) heating facilities. Within this field, a whole range of problems like furnace optimisation, effluent gas cleaning, nitrogen oxide reduction and ash management are currently under investigation. Emphasis is put on cogeneration technologies in small and medium size plants using gasification as well as sterling engines. A large part of the development occurs in small and medium enterprises; it is difficult, however, to site a list of concrete projects in this area.

Some 'cluster' initiatives, which promote enhanced co-operation of SMEs, have been established and are supported by public institutions. They either focus on energy questions, like the 'BioEnergy Cluster' in Upper Austria, or cover broader topics, like the 'TecNet Cluster Wood' in Lower Austria, which also deals with long-lived wood products in the construction industry.

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 towards solar energy systems, solar architecture and transparent insulation systems has been intensified considerably. Due to the demand-side pressure of grass-roots organizations, this research is close to the market and strongly concentrated on practical solutions. The 'Arbeitsgemeinschaft Erneuerbare Energie – AEE' (Society for Renewable Energy, http://www.aee.at/indexeng.html) for example, a non-profit organisation, has contributed considerably to the further development of solar technologies and system technologies in the Framework of national, European and international research and development. Funders of the AEE are, among others, the European Commission, the Federal Ministry of Agriculture, Forestry, Environment and Water Management, the Federal Ministry for Transport, Innovation and Technology and Provincial Governments.

With respect to greenhouse gas mitigation in the transport sector, environmentally friendly transport technologies and research for sustainable mobility play an important role in Austria. The Federal Ministry of Transport, Innovation and Technology will launch a multi annual research and technology development programme on transport technologies. Computer-based simulation programs for engine and vehicle design, new light materials and intelligently designed system components for cutting vehicle weight are regarded as the most promising technology areas. Austrian companies and research institutions in the field of auto industry supply, aeronautics and rail road technology have a long standing reputation as centres of excellence. The close co-operation between research and development with industry has created an environment which safeguards the competitiveness of Austria's transport sector while triggering innovation.

Research for sustainable mobility is primarily aimed at understanding the socio-economic principles of a customer-oriented sustainable transport system. Mobility management and innovative mobility systems are considered of utmost importance. Besides the technological and organisational aspects of an innovative transport system, emphasis is put on needs assessment and customer involvement.

A further important attempt is to develop adaptive forest management strategies in order to increase the sequestration and storage of carbon and to mitigate adverse impacts of climate change to the forests.

The Federal Ministry of Agriculture, Forestry, Environment and Water Management has initiated a research platform with respect to natural disasters ('Forschungsplattform Naturgefahren') in 1999. The platform comprises representatives of the Ministry and its Agencies, of research institutes at Austrian universities and technical consultants; contacts with other relevant institutions in Austria and neighbouring countries are going to be extended. The platform aims at identification of research requirements, development of projects and increased interdisciplinary co-operation (Mayer and Rachoy, 2000).

For examples of research projects and activities in which Austria has been particularly active, consult Table 8.6 on page 150.

8.3 Systematic Observation

Climate observations have a long tradition in Austria, going back to the 18th century. Currently, a dense network of observing stations for meteorological and hydrographical parameters is in operation; further observations relate to mass balance of glaciers and species composition of ecosystems. During recent years, Austria has increasingly engaged in space-based observation programs.

8.3.1 Atmospheric climate observing systems

It is important to note that monitoring the 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 co-operation 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 in existence. Due to this long experience with meteorological measurements, quality- and homogeneity control of the data are highly developed and long time homogeneous datasets are available.

To meet the demands of the complex topography of Austria, a dense network for observing atmospheric climate parameters is established. More than 600 stations are measuring at least temperature and precipitation. 80 of these stations are exchanged internationally within the WWW, 10 within CLIMAT, 2 within the GSN and 1 within the GAW program (see Table 8.1 on the next page). Two institutions are responsible for station maintaining and quality control; the Central Institute for Meteorology and Geodynamics (ZAMG) and the Hydrographical Central Office (HZB). The HZB is also responsible for the river discharge measurements (765 stations) and the ground water storage (3066 stations). All WWW stations are under the direction of the Central Institute for Meteorology and Geodynamics (ZAMG).

As the Austrian contribution to the GAW programme, measurements from the station at the 'Hohen Sonnblick' are provided. This high altitude meteorological observatory (at 3106 metres above sea level) has been operating continuously since 1886, which is the longest continuous and homogeneous meteorological time series for high

Table 8.1: Participation in the global atmospheric observing systems

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

altitudes worldwide. Since the last decade additional measurement programs (e.g. Ozone, UVB, Gamma-spectroscopy) have been performed at the observatory by several research institutes. Germany, Austria and Switzerland have established the GAW-DACH co-operation with the aim of providing a combined data set of global relevance from the alpine stations Zugspitze, Hoher Sonnblick and Jungfraujoch and the observatory at Hohenpeissenberg. (Information at http://www.zamg.ac.at/, in German only)

The measurements of atmospheric constituents are the responsibility of the nine Länder governments and of the Federal Environment Agency; data are collected and published by the Federal Environment Agency. More than 120 stations are distributed all over the country and at least are measuring Ozone and SO_2.

For examples of research projects and activities in which Austria has been particularly active, consult Table 8.7 on page 152.

8.3.2 Terrestrial climate observing systems

Austria has a long tradition in glacier monitoring. About 10 % of Austria's surface area lies between 2000 and 3800 metres above sea level, part of it covered by glaciers. Since the end of the 19^{th} century, length fluctuations of approximately 100 glaciers have been observed continuously. In addition to length measurements, mass balance measurements have been established on several glaciers for decades, using the direct glaciological method. All these data are reported internationally to the World Glacier Monitoring Service (see Table 8.2 on the facing page).

As a result of this extensive experience in glacier monitoring, Austrian researchers are involved within the 'Glacier mass balance network in the Himalayans'. Within this IHP-UNESCO project, support to the start of a Glacier mass balance monitoring network in the Himalayans is given. The main objectives of this program are the promotion of sciences in developing countries and information transfer in science and technology.

The complex orography of Austria requires a high number of measurement stations to describe the water runoff. In addition to 765 stations for river discharge measurements and 3066 stations for ground water storage measurements, more than 850 stations for snow depth measurements are established. The measurements are performed by HZB, measurements of snow depth by HZB and ZAMG.

Phenological observations are performed at meteorological monitoring sites of ZAMG, as well as measurements of radiation and soil temperature. Ecosystem monitoring is based a. o. on project oriented work of research institutes, like the newly established GLORIA programme.

For examples of research projects and activities in which Austria has been particularly active, consult Table 8.7 on page 152.

Table 8.2: Participation in the global terrestrial observing systems

	GTN-G*	GTN-G°	TEMS	MAB
How many stations are the responsibility of the Party?	~100	9	2	4
How many of those are operating now?	~100	9	2	4
How many of those are operating to GCOS standards now?	~100	9	2	4
How many are expected to be operating in 2005?	~100	8	2	4
How many are providing data to international data centres now?	~100	9	2	4

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

8.3.3 Space-based observing programmes

Austrians space-based activities are coordinated by the Austrian Space Agency (ASA)[1]. In January 1987, Austria became a full member of the European Space Agency (ESA). Since January 1994, Austria has also been a member of Europe's Meteorological Satellite Organisation EUMETSAT.

In addition to the involvement in the mandatory programme of ESA (general activities, including general studies, the technology programme and the science programme) Austria participates in the following programmes relevant to research on the climate system:

- ▷ Earth Observation Programme:
  - ▷ European Remote Sensing Satellite ERS-2
  - ▷ Earth Observation Preparatory Programme (EOPP - Extension)
  - ▷ Polar Orbit Earth Observation Missions (ENVISAT and METOP-1)
  - ▷ Meteosat Second Generation (MSG)
  - ▷ Earth Observation Envelope Programme (EOEP)
  - ▷ Earth Watch Global Monitoring for Environment and Security GMES Service Element
- ▷ Programme for the Development of Scientific Experiments (PRODEX)
- ▷ General Support Technology Programme (GSTP)

An ASA staff member represents Austria in the EUMETSAT Council, together with representatives from the Austrian Central Institute for Meteorology and Geodynamics (ZAMG). The programmes for operational meteorology include the Meteosat series of satellites, the second generation of geostationary meteorological satellites (MSG) to be launched in 2001 and the European polar orbiting meteorological satellite system EPS, now under development and in operation from 2003 onwards. Austrian industry is involved in the development of instruments for the latter two programmes. The operational application in weather forecasting and the scientific use of data provided by these satellites are under the jurisdiction of ZAMG.

ASA participates in the working group on remote sensing, under the Federal Ministry of Education, Science and Culture, which was established for information exchange and promotion of remote sensing activities in Austria. ASA acts as the National Point of Contact (NPOC) for the distribution of remote sensing satellite data in close co-operation with the Earthnet programme of ESA and the distribution entity EURIMAGE. ASA is a member of the European Association of Remote Sensing Laboratories (EARSeL) and has represented Austria in the EARSeL Council since 1989.

Additional information about all Austrian space activities can be found in the 'Austrian Report to COSPAR' (Committee on Space Research)[2]

Austria has also taken an active role within the newly approved cooperation programme between the European Commission and the European Space Agency "Global Monitoring for Environment and Security - GMES"[3]. This programme aims at meeting the needs of national and European information needs in the areas of environmental monitoring, and

[1] http://www.asaspace.at

[2] http://www.asaspace.at/download/COSPAR2000.PDF

[3] http://gmes.jrc.it/

natural hazards by using satellite based earth observation technologies. Thus Europe wants to make an active contribution to international environment monitoring.

To underline the importance of the programme the Austrian Federal Ministry for Transport, Innovation and Technology initiates several pilot projects, which examine the use of satellite based earth observation for land use and transport planning. Besides this, Austrian Universities and private companies have already conducted a number of pilot studies using Earth observation data for land ice and forest and applications in the Kyoto framework for organisations such as the European Commission and the European Space Agency. The national coordination is done by the Federal Ministry for Transport, Innovation and Technology and the Austrian Environment Agency.

For examples of research projects and activities in which Austria has been particularly active, consult Table 8.7 on page 152.

Table 8.3: Climate process and climate system studies including modelling

Examples of research projects and activities	Objectives
Aerosol climatology over Europe ✉ Erich Putz; erich.putz@kfunigraz.ac.at	The combination of the ground-based sun-photometer network (AERONET) with satellite instruments permits a global coverage of aerosol data to be made. In this IGBP project an aerosol climatology over Europe is built, which can be used in combination with satellite data for constructing a European UV climatology, based on model results and observation.
Atmospheric General Circulation Statistics from ERA-40 data ✉ Michael Hantel; michael.hantel@univie.ac.at	In the framework of an ECMWF special project ERA-40 data are used to calculate parameters describing the atmospheric general circulation (e.g. transports, diabatic heating rate, dissipation rate of kinetic energy). These parameters can be quite accurately estimated due to the high precision of the ERA-40-data; they shall be used to detect possible changes in atmospheric circulation patterns and to verify climate models.
Atmospheric remote sensing research ✉ Gottfried Kirchengast; gottfried.kirchengast@uni-graz.at W^3 http://www.uni-graz.at/igam-arsclisys	In atmospheric remote sensing research, a first main topic is advancement of the Global Navigation Satellite System (GNSS) based radio occultation technique, which has the potential to sense the atmospheric temperature and humidity fields with a unique combination of global coverage, high vertical resolution and accuracy, long-term stability, and all-weather capability.
Climate history as recorded by ecologically sensitive arctic and alpine lakes in Europe during the last 10.000 years – a multi proxy approach (Chill-10.000) ✉ Roland Schmidt; Roland.Schmidt@oeaw.ac.at	The overall goal of this study is to improve knowledge of holocene climate evolution and variability by producing high-resolution, multi-proxy, and quantitative climate reconstructions across Europe. The reconstructions will be achieved through the analysis of the extensive and unique proxy data available from the sedimentary deposits of remote high-altitude alpine and sub-arctic European lakes, largely unaffected by human impact.
Climate system research ✉ Gottfried Kirchengast; gottfried.kirchengast@uni-graz.at W^3 http://www.uni-graz.at/igam-arsclisys	Topics of key interest include the analysis of naturally and anthropogenically influenced change in the atmosphere's thermal, moisture, and ozone structure (from intra- and interannual variability to interdecadal trends), improvement of climate models and climate forcing inputs via global observational constraints, and climate change detection and attribution.
Heavy Precipitation in Alpine Regions (HERA) ✉ Reinhold Steinacker; reinhold.steinacker@univie.ac.at	Systematic evaluation of mesoscale precipitation systems (1992-1996) using different data sources, statistical and climatological evaluation of the cases and classification into archetypes of mesoscale precipitation systems.

Table 8.3: continued

Examples of research projects and activities	Objectives
High Resolution Modelling of Climate Parameters ✉ Wolfgang Loibl; wolfgang.loibl@arcs.ac.at	The modelling of synthetic daily rainfall records (length and order of rain- and dry episodes) will be continued. A major task is the harmonization of rain and dry-episodes within regions of similar climate in order to allow the modelling of daily precipitation surface maps which is the input to estimate spatial allocated soil moisture information during the year. Further applications have to be discussed.
Intercomparison of different statistical downscaling methods for climate change scenarios in complex terrain ✉ Herbert Formayer; Herbert.Formayer@boku.ac.at	Aim of this project is to validate the usefulness of different statistical downscaling methods in the complex terrain of Austria. The most promising method is used to generate a climate change scenario for Austria with 1 km spatial resolution for different meteorological parameters.
Mesoscale Alpine Program (MAP) ✉ Reinhold Steinacker; reinhold.steinacker@univie.ac.at	Mountains and in particular Alpine-type orography instigate or influence a wide range of mesoscale phenomena. These phenomena and their associated processes are intricate in character, interact with larger and smaller-scale flow, and are responsible for much of the day-to-day mountain weather and for many extreme weather events. Moreover, their composite effect contributes significantly to determining climatic features of mountain regions. The program's coupled overall goals is to further the basic understanding and forecasting capabilities of the physical and dynamical processes that: ▷ govern precipitation over major complex topography; and ▷ determine three-dimensional circulation patterns in the vicinity of large mountain ranges, thereby focusing on key orographic-related mesoscale effects in the Alps. The project is part of a large supranational initiative.
Numerical modelling of transient mesoscale climate records for Austria on a 10km resolution using a Limited Area Model driven by GCM – Data ✉ Johann Züger; johann.zueger@arcs.ac.at Mario Köstl; mario.koestl@rcs.ac.at Wolfgang Loibl: Wolfgang.loibl@arcs.ac.at Austrian Research Centers Seibersdorf	The model used is NCAR's MM5 Version 3.4.0. The input data used for first setup runs and testing are actually NCEP global reanalysis data. There are two nested grids each configured as two way nestings. The validation of model results comparing them with daily climate records of 75 monitoring stations and optimization of model parameters is still in progress. The work will be continued 2002–2003 in cooperation with the Fraunhofer-Institut für Atmosphärische Umweltforschung, Garmisch Partenkirchen, at retrospective modeling of 30 year time series (1971–2001) and – after validation – on climate records forecast modeling for years 2001–2031 applying ECHAM 4 and/or HadCM3 GCM-Data.

Table 8.3: continued

Examples of research projects and activities	Objectives
Phenological Observations and Satellite Data (NDVI): Trends in the Vegetation Cycle in Europe (POSITIVE) ✉ Elisabeth Koch, e.koch@zamg.ac.at W[3] http://www.forst.tu-muenchen.de/EXT/LST/METEO/positive/	POSITIVE will study existing data sets of phenological ground observations in Europe and their relationship with climate and NOAA AVHRR / SPOT4 VEGETATION - NDVI satellite data. The main objective is to develop tools, such as phenological models, as well as techniques for integrating these data for multi-purpose use in the field of global change research.
Synoptic climatology of the Eastern Alps ✉ Hanns Kerschner; hanns.kerschner@uibk.ac.at	On the basis of the daily 'Berliner Wetterkarte', a weather type classification according to the rules and standards of the Swiss Meteorological Office is prepared for the Eastern Alps (Innsbruck–Lake Neusiedl). A daily 'calendar' is presently available for the period 1966–1995 (30 years). Classification work is continuing more or less regularly.

Table 8.4: Research on the impacts of climate change

Examples of research projects and activities	Objectives
Development of Operational Monitoring Systems for European Glacial Areas – Synthesis of Earth Observation Data of the Present, Past and Future (OMEGA) ✉ Michael Kuhn; Michael.Kuhn@uibk.ac.at	The Institute of Meteorology and Geophysics provides a complete set of records and observation with annual records of velocity and glacier length since 1894, climate records at Vent, direct mass balance and a set of maps and photographs. Laser Scanning and radio-echo sounding will be applied to Hintereisferner and neighboring glaciers.
European Mountain Lake Ecosystem: Regionalisation, Diagnostics & Socio-Economic Evaluation (EMERGE) ✉ Michael Kuhn; Michael.Kuhn@uibk.ac.at	Atmospheric deposition into mountain lakes and their environment, hydrology and climatology of selected basins.
Integrating Techniques, Scenarios and Strategies for Global Change of the Catchment of the Upper Danube (GLOWA-Danube) ✉ Michael Kuhn; Michael.Kuhn@uibk.ac.at	The Subproject Glaciology treats storage and runoff from snow and ice in a 1 km-grid of Danube and Inn at Passau.

