National Climate Report

of the Austrian Federal Government

in compliance with the obligations under Art. 4.2 and Art. 12 of the Framework Convention on Climate Change (Federal Law Gazette No. 414/1994)

Vienna, August 1994

Federal Ministry of Environment, Youth and Family Affairs

Preface to the National Climate Report

Climate protection is an issue that concerns each and every one of us!

We all remember the United Nations Conference on Environment and Development - UNCED - in June 1992 in Rio de Janeiro. It was at that global conference that 158 States, among them Austria, signed the United Nations Framework Convention on Climate Change. In February 1994, Austria became the 58th State to ratify this convention.

With this report, Austria complies with one of the obligations under the Convention, namely to compile a National Climate Report (National Communication).

We have been asked to submit a concrete description of the "Greenhouse Effect - Climate Change" issue from an Austrian vantage point:
How large ist the amount of greenhouse gases emitted in Austria?
What strategies have we developed to prevent possible climate change? Will we, as members of an industrial society, accept the responsibility incumbent upon us in this matter? Will we act in a farsighted manner and not confine ourselves to "cosmetic" changes but attack the problem at its source?

Although this Climate Report may not offer a comprehensive solution to this complex set of problems, it certainly marks the beginnings of this process and points the way toward a modern climate protection policy.

At this juncture, I would like to thank all those who have worked with such dedication to complete this comprehensive report in the allotted time. It is the product of an exemplary co-operative effort among all the institutions involved with this issue.

We are now all called upon to display the same measure of co-operation and courage in implementing the concrete measures listed here.

The implementation of these measures will be an initial step toward achieving our Toronto target (20% reduction of CO_2 emissions by the year 2005, based on the emission data for 1988). Needless to say, the sets of measures proposed here are by no means complete and will have to be revised as new developments emerge. Nevertheless, with serious effort on all our part, the goal we have set could be realized.

Only then will we be able to prevent the adverse climate change now feared and, together, bring about the turn of events which our sense of responsibility for future generations compels us to achieve.

Maria Rauch-Kallat
Federal Minister of Environment, Youth and
Family Affairs

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Chapter 1.

Executive Summary

1.1 Introduction

Within the scope of the United Nations Conference on Environment and Development held in Rio de Janeiro in June 1992, 158 countries, including Austria, signed the Framework Convention on Climate Change. The aim of the Convention is to achieve a stabilization of greenhouse gas concentrations in the atmosphere in order to prevent dangerous interference with the climate system caused by human activities. Parties to the Convention are obliged, i.a., to provide regularly emission inventories of greenhouse gases and plans of national measures for their reduction, and to promote the transfer of information and technology. An additional obligation exists for industrialized countries as to report on measures, which will reduce greenhouse gas emissions to 1990 levels by the end of this decade. There is, however, no concrete obligation in regard to the realization of this reduction. Further, the industrialized countries are obliged to provide financial assistance for the developing countries to help them in achieving the objectives of the Convention.

Austria, as the 58th country, ratified the Framework Convention on Climate Change on 28 February 1994; the Convention entered into force on 29 May 1994.

Bearing in mind the precautionary principle Austria has laid down as a national target a 20% reduction of carbon dioxide (CO_2) emissions until 2005 (based on the emissions of 1988) in the Energy Reports 1990 and 1993 of the Austrian Federal Government. This amounts to 44.3 Mt CO_2 in 2005 considering pyrogenic and process related CO_2 emissions. At present, the implementation of measures for achieving the so-called Toronto target is pushed.

This document is Austria's First National Communication, by which Austria is complying with the obligation to communicate informations to the Secretariat of the Intergovernmental Negotiating Committee for a Framework Convention on Climate Change (INC/FCCC) according to Art. 4.2 and Art. 12 of the Convention. This National Communication has to be submitted to the Secretariat by 21 September 1994.

1.2. The Essential Aspects of Austria's Strategy

Austria's strategy provides for preference to be given in principle to measures which reduce the use of energy and take effect essentially in the area of ultimate energy consumption, as opposed to measures which induce a shift in the fuel mix. Measures orientated towards ultimate energy consumption are to take effect primarily in the sectors of small private consumption as well as in the areas of room heating, water heaters and traffic.

On the resources side, the priority classification specific to sources of energy results primarily from the CO_2 emission factors of primary energy forms. The other climate-relevant emissions will have to be taken into account accordingly. In any case clear preference is to be given by approximation to CO_2-neutral primary sources of energy over non-CO_2-neutral sources of energy.

At the beginning of the nineties two committees were set up at the Austrian Federal Ministry of Environment, Youth and Family Affairs in order to develop effective strategies for climate protection. These were: the National CO_2 Commission (Austrian CO_2 Commission - ACC) and the Interministerial Committee to Co-Ordinate Measures to Protect Global Climate (IMC Climate).

The brief of the national CO_2 Commission is to determine scientific and technological potentials, to recommend measures and strategies for achieving the Toronto target and to analyse instruments at expert level. In addition it also looks at ways of reducing emissions of other greenhouse gases and advises the Austrian Federal Government in all matters of climate protection.

The work of the CO_2 Commission forms the specialist basis for the activities of IMC Climate. Represented in this administrative committee are, among others, all the ministries concerned by the matter. Taking into account the catalogue of measures listed in the 1993 Energy Report, which contains largely CO_2-reducing measures, IMC Climate draws up detailed programmes for a comprehensive national strategy for reducing greenhouse gas emissions. The Committee reports to the council of ministers at regular intervals.

1.3. Where does Austria Stand Today - What Has Been Achieved and What Remains To Be Done?

The Austrian Government is actively engaged in developing and pursuing an efficient policy to reduce the national CO_2 emissions by 20% on the basis of 1988 by the year 2005. The Interministerial Committee to Coordinate Measures to Protect Global Climate (IMC Climate) has elaborated a detailed and comprehensive catalogue of measures for reducing greenhouse gas emissions in order to support the Austrian Government in its efforts. On the basis of these measures, it is being anticipated that the reduction measures already under realization could stabilize Austria's CO_2 emissions at the 1990 level by the time period around 2000 to 2005.

The reduction measures to be implemented during the next legislative period (1994-1998) possess, according to preliminary evaluations, sufficient reduction potentials to reduce the level of emissions well below the stabilization target. However, the Austrian Government is fully aware that it has to increase its efforts to ensure further reductions. Moreover, it recognizes that any attempt to reduce greenhouse gas emissions requires a long time before it produces a significant effect. Thus, even if all the necessary governmental decisions have been taken prior to 2005, it may take several years before it will be possible to reach the Toronto target.

1.4. Emission Inventory for Austria

In Austria annual emission inventories for ozone precursor substances such as nitrogen dioxide (NO_x), carbon monoxide (CO), volatile organic compounds with the exception of methane (NMVOC) and for the greenhouse gases carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) because of their supraregional significance and significance in terms of quantity have been drawn up. These emission inventories are subdivided according to the sectors power and heating plants, industry, small consumers and motor vehicle traffic as well as the fuels oil, natural gas and coal.

In Austria emission inventories go as far back as 1980 for NO_x, NMVOC and CO and 1955 for CO_2. No emission trends over time can be given for CH_4 and N_2O since comprehensive emission inventories for these greenhouse gases have only been compiled since 1990.

Table 1.1 lists Austria's emissions for the air pollutants CO_2, CH_4, N_2O, NO_x, NMVOC and CO for 1990. Emissions were determined according to the IPCC method. Pyrogenic as well as process-related emissions have been taken into account.

Table 1.1: Austrian greenhouse gas and air pollutant emissions for 1990 (in 1,000 metric tons; CO_2 in 10^6 metric tons), determined in accordance with the IPCC method.

CO_2	CH_4	N_2O	NO_x	NMVOC	CO
59.2	602.8	4.1	225.5	415.4	1,682.5

Emissions from bunker fuels were not taken into account.

1.5. Projections of Greenhouse Gas Emissions and Reduction Potentials for Austria

With respect to CO_2, the reduction target committed to by Austria, in agreement with the recommendations of the 1988 Toronto Conference, is a 20% reduction in CO_2 emissions by 2005 based on the emissions in 1988.

Five CO_2 emission scenarios have been prepared for Austria. In view of the secondary importance of the process related emissions, in relation to the overall emissions, presently and in future, and to facilitate comparison of different scenarios, the five scenarios focus only on pyrogenic emissions to generate a Toronto target that only accounts for pyrogenic CO_2 emissions, that is 42.4 Mt CO_2/year in 2005.[1]

Three of the five scenarios - a reference scenario (Ref), a stabilization scenario (Stab), and a reduction scenario (Red) - have been prepared by the Austrian Institute of Economic Research (IER) on behalf of Austria's Federal Ministry of Economic Affairs (FMEA). The time horizon of these scenarios is 2005. The other two scenarios, an additional reference scenario (FEA '92) with a time horizon till the year 2005 and an additional reduction scenario (NEnvP) with a time horizon till the year 2025, have been prepared by Austria's Federal Environmental Agency (FEA) and on behalf of Austria's Federal Ministry of Environment, Youth and Family Affairs for its National Environmental Plan (NEnvP), respectively. The various scenarios are illustrated in Figure 1.1, and may be characterized in the following simplified way:

The IER scenarios as well as the FEA '92 scenario originate from the same (IER) energy statistics, which was slightly updated for the more recent IER scenarios.[2] Therefore, IER's reference scenario (Ref) and FEA's reference scenario (FEA '92) are very similar. The main assumptions behind this scenario, i.a., are a mean annual economic growth between 2.5 and 3.0%, constant real energy prices domestically, and ongoing efforts to optimize the use of energy as well as to promote renewable and environmentally more friendly energy sources.

* On the basis of the Ref scenario, it is anticipated that Austria is going to emit about 63.7 and 66.6 Mt CO_2 in the years 2000 and 2005. This corresponds to increases of 10 and 15%, respectively, relative to 1990 (57.8 Mt CO_2 according to IER).

  The mean annual energy and carbon intensities that underlie the Ref scenario are about -1.5 and -0.3% per year (1990-2000 annual growth rates), or -1.4 and -0.3 per year (1990-2005 annual growth rates), respectively.

Both the IER stabilization (Stab) and the IER reduction scenario (Red) describe a situation in Austria, in which CO_2 emission reductions would be realized on the basis of additional savings in energy and structural changes. Otherwise, the overall economic conditions are similar to those assumed for the Ref scenario.

The reduction scenario assumes an increase in energy efficiency, which will generate energy saving potentials that are generally considered to be economically feasible, while the stabilization scenario utilizes the energy saving potential only by about one third. The energy saving potentials reported by the FMEA were used as input values for the scenario calculations.

* The Stab scenario aims at reducing Austria's CO_2 emissions down to the level of 1990, that is 57.8 Mt CO_2/year, by 2005. This effort requires an energy intensity and a carbon intensity of about -2.1 and -0.5% per year, respectively (1990-2005 annual growth rates).

* On the basis of the Red scenario, it appears that there may be a possibility for Austria to reduce its emissions down to about 47.8 and 42.8 Mt CO_2/year by the years 2000 and 2005. This corresponds to decreases in the order of 17 and 26%, respectively, relative to 1990.

  The mean annual energy and carbon intensities are about -3.8 and -0.7% per year (1990-2000 annual growth rates), or -3.8 and -0.8% per year (1990-2005 annual growth rates), if the Red scenario is to be realized until 2000 or 2005, respectively.

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[1] So far, only the process related emissions of Austria's cement industry have been taken into account. They contribute and are expected to continue contributing to Austria's overall emissions by about 2.1 Mt CO_2/year, i.e., {42.4 + (2.1 * 0.8)} Mt CO_2/year = 44.1 Mt CO_2/year.

[2] The demographic data that underlie the updated energy statistics, however, do not take into consideration potential effects such as Austria's recent decision to join the EU.

The NEnvP reduction scenario, finally, also employs IER's most recent energy statistics, but follows a bottom up approach. It builds on generous assumptions with regard to the development of the required energy services. For instance, from 1990 to 2005 Austria's population is allowed to increase by 15%, residential area by 10%, or mobility (in kilometres per capita) by 44%. The scenario also builds on generous approximations with regard to the development of energy application and transformation technologies; only technological options that are within realistic reach, are considered.

* On the basis of the NEnvP scenario, Austria's CO_2 emissions are reduced down to about 46.2 and 41.2 Mt CO_2/year by the years 2000 and 2005. This corresponds to decreases in the order of 18 and 27%, respectively, relative to 1990 (56.4 Mt CO_2 in this scenario).

  The mean annual energy and carbon intensities are about -1.9 and -1.2% per year (1990-2000 annual growth rates), or -2.0 and -1.3% per year (1990-2005 annual growth rates), if the NEnvP scenario is to be realized until 2000 or 2005, respectively.

Temporary removal of CO_2 from the atmosphere, on the other hand, is confined to a few measures that are not yet implemented. The (1990-2005) annual removal rate as the result of afforestation (ca. 2.5 Mt CO_2/year), changes in the forest management (ca. 4.1 Mt CO_2/year), and doubling the use of wood products with a long life-span (ca. 0.2 Mt CO_2/year) would be about 6.8 Mt CO_2/year. This value, however, constitutes rather a potential removal rate and therefore an upper limit.

With respect to CH_4 and N_2O the most recent emission projections for 2000 have been developed by Orthofer and Hackl, 1993, Steinlechner et al., 1994 and Orthofer and Knoflacher, 1994. In 2000 about 600,000 t CH_4 and about 4,200 t N_2O will be emitted accordingly.

1.6. Policies and Measures of Austria

The Interministerial Committee to Coordinate Measures to Protect Global Climate (IMC Climate) has - i.a. based on the Energy Concept 1993 - elaborated a detailed catalogue of measures to support Austria's efforts in reducing its greenhouse gas emissions. This catalogue contains measures, which are already being realized, which are planned to be taken within the next legislative period (1994-1998), or which are in a conceptual stage and will eventually require more time to be realized and to become effective.

The measures under realization are summarized in Table 4.1 in Chapter 4.2. Most of them aim at reducing CO_2 emissions, although some of them refer also to other greenhouse gases. They are grouped according to energy supply and transformation, traffic, industry, small consumers, agriculture, and cross-sectorial measures.

Only for part of the measures has the reduction effect in 2000 been estimated. For these measures the combined reduction effect in 2000 amounts to ca. 4.3-5.1 Mt CO_2/year as a first and crude approximation reflecting the present state of knowledge. Considering the projected increase of Austria's CO_2 emissions from 57.8 Mt CO_2 in 1990 to 63.7 Mt CO_2 in 2000 according to the IER reference scenario (Ref), the measures quantified so far may hardly be sufficient to counterbalance the increase since 1990.

Considering also those measures in Table 4.1, which have or could not yet been quantified, it might be possible for Austria, according to preliminary estimates, to stabilize its CO_2 emissions by the time period around 2000 to 2005. It must be kept in mind, however, that the IER reference scenario already utilizes a specified set of assumptions and measures aimed at optimizing the use of energy. The extent, to which the effect of current measures will meet or exceed the reduction of CO_2 emissions projected in the IER reference scenario, needs still to be analyzed.

Combining the current measures with additional measures, which are planned to be enacted during the next legislative period, a considerable number of additional possibilities to reduce Austria's CO_2 emissions is given. It is the entire set of measures, i.e., the interaction of measures among each other, which contain a CO_2 reduction potential that is very difficult to quantify and which may eventually lead to a reduction well below a stabilization. However, given the fact that most emission reduction measures require a considerable time before they have reached a widespread implementation and can provide a reduction effect that aims for more than a stabilization, it is therefore essential that an optimum timetable needs to be established ensuring a speedy implementation of the identified measures without unnecessary delay. This is in agreement with the recommendations put forward by the Austrian CO_2 commission.

1.7. Vulnerability Assessment of Climate Change and Adaption Measures for Austria

Europe's mountains are particularly vulnerable to climate change. The intricate topography of mountain environments complicates weather patterns, making it difficult to project the specific impact of climate change in these regions. Nevertheless, it is clear that climate change will add to the current strong stresses on Europe's mountain regions, which are already threatened by pollution and population pressures.

For Austria it is anticipated that a doubling of atmospheric CO_2 relative to pre-industrial concentration levels, as to be expected during the first half of next century, will result in an increase in temperature with a maximum in winter (of about 3 C, compared to about 2 C mean annually), an increase in winter precipitation (of about 10 - 20%), a decrease of precipitation during summer, and a decrease in the number of days with snow cover by 10 - 20 days per degree Celsius and year up to altitudes of 2,500 m.

Furthermore, it seems to be likely that a snow cover of at least one month will occur only from 500 m on, if temperature will increase by 2 C at all altitudes. All Austrian glaciers would diminish, many of them would disappear completely. Winter snowfall would decrease in favour of rain, thus increasing run-off. By way of contrast, potential summer evaporation would be higher, thus decreasing run-off.

Forests typically take centuries to adapt to new conditions and so would be especially hardhit. Considering the upset of sensitive stages in the life-cycle of most species, furthermore the fact, that the condition of protective forests is unsatisfactory, because i.a. a significant part of its rejuvenescence is destroyed by deer and therefore prevented, and in addition air pollution and other stress factors such as the encouragement of detrimental insects and biological pathogens, the increase of forest fires and the occurence of severe storms and the warming as such, it is anticipated that the overall result of climate change - dependent on the ecological amplitude of tree species and on adaptation measures in forestry - could lead to a change of composition of tree species and to a partial deforestation in the mountains of southern and central Europe. In already dry regions of Austria forest steppe may expand.

Shallow lakes and the more running waters will experience serious impacts in that the biodiversity will change - cold stenotherm species, e.g., may be strongly decimated or even eliminated - and the biomass of specific organisms will increase. A decoupling of food chains is to be expected. During the warmer seasons of the year an increase in precipitation of calcium due to increased photosynthesis may devastate lakesides of lakes that are already rich in calcium.

Mountain economies may be undermined. A 1 C rise in average temperatures combined with winter drought may reduce the duration of Alpine snow cover at 1,500 m altitude by 40%, with enourmous consequences for tourism and the skiing industry. Drier weather conditions would also lead to a deterioration of energy and water supplies, navigation, and health conditions.

Except for measures aiming at afforestation and changing forest management, Austria has not yet elaborated a detailed program of adaption measures.

Fig. 1.1: Development of Austria's pyrogenic CO_2 emissions on the basis of the total energy use. Process related CO_2 emissions are not taken into account. IER reference scenario: Ref; IER stabilization scenario: Stab; IER reduction scenario: Red; actual statistical data of the Austrian Federal Environmental Agency: FEA; FEA reference scenario based on IER's 1991 energy reference scenario: FEA '92; NEnvP reduction scenario: NEnvP; Austria's Toronto target reduced by its process-related CO_2 emissions (see text): Toronto. Sources: Bundesministerium f. wirtschaftl. Angelegenheiten, 1993; Musil, 1993, modified; Umweltbundesamt, 1992, 1994. (Figure 1.1 is not available electronically)

Chapter 2.

Introduction

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

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

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

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

At the Toronto Conference in 1988, an action plan was recommended which, inter alia, calls for the 1988 CO_2 emission levels to be reduced by 20% and energy efficiency world-wide to be increased by 10% by the year 2005. The Conference also recommended that a comprehensive framework convention be drawn up on the protection of the earth's atmosphere.