Table 8.4: continued

Examples of research projects and activities	Objectives
The Response of Arctic Ice Masses to Climate Change (ICEMASS) ✉ Michael Kuhn; Michael.Kuhn@uibk.ac.at	This project aims at establishing models of the energy and mass balances of glaciers on four Arctic islands in a strong climatic gradient from maritime conditions on Iceland over Svalbard, Franz Josef Land to the dry climate of Severnaya Semlya.
Climate Change Impacts on Agroecosystems in Austria ✉ Josef Eitzinger; Josef.Eitzinger@boku.ac.at	The overall goal of the project is to assess potential climate change impacts on agroecosystems at selected major agricultural regions in Upper Austria, Northeast Austria and Southeast Austria using different crop-weather dynamical models.
Computer-aided simulation of forest development, modification and parameterization of a succession model designed for Austrian conditions.	The project is concerned with the consequences of a possible climate change for forest succession.
Dendroclimatological mass-balance reconstruction for a central alpine glacier ✉ Kurt Nicolussi; Kurt.Nicolussi@uibk.ac.at	Mass balance variations are the determining factor for glacier fluctuations. Using earlywood and latewood widths of Pinus cembra samples from tree-line sites a 600-year long mass balance series has been reconstructed for a central alpine glacier, the Hintereisferner.
Glacier fluctuations and climate in the tropical Rwenzori range, East Africa ✉ Georg Kaser; georg.kaser@uibk.ac.at	The glacier retreat on the Rwenzori mountains was reconstructed for the 20th century. A radiation model is applied to derive eventual changes in air humidity during different phases of retreat and advances of the glaciers.
Glacier fluctuations and climate on the tropical Kilimandjaro, East Africa ✉ Georg Kaser; georg.kaser@uibk.ac.at	The glacier retreat since the Little Ice Age on Kilimandjaro was particularly different from those on other tropical mountains. It is mainly driven by extremely low accumulation amounts and glaciers on the outer slopes of the volcanic cone follow a different regime than those on the plateau. It is planned to model possible scenarios in cooperation with scientists from the University of Massachusetts and the Max Planck Institute for Meteorology in Hamburg.
Glacier mass balance and climate in the tropical Cordillera Blanca, Perú ✉ Georg Kaser; georg.kaser@uibk.ac.at	The impact of climate variables on the mass balance of tropical glaciers is investigated in order to understand the sensitivity of tropical glaciers during both humid and dry seasons. Beside the tool being useful for reconstruction of climate history glacier mass balance is essential to the regional water supply of highly populated and cultivated valleys during the dry season.

Table 8.4: continued

Examples of research projects and activities	Objectives
Global Warming and Tundra Ecosystems: Interaction of Nitrogen Cycling and Ecosystem Productivity ✉ Andreas Richter; arichter@pflaphy.pph.univie.ac.at	The project aims at investigating the impact of global warming on the physiology of arctic and alpine ecosystems, with special emphasis of biogeochemical feedbacks on ecosystem carbon exchange. The main focus of the project will be on: (a) the regulation of below-ground C and N transformation processes, (b) the competition of plants and microbes for nitrogen, and (c) the dynamics and functional changes in microbial decomposer communities.
High-Arctic 1997-2001 – Fish from Sensitive Ecosystems as Bioindicators of Global Climate Change: Effects of El Niño on Metal Accumulation and Stress Response in Char from Small Lakes in the High Arctic ✉ Günter Köck; Guenter.Koeck@uibk.ac.at	The aim of this multi-year IGBP project, which is centered around small sensitive lake ecosystems in the Canadian Arctic Archipelago, is to explain the interactions between short or longer term climatic variation, the bioaccumulation of metals, and various biochemical indicators of stress in land-locked populations of Arctic char (Salvelinus alpinus).
Impacts of Climate Change on River Basin Hydrology in Austria under Different Climatic Conditions (HYDKLIMA) ✉ Hans-Peter Nachtnebel; nacht@edv2.boku.ac.at	The objective of this study is to analyse possible impacts of climate change on hydrological processes and on the water resources in Austrian basins. To cover different climatological regions the Enns river basin, the Gail river, the Traisen and two large groundwater basins (Leibnitzer Feld and Marchfeld) have been selected. The large scale pressure fields from GCMs (ECHAM4 and HADCM3) are used for downscaling of rainfall and temperature. These time series provide the input for different hydrological models to simulate the impacts on the hydrological system. The changes in snow cover, floods and droughts, soil water storage and groundwater recharge are studied in relation to the main water and land use in the regions.
Lateglacial glaciers and climate ✉ Hanns Kerschner; hanns.kerschner@uibk.ac.at	The 'Lateglacial' is a period of glacier recession following the 'Last Glacial Maximum' (LGM), which was interrupted by various sometimes intense glacier readvances in the Alps and abroad. The aim of the project is to map the moraines left by the glacial readvances, to date selected moraines using cosmogenic radionuclides 10Be, 26Al and 36Cl, to reconstruct the respective equilibrium line altitudes (ELA) and finally to synthesise the spatial ELA patterns for selected periods
Modelling of equilibrium line altitude fluctuations of alpine glaciers ✉ Hanns Kerschner; hanns.kerschner@uibk.ac.at	Standard climate data sets and aggregated data sets have been used to model ELA fluctuations of selected glaciers in the Austrian Alps since 1856. The ELA-fluctuations can be interpreted in terms of weather type frequency fluctuations.

Table 8.4: continued

Examples of research projects and activities	Objectives
Simulating post-glacial vegetation development of forest ecosystems in the Eastern Alps. Evaluation of a forest succession model ✉ M.J. Lexer; lexer@edv1.boku.ac.at	For a watershed in the eastern Alps the postglacial vegetation development is reconstructed from a Holocene pollen profile and locally derived R-values. Holocene time series of climate data are reconstructed from proxy data and long-term measurements of temperature and precipitation. A 3D-succession model is implemented at pixel-basis of a GIS and spatially explicit vegetation development for the Holocene is simulated. Model reliability is analysed by comparison of simulated and reconstructed vegetation data.
Spatial explicit modelling of high mountain vegetation at local, regional and global scale: Effects of climate change on biodiversity. ✉ Georg Grabherr; grab@pflyphy.pph.univie.ac.at Michael Gottfried; gottf@pflaphy.pph.univie.ac.at	This project aims to assess, quantify, and model recent and future plant distribution patterns and vegetation in the alpine zone of high mountain region. Based on Digital Elevation Models and using GIS-techniques as well as multivariate analysis computer models have been developed which allow running warming scenarios for an Alpine model mountain (i.e. Mt. Schrankogel in Tyrol; = local scale), and for the Sierra Nevada in Spain (= regional scale). The latter is specifically designed for studying extinction scenarios caused by climate warming. The Sierra-model should ultimately be applied to the target regions of the GLORIA-project (= global scale).
The formation of the phytotoxic substance TRIchloroacetic acid – its significance for the DESertification of semiarid and arid regions in southern Russia and its influence on the natural resources of Arctic regions in northern Russia (TRIDES) ✉ Erich Putz; erich.putz@uni-graz.at W³ http://www.kfunigraz.ac.at/igamwww/rap/	The objective of TRIDES is to investigate the influence of climatic factors on the chemical oxidation of C2-chlorohydrocarbons by means of OH-radicals and to investigate the ecotoxicological risk of this TCA formation as a function of different climate zones and pollution situations in Russia.
The sensitivity of Austrian forests to scenarios of climatic change. An ecological risk assessment ✉ M.J. Lexer; lexer@edv1.boku.ac.at	A spatially explicit 3D-succession model is employed to simulate vegetation response to different climate change scenarios. The model runs are initialized at the sample points of the Austrian Forest Inventory with the current vegetation composition as initial state. Climate data for climate change scenarios is derived from GCM-output by statistical downscaling techniques. Model output will be aggregated to by means of a multicriteria evaluation technique to yield an estimate of risk/adaptation potential representative for different strata of Austrian forests.

Table 8.4: continued

Examples of research projects and activities	Objectives
The significance of the water balance as a stress factor in agricultural plant production in a neighboring region of Austria and the Czech Republic. ✉ Josef Eitzinger; Josef.Eitzinger@boku.ac.at	Two production areas in neighboring regions of Austria and the Czech Republic were chosen to analyze potential negative effects of water stress on winter wheat production for typical local soil conditions. Analysis of water balance is done under conditions for present climate as well as for changed climate using incremental scenarios and GCM's.

Table 8.5: Socio-economic analysis, including both of the impacts of climate change and of response options

Examples of research projects and activities	Objectives
A multiple criteria decision tool for the integration of energy crops into the southern Europe energy system. ✉ Hannes Schwaiger; hannes.schwaiger@joanneum.at	The main purpose of the study was the development of a multiple criteria decision making tool (GIS-based) for establishment of integrated bioenergy systems in rural regions in Southern Europe. In one task an environmental model was developed assessing the GHG balances of different land use change options and the energy systems.
Austrian Carbon Balance Model – ACBM ✉ Rudolf Orthofer; rudolf.orthofer@arcs.ac.at	The main goal of the Austrian Carbon Balance Model (ACBM) was to establish a dynamic model that reflects the behavior of the carbon cycle in Austria. The ACBM simulates the flows and pools of the Austrian carbon system. It covers agriculture and forestry, as well as the energy sector, the production and consumption sector, and waste management.
Austrian Carbon Database Project (ACDb) ✉ Matthias Jonas; jonas@iiasa.ac.at W^3 http://www.iiasa.ac.at/Research/FOR	The Austrian Carbon Database (ACDb) Project specifies the uncertainties underlying Austria's 1990 carbon pools and fluxes, thereby following a full carbon accounting approach. It builds upon existing partial carbon accounts (e.g., Austria's national GHG inventory) and uncertainty knowledge to provide support, in the form of consistent, full-system uncertainty expertise, for Austria's national-scale carbon research (e.g., the ACBM Project). In addition, the partial and full-system uncertainty expertise is used within a novel uncertainty-verification concept to support decision-making under uncertainty, as specifically related to the Kyoto policy process.

Table 8.5: continued

Examples of research projects and activities	Objectives
CO_2 Emissions as a Result of Trends in Techno-Socio-Economic Evolution ✉ Gilbert Ahamer; gilbert.ahamer@kfunigraz.ac.at	When evaluating the feasibility of emission reduction measures on the global level there appear to exist some long-term trends that either help or hinder in attaining the targets. It is the intent of this project to identify such global techno-socio-economic trends and to quantify them by means of the 'Global Change Data Base' GCDB analytical tool. To date the GCDB was applied for the field of land-use change (demand and supply of food) and first analyses have been undertaken for the field of energy demand.
Climate Relevance of Austrian Subsidies ✉ WIFO, Daniela Kletzan; kletzan@wifo.ac.at	Since support measures taken by the state have numerous, and diverse objectives, it is difficult to identify subsidies, which are counter-productive to environmental or climate policies. Within this study the climate relevant subsidies in Austria are identified.
Co-ordination of IEA Bioenergy Task38 ✉ Bernhard Schlamadinger, bernhard.schlamadinger@joanneum.at W3 http://www.joanneum.at/iea-bioenergy-task38	IEA Bioenergy Task 38 on 'Greenhouse Gas Balances of Biomass and Bioenergy Systems' is undertaking a comprehensive assessment of all processes involved in the use of biomass for energy and carbon sequestration, with the goal of identifying energy and land-use strategies that minimize greenhouse gas emissions. Task 38 is a network of national programmes on this topic and is organised such that international expertise is made available to participating countries and the dissemination of Task-related research findings is fostered. Participating countries are Austria, Australia, Canada, Croatia, Denmark, Finland, New Zealand, Norway, Sweden, The Netherlands, U.K., and the U.S.A.
COST Action E21 'Contribution of Forests and Forestry to Mitigate Greenhouse Effects' ✉ Josef Spitzer; josef.spitzer@joanneum.at; Rudolf Orthofer; rudolf.orthofer@arcs.ac.at WG 1: Peter Weiss, weissp@ubavie.gv.at WG 2: Bernhard Schlamadinger, bernhard.schlamadinger@joanneum.at W3 http://www.bib.fsagx.ac.be/coste21/	COST E21 puts the emphasis on the quantification of carbon storage in the forest ecosystems and on the understanding of linkages between human activities and climate change, particularly the role of forests and forestry. The COST Action E21 will integrate natural, socio-economic as well as methodological aspects of cross-sectoral issues relevant for reporting and decision-making at the EU level.

Table 8.5: continued

Examples of research projects and activities	Objectives
COST Action E9 'Life Cycle Assessment of Forestry and Forest Products' ✉ Josef Spitzer; josef.spitzer@joanneum.at WG 1: Hannes Schwaiger, hannes.schwaiger@joanneum.at WG 2: Brigitte Hahn, brigitte.hahn@umbera.at WG 3: Gerfried Jungmeier, gerfried.jungmeier@joanneum.at W^3 http://www.rrz.uni-hamburg.de/cost/e9/	The main objective of the COST Action E9 is to expand multi-disciplinary life cycle assessments to cover the whole forestry and forest products chain, because methodology development and comparison is necessary due to the need for an integrated and balanced approach within the forestry and forest products sector, there is a need for interpretation of results and their transformation into practice, LCA will examine the implications of using wood in comparison with other products and LCA will contribute to the improvement of processes and products. (It is important to note that the Action will not enter – possible commercial – arguments on 'environmental' comparisons of products but will background and supporting information.)
Costs of greenhouse gas reduction with bio energy ✉ gerfried.jungmeier@joanneum.at	The cost of greenhouse gas reduction with bio energy systems for heat and electricity by substituting fossil energy systems are analyzed.
Environmentally Counterproductive Support Measures in the fields of Energy, Transport and Agriculture ✉ Energy: Angela Köppl; angela.koeppl@wifo.ac.at Transport: Karl Steininger; karl.steininger@kfunigraz.ac.at Agriculture: Markus Hofreither; hofreith@edv1.boku.ac.at	The European Commission recommends the reduction of environmentally counterproductive 'support measures' in its Broad Economic Guidelines and in the Communication concerning the Integration of environmental aspects into its economic policy. The aim of this study is to identify environmentally counterproductive subsidies in the areas of energy, transport and agriculture and to develop reform options.
European Study of Carbon in the Ocean, Biosphere and Atmosphere: Biosphere - ESCOBA ✉ Hannes Schwaiger; hannes.schwaiger@joanneum.at	The aim of the study was to investigate, quantify, model and eventually predict the behavior of the global carbon cycle. In one part of the terrestrial project, 'Biosphere' both the carbon exchange processes in managed forests and the effects of wood products and bio fuel use on the carbon balance for selected European countries under current and future climate conditions were analyzed: Austria, Germany, Finland and Portugal.
Fuel wood in Europe for Environment and Development Strategies - FEEDS ✉ Hannes Schwaiger; hannes.schwaiger@joanneum.at	This study was carried out to analyze possibilities to increase fuel wood use for five countries (Austria, Finland, France, Portugal and Sweden) in the year 2020, considering environmental, technological and socio-economic aspects. In one part the possible reduction of greenhouse gases (CO_2, CH_4, N_2O) by substituting fossil fuels with fuel wood have been analyzed.
Graz / Oak Ridge Carbon Accounting Model (GORCAM) ✉ bernhard.schlamadinger@joanneum.at W^3 http://www.joanneum.at/gorcam.htm	GORCAM is a spreadsheet model that has been developed to calculate the net fluxes of carbon to and from the atmosphere associated with land use, land use change, forestry, wood products, and bio energy.

Table 8.5: continued

Examples of research projects and activities	Objectives
Greenhouse gas balance of bio energy systems and transportation systems ✉ gerfried.jungmeier@joanneum.at	Based on a life cycle analyses the greenhouse gas emissions (CO_2, CH_4, N_2O) of heat and electricity supply with bio energy systems are compared to fossil energy systems. In total, 243 different bio energy systems are compared to 96 different fossil energy systems, whereas the bio energy systems have about 88 to 96 % lower emissions. Transportation systems (for people and goods) with bio fuels are compared to conventional transportation systems and possible substitution potentials and their cost are analysed.
Greenhouse gas balance of transportation systems ✉ gerfried.jungmeier@joanneum.at	Based on a life cycle analyses the greenhouse gas emissions (CO_2, CH_4, N_2O) of transportation systems (for people and goods) with bio fuels are compared to conventional transportation systems. Further on, the possible substitution potentials and their cost are analyzed.
IPCC Special Report on Land use, land-use change and forestry (LULUCF), Coordination of chapter 3: Afforestation, reforestation and deforestation (ARD) activities. ✉ bernhard.schlamadinger@joanneum.at W³ http://www.grida.no/climate/ipcc/land_use/index.htm	This Special Report discusses the global carbon cycle and how different land use and forestry activities currently affect standing carbon stocks and emissions of greenhouse gases. It also looks forward and examines future carbon uptake and emissions that may result from employing varying definitional scenarios and carbon accounting strategies, linked to the Kyoto Protocol, within the forestry and land-use sectors. The report is available on the internet.
Land Use and Global Climate Change. Forests, Land Management, and the Kyoto Protocol ✉ bernhard.schlamadinger@joanneum.at W³ http://www.pewclimate.org/projects/land_use.cfm	Report authors Bernhard Schlamadinger and Gregg Marland examine how forests and other lands can be managed to slow the rate of increase in atmospheric carbon dioxide levels, review how the Kyoto Protocol deals with forests and other land uses, and identify outstanding issues that must be resolved if the Protocol is to be implemented.
Plan for intensifying the use of local renewable fuel resources in the provinces of Central and Northern Ostrobothnia in Finland ✉ Hannes Schwaiger; hannes.schwaiger@joanneum.at	The goal of the project was to make detailed plans how to increase the use of local renewable fuels in energy production in the province of Ostrobothnia in Finland. One task aimed at calculating the impacts on greenhouse gas (GHG) emissions of the additional use of wood residues from forests for energy instead of fossil fuels in the provinces of Central and Northern Ostrobothnia.
Reduction potential for greenhouse gases through decentralised bio methanisation ✉ Thomas Amon; amon@mail.boku.ac.at	Amount and composition of manure and organic waste, the potential for production of CH_4 in local, decentralised installations and environmental and economic effects of the measure were analysed.

Table 8.5: continued

Examples of research projects and activities	Objectives
Social acceptance of wind power in Austria W[3] http://www.forschungsforum.at/e/akz.htm	The successful realization of a wind power project depends, in addition to the economic framework conditions, above all on the decision process at a local level. The study gives a comprehensive picture of social processes and identifies inhibiting and promoting factors as well as typical developments involved in the construction of wind power plants.
The Carbon Balance of the Austrian Forests ✉ Peter Weiss; weissp@ubavie.gv.at	The main objectives of the project were: 1) estimate of the annual carbon balance of the above and below ground biomass in Austrian forests between 1961 and 1996, 2) estimate of the carbon stock of the Austrian forests in 1990, 3) analysis of the uncertainty of these data, 4) estimate of the change in the forest soil C pool between 1961 and 1996 and 5) estimate of the possible C source or sink according to Kyoto Protocol Art. 3.3. The project also provides and discusses data to be reported under the UN-FCCC and the Kyoto process.
Uncertainty Estimate for the Austrian Greenhouse Gas Emission Inventory ✉ Wilfried Winiwarter; wilfried.winiwarter@arcs.ac.at	The aim of the project is to analyze the uncertainty of Austria's data on greenhouse gases (CO2, CH4, N2O). The range of the inputs will be assessed and their influence on the greenhouse warming potential estimated.

Table 8.6: Research and development on mitigation and adaptation technologies

Examples of research projects and activities	Objectives
CEPHEUS (Cost Efficient Passive Houses as European Standards) ✉ Helmut Krapmeier; krapmeier.energieinstitut@ccd.vol.at W^3 http://www.energieinstitut.at/cepheus http://www.cepheus.at	Passive Houses are buildings in which a comfortable interior climate can be achieved without an active heating and air-conditioning system. 'CEPHEUS' (Cost Efficient Passive Houses as European Standards) is a broad-based test of acceptance and user behaviour of cost-efficient passive houses in 5 European countries which was realized within the frame of the THERMIE-program of the European Commission. The goal of the Austrian project was to link and to bring to market maturity the findings acquired through the German passive house prototype in Darmstadt-Kranichstein with the capabilities offered by the cost-efficient building know-how specifically available in the Vorarlberg region, the experience with air heating systems in low-energy houses and 'good' architecture and by other model passive houses in other regions of Austria.
Daylight in buildings – innovative systems and monitoring procedures W^3 http://www.forschungsforum.at/e/300tit.htm	The use of artificial light in office and public buildings accounts for a considerable proportion of total energy consumption. Solutions that provide for better use of daylight may considerably reduce consumption of electrical energy As a contribution to the IEA 'Solar Heating and Cooling' program, subtask 'Daylight in buildings', an analysis of existing systems and comparisons of the performance of systems have been done.
Ecobuilding – Building Optimisation with Total Quality (TQ) Assessment ✉ Susanne Geissler; geissler@ecology.at	The construction, use and disposal of buildings cause expenses, material flows, energy consumption and emissions. With intelligent design, construction, management and marketing, it is possible to reduce environmental burdens and costs, improve building quality, and increase building value.
Emissions of CH_4, N_2O and NH_3 during manure storage and reduction potential ✉ Thomas Amon; amon@mail.boku.ac.at	Measurement of CH_4, N_2O and NH_3 emissions from manure storage are performed under farm-like conditions. Different methods for manure treatment are examined with respect to their impact on emissions. The project aims at practical recommendation for cost effective measures.
Forest under climate change: the example of the Austrian dry east. ✉ Georg Grabherr & Hanns Kirchmeir; grab@pflaphy.pph.univie.ac.at, eco@aon.at	This project has been just finalised. It provides comprehensive information for forest practice about recent climate change, its predicted effects on forests and how to adapt forest management, in the subcontinental oak and beech forest region of the east of Austria in particular. The project was designed transdisciplinarily. The recommendations on how to mitigate the effects of climate change is very much based on the expertise and knowledge of forest managers.

Table 8.6: continued

Examples of research projects and activities	Objectives
Greenhouse gas reduction with more efficient pumps and ventilation systems ✉ gerfried.jungmeier@joanneum.at	The possible energy and greenhouse gas reduction with more efficient pumping and ventilation systems in Austria are considered.
Innovative use of Austrian stove fitting technology W³ http://www.forschungsforum.at/e/kach.htm	Starting from Austrian stove fitting technology, the design of an efficient, low emission clay stove for use in developing countries was elaborated on and tested. Further investigations were directed towards the potential for increased use of tile stove technology within the scope of sustainable concepts of energy use.
Possibilities and limitations of greenhouse gas reduction with waste incineration ✉ gerfried.jungmeier@joanneum.at	The possible greenhouse gas reduction of waste incineration instead of landfilling of waste in Austria is analyzed.
Silvicultural response strategies to climatic change in management of European forests (SilviStrat) ✉ M.J. Lexer; lexer@edv1.boku.ac.at W³ http://www.efi.fi/projects/silvistrat/	The overall objective of the project is to develop adaptive forest management strategies in order to increase the sequestration and storage of carbon and to mitigate adverse impacts of climate change in European forests.
Solar air systems W³ http://www.forschungsforum.at/e/sol.htm	Solar air systems convert solar energy to heat, which is transported by the medium air to a storage or directly to a heat dissipation system (in contrast to conventional collectors using water as the medium). Within the scope of the IEA Task 19 program, existing buildings have been evaluated, documented, and analyzed in detail. Different air collectors have been tested. The effect of 'double facades' on energy use has been examined.
Spreading of small-scale biomass plants in Austria W³ http://www.forschungsforum.at/e/bka.htm	The potential of modern wood fired heating systems in household has been examined as well as the possibilities for supply of alternative biomass fuels like biomass pellets.
Strategy for the further promotion of renewable energy sources in Austria with special consideration of the EU's White Paper on Renewable Energies and the Campaign for Take-Off (CTO)	The central question to be answered in this project was ,,To which extent and how can Austria achieve an ambitious market introduction of new renewable energy sources by the year 2010?'. Three scenarios were drawn up for different technologies for the utilisation of NRES by application categories: 1) 'Business-as-usual scenario' based on the current promotion strategy under ELWOG 2000, 2) 'Moderate promotion scenario', 3) 'Ambitious promotion scenario'.

Table 8.6: continued

Examples of research projects and activities	Objectives
Technology Data Supporting Potentials for Emission Reduction in Austria ✉ Gilbert Ahamer; gilbert.ahamer@kfunigraz.ac.at	The Austrian set of emission reduction measures (compare 2nd National Communication) was quantitatively evaluated in 1998 and has served as an input into a macroeconomic model. The aim of the present study ('Technologieunterlegung von Maßnahmen zur Emissionsreduktion') is to support the identified reduction potentials by more detailed data that are taken from an energy technology database. For that target, the IKARUS model developed in Germany has been selected and a draft report has been completed.
The wind potential in Vorarlberg for wind energy usage ✉ Hartwig Dobesch; dobesch@zamg.ac.at W^3 http://www.zamg.ac.at	On the basis of 35 measuring stations with wind and other meteorological elements, the wind field of Vorarlberg is mapped with a resolution of 1 x1 km. In areas and sites where a technical usable wind potential can be expected this resolution will be up to 100 × 100 m. Here the wind energy potential for certain model turbines will be estimated. The methods used are a mesoscale wind field model (ZAWIMOD2) and the method of the European wind atlas (WaSP). Especially sites in the high alpine areas will be considered more closely taking into account icing effects and other adverse Weather conditions.

Table 8.7: Data collection, monitoring and systematic observation, including data banks

Examples of research projects and activities	Objectives
Actinic Flux Determination from Measurements of Irradiance (ADMIRA) ✉ Mario Blumthaler; Mario.Blumthaler@uibk.ac.at	The overall objective of the project is to develop tools whereby existing and future spectral UV irradiance data measured on a horizontal surface may be converted into spectral actinic fluxes, which can be applied to any UV-driven photo reaction
Austrian Glacier Inventory 1999 ✉ Michael Kuhn; Michael.Kuhn@uibk.ac.at	30 years after the first complete inventory, Austrian glaciers were resurveyed in the years 1997–1999. Digital elevation models and orthophotographs are being produced form aerial photographs. The changes form 1969 to 1999 will be related to climatic conditions.

Table 8.7: continued

Examples of research projects and activities	Objectives
Austrian Long-term Climate (ALOCLIM) ✉ Ingeborg Auer; Ingeborg.Auer@zamg.ac.at	The *Climate Fluctuations Task Force* at the Austrian Central Institute for Meteorology and Geodynamics is conducting time series analyses of Austria's climate stations. Thus far, approximately 50 homogeneous series each have been elaborated on and analyzed for temperature, precipitation and snow. For 15 Locations, 9 different parameters (e.g. sunshine duration; vapour pressure) are actually available. In cooperation with other European countries, this homogeneous dataset was expanded throughout the whole Alps.
Austrian Network for Isotopes in Precipitation (ANIP) ✉ Wolfgang Papesch; wolfgang.papesch@arcs.ac.at	The aim of the Austrian Network for Isotopes in Precipitation (ANIP) is to provide input data for hydrological and hydrogeological investigations and to serve as a data-base for climatological changes and trends in sensitive Alpine areas. 71 stations are presently sampled all over Austria with some preference given to the Karst areas north and south of the Alpine mountain range. The network is jointly run by the Austrian Research Centers Seibersdorf and the Austrian Environment Agency. The precipitation is collected on a daily basis in ombrometers (500 cm2) and mixed to monthly samples at stations ranging from 120 to 2250 m in altitude.
Austrian Project on Health Effects of Particulates (AUPHEP) ✉ Clean Air Commission, Austrian Academy of Sciences Helger Hauck; helger.hauck@univie.ac.at	Within this interdisciplinary and multiinstitutional project an extensive aerosol monitoring and analysis program at four different sites in Austria is conducted
Climate reconstruction for the eastern part of Austria using tree rings. ✉ Rupert Wimmer; wimmer@mail.boku.ac.at	Tree rings are used to reconstruct the climatic variability over the past 500 years. Several tree species growing in the eastern part of Austria are intensively investigated. In addition, cores are taken from old buildings and construction sites to extend the chronologies.
Data quality monitoring of the Alpine observing system (DAQUAMAP) ✉ Inga Groehn; inga.groehn@univie.ac.at	GTS data of the Alpine region are evaluated on a regular basis with respect to gross errors and biases. It is based on a 4D variational approach, developed at our Department. Parameters checked are: sea level pressure, (potential) Temperature, humidity (equivalent potential temperature) and wind. This project was initiated within the framework of MAP.

Table 8.7: continued

Examples of research projects and activities	Objectives
Development and calibration of a sea-ice - climate - glacier model in Northern Iceland ✉ Johann Stötter; hans.stoetter@uibk.ac.at W^3 http://geowww.uibk.ac.at/island	The aim of the research project is the development and calibration of a model describing the relationships between sea-ice, temperature and precipitation conditions and glacier extents in Northern Iceland for the period since the mid-19th century, when continuous and homogeneous meteorological records in Iceland start. As an additional result, a GIS-based glacier inventory following the standard of the UNESCO World Glacier Inventory is established for Northern Iceland.
Enhanced resolution analysis of the Alpine atmosphere (VERA) ✉ Reinhold Steinacker; reinhold.steinacker@univie.ac.at	Real time enhanced resolution (i.e. resolving structures beyond the scale resolved by data solely) analyses of the Alpine atmosphere have been carried out for two years. The enhanced resolution is created by a down-scaling algorithm using a variational method. The three one-hourly fields are collected and used to create a long-term time series of mesoscale fields over the Alps. Several new mesoscale features have been uncovered by this method, e.g. the Vienna vortex. Several fields, e.g. pressure, pressure tendency, temperature, humidity, wind, precipitation, cloud cover, cumulus condensation level and level of snow fall are available.
Environmental and Climatic Records from high Elevation Glaciers (ALPCLIM) ✉ Reinhard Boehm; Reinhard.Boehm@zamg.ac.at	Within these EC sponsored project ice core analyses from the high alpine locations Monte Rosa and Mont Blanc are compared with a homogeneous long-term dataset covering the whole Alps. Though it is possible to calibrate the reconstructed climate variability from the ice core analyses with observed data. It is also possible to define the spatial representativity of the ice core data.
European database for Ultraviolet Radiation Climatology and Evaluation (EDUCE) ✉ Mario Blumthaler; Mario.Blumthaler@uibk.ac.at W^3 http://www.muk.uni-hannover.de/EDUCE	The principal objectives are to establish a UV climatology for Europe in combination with investigations into potential long-term changes in the UV radiation environment, to continue the collection and storage of UV radiation and ancillary data in the European UV database, providing a comprehensive database of measurements, together with the software tools needed for efficient search and retrieval of data, to control and assess the quality of the data in the database and to develop, test and implement radiative transfer models, which are the primary tools in both the study of the UV environment and the quality assurance of the measurements.
Glacier mass balance network in the Himalayans ✉ Georg Kaser; georg.kaser@uibk.ac.at	The UNESCO – HKH (Hindukush-Karakorum-Himalaya)-FRIEND group has asked the International Commission on Snow and Ice (ICSI) to help in building up a glacier mass balance network in the Himalayans, to organise a respective training course and to write a manual on glacier mass balance studies. Work on the design of the network and on the manual is in progress. The training course is planned for 2002.

Table 8.7: continued

Examples of research projects and activities	Objectives
Glacier monitoring, Glacier mass balance, long-term modelling of glacier-climate relations and chemical analyses of winter snow ✉ Gernot Patzelt; Gernot.Patzelt@uibk.ac.at Michael Kuhn; Michael.Kuhn@uibk.ac.at Heinz Slupetzky; Heinz.Slupetzky@sbg.ac.at Wolfgang Schöner; Wolfgang.Schoener@zamg.ac.at	A dense glacier monitoring network in cooperation with the 'Österreichischen Alpenverein' has been observing the glacier front variation of ∼100 glaciers since the end of the 19^{th} century. At nine glaciers, mass balance measurements using the direct glaciological method have been established. All these data are reported to the 'World Glacier Monitoring Service'. Additional winter snow cover studies involving chemical analyses of snow have been conducted on the Wurtenkees in the Sonnblick region since 1983. Together with mass balance measurements, profiles of various anions, cations, OH and pH values as well as conductivity profiles are measured each year in May (at the maximum of winter accumulation).
Global Land Ice Measurements from Space (GLIMS) ✉ Helmut Rott; Helmut.Rott@uibk.ac.at	GLIMS is an international project to survey the majority of the world's glaciers, ice caps, and ice sheet margins with the accuracy and precision needed to assess recent changes and trends in glacial environments. The primary data source is the ASTER instrument aboard the EOS Terra spacecraft. The data are analysed at regional centers. We are responsible for GLIMS activities at the Eastern Antarctic Peninsula and for the Austrian glaciers.
Global Land Surface Hydrology from Spaceborne Scatterometers ✉ Wolfgang Wagner; ww@ipf.tuwien.ac.at	The primary aim of this activity is to produce a global soil moisture data base for the years 1992–2000 from scatterometer measurements of the European Remote Sensing Satellites ERS-1 and ERS-2. National and international projects to demonstrate the use of these data in climate modeling and agricultural drought assessment in developing countries have been carried out. European (EUMETSAT) and American operational scatterometer programmes provide the basis for a long-term continuation of this activity.
Global Observation Research Initiative in Alpine Environments (GLORIA) ✉ Georg Grabherr; grab@pflaphy.pph.univie.ac.at gloriaeurope.oecologie@univie.ac.at W^3 http://www.gloria.ac.at	The aim of GLORIA is to establish an effective long-term observation network for detecting the effects of climate change on mountain biota on a global scale. The Multi-Summit approach – GLORIA's basic strategy – will provide such a feasible method. This method is designed to compare biodiversity patterns along the fundamental climatic gradients, vertically as well as horizontally. *GLORIA-EUROPE* started on the 1st of January 2001. The observation network consists of 18 target regions, each with 4 summits as reference units. On each site, the basic sampling design of *GLORIA* – the *Multi-Summit approach* – will be applied. Based on these data, impact scenarios will be developed. The project is designed as a contribution to international efforts for an ecological global change observing system (e.g. of the *EEA*, of *GTOS* and *IGBP*) and to implement the *GLORIA* network on a global scale.

Table 8.7: continued

Examples of research projects and activities	Objectives
Holocene timberline tree-ring chronology for the central Eastern Alps ✉ Kurt Nicolussi; Kurt.Nicolussi@uibk.ac.at	Subfossil logs from timberline sites of the central Eastern Alps are used to establish a calendar dated mulit-millenial tree-ring width chronology. This chronology is the base for the absolute dating of climatically relevant events in the Alps such as glacier advances, snow avalanches and tree-line fluctuations. The tree-ring series are also used to reconstruct summer temperature fluctuations.
Hydrological Atlas of Austria (HAÖ) ✉ Josef Fürst; fuerst@edv2.boku.ac.at Hartwig Dobesch; dobesch@zamg.ac.at H.P. Nachtnebel; nacht@edv2.boku.ac.at W3 http://iwhw.boku.ac.at	The Hydrological Atlas of Austria (HAÖ) will present the hydrology of Austria in a uniform, consistent format to a broader public. The primary format of presentation is the thematic map, which is complemented by tables, texts and diagrams. The Atlas is conceived both as a collection of approximately 50-70 printed maps and in a digital, GIS based version with a set of interactive functions. The chapters on Precipitation, Evapotranspiration, Snow and glaciers, Rivers and lakes, Groundwater and Water balance will contain thematic maps of relevance for the national climate report.
Ice/climate interactions in Patagonia and at the Antarctic Peninsula. ✉ Helmut Rott; Helmut.Rott@uibk.ac.at	This is a cooperative project with the Argentinean Antarctic Institute, going on since 1994. Climate data and glaciological observations are collected at the Eastern Antarctic Peninsula and at the Southern Patagonian Ice field to study the sensitivity of glaciers and ice shelves to climate change. Drastic ice retreat has been observed in part of this region, which can be attributed to pronounced atmospheric warming during the last few decades.
International data exchange as part of the WWW (World Weather Watch) of the WMO. ✉ Wolfgang Lipa; Wolfgang.Lipa@zamg.ac.at	Observational data and other products are made available to meet the needs of the WWW Program of the WMO.
Long term homogenisation of Central European Radiosonde data (CALRAD): ✉ Reinhold Steinacker; reinhold.steinacker@univie.ac.at	Within this project the long-term time series of the Central European Radiosonde data are homogenised and interpolated to a regular grid. The method applied is a variational 4D procedure, developed at our Department. It will be used to objectively determine the Eastern Alpine Flow pattern classification. Furthermore an intercomparison with data of Mountain stations (e.g. Hoher Sonnblick) will be carried out.
Mapping of Carbon Reservoirs in Forests as Input to Post-Kyoto Monitoring ✉ Christian Hoffmann; hoffmann@geoville.com	The project was carried out by GeoVille as a prime contractor under a contract of the European Space Agency. The project was investigating the role that data from the future ESA-MERIS (Medium-Resolution Imaging Spectrometer) sensor, and high optical spatial resolution sensors can play for mapping forests with regard to their potential role in carbon (C) sequestration and carbon dioxide (CO_2) emission mitigation.