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

With the adoption of Resolution 45/212 in late 1990, the UN General Assembly set up an organisational framework for negotiating a convention on measures needed to control the anthropogenic greenhouse effect. This resolution called for a negotiating process to be conducted within an "intergovernmental negotiating committee to prepare an effective framework convention on climate change, containing appropriate commitments and any related instruments as might be agreed upon."

Austria participated actively in the work of this Intergovernmental Negotiating Committee (INC/FCCC). After five rounds of negotiations, the consultations yielded a text which was adopted by 157 States on 9 May 1992 and subsequently signed in June 1992 at the UNCED by 158 States, Austria among them.

The Convention entered into force world-wide on 21 March 1994 (90 days after the date of deposit of the fiftieth instrument of ratification). The Austrian ratification process was completed on 28 February 1994, which meant that the Climate Convention entered into force for Austria on 29 May 1994.

The INC/FCCC has continued to meet in the interim to ensure the continuation of work on the implementation of the Convention and particularly on the preparations for the First Conference of the Parties (COP 1).

The First Conference of the Parties will be held in Berlin in late March/early April 1995.

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

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

Austria would have preferred the Convention to have contained clear targets and timetables for reducing the emissions of greenhouse gases. Nevertheless, the Convention was a crucial first step in that direction, laying a foundation on which future protocol negotiations can be based.

Mention should also be made of the Austrian initiative at the UNCED, the "like-minded declaration". In this joint declaration by Austria, Switzerland and Liechtenstein at the signing of the Framework Convention on Climate Change, the countries committed themselves to a target of stabilising the CO_2 emissions at their 1990 level by the year 2000 as an initial step and of reducing the emissions of CO_2 and other greenhouse gases thereafter. A declaration to the same effect was also issued by the European Community.

Beyond that, Austria has also committed itself to the "Toronto Target" which calls for CO_2 emission levels from 1988 to be reduced by 20% by the year 2005. This target is laid down in writing in the 1990 and 1993 Energy Reports of the Austrian government.

In the international arena, Austria will continue to push for the speedy negotiation of protocols under the Convention so that binding targets and schedules can be established to reduce the emissions of climate-related gases at a global level.

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

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

The developed countries among the first fifty States ratifying the Convention are obligated under Articles 4.2 and 12 of the Convention to submit a First National Communication to the secretariat of the Intergovernmental Negotiating Committee by 21 September 1994. Austria declared its willingness at the 9th session of the INC in February 1994 also to submit its National Communication by 21 September 1994. It did so to ensure that the Austrian National Communication would be on the agenda at the first Conference of the Parties to be held in the spring of 1995. A later submission of the Communication (as late as 29 November 1994 according to the date on which the Convention entered into force in Austria) would have prevented it from being on the agenda. This would have made it impossible for Austria to bring up its progressive position on climate policy in the international discussion.

The basic structure and individual items contained in the National Communication were set by the INC and based on work done by the OECD/IEA. The National Communication in Austria was elaborated in accordance with these guidelines by the IMC Climate (Interministerial Committee for the Co-ordination of Measures on the Protection of Global Climate - see Chapter 4.2 "Outline of the National Strategy"). The text was co-ordinated and harmonised among the departments competent for the subject matter.

The following were instrumental in the preparation of the report:
IIASA - International Institute for Applied Systems Analysis: Dr. Matthias Jonas
GEM - Global Environmental Management: Prof. Bo R. Döös, Krzysztof Olendrzynski
ÖFZS - Austrian Research Centre Seibersdorf: Dr. Rudolf Orthofer, Dipl.-Ing. H. Markus Knoflacher
Univ. Prof. Dipl.-Ing. Dr. Albert Hackl, Chairman of the National CO_2 Commission
ZAMG - Central Institute for Meteorology and Geodynamics: Dr. Hartwig Dobesch, Assistant Professor
The Federal Ministries of:
Science and Research: Mag. Buzeczki
Economic Affairs: Dr. Gerald Vones
the Public Sector and Transport: Mag. Evelinde Grassegger
Agriculture and Forestry: MR Dr. Kastner, Dipl.-Ing. Dr. Schwaiger
Environment, Youth and Family Affairs: Dr. Raimund Quint (unit II/3)
Federal Environmental Agency: Dipl.-Ing. Erich Grösslinger, Dipl.-Ing. Josef Hackl

The Federal Ministry of Environment, Youth and Family Affairs, Unit I/9 (Dr. Helmut Hojesky, Dr. Barbara Kronberger-Kiesswetter, Birgit Kaiserreiner), co-ordinated the production of the National Climate Report, submitted its own contributions to it, and took on the editing tasks of revising and compiling the report.

Other references are listed in Annex III (bibliography).

The Austrian Council of Ministers took official notice of this report on 17 August 1994.

Chapter 3.

Causes and impacts of the greenhouse effect, taking into account sinks of greenhouse gases

3.1 Fundamentals

The greenhouse effect

The earth's surface and the atmosphere absorb a large portion of the short-wave radiation from the sun and are thereby heated up. At the same time, they emit energy as long-wave radiation into space in accordance with their temperature. This irradiance corresponds in its mean annual global amount to the energy of the short-wave solar radiation; i.e. the system is in radiative equilibrium.

The temperature on the earth's surface depends to a significant extent on atmospheric water vapour, carbon dioxide, ozone and other atmospheric gases, which let pass short-wave radiation readily while absorbing quite effectively long-wave radiation. The resulting re-emission of long-wave radiation to the earth's surface causes the natural greenhouse effect.

Without this natural greenhouse effect, the average temperature near the surface of the earth would be -18°C instead of the +15°C it is today.

Since the onset of industrialisation, human activities have increased the concentration of atmospheric gases affecting the climate. Other greenhouse gases, especially chlorofluorocarbons (CFCs), have also been released into the atmosphere, thus intensifying the natural greenhouse effect. This phenomenon is referred to as the additional or anthropogenic greenhouse effect.

In global terms, the greenhouse gases below were responsible for the following percentages of the anthropogenic greenhouse effect from 1980 to 1990 (Deutscher Bundestag, 1992):

CO_2	50%
Methane	13%
Tropospheric ozone	7%
Nitrous oxide	5%
CFCs	22%
Stratospheric water vapour	3%

Characteristics of key trace gases relevant to the climate

Carbon dioxide (CO_2):
The most important anthropogenic greenhouse gas is CO_2. Its mean tropospheric mixing ratio has risen from approx. 280 ppm in the preindustrial age to a current level of approx. 355 ppm, its highest level within the last 160,000 years. The mean tropospheric mixing ratio is currently increasing around the globe at a rate of 0.5% a year. Anthropogenic CO_2 is estimated to remain in the atmosphere for a period of 50 to 200 years depending on the weighting and consideration given to the deep oceans and terrestrial biosphere as intermediate reservoirs.

Methane (CH_4):
Atmospheric methane is a trace gas which has a direct and an indirect effect. Its mean tropospheric mixing ratio is currently at approx. 1.74 ppm, i.e. more than twice its preindustrial value of approx. 0.8 ppm. Its concentration is currently increasing at 0.75% a year.

Halogenated hydrocarbons (CFCs):
Halogenated hydrocarbons are the climate-relevant trace gases with the highest global warming potential due to their high radiation effectiveness and their prolonged atmospheric lifetime. The fully halogenated and the partly halogenated hydrocarbons have no natural sources. They are virtually all industrial in

origin. The mean tropospheric mixing ratio for R11 is currently at about 280 ppt and for R12 at about 480 ppt (ppt = parts per trillion); the annual growth rates are approx. 4%.

Nitrous oxide (N_2O):
This trace gas could become even more significant in its global warming potential. There is still insufficient knowledge about its atmospheric cycle, especially the magnitude of possible sources and sinks. The mean tropospheric mixing ratio of N_2O is now at about 311 ppb and is currently rising at a rate of approx. 0.25% a year.

No firm figures can be given with regard to the mixing ratios and their development over time for the greenhouse gases ozone (O_3) and stratospheric water vapour (H_2O) since the concentration of these gases fluctuates so greatly in time and place.

Owing to to their different physical and chemical properties, the greenhouse gases contribute in varying degrees to the greenhouse effect. The global warming potential, or GWP, is the measure for the warming effect calculated globally relative to CO_2 (see Table 3.1).

While the direct effects of radiation are relatively easy to determine applying physical laws, it is still very difficult to quantify indirect radiation effects arising from the interactions of the greenhouse gases among themselves.

Table 3.1: Global warming potential (in kg) and mean lifetime of the key greenhouse gases in the atmosphere based on 1 kg CO_2 (direct effects only; pos. or negative character of indirect effects is also indicated).

Gas	Lifetime (in years)	Global warming potential (kg) for periods of 20 years	100 years	500 years	Indirect effects
CO_2	~ 120.0	1	1	1	-
CH_4	10.5	35	11	4	pos
N_2O	132.0	260	270	170	?
R11	55.0	4,500	3,400	1,400	neg.
R12	116.0	7,100	7,100	4,100	neg.

Based on the above table and disregarding indirect effects, the following contributions to the greenhouse effect can be calculated for the time horizons 20 years and 100 years utilising the Austrian emissions of 1990 (Table 3.2):

Table 3.2: Contribution of greenhouse gases to anthropogenic greenhouse effect based on the greenhouse gas emissions in Austria in 1990 (in %)

Greenhouse gas	20 years time horizon	100 years time horizon
CO_2	57.2%	71.8%
CH_4	20.4%	8.0%
N_2O	1.0%	1.3%
Fully halogenated CFCs	12.8%	14.8%
Partly halogenated CFCs	8.6%	4.1%

Because of the great uncertainties in determining the global warming potential of the individual greenhouse gases one should refrain from weighing measures or strategies to reduce the emissions of various gases against each other or from not taking up measures simply because they might be less effective. Nor should the differences in global warming potential be used as an excuse for refraining from action.

The natural fluctuations in climate, for which no clear upward or downward trends are emerging as they are for climate change, create a certain amount of "statistical noise" in the climatological observations on the impact of the additional greenhouse effect, i.e. the impending climate change has not yet been unequivocally proven. However, there are several clear indications of it, such as the increase in the earth's mean temperature by 0.3 to 0.6°C and the rise in sea levels by 10 to 20 cm over the last 100 years as well as a marked increase in the incidence of extreme weather situations over the last 10 to 15 years.

Uncertainties about the magnitude of climate change also arise from atmospheric processes which shut out short-wave solar radiation and thus tend to contribute to the cooling of the earth's atmosphere. One such process is the release of dust particles into the atmosphere by volcanic eruptions, such as the recent eruptions of Mount Pinatubo. Another is a rise in the concentration of sulphate aerosols released into the atmosphere by combustion processes.

Nevertheless, all of these uncertainties should not lead us to postpone measures to reduce the emissions of greenhouse gases. The longer we allow the concentration of greenhouse gases in the atmosphere to continue to increase, the more drastic will be the measures we must undertake to stem this increase, let alone reverse it. The necessary decisions must be made now; the Framework Convention on Climate Change is a crucial first step in that direction.

Forecasts on the possible consequences of the greenhouse effect

According to a calculation by the Intergovernmental Panel on Climate Change (IPCC 1990), the global mean temperature could rise by 1.5 to 4.5°C over its present value by the end of the next century if the emissions of greenhouse gases continue to increase at their current rate. This rise translates into an average increase of 0.3°C per decade, a rate three times faster than natural ecosystems can bear according to current scientific knowledge. Climatic zones would shift more rapidly than vegetation zones; a corresponding change in soil types would take centuries at the very least.

This development would have the following effects, inter alia:

Sea level rise:
Global warming up until now has caused a sea level rise of approx. 10 to 20 cm over the last 100 years. If this trend continues, the sea level is expected to rise approx. 65 cm by the end of the 21st century as a result of the thermal expansion of sea water and the melting of continental glaciers. As the sea level rises, many coastal areas and islands will disappear under water, millions of people will be driven from their homes, coastal cities and fertile land will be flooded and ground water reservoirs along the coasts will be salinised.

Changes in precipitation quantities:
The increase in temperature will lead to a change in wind circulation, which in turn will affect the global distribution of precipitation. Although overall precipitation quantities increase as temperatures and the rates of evaporation rise, major regional changes in the frequency and intensity of rainfall will occur. These changes will have substantial effects on agricultural and forestry production, effects made all the worse by the drying up of the soils due to the higher rates of evaporation.

Natural ecosystems:
Natural ecosystems will be especially hard hit by the increase in temperature and the changes in precipitation and evaporation. Climate change will shift global vegetation zones toward the poles, with an increase in the earth's mean temperature of just 1°C causing a shift of some 200 km. Given the projected warming of 0.3°C per decade, most ecosystems will not be able to adapt to the changed conditions and will be threatened with collapse. In many regions, the high proportion of used land will further exacerbate this effect, greatly limiting the areas in which natural ecosystems could otherwise evade the changes. Widespread forest dieback is expected in the middle to high latitudes.

Agriculture:
Agriculture could be confronted with problems of an unprecedented magnitude. As global warming increases, a shift in the growing zones will occur. Plant growth will be threatened by the redistribution of precipitation, the increase in UV-B radiation and the changed chemical composition of the atmosphere.

The already problematic task of supplying food in certain regions of the world will become even more difficult.

Snow cover:
A rise in temperature of just one or two degrees will markedly reduce snow cover in the moderate zones of both hemispheres. According to the findings of a recently published study, a rise in temperature of 3°C would cut in half the amount of land covered by snow in New Zealand. In polar regions, the global warming will increase evaporation and precipitation, which could also cause an increase in snowfall.

Snow cover has a major effect on climate. Snow reflects a large amount of the solar radiation striking it, thus preventing the earth from absorbing excess amounts of heat. A reduction in snow cover would lead to a further warming of the earth's atmosphere as a result of positive feedback. The same holds true for the melting of the glaciers, which can now be observed especially in the Alps and the Andes.

Chapter 3.4 contains more detailed information on the possible effects of the anthropogenic greenhouse effect.

The latest scientific findings point to another aspect of the climate problem. The prolonged relative stability of climate over the last 10,000 years or so appears to be an anomaly in climate history. The predicted increase of CO_2 in the atmosphere could destabilise the counterbalanced global climatic system, causing abrupt temperature jumps of several degrees upward as well as downward within a matter of decades, as occurred during the Eem interglacial period some 120,000 years ago.

The relative stability of the climate over the last 10,000 years is often attributed to the relatively low concentration of CO_2 in the atmosphere, which is less than it was during the Eem interglacial period. According to this theory, the release of CO_2 from the combustion of fossil fuels is now pushing the concentrations of CO_2 back up to the same high levels prevailing in earlier periods of the earth's history, which could lead to a return of the unstable climatic conditions of these earlier periods.

According to this theory, the release of greenhouse gases into the atmosphere could lead not only to the expected warming within the current stable situation, but as a result of destabilisation, to abrupt transitions to other climatic conditions as well.

3.2 Greenhouse gas emissions and emissions from ozone precursors

Annual emission inventories have been drawn up in Austria for the following greenhouse gases due to their quantitative and supraregional significance: carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) as well as for the ozone precursors nitrogen oxides (NO_x), carbon monoxide (CO), and volatile organic compounds with the exception of methane (NMVOC). These emission inventories were divided into the sectors power and heating plants, industry, small consumers (residential, commercial, institutional), and motor vehicle traffic and into the fuels oil, natural gas, and coal.

The calculations for the emissions of large emitters, such as power and heating plants and large industrial plants, were arrived at by analysing the emissions statements required to be drawn up annually under the air pollution control law for steam boiler installations, and by multiplying the consumed fuel quantities (WIFO 1991) by the emission factors specific to each fuel (Bundesministerium f. wirtschaftl. Angelegenheiten, 1990). The emissions from industry and the small consumers were arrived at by multiplying the consumed fuel quantities (WIFO 1991) by the emission factors specific to each type of fuel and installation (BMwA, 1990). Emissions relating specifically to production were determined by multiplying the production units by the emission factors specific to each type of production and installation (Ahamer 1989, CITEPA 1993).

The pollutant emissions caused by motor vehicle traffic were determined by taking account of the total number of vehicles, the average annual volume of driving by the individual vehicle categories, and specific emission factors. The fuel consumption of motor vehicle traffic was calculated using the same method. By way of control, the results of these calculations were subsequently compared with the data found in the available fuel consumption statistics (ÖMV AG, 1993).

3.2.1 Emission quantities and their change over time

Carbon dioxide (CO_2)

In 1990, some 59.2 million metric tons of CO_2 were emitted, most of it generated by the firing of fossil fuels and only a small portion by industrial processes. Table 3.3 presents the CO_2 emissions and the percentage share of total CO_2 emissions attributed to the individual fuels and sectors. The figures are broken down by the fuels coal, oil, natural gas, other, and process-related emissions (e.g. cement industry) and by the sectors electric power generation, district heating, industry, motor vehicle traffic, small consumers, and energy.

Table 3.3: CO_2 emissions in Austria in 1990 (in 1,000 metric tons)

Oil	30, 219	51.10%	Power generation	11,519	19.4%
Coal	13,591	23.00%	District heating	2,183	3.7%
Natural gas	12,784	21.60%	Industry	14,409	24.3%
Other	505	0.85%	Motor vehicle traffic	16,184	27.3%
Processes	2,100	3.50%	Small consumers	12,094	20.4%
			Energy sector	2,810	4.7%
Total	59,199		Total	59,199	

Source: Umweltbundesamt, 1993b

The following emission factors were used to determine the CO_2 emissions (see Table 3.4):

Table 3.4: CO_2 emission factors (in kg/TJ) (Bundesministerium f. wirtschaftl. Angelegenheiten, 1990)

Hard coal	107,000
Brown coal	101,000
Fuel oil	78,000
Natural gas	52,000

The Austrian CO_2 emissions have levelled off in recent years at between 55 and just over 60 million metric tons after a period of rapid economic growth had caused them to double from approx. 30 to some 60 million metric tons between the late 50's and early 70's (see Table 3.5 and 3.6 as well as Fig. 3.1).

Tables 3.5 and 3.6 present the changes in CO_2 emissions since 1955. The data is broken down by the fuels coal, oil, natural gas and industrial processes and by the sectors electric power generation, district heating, industrial combustion, industrial processes, small consumers and energy sector. The anthropogenic CO_2 emissions rose by 111% between 1955 and 1990.

Table 3.5: Change in anthropogenic CO_2 emissions (in 1,000 metric tons) since 1955 broken down by the fuels coal, oil, natural gas, other, and industrial processes as well as total emissions.