Table 8.7: continued

Examples of research projects and activities	Objectives
Measurements of solar UVA and UVB irradiance in high mountains ✉ Mario Blumthaler; Mario.Blumthaler@uibk.ac.at	Within this a long-term project since 1980 variability and trend of solar UV irradiance have been observed as a consequence of short- and long-term variations of atmospheric ozone and of the other atmospheric parameters at the High Alpine Research Station Jungfraujoch (3576 m a.s.l., Switzerland).
Monitoring of total ozone and spectral UV radiation at Sonnblick Contact Stana Simic; Stana.Simic@boku.ac.at	The total ozone column is continuously monitored using a Brewer Spectrometer at the Hoher Sonnblick (3,105 m), Austria, and profiles are made whenever the weather allows. The values are markedly below the 30-year average as measured in Arosa, Switzerland. Interdiurnal variability and larger deviations from monthly averages are subject to meteorological analyses.
Participation in the Global Atmospheric Watch (GAW) Program of the WMO ✉ August Kaiser; August.Kaiser@zamg.ac.at	A GAW station is being established based on four mountain observatories, one being the Hoher Sonnblick (3,105 m) in Austria. For this purpose, a *Sonnblick Task Force* has been set up consisting of representatives from various governmental agencies and university institutions. Part of the necessary measurements are already being carried out; cooperation with Switzerland and Germany has been initiated ('GAW Station: The Alps').
Spectral UV radiation in the area of Vienna and integral UV measurement at Sonnblick ✉ Stana Simic; Stana.Simic@boku.ac.at	A UV broadband sensor (Bentham) is established at the Hoher Sonnblick (3,105 m), Austria, a second one is set up near Vienna, both operating in a continuous mode. Beside monitoring aspects important for man and vegetation, the data collected serve also as a basis for scientific research. Solar UV-A and UV-B irradiance and total irradiance have been measured annually since 1981 in 1-2 measuring periods of eight weeks each at the high mountain research station Jungfraujoch (3,575 m above sea level; Switzerland) to examine the influence of various atmospheric parameters including the total ozone content. For comparison, measurements were carried out at Innsbruck and Hafelekar (577 and 2,300 m above sea level, respectively), both stations being within a horizontal distance of 5.8 km.
Radiative Transfer in the UV: Influence of aerosols and cloudiness ✉ Erich Putz; erich.putz@uni-graz.at W³ http://www.kfunigraz.ac.at/igamwww/rap/	The aim of this project is the construction of a partly automatic station for measuring UV-radiation and significant parameters influencing radiative transfer (Ozone and NO2-content, aerosol-optical characteristics) at an alpine station. By a systematic comparison of measured and modeled radiation data the quantification of the influence of individual physical processes is performed, special interest is taken in cloudiness.

Table 8.7: continued

Examples of research projects and activities	Objectives
The Austrian digitised climate atlas (OEKLIM) ✉ Ingeborg Auer; Ingeborg.Auer@zamg.ac.at	OEKLIM is a detailed multimedia illustration of the Austrian climate (1961–1990) on CD-ROM. It is the basis of a broad spectra of applications as climate impacts, planning or education. It contains climate maps and diagrams, descriptions with text and additional illustrations with pictures and video clips.
UV monitoring in Austria ✉ Mario Blumthaler; Mario.Blumthaler@uibk.ac.at W^3 http://www.uibk.ac.at/projects/uv-index/	9 UVB-Detectors are distributed all over Austria. The data are collected daily, and a map of the maximal UV irradiance in Austria of the previous day is published in the internet, together with daily courses at the stations for the last 30 days and with an archive of the maps.
Verification of ERA-40data with Austrian climate stations ✉ Michael Hantel; michael.hantel@univie.ac.at	The forthcoming ERA-40 dataset (a 40-year four-dimensional analysis of the atmosphere, performed by ECMWF) will be extensively used for climate research. We check this data set against a homogenized time series of Austrian climate stations in order to detect possible inhomogeneities in the ERA-40-dataset due to changes in the observing system.

Chapter 9

Education, Training and Public Awareness

Environmental education has become an important instruction principle in Austria within recent decades. During the recent years, a programme for sustainable development in schools has been implemented; it aims at incorporating the topic in teaching on the one hand and at reduced consumption of resources in school buildings on the other hand. Activities with respect to training and public awareness are manifold at the level of Federation, Länder and municipalities; they are carried out by the administration and by several non-profit organisations, which work in close co-operation with public institutions. As the Austrian population is conscious of the need for a sensible use of energy, advising services on this topic receive broad interest.

9.1 General Policy

The origins of the Austrian school system go back to 1774, when the Austrian Empress Maria Theresia enacted the first "School Edict for all German Regular, Main and Trivial Schools in all Imperial and Royal Dominions" which prescribed obligatory schooling and uniform regulations for the empire. Since then, matters have become somewhat more complex due to a greater differentiation between school types and the division of areas of responsibility between federation and Länder. Among other things, the general organisation of schools and education and the curricula, are under the jurisdiction of the Federation; implementing laws is the responsibility of the Länder. Administrative tasks are, depending on school type, performed at the level of Federation, Länder and municipalities.

Steps related to training and public awareness in the field of climate change are taken by institutions at all levels of administration. Several Länder have established institutions within their administration, which offer a.o. advising services and more, either within the administrative units responsible for building or as specialised units; for example, the Academy for Environment and Nature in Upper Austria. In several Länder, regional energy agencies have been founded as non-profit organisations with collaboration of the Länder, which receive most of their funding by public institutions and by other members like business or labour organisations. At the level of the Federation, the Austrian Energy Agency was founded as an energy research and policy institution in which Federal and Länder administrations and some thirty important institutions and corporations from a variety of economic sectors cooperate.[1].

[1] http://www.eva.or.at/(en)/portrait/index.htm

Advice services are also offered by other non-profit organisations such as 'die Umweltberatung', which are mainly funded by Länder and/or communities, and by grass-roots organisations like the Society for Renewable Energy[2], which co-operate with public institutions on a project basis. Activities at Länder and municipality levels are manifold and only some examples can be mentioned below.

9.2 Education

Environmental protection as a special topic was first included in school curricula in 1970. Since then, environmental education has become an inter-disciplinary instruction principle and issues related to climate protection, like energy-saving and renewable energy, have received increased attention. During recent years, a programme for sustainable development in schools has been implemented, aiming at both teaching and school buildings. The relevant ministries have established a forum for the development of programs, methods and materials for environmental education with dedicated funding. Austria also plays an active role in the OECD/CERI network 'Environment and School Initiatives'.

9.2.1 School Curricula

Starting in 1970 and with increasing importance since the middle of the 1970s, the topics of nature and environmental protection have been embodied in the curricula. Consequently, the new contents of the curricula have found their expression in the appropriate thematic consideration in schoolbooks and through audiovisual media; they have

[2] http://www.aee.at/indexeng.html

been supplemented by information activities within the framework of teacher training and by in-service training for teachers.

As far as content is concerned, environmental education goes beyond nature and environmental protection and covers both the natural environment and the cultural, technical and social environment. In 1979 environmental education became an instruction principle within the curricula of the general educational systems. Since the beginning of the 1990s, it has also been embodied in all the learning programmes, in particular in the vocational school system. Environmental education is regarded as an instruction principle, i.e. its educational – and vocational training – tasks cannot and should not be assigned to one or a few instruction objectives, but can only be mastered in a cross-curricular cooperation of many or all instruction objectives.

Since the mid 1980s the topics of energy saving and of renewable energy production have been integrated into the contents of the different curricula. Since 1990, environmental technology has been integrated into all curricula of intermediate and higher technical vocational schools, with an emphasis on energy-saving technology and construction as well as the utilisation of renewable energy sources. Additionally, a new profession for apprenticeship, the 'Solateur', which means a plumber with special training on solar energy, was established.

In December 1999, the responsible ministries financed an assessment study on the amount and accuracy of the contents of schoolbooks of the lower and upper secondary general schools regarding renewable energy. The study showed that relevant information had been incorporated to a fair extent and recommended some improvements. A short handbook for teachers on that issue has been developed as a first reaction to the results of the study.

9.2.2 Programme "Raising ecological awareness of schools"

In 1996/97, the then Federal Ministry of Education and Cultural Affairs started the programme 'Raising ecological awareness of schools'. The objective of this programme is to interconnect previous measures of the instruction department and, above all, the many decentralised initiatives, placing them under a common goal.

Goals of the programme:

- To devise and implement measures to make schools more environmentally friendly with respect to both 'hardware' (buildings, energy use, etc.) and 'software' (teaching and learning).
- Strive for a sustainable ecological development at schools i.e. the transition of projects into an ecological every-day culture.
- Transfer of the initiative from the visible group of the 'activists' and 'interested people' to a large number of schools.

These goals are demanding and represent a new dimension in the development of environmental education. They also reflect the new tasks, which result from the worldwide obligation for a sustainable development.

Within this programme, schools define the actual ecological, technical and social conditions of their environment (first analysis) and, on the basis of these results; define objectives, targets and/or concrete designs of measures for changes, to be implemented afterwards. These measures deal with, among other things, saving of resources (energy, water, etc. . .); reduction of emissions (waste, traffic, etc. . .); spatial arrangement (from the classroom to the campus); learning culture (communication culture, organisational structure, etc.); and health promotion, as well as the outward effect (influence on the municipality). The planning and implementation of measures should occur to the extent possible with the participation of pupils in co-operation with authorities, business and other interested parties. Measures taken by the schools serve as examples to the general population and the local administration.

On the basis of the successful pilot phase in 1996 and 1998, a competition with more than 200 participating schools and an overall more widespread implementation of the programme across the entire Federation are foreseen for the coming years. (Details can be found on http://www.oekolog.at, in German only).

An assessment study on the environmentally relevant effects of this programme in the year 2000 proved the high interest and high number of activities of schools. It indicated the important role of schools regarding the question of sustainable development. With regard to future developments, the study showed the necessity of providing the schools with appropriate indicators to enable them to control and evaluate their environmental impact and performance.

The program is supported and supplemented at the Länder level. The government of Lower Austria, for example, has started the program 'Umwelt macht Schule', aiming at playful imparting of knowledge at primary and secondary schools about topics like climate protection, regional development, waste and rainforests. During the last five years, 130 teachers in 60 schools have taken part in the programme. In the last school year about 600 pupils from primary schools took training to become 'environmental experts'.

9.2.3 Bonus model for schools

Energy-saving measures are usually economically attractive, as they lead to reduced energy costs. Measures in schools lead to savings for the institutions which maintain schools, mainly the Federal State, Länder and municipalities; savings are accounted to the budget related to public housing or energy consumption of these institutions. The savings in costs are, however, not visible for those who are most affected by and, to a certain extent, responsible for, the measures: For pupils, teachers and the school administration. This is why the Federal Ministry of Agriculture, Forestry, Environment and Water Management and the Federal Ministry of Education, Science and Culture, together with Länder and Climate Alliance Austria, have started an initiative to establish a bonus model for schools. Its aim is to let the schools benefit from the savings in a way that enables them to use part of the saved costs for their own purposes.

An important issue is the joint participation of school maintainers and schools (pupils, teachers and administration) in the planning and implementation of measures. A main target, besides reduced energy requirements of the schools, is a change in awareness related to energy use. Schools will be supported with information (brochure, web site and touring exhibition) and advisory services.

9.2.4 Support Measures

Since 1992, the 'Environmental and Health Education Fund' in the Ministry of Education has provided financial support for environmentally and health-oriented project instruction in schools with an annual financial framework of € 145,300 (ATS 2 million).

Since 1983, the 'Forum of Environmental Education' has been contracted for support and evaluation of demands related to environmental education programmes of the Ministry of Education and the Ministry of Environment. The forum receives financial support of approx. € 0.56 million (ATS 8 million) per year from both Ministries.

This is the continuation of the successful interministerial initiative, unique in Europe, which has operated since 1983 under the title 'Working community on environmental education' on behalf of both Ministries and in close collaboration with them for the promotion of environmental awareness in schools, in institutions of teacher training, in which extra-school youth and adult education are integrated. Their main tasks are:

- ▷ Publication of the magazine 'Environmental Education' and the production of user-oriented materials for the practical work on current topics;
- ▷ Maintenance of a website and a database on the Internet;
- ▷ Organisation of innovative campaigns and competitions throughout Austria, of seminars, workshops and exhibitions;
- ▷ Co-operation for the development of new educational programs of the Ministries of environmental education;
- ▷ Development of teaching and learning methods for education for sustainability.

(Details at http://www.umweltbildung.at, in German only.)

Support is also provided by institutions at the Länder level, which provide teaching aides and prepare workshops for relevant topics. In Lower Austria, for example, 'die Umweltberatung NÖ', an organisation which offers environmental consulting services and is supported by the government of

Lower Austria, has prepared a workshop for young people over the age of 12 called 'Pack your Rucksack'. The intention of the workshop is to highlight the ecological side effects (the 'rucksack') of products, from production to use and disposal. In 2001 a competition was held for the first time among schools in Lower Austria. Pupils created radio, print and internet advertisements about climate change issues; the winners' contributions were actually broadcast and published. The municipal forest management of Vienna organises excursion programs for schools in order to make town-bred children better understand the value and functions of forests.

Initiatives at the school level are also set by Climate Alliance Austria (see below).

9.2.5 Networking at the International Level

The network 'Environment and School Initiatives' (ENSI) started in 1986 as a two-year project in the OECD/CERI[3] Innovation Exchange Program with 11 participating countries, following an initiative of Austria, and became a full project of OECD/CERI with 22 countries participating in 1989. The focus was on the evaluation of environmental education policies in a number of member countries, the development of quality indicators and the dissemination of research results and educational experiences. Since 1995, ENSI has been a decentralised network under the umbrella of OECD/CERI; Austria has taken over the international secretariat for the years 1998 - 2001. ENSI's main areas of work in the field of environmental school initiatives include:

- ▷ Initiating, coordinating and supporting research and school development activities;
- ▷ Publishing and disseminating these activities;
- ▷ Promoting international exchange, understanding and collaboration including the cooperation with other international organisations and their programs;
- ▷ Making policy recommendations and/or statements as appropriate.

[3]Centre for Educational Research and Innovation (ENSI) of the Organisation for Economic Co-operation and Development (OECD)

Under these main activity areas, ENSI undertakes various projects. These include:

- ▷ Developing and sharing research and school development strategies and the tools used for these activities;
- ▷ Organising international workshops, seminars and conferences;
- ▷ Disseminating approved experiences and programs researched by ENSI.

9.3 Training and Advising

The need for information on topics related to climate protection, especially on energy and 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. The compulsory calculation of energy indicator values in the planning stage of a house, for example, and the increased demand for energy-saving technologies and energy from renewable sources, which has been pushed by subsidies, has caused occupational groups like architects and heating engineers to make use of related training possibilities.

Training programmes have been established by the Länder governments themselves and by regional energy agencies, partly in co-operation with other institutions like the vocational training institute of the Federal Economic Chamber. An important step is the training of energy advisers, which consists of a basic course of 50 hours and an advanced course of 150 hours. The courses comprise basic principles of

constructional and energy engineering, energy and climate policy as well as practical training. For many of the participants, ranging from plumbers and chimney-sweeps to employees of power industry and civil servants, the courses are further occupational training, for others the first step towards a new field of activity. Since 1994, for example, about 500 persons in Upper Austria have attended one of 29 courses.

In the year 2000 the Austrian Biomass Association (Österreichischer Biomasseverband), supported by the Federal Ministry of Agriculture, 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. 120 plumbers in 2000 and 260 in 2001 received the certification 'Biowärme-Installateur', so up to now nearly one ninth of all plumbers in Austria are certified 'bioheat-plumbers'.

Furthermore, seminars and workshops for different target groups, a. o. teachers, civil servants from municipalities and architects, are organised by Länder and energy agencies on energy related topics. Activists from municipalities, which have joined the Climate Alliance, receive special support through joint activities of Länder and Climate Alliance Austria. In addition to seminars and specific informational literature, annual meetings of the Climate Alliance municipalities are held in several Länder.

Vienna has established a training programme for drivers of the municipal and public transport fleets. The programme aims at reducing fuel consumption and includes training on a driving simulator. In the course of the environmental management programme within the Viennese administration, training courses for facility managers and all employees raise awareness of energy and climate issues and bring about necessary behavioural changes.

Independent advising services on energy issues, which are offered free of charge by energy agencies and several non-profit environmental consulting organisations and partly by the Länder authorities themselves, have received enormous interest from the population in recent years. Energy advice is directed towards people who are on the point of making a decision about an investment, be it the construction of a house, the installation of a new heating system, better insulation, new windows or other energy efficiency improvements. This service is mainly directed at private households. In most of the Länder, regional energy agencies provide energy consulting services (Oberösterreichischer Energiesparverband, Energieinstitut Vorarlberg, Steiermärkischer Landesenergieverein, Energie Tirol). In Upper Austria, for example, about 10.000 energy consulting sessions per year are carried out for private households.