Year	Coal	Oil	Gas	Other	Ind. proc.	Total
55	18,344	5,483	3,336	0,000	0,926	28,089
56	19,009	5,975	3,830	0,000	0,965	29,779
57	19,306	6,309	4,134	0,000	1,061	30,810
58	17,343	6,853	4,033	0,000	1,074	29,303
59	16,841	7,809	4,621	0,000	1,204	30,475
60	17,285	8,903	5,709	0,000	1,410	33,307
61	17,206	9,762	5,895	0,000	1,537	34,400
62	17,886	11,497	5,828	0,000	1,524	36,715
63	19,316	13,304	5,874	0,005	1,651	40,150
64	18,214	15,193	5,959	0,005	1,898	41,269
65	16,625	16,306	5,785	0,005	2,025	40,746
66	15,496	17,453	5,975	0,005	2,244	41,173
67	14,852	19,442	5,792	0,006	2,267	42,359
68	14,968	21,695	6,289	0,007	2,269	45,228
69	15,856	24,127	7,369	0,007	2,283	49,642
70	15,166	26,413	8,588	0,013	2,472	52,652
71	13,626	29,297	9,240	0,018	2,798	54,979
72	12,537	32,020	9,690	0,019	3,190	57,456
73	12,602	35,095	10,085	0,041	3,133	60,956
74	13,281	30,815	10,684	0,046	3,236	58,062
75	11,479	31,301	10,112	0,046	2,813	55,751
76	12,821	33,195	11,012	0,052	2,943	60,023
77	10,647	32,775	10,630	0,051	3,008	57,111
78	10,734	34,773	11,037	0,084	2,862	59,490
79	12,425	35,465	11,094	0,123	2,797	61,904
80	12,523	35,148	10,665	0,144	2,719	61,199
81	12,716	31,494	10,135	0,161	2,637	57,143
82	12,253	30,507	9,835	0,189	2,450	55,234
83	12,724	28,797	10,190	0,203	2,446	54,360
84	14,614	27,028	11,485	0,234	2,442	55,803
85	14,478	27,794	12,153	0,268	2,273	56,966
86	12,645	29,166	11,948	0,298	2,278	56,335
87	13,251	29,460	12,267	0,321	2,254	57,553
88	12,015	28,812	11,839	0,360	2,100	55,126
89	11,986	28,448	12,608	0,373	2,100	55,515
90	13,591	30,219	12,784	0,505	2,100	59,199
91	14,012	31,816	15,552	0,373	2,100	63,853
92	11,000	30,400	15,300	0,400	2,100	59,200

Table 3.6: Change in CO_2 emissions (in 1,000 metric tons) since 1955 broken down by the sectors electric power generation, district heating, industrial combustion, industrial processes, traffic, small consumers and the energy sector (own-energy use at power plants and refineries)

Yr	Power gen.	Distr. heat	Ind.comb.	Ind.proc.	Traffic	Small cons.	Energy
55	3,727	0,000	10,186	0,926	4,650	7,109	1,491
56	3,946	0,000	11,093	0,965	4,967	7,275	1,533
57	4,019	0,000	11,371	1,061	4,893	7,877	1,589
58	3,353	0,000	11,004	1,074	5,115	7,269	1,488
59	4,316	0,000	11,185	1,204	5,301	7,053	1,415
60	4,300	0,000	12,835	1,410	5,810	7,571	1,381
61	5,423	0,000	12,645	1,537	6,088	7,371	1,335
62	5,945	0,000	12,275	1,524	6,546	9,104	1,341
63	6,740	0,002	12,148	1,651	7,060	11,169	1,379
64	7,342	0,002	13,012	1,898	7,391	10,090	1,532
65	5,972	0,003	13,018	2,025	7,818	10,378	1,532
66	6,336	0,003	12,823	2,244	8,352	9,891	1,524
67	6,505	0,003	12,502	2,267	8,506	11,103	1,473
68	7,132	0,003	13,160	2,269	8,990	12,134	1,539
69	8,854	0,004	14,228	2,283	9,359	13,260	1,655
70	7,348	0,408	14,660	2,472	10,325	15,563	1,877
71	9,737	0,401	14,775	2,798	10,667	14,681	1,920
72	9,746	0,509	15,062	3,190	11,704	15,037	2,209
73	9,579	0,911	15,519	3,133	12,669	16,887	2,257
74	8,551	0,938	16,652	3,236	11,864	14,768	2,052
75	8,354	0,968	14,899	2,813	12,116	14,569	2,032
76	10,771	1,049	15,464	2,943	12,018	15,544	2,234
77	8,538	1,084	14,666	3,008	12,490	15,095	2,231
78	8,799	1,343	14,923	2,862	13,160	16,044	2,361
79	8,848	1,334	15,906	2,797	13,666	17,126	2,226
80	9,015	1,435	15,222	2,719	13,782	16,090	2,936
81	8,636	1,412	14,135	2,637	13,505	13,989	2,891
82	7,928	1,623	13,501	2,450	13,452	13,593	2,687
83	8,059	1,512	13,132	2,446	13,552	12,923	2,736
84	8,793	1,557	13,868	2,442	13,338	13,070	2,733
85	8,726	1,702	13,688	2,273	13,636	14,274	2,668
86	8,613	1,642	12,532	2,278	14,075	14,172	3,022
87	9,282	1,874	12,169	2,254	14,135	14,784	3,055
88	8,004	2,032	12,427	2,100	15,090	12,622	2,851
89	9,017	2,034	12,352	2,100	15,714	11,613	2,685
90	11,519	2,182	12,309	2,100	16,174	12,095	2,820
91	12,585	2,244	12,495	2,100	17,644	13,998	2,787
92	9,900	2,100	12,100	2,100	17,700	12,500	2,800

Table 3.7 below shows the percentage changes in anthropogenic CO_2 emissions between 1955 and 1990.

Table 3.7: Percentage change in anthropogenic CO_2 emissions between 1955 and 1990

Fuel	1955	1990	Change in %
Coal	18,344	13,591	-26%
Oil	5,483	30,219	+451%
Natural gas	3,386	12,784	+278%
Other	0,000	0,505	+505%
Ind. processes	0,926	2,100	+127%
Sectors			
Power generation	3,727	11,519	+209%
District heating	-	2,182	-
Industrial combustion	10,186	12,309	+21%
Industrial processes	0,926	2,100	+127%
Traffic	4,650	16,174	+248%
Small consumers	7,109	12,095	+70%
Energy sector	1,491	2,820	+89%

The Federal Environmental Agency calculated a tentative CO_2 emission value for 1993 of 57.4 million metric tons (not including process-related emissions) based on the monthly energy consumption statistics of ÖSTAT (Umweltbundesamt 1994b). With respect to the Toronto recommendation to reduce CO_2 emissions by the year 2005 by 20% in relation to its 1988 level, there is a discrepancy of some +34% between the CO_2 emissions for 1993 and the targetted CO_2 emissions for 2005.

<u>Methane (CH_4)</u>

The anthropogenic CH_4 emissions totalled 602,800 metric tons in Austria in 1990 (see Table 3.8).

Table 3.8: CH_4 emissions in Austria in 1990 (in 1,000 metric tons)

Power and heating stations	0.1
Small consumers	7.8
Industry	1.0
Motor vehicle traffic	15.3
Extraction and distribution of fossil fuels	91.8
Waste utilisation	228.2
Agriculture	258.6
Total anthropogenic emissions	602.8
Natural emissions	207.6
Total anthropogenic and natural	810.4

Source: Steinlechner et.al., 1994; Orthofer and Hackl, 1993

The major sources of methane emissions in Austria are agriculture, waste utilisation, the extraction and distribution of fossil fuels, and nature. Emissions from animal digestion, farmyard manure, liquid manure and pasture excrement account for 43% of the total anthropogenic CH_4 emissions in Austria; emissions from sewage treatment plants and landfills, for 38%; and emissions from the extraction and distribution of fossil fuels, for 15%. With regard to total CH_4 emissions (including ones from natural sources), the above percentages are 32%, 28% and 11%, respectively.

Figures on the change in CH_4 emissions over time cannot be included since comprehensive emission inventories have only recently begun to be kept.

Nitrous oxide (N_2O)

Since the estimate presented here for N_2O emissions in Austria is based on the standard method suggested by IPCC (1994), there are several, sometimes marked, deviations between it and the national estimates and figures already published (Bauer 1993, Hackl et.al. 1993, Orthofer and Hackl 1993, Vitovec 1991). This is particularly true of several emitter sectors which were not consciously taken into account in the IPCC method such as natural emissions from lightning strikes or the indirect anthropogenic sources from large area nitrogen deposits. In other cases, however, the reverse is true, i.e. an important emitter sector is included in the IPCC method which had not been included in the national inventories. The emissions from saltpetre production is one example.

To ensure comparability, the calculations are also based largely on the emission factors recommended by IPCC. These IPCC suggestions deviate substantially from the Austrian measured values for several of the emitters.

A total of 4,070 metric tons of N_2O was emitted in Austria in 1990 (see Tab. 3.9).

Table 3.9: N_2O emissions in Austria for 1990 (in 1,000 metric tons)

Power and heating plants	0.25
Small consumers	0.40
Industry	0.93
Motor vehicle traffic	0.46
Extraction and distribution of fossil fuels	--
Waste utilisation	--
Agriculture	2.00
Total	4.07

Source: Orthofer and Knoflacher, 1994

The main source of N_2O emissions is agriculture, followed by industry. Agriculture accounts for some 50% of total N_2O emissions.

Figures on the change in N_2O emissions over time cannot be included since comprehensive emission inventories have only recently begun to be kept.

Nitrogen oxides (NO_x)

NO_x emissions in Austria totalled 221,900 metric tons in 1990. The main sources of NO_x emissions were motor vehicle traffic (65%), industry (21%), power and heating plants (5.3%) and small consumers (5.2%). Table 3.10 and Figure 3.2 show the change in NO_x emissions from 1980 to 1990 divided by the sectors power and heating plants, industry, small consumers, motor vehicle traffic, solvents and other.

Table 3.10: Change over time of NO_x emissions in Austria (in 1,000 metric tons) for the period from 1980 to 1992

Year	1980	1983	1985	1987	1988	1989	1990	1992
Power- and heating plants	20.4	20.4	23.4	15.0	11.5	11.8	11.8	12.4
Industry	66.8	60.7	56.9	51.3	49.5	45.3	46.7	40.4
Motor V. Traff.	142.0	144.0	149.0	149.0	148.0	146.5	145.3	130.0
Small cons.	11.0	9.6	9.6	12.3	10.6	11.1	11.7	11.7
Solvents	-	-	-	-	-	-	-	-
Other	5.7	6.0	6.4	6.0	6.1	6.3	6.4	6.3
Total	245.9	240.7	245.3	233.6	225.7	221.0	221.9	200.8

Source: Umweltbundesamt, 1994a

NO_x emissions fell by 10% from 1980 to 1990 and were able to be further reduced by 9.5% from 1990 to 1992.

In the early to mid-80's, some 245,000 metric tons of NO_x were still being emitted each year. Through the use of catalytic converters and new combustion technologies, NO_x emissions from power and heating plants were reduced by 49% and those from industry by 30% between 1980 and 1990.

Despite the 1987 requirement making 3-way catalytic converters with lambda sonde mandatory for newly registered vehicles, NO_x emissions from motor vehicle traffic in 1990 were down just 2.4% from the 1987 figure; however, by 1992, these emissions were able to be reduced by an additional 13%. The reason is two-fold: the steady annual increase in the amount people drive and the long period required for this legal measure to have an effect.

Carbon monoxide (CO)

Carbon monoxide emissions in Austria in 1990 totalled 1,573,100 metric tons (see Table 3.11 and Fig. 3.2). The major emitters were small consumers (51%), motor vehicle traffic (28%), and industry (16%).

Table 3.11: Change in CO emissions in Austria (in 1,000 metric tons) for the period from 1980 to 1992

Year	1980	1983	1985	1987	1988	1989	1990	1992
Power- and heating plants	5.2	5.2	5.2	5.2	6.0	7.6	9.1	8.3
Industry	262.5	263.9	298.2	240.7	239.8	255.5	254.7	220.0
Motor V. Traff.	754.0	684.0	635.0	572.0	532.0	487.0	442.0	348.0
Small cons.	550.9	544.9	646.4	804.5	737.7	792.6	805.2	805.0
Solvents	-	-	-	-	-	-	-	-
Other	63.0	63.0	63.0	62.8	62.1	62.1	62.1	32.3
Total	1,635.6	1,561.0	1,647.8	1,685.2	1,577.6	1,604.8	1,573.1	1,413.6

Source: Umweltbundesamt, 1994a

By 1990, CO emissions had been reduced by a total of 7% from their peak in 1987 and were cut by an additional 10% between 1990 and 1992.

Whereas carbon monoxide emissions caused by small consumers have risen by 46% over the last ten years, those attributable to motor vehicle traffic and industry have been reduced by 41% and 3%, respectively, through the use of secondary measures and improved combustion technology.

Volatile organic compounds excluding methane (NMVOC)

Emissions of volatile organic compounds (NMVOC) totalled 430,300 metric tons in 1990. The main sources of them were motor vehicle traffic (30%), NMVOC emissions from the use of solvents (30%), and small consumers (23%). NMVOC emissions attributable to small consumers and to the use of solvents increased by 51% and 30%, respectively, from 1980 to 1990, while those attributable to traffic were actually cut during the same period by 6% (see Table 3.12 and Fig. 3.2). Total NMVOC emissions fell from 1990 to 1992 by 6.4%.

Table 3.12: Change over time of NMVOC emissions in Austria (in 1,000 metric tons) for the period from 1980 to 1992

Year	1980	1983	1985	1987	1988	1989	1990	1992
Power- and heating plants	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.6
Industry	30.6	31.0	30.8	31.4	31.6	32.0	31.9	31.7
Motor V. Traff.	138.0	143.0	147.0	146.0	140.6	135.0	129.5	114.0
Small cons.	65.5	67.0	75.4	95.7	89.3	97.2	98.9	100.8
Solvents	100.0	110.0	118.0	126.0	130.0	130.0	130.0	122.0
Other	39.8	39.8	39.9	39.7	39.5	39.5	39.5	33.5
Total	374.4	391.3	411.6	439.3	431.5	434.2	430.3	402.6

Source: Umweltbundesamt, 1994a

3.2.2 Emissions inventory according to the IPCC method

Based on the results of the CORINAIR Inventory for 1990 (see Chapter 3.2.3), an emission inventory was drawn up according to the IPCC system. The CH_4 emissions from traffic were not calculated with the COPERT program, but taken from a 1993 study by Orthofer and Hackl. The emissions of the pollutants CO_2, CH_4, N_2O, NO_x and NMVOC were assigned to the following categories according to the IPCC system (IPCC 1994):

1. Energy
2. Industrial Processes
3. Solvent Use
4. Agriculture
5. Land Use Change & Forestry
6. Waste

The IPCC Summary Report for National Greenhouse Gas Inventories according to the IPCC Manual (IPCC 1994) is contained in Annex II. A detailed description of the collected data can be found in Chapter 3.2.3.

The table below presents the results of the emission study carried out according to the IPCC system. There are certain differences between the figures in Table 3.13 and those in Tables 3.3, 3.5, 3.6 and 3.10 to 3.12 due to the calculation methods, the pre-set international emission factors and the statistics that were used.

Table 3.13: 1990 emissions of greenhouse gases and ozone precursors in Austria broken down by individual emitter groups according to the IPCC system (in 1,000 metric tons; CO_2 in millions of metric tons)

Group	NO_x	NMVOC	CH_4	CO	N_2O	CO_2
1	212.4	239.99	116.0	1,381.4	1.4	57.1
2	12.4	7.8	0.0	241.0	1.4	2.1
3	0.0	130.0	0.0	0.0	0	0
4	0.0	11.9	258.6	59.9	2.0	0
5	0.0	0.0	0.0	0.0	0	0
6	0.7	25.8	228.2	0.191	0	0
Total	225.5	415.4	602.8	1,682.5	4.8	59.2

Sources: Umweltbundesamt, 1993a; Orthofer and Knoflacher, 1994; Steinlechner et.al., 1994; Orthofer and Hackl, 1993

A total of 59.2 million metric tons of CO_2 was emitted in 1990.

Agriculture and waste utilisation account for 43% and 38%, respectively, of the total CH_4 emissions. 19% of the total CH_4 emissions are generated during the firing of energy operators.

94% of the NO_x emissions are caused by the firing of energy operators. A small percentage (5.5%) are generated as process-related emissions by industry.

The categories Energy and Solvent Use under the IPCC system are the main sources of NMVOC (57.7% and 31.3%, respectively).

The firing of fuels generated 82% of the total CO emissions; 14% of these emissions are process-related emissions in the industrial sector.

3.2.3 Emissions inventory according to the CORINAIR method

The first supranational project to ascertain the environmental situation in the European Community was carried out by the EC for the reference year 1985. The project, entitled CORINE, involved only the twelve member states of the Community. The project was updated for the year 1990 and other European countries not in the EC were invited to participate, among them Austria. The purpose of collecting data under the CORINE project is to draw up a report on the condition of the environment in Europe; the CORINAIR program covers just air quality. CORINAIR is an emission inventory which is set up to record the air pollutants nitrogen oxide (NO_x), volatile organic compounds (NMVOC), carbon monoxide (CO), nitrous oxide (N_2O), carbon dioxide (CO_2) and methane (CH_4). The emissions from motor vehicle traffic are calculated using the COPERT model, which can be linked to the CORINAIR program.

A uniform data structure is a key prerequisite for collecting comparable supraregional data. A binding list of emitters called SNAP 90 (Selected Nomenclature for Air Pollution) was drawn up for CORINAIR. According to this system, the emissions are divided according to the SNAP Code into the following categories:

1. Power and heating plants, district heating
2. Small furnaces: business, institutions and residential heating

3. Industry and combustion-related processes
4. Processes not involving combustion
5. Extraction and distribution of fossil fuels
6. Solvent use
7. Road traffic
8. Other traffic
9. Waste utilisation, landfills and sewage treatment plants
10. Agriculture
11. Nature

The table below presents the SNAP-based figures for emissions of greenhouse gases and the air pollutants CO_2, CH_4, N_2O, NO_x, NMVOC, and CO for the individual emitter groups in Austria in 1990. There are certain discrepancies between the emission figures in Table 3.14 and those in Tables 3.3, 3.5, 3.6 and 3.10 to 3.12 due to the calculation methods, the pre-set international emission factors and the statistics that were used. Figure 3.3 presents the percentage distribution by relevant emitter group for the classic air pollutants. The regional distribution splitted up into the federal provinces is shown in Figure 3.4.

Table 3.14: 1990 emissions of greenhouse gases and ozone precursors in Austria by individual emitter group according to the CORINAIR system (in 1,000 metric tons; CO_2 in millions of metric tons)

Group	NO_x	NMVOC	CO	CO_2	CH_4	N_2O
1	11.5	0.4	6.3	10.6	0.1	
2	11.7	100.3	779.9	12.5	7.8	0.7*
3	36.8	10.5	27.3	13.2	1.2	
4	12.4	7.8	241.0	**	**	**
5	**	15.8	**	**	91.6	**
6	0.0	130.0	0.0	0.0	0.0	0.0
7+8	152.3	112.5	567.7	13.9	2.7	1.0
9	0.7	25.8	0.2	<0.05	311.0	**
10	**	12.0	60.0	11.1	202.6	7.6
11	0.0	222.2	0.0	0.0	208.0	**
Total	225.4	637.3	1,682.4	50.2	825.0	9.3

Source: Umweltbundesamt, 1993a

* Total from groups 1, 2 and 3; impossible to assign to any single group
** Not yet known

The 11 categories are further subdivided into area and point sources, whereby emitters listed as point sources are defined according to the thermal output of fuel in a furnace or the production output of an enterprise.

To collect data on area sources, activity classes have been set up based on a combination of the SNAP Code and fuel. Corresponding amounts of fuel are assigned to these activity classes and converted into energy quantities by taking into account the territorial units using a top down method.