Related programmes for enterprises exist in many Länder, e.g. 'ÖkoBusinessPlan Wien' or 'ÖkoProfit'. 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. The contents and shape of these programmes differ among the Länder. In Lower Austria, for example, the programme is directed towards environmental certification according to ISO 14001 or EMAS, and it is open to enterprises, municipalities and public institutions.

Assistance by the regional energy agencies is also offered to local and regional authorities in developing and implementing energy strategies and energy action strategies. This service includes an analysis of the present situation as well as concrete measures, which are implemented as a part of the planning process. Detailed information material for the persons responsible for energy issues in communities is also provided by departments of some Länder governments.

Furthermore, the 'Arbeitsgemeinschaft Erneuerbare Energie – AEE' (Society for Renewable Energy) needs to be mentioned. It was founded in 1988 as an independent association to promote the practical use of renewable sources as well as the rational use of energy. Fields of activities are the dissemination of thermal solar systems, translucent insulation, low-energy housing, municipal energy concepts, utilisation of biomass, and photovoltaic and biogas production. To an essential extent, AEE's work consists of advising architects, mechanical engineers, building societies and municipalities in realising definite projects.

9.4 Public Awareness

Comprehensive empirical surveys in the mid 1990s showed that the topic of the environment in particular plays an important role for the general public. Almost nine out of ten people interviewed were concerned about the state of the environment. Air pollution and its effects such as forest damage and the greenhouse effect gave rise to major concern among the population. Those Austrians, who believed in global warming, were aware that they had to contribute personally to fighting the greenhouse effect and were willing to make personal sacrifices. Further information on this topic was welcomed and necessary, as some detailed questions indicated.

As a result, the activities of the Federation and the Länder aimed at supporting the willingness to make personal contributions to protect the climate system and at providing relevant facts and information. Campaigns and initiatives focused on climate change in general, but also on the topics transport and energy.

9.4.1 Climate Change

The success of public relations activities largely depends on the way the information is presented. Special emphasis has to be placed on addressing the hearts and minds of people and thus motivate them to take action to protect the climate system. However, this cannot be achieved merely by pure information. Information must be supplemented by activities such as campaign rallies, where day-to-day behaviour patterns are scrutinized; by free use of public transport; through exhibitions, video presentations, plays and the like. Partnership through direct encounters, for example, within the framework of the Climate Alliance with members of native South American delegations broaden the experience potential and establish emotional bonds.

Based on these basic assumptions, the former Federal Ministry for the Environment, Youth and Family Affairs launched a climate information campaign in 1997. The campaign comprised the following main topics: reduction in energy loss; energy concepts for local communities; energy concepts for industry and trade; ecological building information for private households; saving resources by sustainable economic methods; impact of the greenhouse effect on ecosystems, replacing fossil sources of energy with renewable ones, promoting organic cultivation methods, reducing private transport; consumer behaviour (shopping awareness). Short TV spots with prominent Austrians dealt with these topics.

A CD ROM about the 'Hot Topic Climate', which was produced in cooperation with the Austrian Broadcasting Company in 1997 as a follow-up to the TV campaign, is part of the intensified public relations activities directed especially at younger people. The CD ROM provides information on the greenhouse effect in general and at the same time offers interactive courses of action for individual citizens as a contribution towards resolving the problem. In addition to such a broad campaign, information is distributed by the Federal Ministry of Agriculture, Forestry, Environment and Water Management, through publications and brochures and in co-operation with newspapers. In 2001, the Federal Ministry of Agriculture, Forestry, Environment and Water Management once again started an information campaign on climate change issues. This campaign consists of an information series in newspapers and the distribution of a brochure with the title 'Simply less CO_2'.

Similar activities are organised by the Länder, which provide brochures and touring exhibitions about energy and climate change. Climate change issues are also mentioned regularly in magazines, which are published by the Länder and several municipalities, and at related web sites. Events, Seminars and Conferences are organised periodically by some of the Länder (for example by Oberösterreichische Akademie für Umwelt und Natur).

9.4.2 Transport

Many municipalities participate in the European initiative 'Car Free Day'. Part of the cities are closed to car traffic that day and reserved for pedestrians, bikers, public transport and vehicles without combustion engines. Alternative modes of transport are put in the limelight. Pure information is spiced with street festivals and sports events on the streets etc. People should be motivated to try out alternative modes of transport and to experience what their city or community looks like when motorised road traffic does not affect its appearance.

Several pilot projects for sustainable transport have been started by the Ministry of Agriculture, Forestry, Environment and Water Management in co-operation with other institutions like the Ministry for Transport, Innovation and Technology, the Federal Economic Chamber, Länder and municipalities. They are targeted at sustainable commuting and business-related mobility, at reduced road-traffic during big sporting and entertainment events and at car-free tourist resorts. Awareness of the problems related to road traffic, and awareness of the possibilities and advantages of other forms of transport is absolutely necessary to cause a change in the attitude of commuters and tourists and is, therefore, a central part of these initiatives.

With respect to road traffic, the government of Lower Austria has, in co-operation with driving schools, incorporated information on eco-driving (low fuel consumption and emissions) and a rational use of the car in the obligatory driving lessons to raise the awareness of drivers. Other Länder are preparing similar initiatives. Vienna has established the project 'Car-free residences', where a residential estate was designed in a way to encourage the inhabitants to use public transport and to adopt car sharing instead of buying private cars. A competition between municipalities in Lower Austria was targeted at the reduction of traffic; the winner is currently supported as a model project and evaluated with respect to the applicability of measures in other communities.

9.4.3 Energy

In Austria, people generally tend towards the view that energy is something precious, which should not be wasted. It is, therefore, sensible to raise awareness about possibilities to reduce energy losses and about new and reliable heating systems, for example.

The 'Energiesparmesse', an exhibition about energy efficiency, thermal insulation and renewable energy and related products, which is held annually in Wels (Upper Austria), is an event with a widespread effect. In 2001, about 200,000 visitors attended the three-day event, and the exhibition received excellent coverage in Austrian media. Of course, topic-related consulting was also offered by the local energy agency ('OÖ Energiesparverband') at the exhibition. 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 2001, more than 600 delegates from 63 countries attended the conference and the related seminars. In a competition for initiatives in the fields of energy efficiency and renewable energy sources from all over the world, the Energy Globe Award honours outstanding projects. In 2001, more than 1,000 entries from 75 countries participated in 5 categories. The Energy Globe Award is presented during an international TV gala ceremony.[4]

[4] http://www.esv.or.at/aktuelles/energyglobe/index_e.htm

Activities in the ‘Forest Week’ 2001 (from 11 to 17 June) were focused on the forest as supplier of biomass. The Federal Ministry of Agriculture, Forestry, Environment and Water Management, in co-operation with the Austrian Biomass Association, published a brochure on the topic “Wood Power – Energy Grows. In the Forest.”, which was distributed to schools and municipalities. Further information is provided at the web site of the ministry.

Energy issues are also regularly covered in brochures, touring exhibitions, magazines, CD-ROMs and web sites published by Länder, municipalities, the Chambers of Agriculture and other organisations.

9.4.4 Agriculture and Forestry

Organic farming reduces energy consumption considerably and lowers greenhouse gas emissions, compared to traditional farming practises of the industrialised countries. Organic farms are also excellently equipped to make use of local and regional channels of distribution, which reduces transport needs. However, more work input is necessary to get comparable yields, which in turn leads to a slight increase in prices. The Federal Ministry of Agriculture, Forestry, Environment and Water Management, the Länder and several NGOs support activities to make consumers aware of the high quality of organic products and the other advantages of organic farming. Initiatives for an increased use of organic products in hospital and public institution kitchens, and work canteens have been started.

Extension and further training services on agriculture and forestry are planned and financed by the Federal Ministry of Agriculture, Forestry, Environment and Water Management and organised and provided by the regional Chambers of Agriculture. By means of consultation talks, evening lectures, brochures, excursions and exhibitions, information on topics like environmentally-friendly production and organic farming, bio energy, renewable raw materials and sustainable forest management is provided to farmers and owners of forests. Länder forest authorities undertake related activities.

For several years, the ‘State Award for Exemplary Forest Management’ has received special commendation for outstanding performance in sustainable forest management. About 170,000 owners of forests determine the appearance of Austria’s forests and landscape; the award aims at increasing knowledge about the ways of sustainable use and management of forests. Awards for forest management are also conferred by the Länder. On Länder level related activities can be found, like an annual award for innovative solutions with respect to timber construction in Lower Austria.

9.5 NGO Participation

The Climate Alliance is a partnership between more than 1000 European local authorities and indigenous rainforest peoples with the goal of protecting the earth’s atmosphere. In Austria, almost 400 municipalities and 8 federal provinces 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 of Agriculture, Forestry, Environment and Water Management. The members have committed themselves to:

- Reducing their carbon dioxide emissions by 50 %, by 2010;
- Supporting the indigenous partners to preserve tropical rainforests.

In almost all member municipalities, working groups dealing with the implementation of measures in different areas as energy, transport and procurement have been established. The success of these working groups is usually based on the involvement of committed citizens and local NGOs.

9.5.1 Projects and Activities

Many and diverse activities were undertaken by Climate Alliance Austria from 1998 to 2000. These ranged from nation-wide competitions to regional seminars:

- Every year a competition among the member municipalities is organised, focused on a special topic. The topics in recent years were 'lifestyle', 'municipal carbon dioxide balance' and 'climate protection in agriculture'.
- A nation-wide climate alliance meeting every year allows for intensive discussion and exchange of opinions among the member municipalities. The meetings consist of presentations and excursions; several hundred municipalities have taken part in recent years.
- Information on different subjects of climate protection was offered at about 150 local seminars and regional meetings.
- A periodical, issued five times a year, informs the public about current activities and serves as project exchange for the members.
- Information campaigns have been conducted on special topics such as the advantages of organic farming, the ban of HCFCs and HFCs in municipal procurement, and on fair trade.
- In 2000, for the first time, support was given for the European 'Car Free Day' initiative on 22 September 2000. 70 municipalities participated in activities to promote alternative modes of transport.
- About 50 schools have joined the initiatives of the Climate Alliance and take part in activities within their municipalities. In the year 2000, school classes were invited to carry out projects related to climate protection measures in schools; the best projects won awards.
- A bonus model for schools, which allows schools to get a share of cost savings from reduced energy consumption in school buildings, is currently being established in conjunction with two federal ministries and the Länder.
- The campaign for climate protection includes the business sector, too. After initial analysis and advice by the climate alliance, companies commit themselves to energy saving measures and to a CO_2-reduction target. The performance with respect to the targets is evaluated regularly. To date, 150 companies have joined the climate alliance.

9.5.2 Partnership with indigenous rainforest people

An important part of the activities of the Climate Alliance is the partnership with indigenous rainforest people and raising of awareness for these issues in Austria. Representatives of indigenous people have visited Austrian municipalities and vice versa. Austria has contributed to the protection of the global climate system with a programme for sustainable development in the 'Rio Alto Negro' region since 1993. Rio Alto Negro is a tributary of the Amazon in the north-west of Brazil. In this region, which is somewhat larger than Austria, 23 indigenous peoples have joined together in the umbrella organisation FOIRN. Climate alliance Austria supports FOIRN in their struggle for economic and cultural autonomy and for preserving the tropical rainforests, these being the very basis of their existence, by granting them title of ownership and ensuring the sustainable use of their territories. The main principle is the integration of native people in measures for the protection of their environment.

Support is given in several fields, e.g.:

- Support in surveying of hereditary territory; the territorial rights of the indigenous peoples at Rio Alto Negro were officially confirmed by the President of Brazil in 1998.
- Improvement of infrastructure, e.g. the setting up of a radio-telephone system and supply of boats.
- Projects for improvement of income, education and health, such as marketing of traditional wickerwork and fish farming and support of traditional medicine.

Appendix A

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Appendix B

Greenhouse Gas Inventory Information – Tables

Table B.1: Summary report for national greenhouse gas inventories (CRF Summary 1.A, IPCC Table 7A)

GHG source and sink categories	CO_2 emissions (Gg)	CO_2 removals (Gg)	CH_4 (Gg)	N_2O (Gg)	HFCs P (Gg CO_2 equ.)	HFCs A (Gg CO_2 equ.)	PFCs P (Gg CO_2 equ.)	PFCs A (Gg CO_2 equ.)
Total National Emissions and Removals	65,777.85	−7,633.36	454.35	7.35	3,733.90	870.46	0.00	25.32
1 Energy	53,315.89		18.62	2.74				
A Fuel Combustion / Reference Approach	51,064.86							
/ Sectoral Approach	50,657.62		12.99	2.74				
1 Energy Industries	11,372.78		0.13	0.15				
2 Manufacturing Industries and Construct.	8,630.24		0.32	0.19				
3 Transport	17,643.42		1.79	1.88				
4 Other Sectors	13,011.18		10.74	0.52				
5 Other	0.00		0.00	0.00				
B Fugitive Emissions from Fuels	2,658.27		5.63	0.00				
1 Solid Fuels	0.00		0.01	0.00				
2 Oil and Natural Gas Fuels	2,658.27		5.62	0.00				
2 Industrial Processes	11,943.70		0.14	0.58	3,733.90	870.46	0.00	25.32
A Mineral Products	2,947.45		0.04	0.00				
B Chemical Industrie	492.46		0.10	0.58	0.00	0.00	0.00	0.00
C Metal Production	8,456.00		0.00	0.00				0.00
D Other Production	47.80							
E Production of Halocarbons and SF_6						0.00		0.00
F Consumption of Halocarbons and SF_6					3,733.90	870.46	NE	25.32
G Other	0.00		0.00	0.00	0.00	0.00	0.00	0.00
3 Solvent and Other Product Use	395.64			0.75				
4 Agriculture	0.00	0.00	187.85	3.27				
A Enteric Fermentation			127.93					
B Manure Management			24.90	0.00				
C Rice Cultivation			0.00					
D Agricultural Soils	0.00	0.00	34.97	3.26				
E Prescribed Burning of Savannas			0.00	0.00				
F Field Burning of Agricultural Residues			0.05	0.00				
G Other Agriculture Activities			0.00	0.00				

Table B.1 — continued

GHG source and sink categories	CO_2 emissions	CO_2 removals	CH_4	N_2O	HFCs P	HFCs A	PFCs P	PFCs A
	Gg				Gg CO_2 equ.			
5 Land Use Change & Forestry	0.00	$-7,633.36$	0.00	0.00				
A Forest & Woody Biomass Stock Change	0.00	$-7,633.36$						
B Forest and Grassland Conversion	0.00		0.00	0.00				
C Abandonment of Managed Lands	0.00	0.00						
D CO_2 Emissions and Removals from soils	0.00	0.00						
E Other	0.00	0.00	0.00	0.00				
6 Waste	122.62		247.74	0.01				
A Solid Waste Disposal on Land	0.00		210.66					
B Wastewater Handling			14.37	0.00				
C Waste Incineration	122.62		0.24	0.01				
D Other Waste	0.00		22.48	0.00				
7 Other	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Memo Items:								
International Bunkers	$1,615.14$		0.01	0.01				
Aviation	$1,615.14$		0.01	0.01				
Marine	NE		NE	NE				
Multilateral Operations	IE		IE	IE				
CO_2 Emissions from Biomass	$13,623.21$							

Table B.1 — continued

GHG source and sink categories	SF_6 P	SF_6 A	NO_x	CO	NMVOC	SO_2
	Gg					
Total National Emissions and Removals	0.37	0.03	168.08	864.27	230.51	41.76
1 Energy			146.34	664.27	78.44	32.32
A Fuel Combustion / Reference Approach						
/ Sectoral Approach			143.09	663.81	74.84	28.63
1 Energy Industries			8.26	1.69	0.19	4.14
2 Manufacturing Industries and Construct.			15.20	4.95	0.49	8.89
3 Transport			90.10	244.41	39.61	3.33
4 Other Sectors			29.54	412.76	34.55	12.27
5 Other			0.00	0.00	0.00	0.00
B Fugitive Emissions from Fuels			3.25	0.46	3.60	3.69
1 Solid Fuels			0.00	0.00	0.00	0.00
2 Oil and Natural Gas Fuels			3.25	0.46	3.60	3.69
2 Industrial Processes	0.37	0.03	15.43	177.38	21.57	9.36
A Mineral Products			5.88	18.26	6.23	0.96
B Chemical Industrie	0.00	0.00	4.40	11.11	12.34	3.19
C Metal Production		0.00	4.57	147.58	0.71	5.22
D Other Production			0.59	0.43	2.30	0.00
E Production of Halocarbons and SF_6		0.00				
F Consumption of Halocarbons and SF_6	0.37	0.03				
G Other	0.00	0.00	0.00	0.00	0.00	0.00
3 Solvent and Other Product Use			0.00	0.00	126.94	0.00
4 Agriculture			6.08	1.50	2.64	0.00
A Enteric Fermentation						
B Manure Management					0.00	
C Rice Cultivation					0.00	
D Agricultural Soils			6.07		2.48	
E Prescribed Burning of Savannas			0.00	0.00	0.00	
F Field Burning of Agricultural Residues			0.01	1.50	0.16	0.00
G Other Agriculture Activities			0.00	0.00	0.00	0.00
5 Land Use Change & Forestry			0.00	0.00	0.00	0.00
A Forest & Woody Biomass Stock Change						
B Forest and Grassland Conversion			0.00	0.00	0.00	
C Abandonment of Managed Lands						
D CO_2 Emissions and Removals from soils						
E Other			0.00	0.00	0.00	0.00
6 Waste			0.22	21.11	0.92	0.07
A Solid Waste Disposal on Land				16.68	0.20	
B Wastewater Handling			0.00	0.00	0.00	
C Waste Incineration			0.22	4.43	0.72	0.07
D Other Waste			0.00	0.00	0.00	0.00
7 Other	0.00	0.00	0.00	0.00	0.00	0.00
Memo Items:						
International Bunkers			6.49	1.42	0.55	0.59
Aviation			6.49	1.42	0.55	0.59
Marine			NE	NE	NE	NE
Multilateral Operations			IE	IE	IE	IE