The energy quantities of the individual activity classes are derived from various statistics (ÖSTAT: Group 3-5; Federal Load Distributor: Group 6). The emissions are calculated using emission factors published in the 1990 Energy Report of the Austrian Federal Government (BMwA, 1990) and updated according to the latest findings (e.g. sulphur concentration in heating oil). Any missing emission factors are taken from the Default Emission Factor Handbook (CITEPA, 1993).

The emissions from point sources are determined individually with the help of emission statements. At the regional level, there are four different levels of data collection. The nine federal states (Bundesländer) were selected as the smallest collection units.

Methodology of emission inquiry in the individual groups:

Group 1:
Power stations operated by district heating companies and small-scale power stations (fuel thermal output < 50 MWth) are included as area sources. The figures for large firing/furnace installations with a fuel thermal output > 50 MWth are drawn from the emission statements required under the steam boiler law. The large-scale furnaces are divided into energy and heating supply companies. The use of fuel in these heating supply enterprises is subtracted from the district heating companies to avoid counting it twice.

Group 2:
The small furnaces are recorded solely as area sources. This group includes the categories residential heating, small businesses and services businesses, large-scale business and public administration.
The emissions under the category residential heating included only the pollutant emissions generated in conjunction with room heating and hot water heating. The quantities of fuel used in the category residential heating were determined using various statistics and an appropriate calculation model. The energy quantities used in small and large-scale business and in administration were determined from various statistics supplied by the Austrian National Statistics Office. The pollutant quantities were calculated by multiplying the fuel amount by the corresponding emission factor.

Group 3 and 4:
The industrial emitters were divided into three categories:

a) Combustion not involving contact with treated material (e.g. steam boilers, drying plants)
b) Combustion involving contact with treated material (e.g. sintering plants, cement plants)
c) Processes not involving combustion (e.g. saltpetre plant)

Emissions under a) are calculated using the fuel employed by industry and fuel-specific emission factors. To complete the emissions for Group 3, the data in emission statements was also incorporated. The emissions in Group 4 were determined with the help of emission statements and emission factors for the specific products.

Group 5:
This category includes the NMVOC emissions resulting from the calculations for emissions from the extraction and distribution of natural gas, oil and coal.

Group 6:
The NMVOC emissions from the use of solvents were determined here for industry and the private sector.

The emissions for Groups 7 and 8 were calculated using the COPERT model.

Group 9:
Group 9 comprises the emissions from waste incineration plants as recorded in emission statements. The NMVOC emissions from sewage treatment plants and landfills are based on available studies.

Group 10:
Emissions from straw combustion in the agricultural sector are calculated here.

Group 11:
Emissions from nature are recorded Austria-wide only.

3.3 Information on the uptake of climate-related gases by sinks

World-wide efforts are under way to carry out appropriate forestry measures to offset the high CO_2 emissions from fossil fuel combustion and the destruction of the world forest reserves, especially in the tropics but also in the northern coniferous forest zones. Thus far, however, the scientific findings have often been quite sobering, giving dramatic evidence of the limited possibilities of forestry measures. This is also true for Austria. The reason for the only very limited carbon reservoir potential is mostly the lack of necessary areas for (re)forestation. What is remarkable in this regard is that despite the large carbon reservoirs in the existing, usually mature, forest reserves, which is many times the annual emission values, the annual net carbon binding rates and the possibilities of substantial additional reservoir potentials are relatively small. For example, the cubic meter growth supply of 30.5 million m^3/a from Austria's commercial forests, as calculated by the ÖFI (Austrian Forest Inventory) and converted at mean densities and carbon contents according to GRABNER et.al. (1992) for the distribution of the Austrian timber harvest, amounts to some 7.3 million metric tons of carbon (C) or nearly half of the total annual Austrian CO_2 emissions from the combustion of fossil fuels.

By comparison, reforestation scenarios for Austria yielded annual C binding rates in a range of less than 10% despite the extensive areas involved. One ecological approach for carbon not accounted for in the scenarios is that wood can be used as a substitute product for fossil fuels and for materials produced with large amounts of energy. Whereas the reduction of carbon from the substitution of fossil fuels can be calculated precisely, it is still highly uncertain how much primary energy and thus carbon quantity would actually be saved by the latter sustainable substitution (BURSCHEL et.al., 1993; GRABNER et.al., 1992). The great advantage of this approach is that permanent wood production eliminates the release of fossil carbon into the atmosphere from the very outset since it does not add additional carbon to the atmosphere through decomposition. In other words, any reduction in carbon achieved thereby would be a permanent gain as opposed to the carbon storage offered by wood products, which simply prolongs the storage of forest carbon.

All these calculations were based on the assumptions that the health of our forests will not deteriorate to any great extent, that the level of carbon emissions will not increase (which is an incorrect assumption), and that there will not be negative feedback from the already changing climate any time soon. Mindful of these assumptions, it is quite evident that the carbon reducing effect from the forests and its management in Austria must be assessed cautiously, not euphorically.

Despite this sobering assessment of the limited potential of the forest to mitigate the problem of atmospheric CO_2, no efforts should be left untried to achieve at least a partial success in binding atmospheric carbon. This goal is certainly attainable through measures of afforestation.

At the same time, it is important to remember that the solution to the problem is not to be found in forestry, but in energy policy and, ultimately, in social policy itself. While 2,824,000 metric tons of carbon is taken annually from Austrian forests, the carbon bound in long-lived wood products totals 631,000 metric tons (22%). The annual domestic output of wood is supplemented by the import of wood, semi-finished wood products, and finished wood products. The total volume is 4,747,000 metric tons of carbon, approx. 40% of which is imported. Some 46% of the total annual quantity of wood carbon leaves Austria; 39% is accounted for by domestic residual quantities (waste wood, residual liquors, etc.) and just 13% remains bound for a longer period (on average 48 years) in long-lived wood products (10 years or more).

Binding 1 kg of carbon in medium-lived to long-lived wood products entails the harvesting of 4.3 kg of carbon from domestic forests and the import of 3 kg of carbon as raw materials and semi-finished products, making a total of 7.3 kg of carbon. After the carbon consumed through energy use in production is taken into account (2.7 kg of carbon), the amount employed is 10 kg of carbon. If the Austrian carbon supply stored in medium-lived to long-lived wood products were to double from 1990 to 2005, 6% of the carbon released during this period could be bound (assuming constant CO_2 emissions). In other words, increased consumption of long-lived wood products could make a modest contribution to the reduction of the CO_2 problem in Austria.

Aside from the long-term possibilities from the change-over in forest management mentioned above, afforestation measures could achieve net carbon binding rates of between 0.5 and 1.6 metric tons of carbon/ha.a over the next 100 years according to the biomass curves of the model. The range of variation here depends on the forest community and locality class. Assuming a theoretical maximum area of 500,000 ha, this would total 1.7% to 5.3% of the annual emission.

According to scenarios calculated by the University of Agriculture in Vienna, there is a potential for increasing the carbon reservoir in the Austrian forests if no wood is used. However, these calculations do not take the negative effects of non utilisation into account, among them the substitution of wood by other, more energy-intensive products.

Another interesting option, because of its feasibility, is to convert over the long term from the conventional (clearcut) harvesting method to a management method "more in tune with nature", e.g. selective logging.

3.4. Global Vulnerability Assessment of Climate Change

Attempts to assess the various kinds of impacts a climatic change would have on human activities is in the first place dictated by the necessity to evaluate whether the consequences will be so severe that response action, preventive and/or adaptive, needs to be taken. In making such judgements, account needs to be taken of the fact that, simultaneously with the occurrence of a climate change, there will also be other developments, which can have severe implications, e.g., the rapidly increasing world population and the accompanying increased demand on the global life support system (agriculture, forestry, and water resource management) (Döös, 1991).

A detailed account of the present knowledge about the wide spectrum of consequences of a climatic change cannot be given here. A few points may, however, deserve attention:

3.4.1. The Impact on Agriculture

Climate change would strongly affect agriculture, but scientists still don't know exactly how. Most agricultural impact studies are based on the results of General Circulation Models (GCMs). These climate models indicate that rising levels of greenhouse gases are likely to increase the global average surface temperature by 1.5 - 4.5ºC over the next 100 years, raise sea-levels (thus inundating farmland and making coastal groundwater saltier), amplify extreme weather events such as storms and hot spells, shift climate zones poleward, and reduce soil moisture. Impact studies consider how these general trends would affect agricultural production in specific regions. To date, most studies have assumed that agricultural technology and management will not improve and adapt. New studies are becoming increasingly sophisticated, however, and adjustment experiments now incorporate assumptions about the human response to climate change (IUCC-101, 1993).

So far, the state-of-the-art knowledge can be summarized as follows (IUCC-101, 1993):

* Increased atmospheric concentrations of carbon dioxide (CO_2) may boost crop productivity.

* Climate and agricultural zones would tend to shift towards the poles.

* While some species would benefit from higher temperatures, others might not.

* Mid-latitude yields may be reduced by 10 - 30% due to increased summer dryness.

* The impact on yields of low-latitude crops is more difficult to predict.

* The impact on net global agricultural productivity is also difficult to assess.

3.4.2. The Impact on Natural Terrestrial Ecosystems

Natural terrestrial ecosystems could face significant consequences as a result of the global increases in the atmospheric concentrations of greenhouse gases and the associated climatic changes. Projected changes in temperature and precipitation suggest that climatic zones could shift several hundred kilometres towards the poles over the next 50 years. Flora and fauna would lag behind these climatic shifts, surviving in their present location and, therefore, could find themselves in a different climatic regime. These regimes may be more or less hospitable and, therefore, could increase productivity for some species and decrease that of others. Ecosystems are not expected to move as a single unit, but would have a new structure as a consequence of alterations in distribution and abundance of species (Tegart et al., 1990).

So far, the state-of-the-art knowledge can be summarized as follows (Tegart et al., 1990):

* The rate of projected climate changes is the major factor determining the type and degree of climatic impacts on natural terrestrial ecosystems.

* Some species could be lost owing to increased stress leading to a reduction in global biological diversity.

* Consequences of CO_2 enrichment and climate change for natural terrestrial ecosystems could be modified by other environmental factors, both natural and man-induced (e.g., by air pollution).

* Most at risk are those communities, in which the options for adaptibility are limited (e.g., montane, alpine, polar, island and coastal communities, remnant vegetation and heritage sites and reserves), and those communities, where climatic changes add to existing stresses.

* The socioeconomic consequences of these impacts will be significant, especially for those regions of the globe, where societies and related economies are dependent on natural terrestrial ecosystems for their welfare.

3.4.3. The Impact on Water Resources

Even without climate change, humanity faces increasingly serious problems with water. Rapid population growth and expanding economic activity are already putting enormous pressure on global water resources. The large water requirements of households, industries, and farms increasingly exceed local supplies. Industrial wastes and the intensive use of fertilizers often overload water supplies with dangerous chemicals, while poor irrigation practices raise soil salinity and evaporation rates, putting even greater pressure on water resources. Meanwhile, the need for neighbouring nations to share water resources raises the spectre of political conflict. Most major hydrological basins are shared by several different countries, and it is becoming more and more difficult to manage the waters of rivers that cross international boundaries.

Climate change would probably alter regional precipitation and evaporation patterns. According to climate models, rising levels of greenhouse gases are likely to raise the global average surface temperature by 1.5 - 4.5ºC over the next 100 years. In general, higher temperatures should increase evaporation and therefore precipitation as well; climate models indicate that a doubling of atmospheric CO_2 concentrations would increase global precipitation by about 5%. But while changes in temperature and precipitation would clearly have profound effects on the water cycle, the current generation of climate models still cannot make reliable regional forecasts. It is likely that precipitation would increase in some areas and decline in others. Even in areas where it increased, higher evaporation rates may anyway lead to reduced run-off. Warming would also tend to reduce winter snow accumulation in mountains and other cold regions (IUCC-104, 1993).

So far, the state-of-the-art knowledge can be summarized as follows (IUCC-104, 1993):

* Water resources would become even more vulnerable than they are now.

* A reduced water supply would place greater stress on people, agriculture, and the environment.

* Improved water management is needed to minimize the impact of climate change.

3.4.4. The Impact on Sea-Level

The global mean sea-level may have already risen by around 15 centimetres during the past century. According to a number of studies, the sea has been rising at the rate of 1 - 2 millimetres per year over the past 100 years. Measuring past and current changes in sea-level, however, is exremely difficult. There are many potential sources of error and systematic bias, such as the uneven geographic distribution of measuring sites and the effect of the land itself as the sea-level rises and subsides (IUCC-102, 1993).

So far, the state-of-the-art knowledge can be summarized as follows (IUCC-102, 1993):

* Climate change is expected to cause a further rise of about 20 centimetres by the year 2030.

* Forecasting sea-level rise involves many uncertainties.

* Higher sea-levels would threaten low-lying coastal areas and small islands. Groundwater in some coastal regions would become more saline.

* The flow of estuaries, coastal rivers, and low-lying irrigation systems would be affected, and tidal wetlands and mangrove forests would face erosion and increased salinity.

* The damage caused by floods, storms, and tropical cyclones might worsen.

3.4.5. Possible Social Impacts

Climate change poses an unprecedented challenge to human society. Not only is the challenge unique and of enormous scope, but tackling it will require a political consensus and determination never before seen at the global level. What's more, the predicted impacts of climate change may lead to economic and political instability, making it increasingly difficult for countries to respond to these impacts. At the same time, growing social and economic burdens may divert attention away from the need to address the underlying causes of climate change as well (IUCC-107,1993).

So far, the major, widely supported perceptions may be summarized as follows (IUCC107, 1993):

* Climate change would probably produce *winners* and *losers.*

* Many of today's destabilizing political and social trends would be reinforced, thus accelerating migrations from rural areas to urban centres and from less developed to more developed countries

* Political conflict between the industrialized nations of the North and the less developed nations of the South would probably increase.

* Disputes over limited or diminishing resources such as water and arable land would proliferate, both between individual countries and within them.

* Societies would come under greater stress, social structures would have to adjust rapidly to accelerating change, especially in the public health sector.

* Climate change is likely to have negative effects on the psyches of individuals, if their physical and social environment is changing and they are pried away from their cultural roots.

3.5. National Vulnerability Assessment of Climate Change

3.5.1. How Climate Change Might Impact the European Alps - A Regional Perspective

So far, the state-of-the-art knowledge can be summarized as follows (IUCC-106, 1993):

Europe's mountains are particularly vulnerable to climate change. The intricate topography of mountain environments complicates weather patterns and confuses climate models, making it more difficult to project the specific impact of climate change on these regions. Nevertheless, it is clear that climate change will add to the current strong stresses on Europe's mountain areas, which are already threatened by pollution and population pressures. The recent warming trend is now producing symptoms such as reduced snowfall, retreating glaciers, and increased rock falls that can be expected to worsen with climate change.

Changes in the pattern of precipitation may have an even greater impact than rising temperatures. Because the Alps run east to west, they tend to block or deflect the southward flow of cold northern air (in contrast to North America's north-south Rocky Mountains). According to climate models, as the earth warms this tendency may increasingly cause a northward shift in the precipitation belts associated with the Intertropical Convergence Zone. While the Scandinavian mountains would become wetter, the Alps and Carpathians would become drier, particularly on their southern slopes.

A 10% decline in precipitation in the Alps plus a 1 - 2ºC rise in temperature could produce a 40 - 70% reduction in run-off. Mountains are the water tower for the plains below them. Because the mountains, and particularly the Alps, are the primary source for such major rivers as the Rhine, Rhone, Po, and indirectly also for the Danube, the impact of reduced mountain precipitation would be felt far beyond the mountainous regions themselves.

Violent storms, fires, rockslides, and avalanches may increase. Severe rock falls are likely to multiply with the melting of permafrost, and avalanches will increase as warmer weather creates spring snow conditions. Even if storms do not increase in frequency, they may increase in intensity. Weather patterns could even develop monsoonal tendencies, with very heavy downpours on exposed slopes leading to erosion and flooding. Erosion would be particularly bad if, as appears likely, forests become further weakened by drought, storms, and rising temperatures. A range of unpredictable disasters, such as the emptying of ice- or moraine-dammed lakes (as happened near Salzburg in 1932 when an ice plug shifted), could also be expected.

Ecological zones will tend to move uphill. A temperature rise of 1ºC would result in a vertical shift of these zones by 150 metres, and a 3ºC rise would give the Alps a climate much like that of today's Pyrenees. The result of this vertical shift of zones would be the disappearance of some 75% of the Alpine zone (2,200 - 2,900 metres) and the nival zone (2,900 metres and above). At least 150 plant species would be threatened or would disappear. Even in lower zones, many species may prove unable to adapt as their habitats migrate.

Forests typically take centuries to adapt to new conditions and so would be especially hardhit. Sensitive stages in the life-cycle of most species - including pollination, flower production, and seed germination - would be upset by climate change. Already now, the condition of protective forests is unsatisfactory because i.a. air pollution and other stresses as well as destruction by deer prevent a large portion of its rejuvenescence. Warmer temperatures would encourage insects and biological pathogens that attack trees, killing or weakening them. Forest fires would increase, especially in over-mature stands. A combination of weaker forests and stronger storms would cause more windfalls. The overall result would be widespread deforestation in the mountains of southern and central Europe.

Mountain economies may be undermined. A 1ºC rise in average temperatures combined with winter drought may reduce the duration of Alpine snow cover by 50% at 1,500 metres, with enormous consequences for the skiing industry. High-altitude stations might capitalize on the search for summer sun and warmth but, overall, tourism would be negatively affected. Light snowfalls are already a problem for many ski-site operators in the Alps and could, if they continue, eliminate winter sports from many regions within 20 or 30 years. Drier conditions would also undermine energy and water supplies, navigation, and health conditions. A general melting of the permafrost would make the ground less firm and lead to difficulties for existing transport and housing infrastructure. Alpine agriculture is one economic sector that may benefit from global warming, although southern slopes may suffer from excessive dryness and fruit trees that depend on winter chilling to initiate or accelerate the flowering process may become less productive.

3.5.2. Possible Impacts on Austria - A Survey of Research Results of Relevance to Austria

The impacts of an increased greenhouse effect on the climate of the Alpine region cannot be directly ascertained using even the best available climate models, the global circulation models (GCM's). This region is simply too small. However, as an initial step toward exploring this subject, it may be assumed that the relationships between central European climatic conditions and climatic conditions in the Alpine region would remain essentially the same even if a possible climatic change did occur.

Based on the above assumption, which establishes a link between model-based statements on central European temperatures and Alpine temperature and snow cover statistics, a climate scenario for Austria can be created to estimate these impacts The climate scenario is based on model claims that the concentration of pre-industrial CO_2 is expected to double in the first half of the next century.

A rise in temperature, particularly in the winter (2°C on annual average, 3°C in the winter); an increase in total precipitation in the winter (10-20%); a trend toward declining precipitation in the summer; a decrease in the number of days with snow cover (10-20 days/°C and year) at altitudes up to 2,500 m.

The key question of whether current climatic data might not already reflect the climatic changes calculated on the basis of these models has been answered by a study covering several Austrian climatic data (temperature, precipitation, snow cover, etc.) collected over the last 200 years. The study found no trends which could be unequivocally attributed to the anthropogenic greenhouse effect. However, this finding is not interpreted as contradictory to the model-based predictions for the 21st century.