Table B.2: Emission trends summary, in Gg CO_2 equivalent

GHG emissions	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
CO_2 emissions (without LUCF)	62,132	66,024	60,154	59,901	61,756	63,754	64,889	66,829	65,489	65,778
CH_4	11,290	11,069	10,804	10,675	10,502	10,279	10,108	9,862	9,640	9,541
N_2O	2,033	2,119	2,136	2,196	2,260	2,275	2,266	2,253	2,282	2,279
HFCs	4	6	9	12	17	546	625	718	816	870
PFCs	963	974	576	48	54	16	15	18	21	25
SF_6	518	683	725	823	1,033	1,175	1,246	1,148	955	730
Total (without CO_2 from LUCF)	76,939	80,875	74,404	73,656	75,621	78,044	79,150	80,828	79,203	79,224

GHG source and sink categories	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1 Energy	49,929	54,483	49,669	49,357	50,613	52,389	54,024	54,779	54,238	54,556
2 Industrial Processes	14,420	14,063	12,625	12,366	13,220	14,102	13,746	14,828	13,980	13,752
3 Solvent and Other Product Use	755	669	614	593	594	613	612	638	628	628
4 Agriculture	5,591	5,520	5,367	5,334	5,282	5,140	5,077	5,048	5,044	4,958
5 Land-Use Change and Forestry	−9,215	−13,504	−8,656	−8,982	−7,862	−7,254	−5,385	−7,633	−7,633	−7,633
6 Waste	6,243	6,139	6,129	6,005	5,912	5,799	5,691	5,535	5,313	5,330
7 Other	0	0	0	0	0	0	0	0	0	0

Table B.3: Summary report for CO_2 equivalent emissions 1999, in Gg (CRF Summary 2)

GHG source and sink categories	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Total
Total National Emissions and Removals	58,144.50	9,541.44	2,279.28	870.46	25.32	729.90	71,590.90
1 Energy	53,315.89	391.00	849.57				54,556.46
A Fuel Combustion (Sectoral Approach)	50,657.62	272.74	849.57				51,779.93
1 Energy Industries	11,372.78	2.77	46.19				11,421.74
2 Manufacturing Industries and Construct.	8,630.24	6.75	57.92				8,694.92
3 Transport	17,643.42	37.69	584.24				18,265.35
4 Other Sectors	13,011.18	225.53	161.21				13,397.92
5 Other	0.00	0.00	0.00				0.00
B Fugitive Emissions from Fuels	2,658.27	118.26	0.00				2,776.53
1 Solid Fuels	0.00	0.17	0.00				0.17
2 Oil and Natural Gas Fuels	2,658.27	118.09	0.00				2,776.36
2 Industrial Processes	11,943.70	2.98	179.63	870.46	25.32	729.90	13,752.00
A Mineral Products	2,947.45	0.85	0.00				2,948.30
B Chemical Industrie	492.46	2.07	179.63	0.00	0.00	0.00	674.16
C Metal Production	8,456.00	0.06	0.00		0.00	22.23	8,478.28
D Other Production	47.80						47.80
E Production of Halocarbons and SF_6				0.00	0.00	0.00	0.00
F Consumption of Halocarbons and SF_6				870.46	25.32	707.68	1,603.46
G Other	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3 Solvent and Other Product Use	395.64		232.50				628.14
4 Agriculture	0.00	3,944.83	1,013.15				4,957.98
A Enteric Fermentation		2,686.43					2,686.43
B Manure Management		522.96	0.00				522.96
C Rice Cultivation		0.00					0.00
D Agricultural Soils		734.32	1,012.05				1,746.37
E Prescribed Burning of Savannas		0.00	0.00				0.00
F Field Burning of Agricultural Residues		1.12	1.11				2.23
G Other Agriculture Activities		0.00	0.00				0.00

Table B.3 — continued

GHG source and sink categories	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Total
5 Land Use Change & Forestry	−7,633.36	0.00	0.00				−7,633.36
6 Waste	122.62	5,202.63	4.43				5,329.68
A Solid Waste Disposal on Land	0.00	4,423.78					4,423.78
B Wastewater Handling		301.80	0.00				301.80
C Waste Incineration	122.62	4.97	4.43				132.02
D Other Waste	0.00	472.08	0.00				472.08
7 Other	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Memo Items:							
International Bunkers	1,615.14	0.29	4.48				1,619.90
Aviation	1,615.14	0.29	4.48				1,619.90
Marine	NE	0.00	0.00				0.00
Multilateral Operations	IE	0.00	0.00				0.00
CO_2 Emissions from Biomass	13,623.21						13,623.21

	CO_2 emissions	CO_2 removals	Net CO_2	CH_4	N_2O	Total emissions
	Gg CO_2 equivalent					
Land-Use Change and Forestry – Total	0.00	−7,633.36	−7,633.36	0.00	0.00	−7,633.36
A Changes in Forest and Other Woody Biomass Stocks	0.00	−7,633.36	−7,633.36			−7,633.36
B Forest and Grassland Conversion	0.00		0.00	0.00	0.00	0.00
C Abandonment of Managed Lands	0.00	0.00	0.00			0.00
D CO_2 Emissions and Removals from Soil	0.00	0.00	0.00			0.00
E Other	0.00	0.00	0.00	0.00	0.00	0.00

Total CO_2 Equivalent Emissions without Land-Use Change and Forestry	79,224.26
Total CO_2 Equivalent Emissions with Land-Use Change and Forestry	71,590.90

Table B.4: CO_2 emissions 1990–1999 in Tg

GHG source and sink categories	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Total Emissions/Removals with LUCF	52.92	52.52	51.50	50.92	53.89	56.50	59.50	59.20	57.86	58.14
Total Emissions without LUCF	62.13	66.02	60.15	59.90	61.76	63.75	64.89	66.83	65.49	65.78
1 Energy	48.82	53.34	48.54	48.15	49.34	51.06	52.71	53.54	52.98	53.32
A Fuel Combustion (Sectoral Approach)	46.69	51.07	46.16	45.83	46.93	48.70	50.03	50.91	50.17	50.66
1 Energy Industries	12.38	13.40	9.81	9.13	9.40	10.92	11.41	11.87	10.85	11.37
2 Manufacturing Industries and Construct.	7.43	6.81	6.95	6.85	6.66	7.51	8.78	9.03	9.66	8.63
3 Transport	13.57	15.06	15.05	15.10	16.16	15.43	15.38	15.83	16.81	17.64
4 Other Sectors	13.31	15.80	14.35	14.74	14.71	14.84	14.46	14.18	12.86	13.01
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	2.14	2.27	2.38	2.32	2.41	2.35	2.68	2.63	2.81	2.66
1 Solid Fuels	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2 Oil and Natural Gas Fuels	2.14	2.27	2.38	2.32	2.41	2.35	2.68	2.63	2.81	2.66
2 Industrial Processes	12.75	12.21	11.14	11.30	11.94	12.19	11.68	12.77	12.01	11.94
A Mineral Products	3.80	3.68	3.74	3.57	3.71	3.07	3.07	3.14	3.05	2.95
B Chemical Industrie	0.42	0.43	0.39	0.43	0.41	0.49	0.48	0.48	0.52	0.49
C Metal Production	8.46	8.04	6.95	7.25	7.77	8.59	8.08	9.11	8.38	8.46
D Other Production	0.06	0.06	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
E Production of Halocarbons and SF_6										
F Consumption of Halocarbons and SF_6										
G Other	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3 Solvent and Other Product Use	0.52	0.44	0.38	0.36	0.36	0.38	0.38	0.41	0.40	0.40
4 Agriculture	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
A Enteric Fermentation	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B Manure Management	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C Rice Cultivation	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
D Agricultural Soils	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
E Prescribed Burning of Savannas	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
F Field Burning of Agricultural Residues	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G Other Agriculture Activities	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table B.4 — continued

GHG source and sink categories	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
5 Land Use Change & Forestry	−9.21	−13.50	−8.66	−8.98	−7.86	−7.25	−5.39	−7.63	−7.63	−7.63
A Forest & Woody Biomass Stock Change	−9.21	−13.50	−8.66	−8.98	−7.86	−7.25	−5.39	−7.63	−7.63	−7.63
B Forest and Grassland Conversion	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C Abandonment of Managed Lands	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
D CO_2 Emissions and Removals from soils	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
E Other	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6 Waste	0.04	0.04	0.09	0.09	0.11	0.12	0.11	0.12	0.11	0.12
A Solid Waste Disposal on Land	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B Wastewater Handling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C Waste Incineration	0.04	0.04	0.09	0.09	0.11	0.12	0.11	0.12	0.11	0.12
D Other Waste	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7 Other	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Memo Items:										
International Bunkers	0.94	1.10	1.17	1.14	1.20	1.33	1.47	1.52	1.84	1.62
Aviation	0.94	1.10	1.17	1.14	1.20	1.33	1.47	1.52	1.84	1.62
Marine	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Multilateral Operations	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE
CO_2 Emissions from Biomass	11.50	10.85	10.87	11.10	13.24	14.48	14.31	13.90	13.43	13.62

Table B.5: CH_4 emissions 1990–1999 in Gg

GHG source and sink categories	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Total Emissions	537.60	527.11	514.47	508.34	500.07	489.47	481.34	469.60	459.04	454.35
1 Energy	24.66	22.81	20.57	22.08	21.19	22.73	22.27	19.58	19.19	18.62
A Fuel Combustion (Sectoral Approach)	20.40	18.30	16.15	17.41	16.39	17.49	16.70	14.21	13.68	12.99
1 Energy Industries	0.15	0.17	0.12	0.12	0.10	0.10	0.11	0.13	0.13	0.13
2 Manufacturing Industries and Construct.	0.46	0.44	0.45	0.45	0.26	0.29	0.36	0.38	0.37	0.32
3 Transport	3.31	3.45	3.11	2.85	2.69	2.46	2.21	2.02	1.95	1.79
4 Other Sectors	16.48	14.25	12.47	14.00	13.34	14.64	14.01	11.68	11.24	10.74
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	4.27	4.51	4.42	4.67	4.80	5.24	5.57	5.37	5.51	5.63
1 Solid Fuels	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
2 Oil and Natural Gas Fuels	4.25	4.49	4.41	4.65	4.79	5.23	5.56	5.36	5.50	5.62
2 Industrial Processes	0.14	0.14	0.14	0.15	0.15	0.16	0.16	0.18	0.20	0.14
A Mineral Products	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
B Chemical Industrie	0.10	0.11	0.09	0.11	0.11	0.12	0.12	0.13	0.16	0.10
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	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
E Production of Halocarbons and SF_6										
F Consumption of Halocarbons and SF_6										
G Other	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3 Solvent and Other Product Use	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE
4 Agriculture	217.43	213.93	206.50	204.78	202.83	196.54	193.55	192.13	191.95	187.85
A Enteric Fermentation	154.42	151.25	144.33	141.71	140.56	135.17	132.70	131.21	130.65	127.93
B Manure Management	27.47	27.07	26.49	27.31	26.92	26.43	25.87	25.89	26.27	24.90
C Rice Cultivation	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
D Agricultural Soils	35.48	35.56	35.63	35.71	35.30	34.89	34.93	34.97	34.97	34.97
E Prescribed Burning of Savannas	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
F Field Burning of Agricultural Residues	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
G Other Agriculture Activities	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table B.5 — continued

GHG source and sink categories	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
5 Land Use Change & Forestry	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
A Forest & Woody Biomass Stock Change	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
B Forest and Grassland Conversion	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
C Abandonment of Managed Lands	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
D CO_2 Emissions and Removals from soils	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
E Other	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6 Waste	295.37	290.22	287.26	281.33	275.90	270.04	265.35	257.72	247.70	247.74
A Solid Waste Disposal on Land	258.97	253.67	250.51	244.44	238.94	233.05	228.34	220.68	210.66	210.66
B Wastewater Handling	13.73	13.88	14.06	14.19	14.26	14.29	14.31	14.34	14.35	14.37
C Waste Incineration	0.19	0.19	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.24
D Other Waste	22.48	22.48	22.48	22.48	22.48	22.48	22.48	22.48	22.48	22.48
7 Other	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Memo Items:										
International Bunkers	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Aviation	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Marine	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Multilateral Operations	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE
CO_2 Emissions from Biomass										

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Table B.6: N_2O emissions 1990–1999 in Gg

GHG source and sink categories	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Total Emissions	6.56	6.84	6.89	7.09	7.29	7.34	7.31	7.27	7.36	7.35
1 Energy	1.89	2.16	2.26	2.41	2.66	2.76	2.72	2.68	2.76	2.74
A Fuel Combustion (Sectoral Approach)	1.89	2.16	2.26	2.41	2.66	2.76	2.72	2.68	2.76	2.74
1 Energy Industries	0.14	0.16	0.12	0.11	0.12	0.14	0.13	0.12	0.14	0.15
2 Manufacturing Industries and Construct.	0.10	0.10	0.10	0.10	0.16	0.18	0.20	0.21	0.20	0.19
3 Transport	1.05	1.30	1.47	1.61	1.80	1.84	1.82	1.81	1.90	1.88
4 Other Sectors	0.61	0.61	0.57	0.59	0.58	0.61	0.57	0.55	0.52	0.52
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	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1 Solid Fuels	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE
2 Oil and Natural Gas Fuels	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE
2 Industrial Processes	0.60	0.60	0.55	0.58	0.57	0.55	0.56	0.55	0.57	0.58
A Mineral Products	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B Chemical Industrie	0.60	0.60	0.55	0.58	0.57	0.55	0.56	0.55	0.57	0.58
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	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
E Production of Halocarbons and SF_6										
F Consumption of Halocarbons and SF_6										
G Other	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
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	3.31	3.32	3.32	3.33	3.30	3.27	3.27	3.27	3.27	3.27
A Enteric Fermentation	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
B Manure Management	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
C Rice Cultivation										
D Agricultural Soils	3.30	3.31	3.32	3.33	3.30	3.26	3.26	3.26	3.26	3.26
E Prescribed Burning of Savannas	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
F Field Burning of Agricultural Residues	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G Other Agriculture Activities	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table B.6 — continued

GHG source and sink categories	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
5 Land Use Change & Forestry	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
A Forest & Woody Biomass Stock Change	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
B Forest and Grassland Conversion	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
C Abandonment of Managed Lands	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
D CO_2 Emissions and Removals from soils	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
E Other	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6 Waste	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
A Solid Waste Disposal on Land										
B Wastewater Handling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C Waste Incineration	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
D Other Waste	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7 Other	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Memo Items:										
International Bunkers	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Aviation	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Marine	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Multilateral Operations	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE
CO_2 Emissions from Biomass										

Table B.7: NMVOC emissions 1990–1999 in Gg

GHG source and sink categories	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Total Emissions	344.54	314.03	280.27	268.87	259.00	259.99	249.25	245.42	236.08	230.51
1 Energy	156.62	152.39	134.60	128.34	117.96	112.83	102.58	90.28	84.05	78.44
A Fuel Combustion (Sectoral Approach)	147.84	142.75	124.88	118.66	110.78	106.40	97.04	85.27	79.59	74.84
1 Energy Industries	0.36	0.43	0.28	0.24	0.20	0.18	0.17	0.19	0.18	0.19
2 Manufacturing Industries and Construct.	1.17	1.07	1.13	1.11	0.45	0.53	0.66	0.71	0.67	0.49
3 Transport	95.92	97.22	84.69	74.95	68.51	60.44	53.23	47.62	43.53	39.61
4 Other Sectors	50.39	44.02	38.78	42.36	41.62	45.25	42.98	36.76	35.22	34.55
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	8.78	9.64	9.72	9.68	7.18	6.43	5.54	5.00	4.46	3.60
1 Solid Fuels	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2 Oil and Natural Gas Fuels	8.78	9.64	9.72	9.68	7.18	6.43	5.54	5.00	4.46	3.60
2 Industrial Processes	16.73	18.11	19.71	21.18	21.53	21.50	21.52	21.53	21.59	21.57
A Mineral Products	5.52	5.54	5.86	6.07	6.36	6.22	6.25	6.24	6.24	6.23
B Chemical Industrie	8.29	9.64	10.99	12.34	12.34	12.34	12.34	12.34	12.34	12.34
C Metal Production	0.59	0.57	0.54	0.51	0.56	0.61	0.61	0.66	0.71	0.71
D Other Production	2.34	2.36	2.32	2.26	2.27	2.33	2.32	2.30	2.30	2.30
E Production of Halocarbons and SF_6										
F Consumption of Halocarbons and SF_6										
G Other	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3 Solvent and Other Product Use	167.69	140.03	122.39	115.79	115.96	122.13	121.63	130.10	126.94	126.94
4 Agriculture	2.68	2.67	2.67	2.67	2.66	2.65	2.64	2.64	2.64	2.64
A Enteric Fermentation										
B Manure Management	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C Rice Cultivation	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
D Agricultural Soils	2.52	2.51	2.51	2.51	2.50	2.49	2.48	2.48	2.48	2.48
E Prescribed Burning of Savannas	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
F Field Burning of Agricultural Residues	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16
G Other Agriculture Activities	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table B.7 — continued

GHG source and sink categories	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
5 Land Use Change & Forestry	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
A Forest & Woody Biomass Stock Change										
B Forest and Grassland Conversion	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C Abandonment of Managed Lands										
D CO_2 Emissions and Removals from soils										
E Other	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6 Waste	0.81	0.82	0.89	0.89	0.90	0.89	0.87	0.88	0.86	0.92
A Solid Waste Disposal on Land	0.25	0.24	0.24	0.23	0.23	0.22	0.22	0.21	0.20	0.20
B Wastewater Handling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C Waste Incineration	0.57	0.58	0.65	0.66	0.67	0.67	0.65	0.67	0.66	0.72
D Other Waste	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7 Other	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Memo Items:										
International Bunkers	0.32	0.34	0.36	0.35	0.37	0.40	0.44	0.46	0.55	0.55
Aviation	0.32	0.34	0.36	0.35	0.37	0.40	0.44	0.46	0.55	0.55
Marine	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Multilateral Operations	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE
CO_2 Emissions from Biomass										

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Table B.8: NO_x emissions 1990–1999 in Gg

GHG source and sink categories	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Total Emissions	191.20	194.65	185.00	173.04	179.95	168.48	163.49	170.10	168.18	168.08
1 Energy	167.38	170.69	161.12	149.21	156.73	146.36	141.90	148.15	146.16	146.34
A Fuel Combustion (Sectoral Approach)	163.06	166.37	156.93	145.81	153.32	142.97	138.42	144.68	142.80	143.09
1 Energy Industries	14.48	12.18	10.88	8.25	7.15	8.06	8.16	9.40	8.47	8.26
2 Manufacturing Industries and Construct.	19.34	16.32	16.10	14.36	13.94	15.00	16.59	17.60	18.03	15.20
3 Transport	98.77	105.32	99.87	96.24	101.48	89.50	86.60	86.56	86.96	90.10
4 Other Sectors	30.47	32.55	30.08	26.95	30.75	30.41	27.06	31.12	29.34	29.54
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	4.32	4.32	4.19	3.40	3.41	3.38	3.48	3.47	3.36	3.25
1 Solid Fuels	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2 Oil and Natural Gas Fuels	4.32	4.32	4.19	3.40	3.41	3.38	3.48	3.47	3.36	3.25
2 Industrial Processes	17.43	17.52	16.86	17.12	16.84	15.81	15.35	15.77	15.72	15.43
A Mineral Products	7.64	7.63	7.67	7.49	7.50	6.19	5.98	6.15	5.98	5.88
B Chemical Industrie	4.07	4.18	4.29	4.40	4.40	4.40	4.40	4.40	4.40	4.40
C Metal Production	5.16	5.13	4.33	4.68	4.37	4.63	4.39	4.63	4.75	4.57
D Other Production	0.55	0.58	0.57	0.55	0.57	0.59	0.59	0.59	0.59	0.59
E Production of Halocarbons and SF_6										
F Consumption of Halocarbons and SF_6										
G Other	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3 Solvent and Other Product Use	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4 Agriculture	6.16	6.17	6.18	6.19	6.14	6.09	6.08	6.08	6.08	6.08
A Enteric Fermentation										
B Manure Management										
C Rice Cultivation										
D Agricultural Soils	6.15	6.17	6.18	6.19	6.13	6.08	6.08	6.07	6.07	6.07
E Prescribed Burning of Savannas	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
F Field Burning of Agricultural Residues	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
G Other Agriculture Activities	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table B.8 — continued

GHG source and sink categories	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
5 Land Use Change & Forestry	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
A Forest & Woody Biomass Stock Change										
B Forest and Grassland Conversion	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C Abandonment of Managed Lands										
D CO_2 Emissions and Removals from soils										
E Other	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6 Waste	0.23	0.26	0.84	0.52	0.24	0.23	0.16	0.10	0.21	0.22
A Solid Waste Disposal on Land										
B Wastewater Handling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C Waste Incineration	0.23	0.26	0.84	0.52	0.24	0.23	0.16	0.10	0.21	0.22
D Other Waste	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7 Other	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Memo Items:										
International Bunkers	3.33	3.84	4.09	3.98	4.19	4.64	5.13	5.31	6.40	6.49
Aviation	3.33	3.84	4.09	3.98	4.19	4.64	5.13	5.31	6.40	6.49
Marine	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Multilateral Operations	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE
CO_2 Emissions from Biomass										

Umweltbundesamt
Federal Environment Agency - Austria

Table B.9: CO emissions 1990–1999 in Gg

GHG source and sink categories	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Total Emissions	1306.26	1286.81	1205.55	1176.87	1150.60	1048.73	1023.44	1023.54	969.75	864.27
1 Energy	1008.78	1014.79	892.71	855.24	816.27	785.96	736.21	731.89	692.53	664.27
A Fuel Combustion (Sectoral Approach)	1004.13	1013.99	892.26	854.78	815.75	785.41	735.77	731.15	692.18	663.81
1 Energy Industries	0.72	0.73	0.87	0.69	0.72	0.95	1.05	1.12	1.23	1.69
2 Manufacturing Industries and Constr.	6.57	6.45	6.61	6.55	4.08	4.78	5.79	6.05	5.52	4.95
3 Transport	483.43	503.17	444.95	402.13	372.35	341.76	306.60	279.78	264.29	244.41
4 Other Sectors	513.42	503.63	439.84	445.42	438.60	437.92	422.33	444.20	421.13	412.76
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	4.65	0.80	0.45	0.46	0.52	0.55	0.44	0.74	0.35	0.46
1 Solid Fuels	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2 Oil and Natural Gas Fuels	4.65	0.80	0.45	0.46	0.52	0.55	0.44	0.74	0.35	0.46
2 Industrial Processes	271.06	246.02	287.03	296.31	309.43	238.35	263.23	268.28	254.61	177.38
A Mineral Products	20.63	21.43	21.74	21.52	21.32	18.35	18.92	18.88	18.62	18.26
B Chemical Industrie	12.67	12.18	11.68	11.20	11.19	11.17	11.14	11.20	11.16	11.11
C Metal Production	237.36	211.98	253.20	263.20	276.51	208.40	232.74	237.77	224.40	147.58
D Other Production	0.40	0.42	0.41	0.40	0.42	0.43	0.43	0.43	0.43	0.43
E Production of Halocarbons and SF_6										
F Consumption of Halocarbons and SF_6										
G Other	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3 Solvent and Other Product Use	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4 Agriculture	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50
A Enteric Fermentation										
B Manure Management										
C Rice Cultivation										
D Agricultural Soils										
E Prescribed Burning of Savannas	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
F Field Burning of Agricultural Resid.	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50
G Other Agriculture Activities	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table B.9 — continued

GHG source and sink categories	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
5 Land Use Change & Forestry	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
A Forest & Woody Biomass Stock Ch.										
B Forest and Grassland Conversion	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C Abandonment of Managed Lands										
D CO_2 Emiss. and Removals from soils										
E Other	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6 Waste	24.92	24.50	24.31	23.82	23.39	22.92	22.51	21.87	21.11	21.11
A Solid Waste Disposal on Land	20.51	20.09	19.84	19.36	18.92	18.46	18.08	17.48	16.68	16.68
B Wastewater Handling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C Waste Incineration	4.41	4.41	4.47	4.46	4.47	4.46	4.42	4.39	4.42	4.43
D Other Waste	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7 Other	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Memo Items:										
International Bunkers	0.81	0.87	0.92	0.90	0.94	1.03	1.14	1.17	1.40	1.42
Aviation	0.81	0.87	0.92	0.90	0.94	1.03	1.14	1.17	1.40	1.42
Marine	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Multilateral Operations	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE
CO_2 Emissions from Biomass										

Table B.10: SO_2 emissions 1990–1999 in Gg

GHG source and sink categories	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Total Emissions	90.73	81.83	62.96	59.87	56.59	56.00	52.70	50.40	46.37	41.76
1 Energy	80.11	72.38	54.82	51.51	47.78	47.59	43.33	41.00	36.97	32.32
A Fuel Combustion (Sectoral Approach)	75.85	68.97	49.97	45.99	43.47	43.08	38.64	37.28	33.13	28.63
1 Energy Industries	15.19	15.22	7.30	6.54	4.29	4.88	4.80	6.43	4.01	4.14
2 Manufacturing Industries and Construct.	25.74	17.85	13.04	11.33	9.56	12.15	11.66	12.85	13.75	8.89
3 Transport	5.10	5.73	6.02	6.31	7.37	6.95	2.70	2.83	3.06	3.33
4 Other Sectors	29.82	30.16	23.62	21.81	22.24	19.10	19.48	15.16	12.32	12.27
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	4.25	3.41	4.85	5.52	4.31	4.51	4.69	3.73	3.84	3.69
1 Solid Fuels	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2 Oil and Natural Gas Fuels	4.25	3.41	4.85	5.52	4.31	4.51	4.69	3.73	3.84	3.69
2 Industrial Processes	10.52	9.36	7.99	8.29	8.76	8.35	9.32	9.34	9.35	9.36
A Mineral Products	1.10	1.06	1.03	0.93	1.09	0.77	1.24	1.04	1.00	0.96
B Chemical Industrie	2.68	2.85	3.02	3.19	3.19	3.19	3.19	3.19	3.19	3.19
C Metal Production	6.74	5.44	3.94	4.17	4.48	4.39	4.89	5.12	5.15	5.22
D Other Production	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
E Production of Halocarbons and SF_6										
F Consumption of Halocarbons and SF_6										
G Other	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3 Solvent and Other Product Use	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4 Agriculture	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
A Enteric Fermentation										
B Manure Management										
C Rice Cultivation										
D Agricultural Soils										
E Prescribed Burning of Savannas										
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 Agriculture Activities	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table B.10 — continued

GHG source and sink categories	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
5 Land Use Change & Forestry	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
A Forest & Woody Biomass Stock Change										
B Forest and Grassland Conversion										
C Abandonment of Managed Lands										
D CO_2 Emissions and Removals from soils										
E Other	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6 Waste	0.10	0.09	0.15	0.07	0.06	0.06	0.05	0.05	0.06	0.07
A Solid Waste Disposal on Land										
B Wastewater Handling										
C Waste Incineration	0.10	0.09	0.15	0.07	0.06	0.06	0.05	0.05	0.06	0.07
D Other Waste	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7 Other	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Memo Items:										
International Bunkers	0.76	0.89	0.95	0.93	0.98	0.92	0.47	0.48	0.58	0.59
Aviation	0.76	0.89	0.95	0.93	0.98	0.92	0.47	0.48	0.58	0.59
Marine	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Multilateral Operations	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE
CO_2 Emissions from Biomass										

Table B.11: HFC, PFC and SF_6 emissions 1990–1999 in Gg

Greenhouse gases	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Emissions of HFCs – CO_2 equivalent (Gg)	4	6	9	12	17	546	625	718	816	870
HFC-23	0.0002	0.0003	0.0004	0.0005	0.0007	0.0002	0.0003	0.0003	0.0004	0.0005
HFC-32	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0002	0.0004	0.0006	0.0009
HFC-41	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
HFC-43-10mee	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
HFC-125	0.0000	0.0000	0.0000	0.0000	0.0000	0.0014	0.0057	0.0110	0.0148	0.0162
HFC-134	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
HFC-134a	0.0014	0.0021	0.0032	0.0046	0.0067	0.4143	0.4578	0.5089	0.5677	0.6020
HFC-152a	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0003	0.0006	0.0008	0.0007
HFC-143	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
HFC-143a	0.0000	0.0000	0.0000	0.0000	0.0000	0.0004	0.0025	0.0056	0.0081	0.0095
HFC-227ea	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0001
HFC-236fa	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
HFC-245ca	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Emissions of PFCs – CO_2 equivalent (Gg)	963	974	576	48	54	16	15	18	21	25
CF_4	0.1328	0.1338	0.0793	0.0048	0.0050	0.0008	0.0007	0.0009	0.0009	0.0015
C_2F_6	0.0109	0.0114	0.0066	0.0018	0.0023	0.0011	0.0011	0.0014	0.0016	0.0017
C_3F_8	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
C_4F_{10}	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
c-C_4F_8	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
C_5F_{12}	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
C_6F_{14}	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Emissions of SF_6 – CO_2 equivalent (Gg)	518	683	725	823	1,033	1,175	1,246	1,148	955	730
SF_6	0.02	0.03	0.03	0.03	0.04	0.05	0.05	0.05	0.04	0.03

Table B.12: CO_2 emissions by fuels 1990 and 1999

		Year: 1990			Year: 1999		
		Emissions CO_2	Activity	Emission factor	Emissions CO_2	Activity	Emission factor
		[Tg]	[PJ]	[g/PJ]	[Tg]	[PJ]	[g/PJ]
1.A.1.	Energy Industries	12.38	189.01		11.37	202.25	
	Liquid Fuels	1.85	43.71	0.042	2.26	56.31	0.040
	Solid Fuels	6.38	68.80	0.093	3.81	41.76	0.091
	Gaseous Fuels	4.15	75.39	0.055	5.30	96.39	0.055
	Biomass	0.11	1.02	0.110	0.85	7.78	0.110
	Other Fuels	0.00	0.08	0.010	0.00	0.00	0.000
a.	Public Electricity and Heat Production	12.36	168.67		11.33	173.66	
	Liquid Fuels	1.85	23.69	0.078	2.26	28.50	0.079
	Solid Fuels	6.38	68.80	0.093	3.81	41.76	0.091
	Gaseous Fuels	4.13	75.06	0.055	5.26	95.63	0.055
	Biomass	0.11	1.02	0.110	0.85	7.78	0.110
	Other Fuels	0.00	0.08	0.010	0.00	0.00	0.000
b.	Petroleum Refining	0.00	20.02		0.00	27.82	
	Liquid Fuels	IE	20.02	0.000	IE	27.82	0.000
	Solid Fuels	0.00	0.00	0.000	0.00	0.00	0.000
	Gaseous Fuels	0.00	0.00	0.000	0.00	0.00	0.000
	Biomass	0.00	0.00	0.000	0.00	0.00	0.000
	Other Fuels	0.00	0.00	0.000	0.00	0.00	0.000
c.	Manufacture of Solid Fuels and Other Energy Industries	0.02	0.33		0.04	0.77	
	Liquid Fuels	0.00	0.00	0.000	0.00	0.00	0.000
	Solid Fuels	0.00	0.00	0.000	0.00	0.00	0.000
	Gaseous Fuels	0.02	0.33	0.055	0.04	0.77	0.055
	Biomass	0.00	0.00	0.000	0.00	0.00	0.000
	Other Fuels	0.00	0.00	0.000	0.00	0.00	0.000
1.A.2	Manufacturing Industries and Construction	7.43	208.93		8.63	256.09	
	Liquid Fuels	2.62	39.49	0.066	1.90	29.96	0.064
	Solid Fuels	0.61	68.07	0.009	0.53	72.00	0.007
	Gaseous Fuels	4.00	73.64	0.054	6.17	114.03	0.054
	Biomass	0.79	7.24	0.110	4.06	36.98	0.110
	Other Fuels	0.20	20.50	0.010	0.02	3.12	0.008
a.	Iron and Steel	0.00	15.91		0.00	14.59	
	Liquid Fuels	IE	0.00	0.000	IE	0.00	0.000

Table B.12: (continued)

		Year: 1990			Year: 1999		
		Emissions CO_2	Activity	Emission factor	Emissions CO_2	Activity	Emission factor
		[Tg]	[PJ]	[g/PJ]	[Tg]	[PJ]	[g/PJ]
	Solid Fuels	IE	15.91	0.000	IE	14.59	0.000
	Gaseous Fuels	IE	0.00	0.000	IE	0.00	0.000
	Biomass	IE	0.00	0.000	IE	0.00	0.000
	Other Fuels	IE	0.00	0.000	IE	0.00	0.000
b.	Non-Ferrous Metals	0.00	0.00		0.00	0.00	
	Liquid Fuels	IE	0.00	0.000	IE	0.00	0.000
	Solid Fuels	IE	0.00	0.000	IE	0.00	0.000
	Gaseous Fuels	IE	0.00	0.000	IE	0.00	0.000
	Biomass	IE	0.00	0.000	IE	0.00	0.000
	Other Fuels	IE	0.00	0.000	IE	0.00	0.000
c.	Chemicals	0.00	0.00		0.00	0.00	
	Liquid Fuels	IE	0.00	0.000	IE	0.00	0.000
	Solid Fuels	IE	0.00	0.000	IE	0.00	0.000
	Gaseous Fuels	IE	0.00	0.000	IE	0.00	0.000
	Biomass	IE	0.00	0.000	IE	0.00	0.000
	Other Fuels	IE	0.00	0.000	IE	0.00	0.000
d.	Pulp, Paper and Print	0.00	0.00		0.00	0.00	
	Liquid Fuels	IE	0.00	0.000	IE	0.00	0.000
	Solid Fuels	IE	0.00	0.000	IE	0.00	0.000
	Gaseous Fuels	IE	0.00	0.000	IE	0.00	0.000
	Biomass	IE	0.00	0.000	IE	0.00	0.000
	Other Fuels	IE	0.00	0.000	IE	0.00	0.000
e.	Food Processing, Beverages and Tobacco	0.00	0.00		0.00	0.00	
	Liquid Fuels	IE	0.00	0.000	IE	0.00	0.000
	Solid Fuels	IE	0.00	0.000	IE	0.00	0.000
	Gaseous Fuels	IE	0.00	0.000	IE	0.00	0.000
	Biomass	IE	0.00	0.000	IE	0.00	0.000
	Other Fuels	IE	0.00	0.000	IE	0.00	0.000
f.	Other	7.43	193.02		8.63	241.50	
	Liquid Fuels	2.62	39.49	0.066	1.90	29.96	0.064
	Solid Fuels	0.61	52.15	0.012	0.53	57.41	0.009
	Gaseous Fuels	4.00	73.64	0.054	6.17	114.03	0.054

Table B.12: (continued)