The following impacts on Austria are conceivable based on the above climate scenario (ÖAW, 1992, 1993):

3.5.2.1 The Impact on the Water Balance

The climatography of Austria indicates a good correlation between temperature and the duration of snow cover under present climatic conditions, with a characteristic curve relating to altitude in the winter. Based on the location of the zero level, where rain turns into snow, and taking into consideration the relationship between today's duration of snow cover at today's temperatures, it can be assumed that a temperature increase of 2°C in the winter at all altitudes would mean that a one-month snow cover would not occur until an altitude of 500 m and above; for a temperature increase of 4°C, it would not occur until an altitude of 1,500 m above. Of course, this general estimate must be adjusted by several hundred meters to take the respective location on the given slope into account.

Aside from the freezing level, the total amount and temporal distribution of snowfall are other critical variables in assessing snow conditions in the future. However, precipitation and other components of the water balance (runoff, evaporation and storage) are distributed with much less regularity in terms of time and space than temperature. This makes their prediction or regionalisation based on a GCM prediction so uncertain that definitive statements can only be made about the development of the quality of the water balance in the high Alps.

* Several glaciers are already melting. A large-area increase in temperature would shift not only the zero level upward, but with it the climatic snowline and the equilibrium line of the glaciers. All Austrian glaciers would decrease in size and some would disappear altogether.

* Snowfall as a share of total winter precipitation would decrease and rain increase, resulting in a corresponding rise in winter runoff. With the snow cover melting earlier, the annual ground-water cycle would change, too, causing soils to be damper in the winter and drier in the early summer. This would complicate the condition of the soil, because the decreased snow cover would cause it to freeze more frequently in the winter despite the general warming trend. During the summer,

there would also be a higher potential for evaporation, which would lead to a decrease in summer runoff.

* It must be assumed that changes in precipitation patterns would have a disproportionately large impact on runoff.

* Evaporation would in all likelihood continue to remain insignificant in absolute terms even if relatively great changes occurred in the individual components of the water balance.

The presence of glaciers in a catchment area can delay peak runoff to midsummer. Moreover, glaciers have a balancing effect in a runoff region, because the incresed melting of glacial ice offsets any lack of precipitation that may occur in periods of fair weather.

Austria currently has over 900 glaciers covering an area of some 500 km^2. Together, their total volume equals just 20 km^3. If this ice were spread evenly over all of Austria, it would be equivalent to water 200 mm deep. In other words, the hydrological significance of Austria's glaciers is not in their absolute storage capacity but in the shift in seasonal water supplies they cause.

The economic significance of snow and ice for agriculture and forestry, the energy sector and tourism is obvious. It is therefore absolutely essential to continue taking stock of these resources and checking the stage of their reactions to climatic changes.

3.5.2.2 The Impact on the Ecology of Surface Waters

Though a 1 to 2°C increase in the mean annual air temperature is of little significance to deep lakes, it can have much greater impacts on shallow ones (such as the Lake Neusiedl), where there is a close correlation between water and air temperature, and especially long-lasting effects on flowing water due to the marginal temperature range found in it.

According to a number of individual studies on the impacts of temperature increases, density changes, CO_2 increases, etc. on surface waters and the aquatic animals that inhabit them, the future is likely to bring a partial change in the composition of species and greater biomass for certain organisms. The uncoupling of food chains is expected to be of particular significance.

The CO_2 concentration of most bodies of water will probably not be affected by higher levels of CO_2 in the atmosphere since sufficient quantities of carbon dioxide are usually available anyway due to the equilibrium of carbonate and bicarbonate. Nevertheless, an increase in precipitation of calcium could occur in lakes in warm weather as a result of increased photosynthesis. This in turn could cause the karstification of the water along the shore in lakes with extremely high concentrations of calcium.

Greater amounts of CO_2 in the air might have a positive effect on lakes with silicate bottoms, which have a naturally lower concentration of carbon dioxide due to their lower reservoirs of calcium. This would include all bodies of water which have a low pH value due to natural or anthropogenic causes such as the ones located in the Austrian Waldviertel and Mühlviertel regions and high in the Austrian Alps.

The low solubility of oxygen at high temperature becomes a problem in places where there is already a lack of oxygen, e.g. in the vicinity of sewage outlets.

An increase in temperature is likely to decimate species like river trout which exist in a narrower, colder temperature range while leading to a broadening of the biotope of other species such as certain types of carp which thrive in a broader, warmer temperature range. In general, it is expected that most aquatic animals will be able to keep pace with and genetically adapt to a slow pace of warming.

If the anthropogenic climate change causes additional secondary effects besides a temperature increase, such as a drop in precipitation or a reduction in water flow, the impacts on Austria's fresh water fauna will be further intensified. The change in the runoff pattern could cause the remaining water to heat up to a relatively greater extent than would otherwise be the case, causing bodies of water that already had a high electrolyte content to become salinized. Migrating aquatic organisms are particularly hard hit by a change of this kind since it sometimes result in inadequate environmental conditions and can even destroy spawning grounds, causing a species to become extinct and entire food chains to be affected.

Many of the aquatic plants in Austria already classified as endangered (e.g. various kinds of pond and water lilies and red and brown algae) could disappear altogether if the water temperature rose and/or be replaced by other species more partial to higher temperatures.

3.5.2.3 The Impact on Vegetation

In the plant kingdom, forests and forest soils provide vast stores of carbon as part of the global organic carbon cycle. According to the carbon inventory drawn up for Austria, two thirds of the non-fossil carbon, or 0.8 of 1.2 billion metric tons of carbon, is contained in the humus of soils and about one third in the vegetation itself. Forests, which cover 46% of the land surface of Austria, and forest soils account for 75% of the entire carbon supply. The trees in forests alone contain 90% of the carbon stored in plants; the amount in field crops is negligible by comparison.

The increase in CO_2 in the atmosphere could have direct and indirect effects on vegetation in Austria in many different respects:

In many species of plants, for example, one direct effect of higher CO_2 concentrations is expected to be higher rates of photosynthesis and greater efficiency in utilising water and nitrogen.

Indirect effects include any consequences for vegetation relating to the predicted climate change. A change in temperature (and precipitation) patterns could affect the growth of plants and thus their spatial distribution (possibly even above the current treeline) while at the same time influencing the intensity levels and stress patterns of various abiotic and biotic stress factors. The latter could, in turn, affect vegetation in terms of the composition of species.

For example, a rapid increase of 2° C in the mean annual temperature throughout the Alpine foothills and submontane areas of the peripheral Alps (currently between 8° and 9°C) could result in the wide-spread extinction of the spruce forests that now dominate there, because the spruces are limited in their ecological range by a minimum precipitation of 500 and 600 mm and by a maximum mean annual temperature of 9°C.

By the same token, the forest steppe is expected to continue expanding in Austria's driest areas in the Pannonian region (Weinviertel, Marchfeld). It is doubtful that the increased evapo-transpiration resulting from the higher temperatures will be able to be offset by the consequences listed above.

3.5.2.4 Possible Social Impacts

A change in the climatic conditions is expected to have direct and indirect impacts on the health and well-being of individuals and of the population as a whole.

The direct effects of an increase in temperature pertain primarily to the increase in heat stress and, above a certain temperature, to a higher rate of illness and death.

Though the increase in temperature is expected to alter the dispersion areas of pathogens and their carriers as well as shift characteristic periods for certain diseases, these factors will have only negligible consequences for Austria given the current hygienic conditions of this country.

Ultraviolet radiation could increase as the stratospheric ozone layer is reduced by halogenated hydrocarbons, also active as greenhouse gases. This process, in turn, would lead to a rise in the incidence of skin diseases, photo allergic reactions, effects on the immune system and to the induction of various kinds of skin cancer.

Austria could also be faced with a rising tide of immigration by people whose means of subsistence have deteriorated as the result of climatic changes. These migrations would unleash not only economic problems but emotional and social ones, as well. Stress situations could also be heightened by the possible need to change ingrained patterns of daily life.

Fig. 3.1., Fig.3.2., Fig.3.3. and Fig. 3.4. are not available electronically.

Chapter 4.

Measures and strategies to combat the greenhouse effect

4.1 Global instruments

Global environmental problems such as the depletion of the stratospheric ozone layer, the large-area movement of air pollution, or the decline in species diversity can be solved only through a concerted international effort in which all countries are involved. This effort must take account of the varying degrees of responsibility to be borne by the developed and developing countries.

Various international environmental protection instruments have been developed over the past 10 to 15 years. At a European level, the 1979 Geneva Convention on Long-Range Transboundary Air Pollution marked a breakthrough in laying the basis for air pollution control measures in Europe. The protocols on emission reduction of the classic air pollutants (SO_2, NO_x, VOC) which were negotiated under this convention are also relevant with regard to strategies for combating the greenhouse effect. Tropospheric (surface) ozone is a greenhouse gas; the ozone burden can be reduced by cutting the emissions of precursors such as nitrogen oxides and volatile organic compounds.

Other milestones in the international environmental efforts have been the Vienna Convention for the Protection of the Ozone Layer, 1985, and the Montreal Protocol on Substances that Deplete the Ozone Layer, 1987, and its amendments. An important contribution to an effective climate protection policy has also been made by phasing out the use of fully halogenated and (with certain delays) partly halogenated chlorofluorocarbons (CFCs), because of the high global warming potential of these substances.

Lastly, the Framework Convention on Climate Change, 1992, directly addressed the anthropogenic greenhouse effect and the impacts of climate change which could result from it. The task now is to work out emission reduction targets and strategies in negotiations on future protocols.

Austria has always gone further in its national implementation of these international instruments and, guided by the precautionary principle, has committed itself to much tougher obligations. These efforts are concrete proof of the sense of responsibility Austria feels for environmental protection at an international level.

4.2. Outline of the national strategy for combating a possible anthropogenic climate change

<u>National target</u>

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

To assist with the development of effective strategies for climate protection two committees were set up at the beginning of the nineties: the National CO_2-Commission and the Interministerial Committee to Co-ordinate Measures to Protect Global Climate (IMC Climate).

<u>National CO_2 Commission</u>

The National CO_2-Commission was set up in May 1990 by the Federal Minister of Environment, Youth and Family Affairs. Its brief is to determine scientific and technological potentials, to recommend measures and strategies and to analyse instruments, through which the target of a 20% reduction in CO_2 emissions by the year 2005 can be achieved. In addition it also looks at ways of reducing other greenhouse gases and advises the Austrian Federal Government in all matters of climate protection. In September 1993 it set up a Task Force under the name "Economic Instruments and Institutional Outline Conditions for the Climate Policy".

The members of the Commission include scientists of all relevant research branches of Austrian universities; environmental protection delegates of the political parties represented in Parliament; and representatives of the "social partners" - Association of Industrialists, Federal Chamber for Trade and Commerce, Federation of Trade Unions, Chamber of Labour, and the Presidential Conference of the Agricultural Chambers. In this way the various policy makers are involved in the development of measures at a very early stage.

Since its founding the Commission has provided a lot of significant research work. The points of main emphasis have been in the sectors of heat insulation, solar energy, forestry, the industrial use of energy, transport, the possible reform of energy taxation. After the submission of an interim report in 1991, 1992 saw the publication of the abridged version of the 1991 Annual Report as well as recommendations by the Commission for an action programme, which were presented in a bilingual version as Austria's contribution to UNCED 1992 in Rio. The Commission also presented Annual Reports for 1992 and 1993 respectively. The Annual Reports of the CO_2-Commission contain all the final reports from research projects by the body in each respective year as well as the resulting recommendations for action for the federal government, provinces and communities. This year's recommendations by the body deal in particular with the subject areas of buildings, heating supply, domestic appliances, traffic, fiscal policy and considerations on energy concepts.

The work by the CO_2-Commission forms the specialist basis for activities in the

IMC Climate.

The Interministerial Committee to Co-ordinate Measures to Protect Global Climate was founded in January 1991 and is established at the Federal Ministry of Environment, Youth and Family Affairs. Representatives of all the ministries concerned by the subject matter have been commissioned - in close co-operation with the national CO_2-Commission - to develop detailed programmes for a comprehensive national strategy for reducing greenhouse gas emissions and to formulate legistic and economic instruments for their implementation.

The task of the IMC Climate is, "on the basis of the results of work by the ... CO_2-Commission and other studies of relevance on the subject and taking into account the target of a 20% reduction in CO_2 emissions by the year 2005 as formulated in the '1990 Energy Report' and with due consideration for the international trend, to put forward concrete programmes and to formulate proposals for the legistic and economic instruments necessary for implementation". Project groups under the responsibility of the ministry competent in each case are working on the sectors of energy, agriculture and forestry, science and research as well as fiscal and economic instruments.

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

To date three interim reports by the IMC Climate have been brought to the attention of the Federal Government in the form of Council of Ministers papers. A comprehensive catalogue of measures on climate protection was adopted with the last interim report. It sets the following points of main emphasis for the implementation of climate protection programmes:

- Power production/electricity supply industry
  * Fuel switching at thermal power plants (e.g. fuel switch to gas)
- Room heating and water heaters
  * Mix of measures for a tightening of building regulations and norms, introduction of an energy coefficient, tightening of residential building subsidies, co-ordination of the extension of conducted energy, priority for the utilisation of district heating
- Renewable energies
  * Full utilisation of the potentials of energy use through renewable fuels (wind, biogas, sewage gas, landfill gas, biomass, sun)
- Combined heat and power plants

* Large-scale replacement of thermal power plants without heat utilisation by those with CHP.

- Traffic
  * Comprehensive catalogue of measures (extension of infrastructure for combined carriage, traffic organisation, R&D, fleet fuel consumption regulations)
- Economic instruments
  * Introduction of a comprehensive energy and CO_2 levy with due consideration for international competitiveness.

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

The following table 4.1 shows - in a comprehensive way - the national measures, their target, the status of implementation and, if available, the reduction potential for the year 2000. For the purpose of clarity only measures, which have already been implemented or are definitely planned to be implemented soon, have been taken up into this table. (not available electronically)

4.2.1. Carbon dioxide

4.2.1.1. Energy supply and transformation

Voluntary measures/subsidies under implementation:

1. Promotion of the use of district heating and block heating and of the use of renewable sources of energy

Assessment: The enhanced use of district and block heating is of key significance in terms of the energy industry, for a number of reasons. The resources used thus far in promoting district heating appear far too insignificant.
Residential building subsidies should be increased in the event of connection to district and proximity heating systems. Such subsidies should likewise be increased when environmentally favourable heating and water heating systems are used in conjunction with renewable sources of energy.
Competent authority: Federal government, Länder
Current situation: On the one hand biomass is promoted mainly as part of district heating promotion. The use of biomass (e.g. chippings) in regional block and district heating networks (whenever possible with combined heat and power) has already gained considerable status in terms of energy policy. In 1993 alone, 57 projects with a promotable total investment volume of ATS 555 million (100 ATS is approx. 9 US $) were promoted by investment subsidies in the amount of some ATS 51 million. In addition, as part of the tariffing for electrical energy, infeed from combined heat and power plants on a biomass basis are assisted with special tariff incentives.

There is consensus in principle among the government parties on the necessity to extend the district heating subsidy, which terminated at the end of 1993.

As part of the agricultural subsidies the cultivation of regrowable raw materials for energy and industrial use is promoted with direct subsidies. The aim of these efforts is to convert agriculturally used acreage from cereal production to the production of regrowable raw materials for energy and industrial use, and in this way to contribute towards reducing the dependency on energy imports as well as reducing CO_2 emissions. In addition, as part of the investment subsidies, subsidies are also provided in the energy sector for biomass heating plants for individual operations, biogas plants, small-scale biomass district heating generation and conduction plants as well as district heating distribution plants, and plants for producing fuels from regrowable raw materials used mainly for the purpose of the self-sufficiency of agricultural and forestry operations.

2. Promoting the supply of electricity into the public grid

Assessment: The supply of electricity is to be promoted on the basis of the considerable potentials that exist in this area. In principle suppliers should be granted tariffs in the amount of the "avoided costs" which must reflect the costs avoided in the long term as a result of the supply.

The added costs incurred by the electricity utilities are to be taken into account in the pricing in the event of repercussion in the electricity price calculation.
Given the characteristics particular to Austria with regard to winning methods and requirements (hydro-thermal interconnected system), promotion is to be given primarily to the application of electricity generation technologies that are as efficient as possible, in particular combined heat and power, which ideally complements hydraulic power.
Competent authority: Federal government, Länder
Current situation: In the course of the continually promoted tariff reform, a tariff incentive for the application of combined heat and power has already been established through the restructuring of the inter-connected tariff and the federal supply order. An evaluation of the repercussions of these measures is in preparation.

In February 1994 a general agreement between the Republic of Austria, represented by the Federal Minister of Economic Affairs, and the Austrian Association of Electricity Utilities (VEÖ), was

concluded initially for three years. In order clearly to improve compensation for electricity supplied from photovoltaic and wind power stations as well as from generation plants operating the basis of biomass or landfill gas or clarification gas, the agreement provides for subsidies in the amount of 100% and 20% respectively for the corresponding delivery prices applicable in each case for the utility company drawing the electricity. The compensation paid for supplies from photovoltaic and wind power stations will therefore be raised up to ATS 1.75 per kWh (in the winter peak tariff), and up to ATS 1.05 per kWh (100 ATS is approx. 9 US$) for supplies from biomass installations as well as landfill and clarification gas installations.
By early June 1994 a total of seven provincial companies and provincial capital utility companies as well as a number of small and medium-sized power supply companies had acceded to the agreement.

Planned implementation:

3. Tightening of the energy-relevant building code, regional planning and land development regulations

Implementation of Item 18 of the resolution dated 2 April 1994 (tightening of energy saving measures) adopted by the Nationalrat (First Chamber of Parliament) and tightening of building norms, energy pass, energy coefficient, tightening of residential building promotion.
Reduction potential: not attributable at present, however considerable cuts in the future room heating requirements in old and new housing are possible insofar as orientation towards low energy house standard is effected.
Costs: difficult to quantify, minimum added costs in the case of new housing and old building renovation, efficient monitoring of subsidies necessary in the case of residential building promotion and old building renovation promotion.
Assessment: easily implementable measure, implementation by agreement as per Art. 15a B-VG (Federal Constitution Act).
Despite the difficulty in quantifying them, measures aimed at lowering room energy requirements are to be implemented in only due to the population increase and the resulting demand for residential buildings.
Competent authority: Federal government, Länder
Art. 15a B-GV Agreement: Federal and Länder governments or building code: federal Länder only, room heating allocation between sources of energy - building code: municipalities and federal Länder; district heating promotion: Federal government, Länder; residential building subsidy: federal Länder.

4. Conclusion of an Art. 15a B-VG (Federal Constitution Act) Agreement on achieving the CO2 emission reduction target between Federal and Länder governments

In such an agreement the Federal and Länder governments should specify on the one hand the attainment of the target of a 30% reduction in CO_2 emissions by 2005 relative to 1988 and, on the other, the regulations to be taken at federal and Länder level for this purpose.
Assessment: fundamental measure to be rated as extremely important.
Competent authority: Federal government, Länder
Current situation: A draft of such an agreement is in preparation.

5. Promotion of combined heat and power in industry and in room heating supply

Promotion of combined heat and power with electricity supply into the national grid - optimum process concept for the cascaded utilisation of temperature levels (see also Chapter 4.2.1.3): With regard to promoting the expansion of CHP, the subjects of supply tariffing, maintenance of reserves and tariff structure will have to be discussed further
Costs: seem appropriate to the anticipated reduction
Assessment: highly effective measure;
The provision of such comprehensive packages as, for example, the use of combined heat and power in the area of process heat guarantees a marked improvement in efficiency due to a focused and economic use of natural gas, as a result of which considerable energy savings effects and therefore CO_2 reductions can be achieved especially in the trade and industry sector.