		Year: 1990			Year: 1999		
		Emissions CO_2	Activity	Emission factor	Emissions CO_2	Activity	Emission factor
		[Tg]	[PJ]	[g/PJ]	[Tg]	[PJ]	[g/PJ]
	Biomass	0.79	7.24	0.110	4.06	36.98	0.110
	Other Fuels	0.20	20.50	0.010	0.02	3.12	0.008
1.A.3	Transport	13.57	185.27		17.64	238.93	
	Gasoline	8.12	111.29	0.073	6.57	89.56	0.073
	Diesel	5.44	73.83	0.074	11.07	149.25	0.074
	Natural Gas	0.00	0.00	0.000	0.00	0.00	0.000
	Solid Fuels	0.01	0.07	0.095	0.00	0.03	0.095
	Biomass	0.00	0.00	0.000	0.00	0.00	0.000
	Other Fuels	0.01	0.09	0.074	0.01	0.08	0.073
a.	Civil Aviation	0.07	0.96		0.11	1.73	
	Aviation Gasoline	0.01	0.12	0.074	0.01	0.09	0.074
	Jet Kerosene	0.06	0.83	0.072	0.10	1.64	0.063
b.	Road Transportation	13.28	181.35		17.21	232.79	
	Gasoline	8.05	110.33	0.073	6.46	87.83	0.074
	Diesel Oil	5.23	71.02	0.074	10.75	144.97	0.074
	Natural Gas	0.00	0.00	0.000	0.00	0.00	0.000
	Biomass	0.00	0.00	0.000	0.00	0.00	0.000
	Other Fuels (please specify)	0.00	0.00		0.00	0.00	
c.	Railways	0.17	2.33		0.15	1.99	
	Solid Fuels	0.01	0.07	0.095	0.00	0.03	0.095
	Liquid Fuels	0.17	2.26	0.074	0.15	1.96	0.074
	Other Fuels (please specify)	0.00	0.00		0.00	0.00	
d.	Navigation	0.05	0.64		0.06	0.79	
	Coal	0.00	0.00	0.000	0.00	0.00	0.000
	Residual Oil	0.00	0.00	0.000	0.00	0.00	0.000
	Gas/Diesel Oil	0.04	0.56	0.074	0.05	0.71	0.074
	Other Fuels (please specify)	0.01	0.09		0.01	0.08	
	Gasoline	0.01	0.09	0.074	0.01	0.08	0.073
e.	Other Transportation	0.00	0.00		0.12	1.62	
	Liquid Fuels	0.00	0.00	0.000	0.12	1.62	0.074
	Solid Fuels	0.00	0.00	0.000	0.00	0.00	0.000
	Gaseous Fuels	0.00	0.00	0.000	0.00	0.00	0.000

Table B.12: (continued)

		Year: 1990			Year: 1999		
		Emissions CO_2	Activity	Emission factor	Emissions CO_2	Activity	Emission factor
		[Tg]	[PJ]	[g/PJ]	[Tg]	[PJ]	[g/PJ]
1.A.4	Other Sectors	13.31	287.24		13.01	270.03	
	Liquid Fuels	7.85	104.54	0.075	8.07	108.11	0.075
	Solid Fuels	2.56	27.48	0.093	1.22	13.06	0.093
	Gaseous Fuels	2.89	52.53	0.055	3.71	67.50	0.055
	Biomass	10.34	102.30	0.101	8.12	80.77	0.100
	Other Fuels	0.00	0.39	0.010	0.01	0.61	0.010
a.	Commercial/Institutional	4.38	114.21		2.29	69.45	
	Liquid Fuels	3.06	40.24	0.076	1.22	16.11	0.076
	Solid Fuels	0.46	5.14	0.089	0.11	1.13	0.096
	Gaseous Fuels	0.85	15.53	0.055	0.96	17.43	0.055
	Biomass	5.40	52.91	0.102	3.46	34.17	0.101
	Other Fuels	0.00	0.39	0.010	0.01	0.61	0.010
b.	Residential	7.80	157.82		9.43	183.05	
	Liquid Fuels	3.66	49.10	0.075	5.57	74.46	0.075
	Solid Fuels	2.10	22.33	0.094	1.11	11.92	0.093
	Gaseous Fuels	2.04	37.00	0.055	2.75	50.07	0.055
	Biomass	4.94	49.39	0.100	4.66	46.60	0.100
	Other Fuels	0.00	0.00	0.000	0.00	0.00	0.000
c.	Agriculture/Forestry/Fisheries	1.13	15.21		1.29	17.54	
	Liquid Fuels	1.13	15.20	0.074	1.29	17.54	0.074
	Solid Fuels	0.00	0.01	0.000	0.00	0.00	0.000
	Gaseous Fuels	0.00	0.00	0.000	0.00	0.00	0.000
	Biomass	0.00	0.00	0.000	0.00	0.00	0.000
	Other Fuels	0.00	0.00	0.000	0.00	0.00	0.000
1.A.5	Other (Not elsewhere specified)	0.00	2.79		0.00	7.26	
	Liquid Fuels	IE	0.00	0.000	IE	0.39	0.000
	Solid Fuels	IE	0.00	0.000	IE	0.00	0.000
	Gaseous Fuels	IE	0.03	0.000	IE	0.31	0.000
	Biomass	0.25	2.75	0.090	0.59	6.56	0.090
	Other Fuels	IE	0.00	0.000	IE	0.00	0.000

Table B.13: CO_2 emissions 1955–1979 by sectors, in Tg

GHG source categories	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1965	1967
National Total	29.75	31.18	32.35	31.08	32.12	34.63	35.26	37.97	41.24	42.28	41.77	42.21	43.19
1 All Energy (Fuel Combustion)	26.36	27.20	27.98	26.93	27.77	29.37	30.21	32.92	36.29	36.99	36.34	36.75	38.07
Electricity generation	3.79	3.98	4.10	3.44	4.47	4.44	5.63	6.16	6.95	7.57	6.09	6.47	6.60
District heating	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Industry Combustion	8.30	8.79	8.86	8.73	8.87	9.90	9.71	9.78	9.83	10.56	10.66	10.68	10.63
Traffic	4.66	4.98	4.91	5.13	5.31	5.82	6.10	6.56	7.07	7.40	7.83	8.36	8.51
Small Consumers	6.61	6.73	7.31	6.66	6.41	6.87	6.64	8.25	10.25	9.15	9.40	8.93	10.09
Own use of Energy Sector	3.00	2.72	2.80	2.98	2.71	2.35	2.13	2.17	2.19	2.30	2.37	2.31	2.23
2 Industrial Processes	3.38	3.98	4.37	4.15	4.35	5.26	5.05	5.05	4.94	5.29	5.43	5.46	5.12

GHG source categories	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
National Total	46.10	50.73	53.83	56.15	58.59	62.23	59.58	57.40	61.99	59.18	61.18	63.56
1 All Energy (Fuel Combustion)	40.67	44.69	47.20	49.48	51.50	55.06	51.91	50.62	55.01	52.39	54.30	55.87
Electricity generation	7.27	9.08	7.52	10.11	10.10	9.90	8.86	8.65	11.19	8.84	9.09	9.15
District heating	0.00	0.00	0.39	0.38	0.49	0.89	0.92	0.95	1.03	1.07	1.31	1.29
Industry Combustion	11.01	11.76	12.03	12.26	12.50	12.87	13.64	12.35	12.81	12.26	12.33	12.29
Traffic	9.00	9.37	10.33	10.67	11.71	12.67	11.87	12.12	12.02	12.49	13.16	13.67
Small Consumers	11.06	12.09	14.33	13.46	13.86	15.83	13.96	13.93	15.01	14.85	15.81	17.13
Own use of Energy Sector	2.33	2.40	2.60	2.60	2.84	2.90	2.66	2.64	2.95	2.88	2.60	2.34
2 Industrial Processes	5.43	6.03	6.63	6.66	7.10	7.18	7.67	6.78	6.98	6.79	6.89	7.69

Umweltbundesamt
Federal Environment Agency - Austria

Table B.14: CO_2 emissions 1980–1999 by sectors, in Tg

GHG source and sink categories	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
Total Emissions/Removals with LUCF	59.36	48.76	44.13	42.98	48.89	46.36	47.36	46.83	45.90	45.48
Total Emissions without LUCF	63.82	59.84	57.39	56.51	58.39	59.23	58.51	59.81	57.21	57.97
1 Energy	49.82	45.94	44.79	43.65	44.49	45.74	45.52	47.21	44.28	44.80
A Fuel Combustion	47.18	43.57	42.76	41.84	42.58	43.76	43.57	45.25	42.44	42.88
1 Energy Industries	9.05	8.59	8.71	8.73	9.51	9.50	9.36	10.01	8.63	9.36
2 Manufacturing Industries and Construct.	10.98	10.14	9.57	8.08	7.75	8.08	7.68	7.65	7.14	6.66
3 Transport	11.52	11.23	11.28	11.52	11.24	11.39	11.81	11.90	12.75	13.22
4 Other Sectors	15.63	13.61	13.20	13.51	14.07	14.79	14.72	15.68	13.92	13.63
5 Other	–	–	–	–	–	–	–	–	–	–
B Fugitive Emissions from Fuels	2.64	2.37	2.03	1.81	1.91	1.98	1.95	1.96	1.84	1.92
1 Solid Fuels	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE
2 Oil and Natural Gas Fuels	2.64	2.37	2.03	1.81	1.91	1.98	1.95	1.96	1.84	1.92
2 Industrial Processes	13.55	13.44	12.13	12.38	13.40	12.99	12.47	12.08	12.39	12.63
3 Solvent and Other Product Use	0.44	0.45	0.46	0.47	0.48	0.49	0.51	0.52	0.53	0.54
4 Agriculture	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5 Land Use Change & Forestry	−4.45	−11.08	−13.27	−13.53	−9.50	−12.87	−11.15	−12.98	−11.31	−12.49
6 Waste	0.01	0.01	0.01	0.01	0.01	0.010.	0.01	0.01	0.01	0.01
7 Other	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
International Bunkers	0.40	0.45	0.41	0.48	0.58	0.63	0.63	0.65	0.84	1.02
Aviation	0.40	0.45	0.41	0.48	0.58	0.63	0.63	0.65	0.84	1.02
Marine	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Multilateral Operations	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE
CO_2 Emissions from Biomass	4.67	4.96	5.62	5.73	6.65	7.25	12.12	12.34	13.29	13.11

Table B.14 — continued

GHG source and sink categories	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Total Emissions/Removals with LUCF	52.92	52.52	51.50	50.92	53.89	56.50	59.50	59.20	57.86	58.14
Total Emissions without LUCF	62.13	66.02	60.15	59.90	61.76	63.75	64.89	66.83	65.49	65.78
1 Energy	48.82	53.34	48.54	48.15	49.34	51.06	52.71	53.54	52.98	53.32
A Fuel Combustion	46.69	51.07	46.16	45.83	46.93	48.70	50.03	50.91	50.17	50.66
1 Energy Industries	12.38	13.40	9.81	9.13	9.40	10.92	11.41	11.87	10.85	11.37
2 Manufacturing Industries and Construct.	7.43	6.81	6.95	6.85	6.66	7.51	8.78	9.03	9.66	8.63
3 Transport	13.57	15.06	15.05	15.10	16.16	15.43	15.38	15.83	16.81	17.64
4 Other Sectors	13.31	15.80	14.35	14.74	14.71	14.84	14.46	14.18	12.86	13.01
5 Other	–	–	–	–	–	–	–	–	–	–
B Fugitive Emissions from Fuels	2.14	2.27	2.38	2.32	2.41	2.35	2.68	2.63	2.81	2.66
1 Solid Fuels	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE
2 Oil and Natural Gas Fuels	2.14	2.27	2.38	2.32	2.41	2.35	2.68	2.63	2.81	2.66
2 Industrial Processes	12.75	12.21	11.14	11.30	11.94	12.19	11.68	12.77	12.01	11.94
3 Solvent and Other Product Use	0.52	0.44	0.38	0.36	0.36	0.38	0.38	0.41	0.40	0.40
4 Agriculture	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5 Land Use Change & Forestry	−9.21	−13.50	−8.66	−8.98	−7.86	−7.25	−5.39	−7.63	−7.63	−7.63
6 Waste	0.04	0.04	0.09	0.09	0.11	0.12	0.11	0.12	0.11	0.12
7 Other	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
International Bunkers	0.94	1.10	1.17	1.14	1.20	1.33	1.47	1.52	1.84	1.62
Aviation	0.94	1.10	1.17	1.14	1.20	1.33	1.47	1.52	1.84	1.62
Marine	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Multilateral Operations	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE
CO_2 Emissions from Biomass	13.33	12.66	12.70	12.91	13.34	14.61	14.80	14.42	13.83	13.89

Table B.15: CO_2 emissions 1955–1979 by fuels, in Tg

	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1965	1967
National Total	29.75	31.18	32.35	31.08	32.12	34.63	35.26	37.97	41.24	42.28	41.77	42.21	43.19
All Energy (Fuel Combustion)	26.36	27.20	27.98	26.93	27.77	29.37	30.21	32.92	36.29	36.99	36.34	36.75	38.07
Coal	18.35	18.28	18.41	16.92	16.23	15.69	15.50	16.67	18.24	16.98	15.44	14.46	14.03
Oil	5.48	5.97	6.31	6.85	7.81	8.90	9.76	11.50	13.30	15.19	16.31	17.45	19.44
Gas	2.53	2.95	3.25	3.15	3.73	4.78	4.95	4.76	4.74	4.81	4.59	4.83	4.59
Waste	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01
Process	3.38	3.98	4.37	4.15	4.35	5.26	5.05	5.05	4.94	5.29	5.43	5.46	5.12

	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
National Total	46.10	50.73	53.83	56.15	58.59	62.23	59.58	57.40	61.99	59.18	61.18	63.56
All Energy (Fuel Combustion)	40.67	44.69	47.20	49.48	51.50	55.06	51.91	50.62	55.01	52.39	54.30	55.87
Coal	13.94	14.49	13.53	12.18	10.95	10.87	11.10	9.72	11.11	9.00	8.42	8.93
Oil	21.69	24.13	26.41	29.30	32.02	35.09	30.81	31.30	33.19	32.77	34.77	35.46
Gas	5.03	6.07	7.24	7.99	8.50	9.05	9.94	9.55	10.64	10.56	11.01	11.34
Waste	0.01	0.01	0.02	0.02	0.02	0.05	0.05	0.05	0.06	0.06	0.10	0.14
Process	5.43	6.03	6.63	6.66	7.10	7.18	7.67	6.78	6.98	6.79	6.89	7.69

Table B.16: CO_2 emissions 1980–1999 by fuels, in Tg

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
National Total	63.82	59.84	57.39	56.51	58.39	59.23	58.51	59.81	57.21	57.97
All Energy (Fuel Combustion)	47.18	43.57	42.76	41.84	42.58	43.76	43.57	45.25	42.44	42.88
Solid	7.71	8.09	7.98	8.13	9.41	9.10	8.14	9.05	7.43	7.46
Liquid	31.25	27.75	27.21	26.09	24.53	25.16	26.05	26.39	25.67	25.37
Gaseous	8.10	7.60	7.43	7.48	8.48	9.32	9.17	9.61	9.11	9.82
Other	0.12	0.13	0.14	0.14	0.16	0.19	0.21	0.21	0.23	0.23
Process	16.64	16.27	14.63	14.67	15.81	15.47	14.94	14.56	14.77	15.10

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
National Total	62.13	66.02	60.15	59.90	61.76	63.75	64.89	66.83	65.49	65.78
All Energy (Fuel Combustion)	46.69	51.07	46.16	45.83	46.93	48.70	50.03	50.91	50.17	50.66
Solid	9.55	10.70	6.99	5.82	5.91	6.80	7.14	7.25	5.46	5.56
Liquid	25.88	28.50	27.23	27.40	28.01	27.66	27.75	29.08	29.67	29.87
Gaseous	11.04	11.66	11.74	12.40	13.00	14.22	15.08	14.51	14.99	15.19
Other	0.21	0.21	0.21	0.21	0.02	0.02	0.06	0.06	0.05	0.04
Process	15.45	14.96	13.99	14.07	14.82	15.05	14.86	15.92	15.32	15.12

Appendix C

Abbreviations, Terms and Units of Measurement

Abbreviations and Terms

ACCC	Austrian Council on Climate Change
AGBM	Ad hoc Group on the Berlin Mandate
ARCS	Austrian Research Center Seibersdorf
ATS	Austrian Schilling
B-VG	Federal Constitution Act (Bundesverfassungsgesetz)
CFCs	chlorofluorocarbons
CH_4	methane
CHP	combined heat and power
CO	carbon monoxide
CO_2	carbon dioxide
COP	Conference of the Parties
CORINAIR	Coordination d'information environmentale projet partiel air
CRF	Common Reporting Format
EDF	European Development Fund
ECE (UN)	Economic Commission for Europe
FCCC (UN)	Framework Convention on Climate Change
FEA	Federal Environment Agency Austria
FMAF	Federal Ministry of Agriculture and Forestry
FMAFEW	Federal Ministry of Agriculture, Forestry, Environment and Water Management
FMEAL	Federal Ministry of Economic Affairs and Labour
FMFA	Federal Ministry of Foreign Affairs
FMTT	Federal Ministry for Transport, Innovation and Technology
GAW	Global Atmosphere Watch
GCM	global circulation model
GDP	gross domestic product
GEF	Global Environment Facility
GET	Global Environment Trust Fund
Gg	gigagram (1,000 tons)
GHG	greenhouse gas
GNP	gross national product
HFCs	hydrogenated fluorocarbons
HGV	heavy goods vehicle
HZB	Hydrographical Central Office
ICAO	International Civil Aviation Organisation
IEA	International Energy Agency
IER	Austrian Institute of Economic Research (WIFO)
IGBP	International Geosphere-Biosphere Program
IHDP	International Human Dimensions Program (of Global Env. Change)
IIASA	International Institute for Applied Systems Analyses
IPCC	Intergovernmental Panel on Climate Change
Land, *pl.* Länder	Federal Province(s) of Austria
maSl	metres above Sea level
NEP	National Environmental Plan
NGO	non-governmental organisation
NMVOC	non-methane volatile organic compound
NO_x	oxides of nitrogen
N_2O	nitrous oxide

ODA	Official Development Assistance
OECD	Organisation for Economic Cooperation and Development
PFCs	perfluorocarbons
SADC	South African Development Cooperation
UNEP	United Nations Environment Program
US$	United States Dollar
VAT	value added tax
VOC	volatile organic compounds
WCRP	World Climate Research Program
WMO	World Meteorological Organisation
WWW	World Weather Watch / World Wide Web
ZAMG	Central Institute for Meteorology and Geodynamics

Units of Measurement, Currencies

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

1 € = 13.7603 ATS
1 billion € = 1000 million € (10^9)