Competent authority: Federal government, Länder
District heating promotion: Federal government and Länder; allocation of room heating market between sources of energy, building code: municipalities and Länder.
-> Supply of "derived current" into public supply networks, appropriate legal foundation; the subject of crossborder electricity supply into public supply networks is to be legally regulated by the federal supply order effective as of 1 May 1992.
Current situation: In 1993 several industrial plants were equipped with a combined heat and power installation; as a result a considerable amount of energy was saved particularly in industry, an energy-intensive sector.

6. Energy/CO_2 tax

The directive proposal for the introduction of an energy and CO_2 tax within the European Union submitted by the EC Commission in June 1992 and currently under debate is of vital importance for a necessary joint approach by European states in the area of a CO_2 and energy levy.
The implementation of the EC proposal in Austria at the introductory taxation level would bring a tax yield of around ATS 4.7 billion on the basis of Austrian 1991 energy consumption (100 ATS is approx. 9 US$). Once the planned ultimate level for the levy is reached, the yield at constant consumption - control effects excepted - would reach ATS 15 to 16 billion (exceptional regulations not considered).
The energy and CO_2 levy can be regarded as an essential element of an effective catalogue of measures for achieving the CO_2 reduction target.
Reduction potential: depends on concept. The energy forecast of the Austrian WIFO Institute assumes an increase in CO_2 emissions of 15% by 2005 (1990 basis). An energy and CO_2 tax on the scale of the EC Commission proposal could reduce this increase by one third to one half.
Costs: The overall economic costs of this measure in Austria cannot be specified according to current knowledge levels; in principle an energy and CO_2 tax would stimulate the most cost-effective reduction measures. With regard to the anticipated effects on overall economic production, neutral solutions appear feasible.
Assessment: For considerations of environmental policy in particular, a long term objective must be to take the external costs of the impairment to the environment caused by the use of energy into consideration in the cost accounting of consumers. For this reason a combined CO_2/energy levy potentially could be of great significance (1993 Energy Report). As a medium to long-term measure it seems to be very effective.
Competent authority: Federal government

7. Continuation of the electricity tariff reform

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

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

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

Concepts/Projects:

8. Preparation and co-ordination of energy concepts at municipal and provincial level - Provision of regional energy concepts and energy statements

Assessment: With the compilation of the "CO_2/energy scenarios" as the basis for the 1993 Energy Concept and its catalogue of measures the Federal Government has taken a first step towards the co-ordination of the energy concepts of the federal and Länder governments. The methodology and execution principles are being continually refined and improved. Regionalised models are to be incorporated in the energy and energy saving concepts. In this way a foundation essential in a co-operative federal state is to be created in order to
- achieve a reorganisation of the law of conducted energies on the basis of new delimitations between the federal government and the Länder in terms of jurisdiction, in particular with regard to the winning, distribution and levy structures of conducted energy;
- obtain, on the utilisation side, the optimum co-ordination in terms of energy policy between federal government and Länder instruments (especially those of building right and dwelling right) and, in this context, to make use also of the instrument of the agreement between federal government and Länder as per Art. 15a of the Federal Constitution.
Competent authority: Länder
Current situation: The first exemplary publication of a nationwide multi-regional energy statement took place in 1988 for report year 1983; 1991 saw the founding of the Regionalised Energy Statements Association. At the end of 1993 it was agreed to compile rough statements on the federal provinces by ÖSTAT in close co-operation with the federal provinces. ÖSTAT will be calculating these statements for the first time in the first half of 1994 for report year 1993.
There have been a number of contacts and negotiations between the federal government and the Länder, in particular on the areas of
- agreement as per Art. 15a B-VG (Federal Constitution Act) on energy savings and the reduction of CO_2 emissions
- compilation of regionalised energy statements
- co-operation between federal government and Länder in the area of energy research
- promotion of regional and municipal energy concepts.

As part of the energy research co-operation a study into the energy saving potential of electrical household applications was especially promoted. The promotion of regional and municipal energy concepts is to be continued.

Concrete research on cost/benefit indications has been prepared in the course of work already in progress on energy and CO_2 reduction scenarios.

Since the submission of the 1993 Energy Report before the Council of Ministers on 25 May 1993 some 30 subsidy approvals have been granted for municipal, local and regional energy concepts.

9. Planning and conceptual considerations on the realisation of a lasting power industry as part of the energy concepts to be drawn up by the Federal Government

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

10. Utilisation of waste heat in industrial processes and electricity production

Supply of waste heat into heat supply networks to cover the room heating demand; examination of the possibility of a waste heat utilisation offer,
Creation of regulating outline conditions to promote the supply of waste heat to suitable district heating networks.
Promotion of combined heat and power through appropriate supply tariffs, among others
Use of existing instruments for the promotion of trade and industry to promote the utilisation of waste heat (see also Chapter 4.2.1.3).
Assessment: regional and sector-specific studies necessary. Problem of the availability of waste heat dependent on the corresponding industrial process.
With regard to promoting the expansion of waste heat utilisation and power cogeneration, the issues of supply tariffing, maintenance of reserves and tariff structure will have to be discussed further.
Competent authority: Federal government, Länder
Current situation: With regard to waste heat utilisation from power plants, research into the case studies on combined power and heat is to be extended initially to the sector of utility companies.

11. Setting-up of energy supply areas co-ordinated in terms of regional development - Improved harmonisation of conducted fuels (gas and district heating), particularly of renewable fuels for room heating provision (essentially biomass)

This can be achieved through both zoning plans and regional development.
Assessment: These planning documents are to contain recommendations for the co-ordination of conducted energies, taking into account or incorporating building codes as well as regional development and zoning plans.
The sensible co-ordination of federal government and Länder competences in legislation and execution should be aimed ultimately at obtaining optimum energy supply structures, resulting in the best possible co-ordination of the supply with conducted energy while making use of local energy resources and local waste heat potentials and integrating renewable fuels and new technologies. This approach should harmonise with the prevailing circumstances in settlement and production structures and their anticipated development as well as the requirements of environmental protection.
Reduction potential: not quantifiable, yet of great significance since district heating systems based on combined heat and power and/or biomass and the use of waste heat from waste incineration plants present a considerable CO_2 (and CH_4) substitution potential.
Costs: planning expenditure, subsidy requirements (connection charges and line construction) in the case of marked price differences with rival fuels.
Assessment: the choice of fuel and energy technology, especially in the room heating sector, is a medium to long term commitment for investment decisions. Given the current price competition between fossil, renewable and conducted fuels (gas for district heating) in municipal and rural areas, long-term, ecologically favourable fuel priorities are to be made using "regional development measures in energy matters". In this connection regional energy concepts are set to play an important role especially in view of the emphasis on the use of biomass, based essentially on local circumstances, as a starting point for sensible delimitations, for example of district heating supply compared with the use of natural gas.
Competent authority: Federal government, Länder
Current situation: In co-ordination with interest representatives and with the involvement of experts, the main parameters for a reform of the law on conducted energies are currently being reviewed.

Main stages:
--> Authorization of studies together with the Länder
Competent authority: Co-operation between federal government and Länder
--> Agreements between fuel suppliers
Competent authority: Länder, municipalities, utility companies
--> Examination of an arrangement for delimitating heating supply areas
Competent authority: Federal government
--> Reorganisation of the law of conducted fuels (1993 Energy Report)

Competent authority: Federal government

12. Introduction of least cost planning (LCP) as part of the reorganisation in the law regulating prices in the electricity sector

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

In the opinion of the federal government, least cost planning is an instrument that can be used to remedy existing shortcomings in the market as well as regulation deficits when the marginal costs of the additional provision of electrical energy are higher than the costs for an increase in efficiency in ultimate consumption. In such cases programme costs for efficiency-enhancing investments are to be recognised.

In a subsequent phase, equivalent steps ought to be examined for the area of other fuels (1993 Energy Report).
Assessment: the measure is considered as urgent.
Competent authority: Federal government
Current situation: A study on "LCP in Austria", commissioned by the Federal Government, is currently in progress.

13. Examination of energy-relevant issues in connection with
a) Third Party Financing (TPF)

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

b) The problem area of landlord and tenant

As part of the restructuring of the dwelling right, one objective is the allowability of energy rehabilitation measures in the rent for the dwelling (at a cost-neutral charge for the tenant): the tenant should be entitled under certain circumstances to arrange for the execution of energy-relevant improvements and/or to reclaim the costs of such improvements from the landlord.
Assessment: the appropriate measures appear urgent
Competent authority: Federal government

4.2.1.2. Traffic

Measures under implementation:

1. Tax on standard fuel consumption and reform of the tax on motor vehicles

Assessment: The introduction of the tax on standard fuel consumption as of 1 January 1992 and of the engine-related insurance tax as of 1 May 1993 is seen as a step towards vehicles with optimised pollutant emission and low consumption.
Competent authority: Federal Government
Current situation: In 1993 the trend towards vehicles with larger engine capacities was broken for the first time. The marked trend towards Diesel also results in reductions in fuel consumption and CO_2 emissions; the current share of Diesel vehicles in new registrations is above 40%, while the Diesel share of the vehicle fleet as a whole is over 18% (compared to around 3% in the mid-sixties).

2. Mineral oil taxation

Reduction potential: regarded as minimal in the case of a one-off increase in mineral oil tax.
Assessment: An increase in mineral oil tax would increase the costs per kilometre and thus offset the high growth rates for overall vehicle performance.
Adjustment to fuel prices in Germany through an increase in mineral oil tax could bring in an estimated tax yield of ATS 5.6 billion (100 ATS is approx. 9 US$).
A one-off increase in mineral oil tax is to be regarded as a measure that offsets the high growth rates in overall vehicle performance in terms of trend only.
Competent authority: Federal Government
Current situation: Introduction of the earmarked increase in mineral oil tax for financing the extension of rail-bound local traffic was achieved on 1 January 1994 (increase of ATS 0.50 per litre for petrol).

3. Night driving ban for HGVs

General HGV night driving ban for non-low noise HGVs, 60 km/h speed limit for low-noise HGVs at night.
Competent authority: Federal Government
Current situation: These provisions were adopted in the 19th amendment to the Road Traffic Regulations and come into force on 1 January 1995.

4. Electronic speed limitation for trucks and buses

This technical measure prevents HGVs and omnibuses from exceeding specific maximum speeds,
Competent authority: Federal Government
Current situation: The provisions concerning electronic speed limiters for HGVs as of 12 tonnes (max. 85 km/h) and for omnibuses over 10 tonnes (max. 100 km/h) come into force on 1 January 1995.

5. Monitoring the adherence to existing speed limits

Costs: It should be envisaged, that a certain percentage of the fine should be used to cover the increasing costs of monitoring.
Assessment: positive assessment, because better monitoring enhances safety in traffic.
Meeting the legal speed limits on highways is connected with large reductions in fuel consumption (1 to 1.5 litres per 100 km). Advantage of a quick effect of the measure.
Competent authority: Länder, federal government
Current situation: The enhanced monitoring has been laid down in the 19th amendment to the Road Traffic Regulations and enters into force on 1 October 1994.

6. Restrictive quota regulations for HGVs and omnibuses with all eastern neighbouring states

In addition modern goods traffic agreements (incentives for rolling highways) were concluded with a number of countries (Hungary, Poland).
Competent authority: Federal Government

Planned implementation:

7. Continued implementation of the guidelines in the 1991 Master Transportation Concept

The 1991 Master Transportation Concept adopted the goal of reducing CO_2 by 20% by the year 2005 (from 1988 levels) and formulated appropriate measures to bring about this reduction. These measures were elaborated on in the Energy Concept of 1993 and are based on the following principles:
- Avoid unnecessary traffic (through greater use of telecommunications, etc.)

- Shift traffic to more energy efficient and environmentally compatible means of transport (in particular, shift freight traffic to rail or water), to public mass transit and non-motorised modes of transportation
- Undertake technical innovations in motor vehicles to optimise energy

One measure deemed especially effective is the push to use ecologically sounder modes of transportation, inter alia, by implementing item 15 of the resolution by the *Nationalrat* (First Chamber of Parliament) dated 2 April 1992 regarding the reduction of ozone precursors.
Corresponding suggestions from the Master Transportation Concept:

A. Launch urban planning measures to reduce traffic movement, provide for shorter transportation distances, and create or maintain decentralised local shopping systems.
B. Make the regional zoning of land for construction contingent on providing access to public mass transit
C. Vary support for residential construction according to its location and whether access to public mass transit is provided for in the project
D. Give preferential treatment to the acquisition of construction sites near public mass transit stops/stations - include this aspect in the building code
E. Create integrated bike path concepts not confined to tourism and recreation, include a financing concept (Competent authority: municipalities)
F. Limit individual traffic, especially in downtown areas - limit entry to city centres by such measures as pedestrian zones (Competent authority: municipalities)
G. Manage parking space (Competent authority: municipalities)

<u>Assessment:</u> Chief measures to reduce individual traffic and energy consumption
<u>Competent authority:</u> Federal Government, *Länder,* municipalities
<u>Current situation:</u>
1. Expansion and improvements of rail infrastructure and in modal split; especially in population centres and ecologically sensitive regions.

- ATS 15 billion (100 ATS is approx. 9 US$) are spent annually to improve the quality and quantity of rail infrastructure. It should be emphasised that nearly 93% of the energy needs for the railways is covered by hydroelectric power.
- A total of ATS 21 billion in federal funds are allocated in 1994 for investments in public transportation, to be spent for short-distant rail-bound traffic projects of the Austrian Federal Railways and for investments under the *"NEUE BAHN"* (THE NEW RAILWAY) project and for new connection points in the high-priority rail system.
- A push to expand combined transport, especially through the transit treaty whose major elements will remain in force even after Austria joins the EU. Other measures relating to theses stepped up efforts are the expansion of the rail infrastructure and extensive replacement of fleets. Inland navigation has been included in combined transport through a special government promotion program and the establishment of the *"Wasserkombi"*.
- Regional planning and infrastructure planning are co-ordinated in the Federal Traffic Route Plan, which is still under preparation. Energy consumption is considered the key criterion in assessments of traffic operator infrastructure projects covering all operators.

2. Stepped-up efforts in research and development (refer also to Chapter 4.2.5)

- National research priorities in transportation in conjunction with the Innovation and Technology Fund: traffic/energy technology (e.g. logistics) as well as environmental technology (focus on electric cars, innovative motor vehicle concepts); telecommunications is a further priority.
- Special R&D activities in conjunction with traffic information/control systems by setting up information and warning systems on hazardous goods transport on the Inntal-Brenner route (CITRA); this is a practical trial of technologies for non-contact vehicle-travel route contact.

3. Totally optimised traffic systems, such as traffic congestion management which incorporates public mass transit systems
4. Legally required annual engine inspections for trucks and cars.
5. Campaigns to increase awareness about fuel-saving behaviour in road traffic.
6. Possible measures, some under discussion internationally, are being analysed in conjunction with a study entitled "Consumption reduction models and an estimate of their effect on Austria"; an Austrian strategy will be formulated by the autumn of 1994 on the basis of the findings.

8. Reduction in fuel consumption of motor vehicles

Improving the energy efficiency of motor vehicles ---> 3 litre car.
Reduction potential: approx. 280,000 metric tons of CO_2 per year, or 0.4% of total CO_2 emissions.
Assessment: A study carried out by AVL for ÖMV AG entitled "Study on future engine/travel combinations with extremely low fuel consumption" has shown the technical feasibility of motor vehicle designs with consumption rates of from 3 to 3.5 l/100 km. However, this measure must be seen as just one essential component in the packet of measures, because fleet consumption reductions pertain to new vehicles only. They therefore have a delayed effect and are also offset by the annual increase in the number of vehicles.
Competent authority: Federal government
Current situation: The discussion conducted with the automobile manufacturers over the last three years has borne fruit in that it now appears possible to have vehicles with standard fuel efficiency rates of 3 l/100 km on the road by the year 2000. Standard fuel efficiency rates of 5 l/100 km are already common today, especially for diesel powered vehicles and the car industry has announced further savings potential.
As part of the CEMT (Conference of Eur. Transport Minister), negotiations are currently underway on the CO_2 resolution; this will also contain fuel consumption reductions for the motor vehicle industry which will enable the average fuel consumption of newly registered vehicles to be cut by at least 25% from 1995 to 2005 (40% by the year 2010). During its term as CEMT president in 1995, Austria will make every effort to see that this resolution is adopted as quickly as possible.

9. Use of biogenic fuels in ecologically sensitive areas

Biogenic fuels are to be required in environmentally sensitive areas such as on protected waterways, in nature preserves, in inland navigation, and on alpine ski slopes.
Competent authority: *Länder*, Federal government
Current situation: Recommendations have been issued by the Federal Ministry for Agricultural and Forestry to the Federal Hydraulic Engineering Administration and the water rights authorities to require or to use biogenic fuels; part of these recommendations have already been implemented. (Refer also to Chapters 4.2.1.6 and 4.2.1.8.)

10. Road pricing

Assessment: Preparations are already underway for an Austria-wide toll system for the motorways and expressways based on the ASFINAG Law in its version of 1991.
However, no political decision has yet been made on whether a system of this kind will actually be instituted. This system would allow the available infrastructure to be better utilised in areas with capacity bottlenecks by improving the distribution of traffic and thus have a positive effect on the environmental situation (e.g. reduction of traffic congestion). Other advantages are the possibility of varying the rates according to place, time, and emissions, of pricing transit and holiday traffic and of building up an international road-pricing system.
Competent authority: Federal government

Concepts/Projects:

11. Anchoring stricter speed limits (80/100) in the law (Road Traffic Law (StVO))

Assessment: The priority here is to enforce existing speed limits more strictly and to earmark part of the fines for enforcement measures.
Beyond that, changes in speed in the 100-130 km/h range reduce fuel consumption slightly (0.5-0.75 l/100 km). Since the safety argument is the primary one, the speed limits should be adjusted according to the danger of the given section of road.
Competent authority: Federal government, *Länder.*

12. Ecology bonus

The Austrian transportation club *Verkehrsclub Österreich* conducted a study entitled "Ecology Bonus" to determine the effect a 100% fuel price increase would have on Austria. The ecology bonus would be a control tax aimed at adjusting the price to better reflect the actual costs but the revenues collected would be returned to the population on a uniform per capita basis.
Assessment: Enacting an ecology bonus is a long-term goal since it would entail a burden on the economy and possibly lead to people crossing the border to fuel their vehicles. It is therefore only feasible if done as part of an international effort.
Competent authority: Federal government

13. Consumption limits for non-road bound vehicles (e.g. aircraft)

It should be noted that tremendous advances have been made in aircraft jet engines in recent years, leading to the lowering of fuel consumption per person-kilometre by 30% to 40%. However, a further reduction in fuel consumption is essential.

Further measures relating to total systems optimised in terms of traffic and energy:
- better combinations of rail and air traffic
- substitution of short flights especially by rail

14. Intensifying the promotion of innovative vehicle designs

Further development of hybrid drives;
continuation of research programs
Competent authority: Federal government

4.2.1.3 Industry - Combustion and processes

In the past already, Austrian industry has already provided impressive proof of its energy saving successes. For instance, it succeeded in lowering its energy consumption by almost 5% between 1973 and 1992 for an increase in production of more than 65%, and at the same time in reducing oil consumption by 68% over the same period.

In spite of these successes there is still more potential for savings in industrial processes, in particular in the sector of process heat.

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

Voluntary measures/subsidies under implementation:

1. Combined heat and power installations

Competent authority: Federal government
Current situation: In particular, combustion technology with a high cascaded energy utilisation is to be promoted in the future, also. A doubling of the 900 MW_{el} output of combined heat and power installations installed in 1990 is within the scope of estimated and possible potentials.

2. Optimisation of mechanical systems

Assessment: In the corporate sector there are possibilities for savings in mechanical drive systems, especially as a result of the following improvements:
- Optimum drive type
- Recuperative braking
- Load-dependent motor control

- Low-friction bearing mounting (tribological measures)

These are mainly technical measures, and their realisation is the responsibility of the companies themselves, the institutions advising them as well as the civil engineers concerned by planning and project planning.
Competent authority: Federal government
Current situation: Considerable energy saving successes have already been achieved in industrial plants following the swift development of cost-effective electronic speed controllers and the use of simple asynchronous machines.

3. Fuel switch

Competent authority: Federal government
Current situation: Conversion within fossil fuels has been almost completely achieved to a sensible extent. There are still considerable potentials in the area of combustible waste and biomass. The share of these fuels, which are sensible also from the viewpoint of overall environmental policy, could under certain circumstances be increased to a share of 15 to 20% of the total industrial energy consumption.

4. Improving information about the energy flow in businesses

Competent authority: Federal government
Current situation: By 1991, six service contracts had been concluded with consulting firms, under which energy advice was given to industrial companies free of charge. Some 370 companies were included in the on-site inspections and consulting activities under these agreements.
One focal point of the advice was for the companies to use a scheme involving energy accounting and an energy inventory to create as complete a picture of their internal energy flow as possible.

The success of this campaign is evident from the fact that the ATS 5 million (100 ATS is approx. 9 US$) in costs accrued for it thus far have yielded potential cost savings at the companies of some ATS 120 million a year, with the proposed energy savings estimated at some 1.25 PJ a year.

At the end of 1993 another service contract was concluded for energy consulting. This time the lower limit of annual consumption for the energy consumers to be included in the study was set at 20 TJ so that smaller industrial companies and larger trade businesses could also take advantage of this campaign.

The next step is to analyse the available statistical material and to compile it in an anonymous form so it can be used for informational purposes.

4.2.1.4 Small consumers

Measures under implementation:

1. Consumption-related heating costs accounting

Reduction potential: 15-20% reduction of heating consumption. Potential in tons of CO_2 cannot be quantified at present.
Costs: low
Assessment: The development of more precise and cheaper heat measuring instruments (relatively cheap measure) and rehabilitation in terms of heating technology of buildings and heat supply installation (relatively expensive measure) could prevent the trend towards accounting as a percentage of usable floor space and the 15-20% higher energy consumption observed in this connection.
Competent authority: Federal government
Current situation: Stipulation of consumption-related heating costs accounting in the Heating Costs Accounting Act (Federal Law Gazette 827/1992).

Planned implementation:

2. Consumption reduction for electrical appliances and motors as well as lighting and electronic systems

The determination of maximum consumption standards in conjunction with a complete product coding (energy consumption) would appear sensible.
Preparation and enactment of orders as per Section 8 Electrical Engineering Act.
Reduction potential: 1.25 million tonnes of CO_2/year, i.e. 2.2%
Assessment: The reduction potential is based on an investigation of the trends currently detectable with regard to efficiency improvement, appliance replacement, degree of outfitting with electrical appliances and number of households. In each case the old appliances are replaced by the best available appliance on the market. As was estimated, by using the most efficient electrical appliances, especially in the household appliance sector, the consumption of electrical energy for this appliance group could be reduced by approx. 30%. Therefore, the full utilisation of the electricity saving potential in small consumption through the accelerated market introduction of the most efficient appliances is a priority target in energy policy.
Competent authority: Federal government
Current situation: The appropriate task forces have been set up to implement the relevant catalogue of measures and to prepare ordinances for
* product declaration on specific current consumption
* the provision of summary information to give an insight into all the appliances on offer on the domestic market (comparative lists)
* legal requirement to stipulate maximum consumption limits
* targeted limitation of standby losses for equipment in the sector of office and entertainment electronics
* compilation of accompanying measures for the points listed above

Work is now completed on draft ordinance for implementing Directive 92/75/EEC by the Council, dated 22 September 1992, on household appliances indicating the consumption of energy and other resources by means of standardised labels and product information in conjunction with the implementing directive for that Directive (concerning large household appliances in the refrigerating/deep-freezing sector).

Work is currently in preparation on determining the nationwide consumptions by standby equipment operation and on compiling a catalogue of measures for specific limitation.

3. Improving the thermal quality of old and new structures - substantially higher standards for thermal protection of buildings

By raising the standards in building codes to reflect the advancements in technology ---> better thermal insulation using environmentally compatible materials and monitoring compliance with this standard.
- Provision for an energy certificate for buildings (see proposal for an EC Directive from the Council dated 26 June 1992)
- Setting of characteristic energy figures instead of k values (characteristic energy figures should be implemented within the framework of Art. 15 a of the Federal Constitutional Law agreement and be made gradually stricter according to a designated schedule)
Reduction potential: Not yet quantified for the entire set of measures, however it can be assumed that the potential for reduction is very high.
The potential for energy savings in room heating and water heating is very high. Some 40% of the total end energy is used for room heating and water heating. More than 80% of it is related to the use of energy for heating. The savings potential is substantial.
Assessment: Measures are urgently needed.

Current situation: Since the competence in this area is distributed among the Federal Government and the *Länder* and the building codes fall under the jurisdiction of the *Länder* in particular, an agreement in accordance with Art. 14a Federal Constitutional Law was applied as a legal instrument to formulate common goals of the Federal Government and the *Länder* and to co-ordinate future action. The first agreement on saving energy, dating from 1980, is to be replaced by an improved and updated version. On completion of negotiations with the *Länder* and of the appraisal procedure, a draft was approved by the Ministerial Council, which the Federal Government is ready to approve following its passage by the *Nationalrat* (First Chamber of Parliament).
Competent authority: Federal Government, *Länder*

4. Improvement of thermal quality of heating systems
Co-ordination of fuel-boiler-trap

Provision for a legally stipulated type test regarding emissions and efficiency inter alia through implementation of points 7 and 8 of the resolution by the *Nationalrat* (First Chamber of Parliament) dated 2 April 1992 (small furnaces)
- Basic separation of water heating from room heating
- Stepped up promotion of modern combustion technologies
- Integrated co-ordination of all system components (e.g. burner-boiler-trap)
- Improvement in control and instrumentation technology for heating systems
- Improved maintenance, servicing and inspection of heating systems

Assessment: substantial measure also for reducing the emissions of other substances which pollute the air
Competent authority: Federal Government, *Länder*

Concepts/Projects:

5. Energy accounting in public buildings and in trade and industry

For public buildings: Have BVFA Arsenal keep energy accounts - commissioning of BVFA Arsenal by Federal Ministry for Economic Affairs
Assessment: recommended measure - government setting an example
Competent authority: Federal government

6. Easing restrictions on the use of wood as a building material in compliance with the thermal insulation standards

Harmonisation of the separate building codes and their adaptation to the possible use of wood under current technical conditions
Assessment: promising measure
Competent authority: *Länder*, Federal Government

7. Subsidy for rehabilitation of old buildings

As part of promoting residential construction - funds for the rehabilitation of houses in the *Länder* should be made contingent on the submission of an energy rehabilitation plan and on compliance with the thermal insulating standards (see Chapter 4.2.1.3).
Costs: depends on the grants involved.
Competent authority: *Länder*

8. Adopting energy-based parameters in the promotion of residential housing

Government support of residential housing promotion was to be assessed on a graduated basis according to energy quality standards. Characteristic energy numbers were to be applied to represent the standard consumption of energy in a housing unit. Since the expense for constructing or rehabilitating a building or apartment could be increased if low characteristic energy figures are applied, the grants should be graduated accordingly.

Assessment: essential control measure
Current situation: With regard to government promotion policy, the compilation "Energy-related government promotion in the sector of residential construction promotion/residential housing rehabilitation in the Federal Provinces" was updated and a work group "Government Promotion Policy" was instituted. The task of this work group is to help identify the differences in promotional instruments not tied to specific regional characteristics and current promotion requirements with special emphasis on stepping up efforts with regard to district heat.
Competent authority: *Länder*

9. Reducing government support in the promotion of new residential housing construction where electric resistance heating is to be installed

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

4.2.1.5. Agriculture

Voluntary measures/subsidies under implementation:

1. Extension of biological farming and integrated husbandry, further reduction in fertilizer applications through the targeted use of fertilizer in accordance with requirements

Assessment: Seems an important measure given its double effect (reduction in N_2O emissions and savings of energy for fertilizer production).
Competent authority: Federal government, Länder
Current situation: In agriculture fertilizer application (nitrogen, phosphate) is recessive overall. From 333,000 tonnes of pure nutrient in the 1987/88 accounting year to 241,000 tonnes of pure nutrient in the 1992/93 accounting year.

Biological farming as the most consistent form of renouncing the use of mineral fertilizers and chemical crop pesticides has shown a rapid upwards trend since 1988. In this area there are already at present subsidies for farming operations with biological farming methods and "bio-associations".

A turnaround in these trends is not anticipated even after Austria's accession to the EU. While the abolition in the fertilizer levy does make these supplies cheaper, the increased use of mineral fertilizers is counteracted by the effects of the fall in agricultural farming prices and the environmental demands to be felt much more strongly in agriculture in the future. Following Austria's accession to the EU, biological farming will be strengthened as part of ÖPUL (Austrian Programme for the Promotion of Environmentally Compatible Agriculture) and various measures of integrated husbandry are to be promoted for the first time.

2. Cultivation of oil-seed crops aimed at substituting fossil fuels with biogenic fuels - Provision of biogenic fuels and lubricants for environmentally sensitive areas of use

Reduction potential (1988 basis): 0.3 million tonnes CO_2/year or 0.5%
Costs: in accordance with the amount of financial allocations, subsidies
Assessment: multiple use for the environment, many of the necessary structures already in place; if financial incentives were provided - quickly implementable
Competent authority: Federal Government, Länder; subsidies by the Federal Ministry of Agriculture and the Länder possible as part of the private enterprise administration
Current situation: Rape acreage has risen from 31,000 ha in 1988 to 57,000 in 1993, with an average yield of some 2,500 kg/ha. Agricultural subsidies are available for rape cultivation.
With the so-called chain-saw regulation an initial step has been taken with regard to the use of biogenic lubricants. Consideration of the criterion "regenerative resources basis" in the guidelines for the Austrian eco-label.

3. Utilising the energy of surplus straw

(Due to a number of measures straw burning on open fields has been recessive since 1988. With the law banning the burning of biogenic waste (Federal Law Gazette 403/1993) the burning of straw on open fields has been restricted to a very large extent.
For this reason this measure is of increasing significance.)
Reduction potential (1988 basis): approx. 0.6 m tonnes of CO2 per year, or 1%.
Costs: retrofit measures on firing installations
Assessment: many of the necessary structures have already been created: technical modifications to firing installations required in part.
Competent authority: Room heating distribution among energy carriers **-** regional planning: municipalities and *Länder*; government promotion of district heating: Federal Government, *Länder*; government promotion of residential construction: *Länder*, for combined heat and power schemes (CHP): feed regulations; waste management: Federal Government
Current situation: No dynamic trend is currently in sight. There is some government promotion of agriculture in this regard and of some other sectors of the economy.

4. Determination of biogas potential for economically feasible uses and the substitution of fossil fuels with biogas (refer also to Chapter 4.2.2)

Costs: development of the necessary infrastructure.
Assessment: An effective measure in light of the double effect on the climate (reduction of methane emissions and the substitution of fossil fuels).
Competent authority: Feed regulations (Federal Government and *Länder*), government promotion of district heat: *Länder*; distribution of room heating market according to energy carriers **-** regional planning: municipalities and *Länder*; government promotion of residential housing: *Länder*; waste management: Federal government
Current situation: No dynamic trend currently in sight. There is some government support for the erection of biogas plants in agriculture as well as other sectors of the economy.

4.2.1.6. Forestry and land use

Planned implementation:

1. Maintenance of a vital forest as CO_2 sink

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

- Reduction in deer and grazing damage to an ecologically sustainable level through the implementation of the appropriate provisions of game legislation.
Assessment: important measure for achieving the regeneration of near-natural forest regions
Competent authorities: Länder

- Forestry measures (management regulations) for a lasting management of Austrian yield forests. Measures for maintaining the water regime as well as site-related planting to prevent single cropping.
Competent authority: Federal Ministry of Agriculture and Forestry

Concepts/projects:

2. Extension of the forest area (up until 2005)

Reduction potential: 2.5 m tonnes of CO2 per year
Assessment: Through afforestation (extension of the CO2 sinks) a certain strengthening of the "depot effect" (C-fixing) can be achieved.
In this way success in CO2 reduction could be obtained in the short to medium term. However, there are limitations imposed on intensive afforestation by the available surface area. 46% of the national territory of Austria is already covered with forests.
Competent authority: Federal government

3. Improvement in the stand structure

The timber stock and stores of humus can be increased by forms of forest management.
There is still a need for research in a number of areas. There are no figures at present on the increase in the store of humus.
Intensified setting of mixed forest on denuded and windbreak areas would seem recommendable.
Reduction potential: 4.1 million metrictonnes of CO_2 per year.
Competent authority: Federal government

4. Doubling the use of long-lived wood products

Reduction potential: (Base year: 1988): 0.2 million metric tons of CO_2 per year or 0.4%
Costs: very slight
Assessment: Relatively large amounts of CO_2 could be bound from the atmosphere over the medium term through the increased use of long-lived wood products (enlargement of the CO_2 reservoir). This would be a sensible industry-wide policy for the Austrian woodworking and wood-processing industry.
Competent authority: Building code: *Länder*
Current situation: In the period from 1988 to 1993 approx. 700,000 m³ of sawnwood was sold as building material, furniture, etc. in Austria, which results in the binding of approx. 771,000 metric tons of CO_2 over the medium to long term.

4.2.1.7. Sector-overlapping measures

There are several energy-specific promotion programmes at the Federal Government level. As part of the innovation and technology fund, technology projects with special emphasis on renewable fuels are being promoted within the "Energy Technology" programme (term: 1992- 1996).
Competent authority: Federal Government

Promotion of renewable fuels:

For many years already, the Federal Government's energy policy has given such significance to the intensified use of renewable energies that it is justifiably considered as the "corner stone" and foundation of the domestic energy supply. Besides the maximum possible utilisation of all existing energy saving potentials, the best possible opportunities for achieving the CO_2 emission reduction target are seen in the greatest possible tapping of renewable sources of energy, in particular in the stronger market penetration of biomass.

Over the last few years the continuous and responsible use of hydraulic power and the more intensified tapping of other renewable sources of energy, in particular biomass, have served to cover two thirds of the domestic yield.

At present the utilisation of hydro power provides approx. 150 PJ (approx. 13% of total energy consumption) while other renewable fuels provide approx. 140 PJ (12% of total energy consumption).

Compared with other European countries, this puts Austria at the very forefront; around one quarter of the entire energy supply comes from renewable sources.

The relative shares of renewable sources of energy excluding hydraulic power are currently as follows:

Firewood	66%
Saw by-products and hogged wood	6.7%
Bark	6.4%
Spent liquor	13.6%
Straw	0.6%
Combustible waste	3.1%
Heat pumps	2.9%
Biogas	0.3%
Active solar energy	0.3%
Geothermal energy	0.1%

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

The instruments and measures listed below are aimed at the additional tapping of 30 to 40 PJ above the existing yield.
- Research programmes for renewable energy
- Reduction of information deficits when utilising renewable energy
- Tightening of the subsidy system
- Fair outline conditions for all fuels.

Utilising the energy value of biomass is of significance in terms not only of the national economy but also of the regional economy as it enables decentralised energy extraction, with favourable repercussions on local economic development. For people, decentralised systems are more easily manageable and therefore entail greater social acceptance. There are also advantages to a decentralised energy supply in the light of supply safety.

Finally, an increased utilisation of biomass would create additional job possibilities not only in agriculture, but in machine and plant construction and in the building trades. The primary goal with respect to biomass utilisation is to create evaluation criteria for determining what form of utilisation would be most expedient in all regards.

As part of the priority area "Energy Technology" set up by the Innovation and Technology Fund (ITF) in 1992, 22 projects had received a total of ATS 103 million (100 ATS is approx. 9 US$) in government support from the Federal Ministry for Science and Research and the Federal Ministry for the Public Sector and Transport by 1 July 1994. These projects, too, were developed against the backdrop of pressing needs to reduce energy emissions. As part of the ITF priority area "Environmental Technology", 120 projects have received a total of ATS 279 million in government support from the Federal Ministry for Science and Research and the Federal Ministry for the Public Sector and Transport since 1988.

Voluntary measures / subsidies under implementation:

1. Use of biomass as a fuel and raw material

- Use of wood in furnaces (to replace fossil fuels)

Reduction potential: (Base year: 1988): 2.9 million metric tons of CO_2 a year or 5.2%

Costs: possible costs for the conversion of existing furnaces
Assessment: Very effective and relatively cost-effective measure. However, it is important to ensure that the firing takes place in systems which reflect the current state of the art.
Competent authority: Division of the room heating market between energy carriers - regional planning: municipalities and *Länder*
Government promotion of district heating: Federal government and *Länder*; government promotion of housing construction: *Länder*; in conjunction with combined heat and power schemes (CHP): feed order or law.
Current situation: From the forests alone, approx. 400,000 additional cubic meters of firewood were produced and consumed in the period from 1988 and 1993. This translates into a CO_2 reduction of approx. 440,000 metric tons.
In the sector of modern chip and bark furnaces alone, the same period saw the installation of 10,000 small plants (less than 100 kW output), 1,600 medium-sized plants (from 100 to 1000 kW) and 200 large-sized plants (more than 1 MW).
Modern split billet furnaces have also come on the scene and sales figures for them have already surpassed those for chip furnaces. These modern wood-burning furnaces help to improve the emissions situation by utilising wood energy more efficiently and by replacing fossil energy or at least not creating extra demand for it. Government grants for agriculture currently exist in this area.
-->Should be pushed by increasing the price for fossil fuels and establishing priority areas where renewable energy sources should be used for room heating

- Use of biodiesel

Current situation: In a series of research and experimental programs including fleet tests, the technical groundwork was laid for the production and use of biogenic fuels and lubricants. Two industrial plants and five small plants on farms were erected to produce rape methyl ester (RME) with an annual capacity of approx. 30,000 metric tons of RME (corresponds to a rapeseed cultivation area of approx. 30,000 ha). There are government grants to agriculture for the erection of RME plants and for the cultivation of rapeseed. (Refer also to Chapter 4.2.1.5).

- energy utilisation of excess straw (see Chapter 4.2.1.5.)

- energy utilisation of biogas, landfill gas, and sewage gas (see Chapters 4.2.1.5. and 4.2.2.)

2. Utilisation of solar energy, especially for water heating, and partial solar room heating - use of solar collectors - passive solar energy utilisation (scenario 1 = no change in use and scenario 2 = increased use)

Reduction potential: (Base year: 1988): Scenario 1: 0.6 million metric tons of CO_2 per year, 1.1%; scenario 2: approx. 1.3 million metric tons per year, 2.3%.
Costs: Since installation costs are offset by the energy costs saved, this measure should be well accepted.
Assessment: Relatively high reduction potential in connection with quick implementation; high acceptance can be expected.
Competent authority: promotion: *Länder* and municipalities; building code: *Länder*; promotion of residential housing: *Länder*
Current situation: A dynamic trend is emerging in the utilisation of solar energy. The construction of solar systems is currently being promoted in all *Länder*, in many municipalities, by the Environmental Fund and by agricultural development institutions.
Austria is one of the best equipped countries in the world in terms of solar collectors. In 1994, the area covered by installed solar collectors will top the 1 million m2 mark.

3. Photovoltaic utilisation of solar energy

At the federal level, the Environmental Fund currently promotes commercial plants. At the provincial level, support is currently available in Burgenland, Lower Austria, Upper Austria and Vienna.

A solar energy program was launched by the Federal Ministry for Economic Affairs. It consists of the subprograms:
- Broad-based test for photovoltaic systems
- Broad-based test for electric cars
- Measures for a rapid market launch of these technologies
- Scientific program to accompany these tests and measures.

Specifically, this has entailed:
Promotion of photovoltaic systems in 1992 and 1993:
Subject: erection and commissioning of mains-coupled PV systems with a peak output of 1 to a max. of 3.6 kW (in exceptional cases from a lower limit of 0.3 kW to an upper limit of 10 kW).
Current situation: The government promotes this area by awarding a fixed non-repayable grant per kilowatt of installed solar output; together with the contributions from the electric supply companies, these funds amount to ATS 80,000 (100 ATS is approx. 9 US$). Of this amount, ATS 10,000 constitute a discounted advance payment for the power generated within 10 years; in addition to this amount, a compensation payment will also be rendered by the utilities on input to network.

The grant commitments have already exhausted the 200 kW framework initially set up. Other projects totalling more than 190 kW have already been submitted. In view of the strong interest that has been shown, talks are under way with the electricity supply industry to establish an additional quota.

A 5-year scientific program to accompany these measures is being sponsored by the Federal Ministry for Science and Research. Its purpose is to establish new technical findings and to expand knowledge regarding the relevance of these technologies to energy and environmental policy.

The acquisition of a solar or electric vehicle by private buyers is being promoted by granting a ATS 10,000 bonus. A very favourable financing campaign for electric-powered commercial vehicles was established for industry.
As of the end of November 1993, the bonus had been paid to 93 vehicle owners. A that point, grant commitments had already been made for an additional 44 vehicles. As of 10 March 1994, a total of 148 commitments had been made.
Electric-powered vehicles were already exempted from the motor vehicle tax effective 1 January 1992 as part of the overall revision of the motor vehicle tax to comply with environmental criteria.

4. Utilisation of environmental energy by means of heat pumps

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

Based on these premises and after having weighed the advantages of using heat pumps against any negative impacts they may have on the environment, it has been decided to continue promoting the increased use of heat pumps. The corresponding promotional measures are being continued, especially in the area of room heating and water heating.

At the same time, great efforts are being made to find substitute coolants which are not considered to have a harmful effect on the climate. Austria is participating in pertinent international research projects on this topic (especially the IEA).

Concepts/Projects:

5. Utilisation of wind energy

Current situation: The Federal Ministry for Economic Affairs is currently studying the feasibility of launching a program for wind power similar to that for photovoltaic systems, drawing on its experiences from the broad-based photovoltaic tests and the procedures involved with them.

A "Joint Venture for Wind Power" submitted a proposal for a promotional program in January 1994. Prior to that, a study entitled "Wind power in Austria" was commissioned; an interim report was released in August 1993.

6. Utilisation of geothermal power as a source of energy

Current situation: At the current time, a geothermal output of approx. 14 MW is being utilised in the Southern Styrian/Burgenland Basin and the Upper Austrian molasse zone. These regions are also considered the most promising areas for further developing the utilisation of geothermal power as a source of energy. The usable geothermal potential is substantially higher.

There was already an opportunity to promote geothermal projects in conjunction with the promotion of district heating. The government will continue to promote the creation of regional/municipal energy concepts as well as the geothermal studies that sometimes accompany them.

The possibilities of incorporating promising geothermal areas in the regional heat plans were explored in talks with the *Länder*. Assuming further specific studies will be done, the *Länder* have been called upon to specify in their regional heat plans the priority district heating areas for use of geothermal energy and to see that its use is implemented, drawing on the pertinent promotional instruments of local government to do so.

7. Continuation of the analysis of the Austrian system of government promotion from the standpoint of its possible effects on the emission of greenhouse gases

Substantial funds are spent by local government in conjunction with the administration of government promotion efforts.
Considerable reductions in emissions can be induced from the existing promotional systems. Negotiations are now under way in the promotion co-ordination committee to create an "eco-social valuation scheme" for the public administration of government promotional efforts.
Competent authority: Federal Government, *Länder*

4.2.2. Methane

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

4.2.2.1 Waste and waste water treatment

Planned implementation:

1. Energy utilisation of landfill gas

Costs: development of necessary infrastructure
Assessment: A very effective measure in terms of the climate due to the double effect (energy conservation and the reduction of CH_4 emissions)
Competent authority: Feed regulations: *Länder*, Federal Government; waste management: *Länder* or Federal Government; study of mandatory utilisation of landfill gas: Federal Government
Current situation: A draft order on landfills was drawn up by the Federal Ministry of Environment, Youth and Family Affairs and sent to experts for review.

2. Energy utilisation of sewage sludge

Assessment: should be utilised to avoid methane emissions
Competent authority: Study of mandatory utilisation of sewage gas: Federal Government; feed regulations: *Länder*, Federal Government; waste management: Federal Government

4.2.2.2 Agriculture

Concepts/Projects:

1. Study on the use of corresponding systems with catalytic combustion or with biofilters at fertiliser storage sites above a certain size

Assessment: Much research still needs to be done in this area.
Competent authority: *Länder*, Federal Government
Current situation: Together with the Federal Ministry for Science and Research, the Federal Ministry for Agriculture and Forestry has commissioned research project *L757* "The Contribution of Agriculture to the Ozone Problem", which is also relevant to this topic.

2. Determination of biogas potential for economically feasible use and replacement of fossil fuels by biogas (refer also to Chapter 4.2.1.5)

Costs: development of the necessary infrastructure **-** promotion of projects by the Ecology Fund are possible
Assessment: A very effective measure due to the double effect on the climate (reduction of CH_4 emissions and substitution of fossil fuels)
Competent authority: Feed regulations: *Länder*, Federal Government; district heat promotion: *Länder*; distribution of regional heating market according to energy carriers **-** regional planning: municipalities and *Länder*; promotion of residential housing: *Länder*
Current situation: Together with the Federal Ministry for Science and Research, the Federal Ministry for Agriculture and Forestry has commissioned research project *L757* "The Contribution of Agriculture to the Ozone Problem", which is also relevant to this topic.

4.2.2.3. Evaporation losses

Concepts/projects:

1. Reduction in methane losses from natural gas supply networks

At present methane emissions from line losses within Austria amount to approx. 7,700 tonnes per year.
Up until 1993 Austria obtained its natural gas almost exclusively from the former Soviet Union. In many instances the conveyance facilities have been accused of having considerable leakages and, as a result, of releasing a CO_2 equivalent of unburnt natural gas (methane) imputable to the recipient country, thereby cancelling out completely the relative cost-effective CO_2 record of natural gas. In the meantime these allegations have on the one hand been refuted by the investigations of the CO_2 Commission; on the other, Austria is making efforts in general to diversify its natural gas purchases and in particular to obtain it from modern production plants through modern line systems.

Since autumn 1993 natural gas is being supplied to Austria from Norway.

A planning syndicate led by ÖMV is currently looking at the technical and economic feasibility of landing liquefied natural gas from the Mediterranean region and of building a pipeline from the northern Adriatic to Central Europe.

Trade policy issues are continually being introduced into bilateral discussions (e.g. in "mixed commissions").

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

In 1993 the partners of Austria Ferngas (8 provincial companies) attended the trial run of a fuel cell at the Wiener Stadtwerke (Vienna Municipal Authorities). Several provincial district gas companies are currently testing natural gas powered vehicles at their plants.

Competent authority: Federal Government.

4.2.3. Nitrous oxide

4.2.3.1 Industry - combustion and processes

Concepts/Projects:

1. Replacement of urea by ammonia in the non-selective catalytic reduction of nitrogen oxides

Review of instruments: Federal Government
Competent authority: Federal Government

2. Optimisation of the combustion temperature in fluid bed technology

Review of instruments: Federal Government
Competent authority: Federal Government

3. Feasibility study on setting N_2O emission standards

Review of instruments: Federal Government
Competent authority: Federal Government

4.2.3.2 Agriculture

Concepts/Projects:

1. Expansion of integrated land management, decrease in the use of fertilisers by using fertilisers in a targeted manner tailored to actual needs

Assessment: Appears to be an important measure due to its double effect (energy conservation and reduction of N_2O emissions)
Competent authority: Federal Government, *Länder*
(refer also to Chapter 4.2.1.5)

2. Development of strategies to avoid N_2O

Commissioning of relevant research projects
Competent authority: Federal Government, *Länder*
Current situation: Together with the Federal Ministry for Science and Research, the Federal Ministry for Agriculture and Forestry has commissioned research project *L757* "The Contribution of Agriculture to the Ozone Problem", which is also relevant to this topic.

4.2.3.3 Transport sector

Concepts/Projects:

1. Setting N_2O emission standards (--> motor vehicle implementation order)

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

Competent authority: Federal Ministry for the Public Sector and Transport
Refer also to the measures described in Chapter 4.2.1.2 for reducing fuel consumption and traffic volume.

4.2.4 Reduction measures for other greenhouse gases

With regard to the ozone precursors nitrogen oxides and volatile organic compounds, Austria has passed an ozone law (Federal Law Gazette 210/1992) which establishes a gradual reduction in emissions of 40% by the end of 1996, of 60% by the end of the year 2001 and of 70% by the end of the year 2006 - based on 1985 for NO_x and 1988 for VOC. To reach this target, a resolution containing a measures catalogue was adopted by the *Nationalrat* (First Chamber of Parliament) at the same time the ozone law was passed. It calls on the competent federal ministers to implement concrete measures in their respective areas of competence.

Among the measures provided for in the resolution to the Ozone Law, the following orders or laws have already gone into effect:

* "Equipping filling stations with gas displacement systems" (as of 1 January 1993)

* "Limitation of the emission of air polluting substances from systems used in cement production" (as of 30 January 1993)
  "Limitation of the emissions of air polluting substances from foundries" (as of 17 June 1994)
  "Limitation of the emission of air polluting substances from systems used in gypsum production" (as of 21 October 1993)
  "Limitation of the emission of air polluting substances from baking ovens used in brick manufacture" (as of 21 October 1993)
  "Limitation of the emission of air polluting substances from systems used in glass production" (as of 7 July 1994)

Orders are currently under preparation on the limitation of the emissions of air polluting substances from systems used in the production of wood particleboard, non-ferrous metals, iron and steel, and from painting plants.

* "Ban on the combustion of biogenic material outside of plants" (as of 1 July 1993)

* "37th KDV Amendment" (as of 1 January 1994) - an order which, inter alia, provides that the stricter EU exhaust emission standards for trucks is binding on Austria beginning on 1 January 1994 on expiration of the transitional period provided for in the EEA Treaty.

Work continues on implementing the rest of the measures in the resolution.

Many of the measures for the greenhouse gases CO_2, CH_4 and N_2O named in the catalogue of measures have a high reduction potential for ozone precursor emissions, too.

Austrian regulations regarding substances which deplete the ozone layer:

1. Fully halogenated chlorofluorocarbons (CFCs)

Key areas of regulation:

• Ban on CFCs as a propellant gas in spray cans since 1 March 1990 (Federal Law Gazette No. 55/1989). This has reduced the consumption of CFC by more than 50% (or more than 4,000 metric tons).
  With the passing into force of the CFC order (Federal Law Gazette No. 301/1990), the use of CFCs will be able to be eliminated completely by 1 January 1995.

Regulation is aimed at the following uses in particular:

◦ from 1 January 1991: a 50% reduction in foams

- from 1 January 1994: ban as a solvent
- from 1 January 1992: ban as a coolant in large systems (cooling plants, air conditioners, heat pumps...)
- from 1 January 1994: ban as a coolant in small systems
- from 1 January 1993: ban on use in foams
- from 1 January 1995: ban on use as a cleaning agent for textiles.

The reduction potential in these uses totals approx. 4,000 metric tons.

2. Halons

The halon order (Federal Law Gazette No. 576/1990) prohibits the use of halons, usually used as a fire extinguishing substance, in all new systems.
Refilling existing systems with halon is permitted only in very few cases (high risk to human health and life). There are also strict limitations on the trading and marketing of halons.
With these measures, Austria has complied not only with the requirements of the Montreal Protocol but will have eliminated the use of this substance by 1995 instead of the 1996 deadline set in the Protocol.

3. Ban on carbon tetrachlorides and 1,1,1 tetrachloroethane (Federal Law Gazette No. 776/1992)

Although the toxicity of carbon tetrachloride limited its use in Austria to only relatively small amounts, 1,1,1 tetrachloroethane is used for cleaning and degreasing in a variety of areas (particularly for the degreasing of metal surfaces and in the textile branch). It is estimated that some 1,800 metric tons of it are used a year.

Key regulations:

- Carbon tetrachlorides have been banned since 1 January 1993
- The use of 1,1,1, tetrachloroethane will be banned for most uses beginning on 1 January 1995. Exceptions pertain to self-contained systems. This step will greatly reduce emissions in the years ahead and enable the elimination of the use of this substance before the year 2000.

4. F-22 Order (Federal Law Gazette No. 673/1992)

F-22 is one of the partly halogenated chlorofluorocarbons. The Montreal Protocol calls for its use to be eliminated by 2030.
Since F-22 is now widely used in spray cans instead of the previously used CFCs and has a far from negligible potential to deplete the ozone, the use of this substance was banned effective 1 January 1993.
The resulting reduction potential is at least 1,000 metric tons a year.

4.2.5 Research and Systematic Observation

4.2.5.1. Research

The research efforts connected with greenhouse gas emissions and the possibilities of reducing them are focused in areas which are significant to the current emission balance in Austria and to the contributions which imported and domestic energy carriers make to covering energy needs. They include the following areas:

* **Biomass,** issues relating to forest management, combustion technologies, emissions and their reduction
* **Greenhouse gas emission,** precise quantification of pyrogenic and cold emissions of CO_2, CH_4 and N_2O
* **Separation of CO from combustion gases** and the possibilities of disposing of separated CO_2 in Austria

* **Greenhouse gas emissions outside of Austria** from the supplying of imported fossil energy carriers
* **Issues related to the overall economy** in conjunction with fiscal and legal measures to reduce CO_2
* **Quantification of emission reduction potentials** for selected stationary and mobile CO_2 emission sources
* **Legal instruments** to promote organisational, technical and fiscal measures for reducing greenhouse gases
* **Costs** of emission-reducing measures

Research work and studies on these issues are being carried out by the following institutions, among others:

* Austrian CO_2 Commission, or ACC (*Österreichische CO_2-Kommission*)
* Austrian Federal Environmental Agency (*Umweltbundesamt, UBA*)
* Energy Utilisation Agency (*Energieverwertungsagentur, EVA*)
* Technical University of Vienna (TU-Wien)
* Technical University of Graz (TU-Graz)
* Commission for Air Pollution Control of the Austrian Academy of Sciences (*Kommission für die Reinhaltung der Luft der Österreichischen Akademie der Wissenschaften)*
* Austrian Research Centre Seibersdorf (*Österr. Forschungszentrum Seibersdorf, ÖFZS*)
* University of Linz (Uni-Linz)
* University of Vienna (Uni-Wien)
* Joanneum Research Graz
* University of Agriculture, Vienna (*Universität für Bodenkultur, Boku-Wien*)
* Business Chamber of Austria (*Wirschaftskammer Österreich, WKÖ*)
* Federal Chamber for Workers and Employees (*Bundeskammer für Arbeiter und Angestellten BAK*)
* Association of Electricity Supply Companies (*Verband der Elektrizitäts-versorgungsunternehmen, VEU*)
* International Institute for Applied Systems Analysis (IIASA).

These research activities are commissioned by the competent ministries, special interest associations, industry, Laxenburg Academy for the Environment and Energy, et.al.

* Main work theme "Anthropogenic climate changes: Possible repercussions on Austria - Possible measures in Austria": In its inventory, the report presented the current level of knowledge with regard to the repercussions of the additional greenhouse effect created by man on climate, hydrology, limnology, vegetation and people in Austria, and a catalogue of possible measures was drawn up.

* Global change: In the area of "Global Change" research, a task force is currently drafting a report on Austria's activities and possible interactions with European initiatives.

* National Climate Committee: The National Climate Committee has been commissioned to collect national contributions to the world climate programme, an initiative of the World Meteorological Organisation.

* Research project "Evaluation of selected, technical, economic and social aspects of an energy tax with integrated CO2 levy": The final report is now available and is shortly to be approved.

Among the scientific investigations commissioned by the Federal Government was the study "Energy plants - Compilation of the results of existing research work". This study was submitted in March 1993 and contains a summary of research projects conducted in Austria in the sector of energy plants. In addition concrete research orders have been placed in the sector of biomass (e.g. "Producing timber with rapid-growing tree species in short rotation and targeted biomass production for energy extraction". Other research projects such as for example boosting the use of bio-Diesel are being subsidised.

Work is currently in progress on drawing up an implementation-orientated research concept by the Federal Government and the Länder for the residential and office building sector.

Within the overall context of determining the potential of thermal building rehabilitation in Austria a study has been completed on primary energy use for new housing construction and demolition and reconstruction as well as the thermal improvement of building assets.

Several of the studies conducted in conjunction with the Austrian CO_2 Commission and commissioned by the Federal Ministry of Environment, Youth and Family Affairs are briefly described below by way of example.

Research Projects in 1992

Monthly CO_2 emissions from fossil fuels in Austria 1987 - 1992

Authors: A. Hackl and W. Vitovec

The monthly CO_2 emissions from the combustion of fossil fuels in Austria were calculated on the basis of energy statistics from January 1987 to December 1992 (Austrian national statistics office: *Österreichisches Statistisches Zentralamt, ÖSTAT*) . There were strong seasonal fluctuations in emissions, with the maximum values occurring in the winter and the minimum values in mid-summer. The lowest monthly emissions were approx. 3 million metric tons of CO_2, the highest approx. 6 million metric tons.
The pattern of emission fluctuations was similar to that for heating-degree days, which is a measure of heating requirements.

In sum, the two factors influencing the monthly CO_2 emissions are the ambient temperature, expressed in heating-degree days, and the output of hydroelectric power stations. Because there is no direct correlation between these two factors, they can either mutually reinforce each other's effect on the CO_2 emissions or offset it. The monthly CO_2 emissions are of limited suitability for evaluating the efficiency of CO_2 reduction strategies, but they do help us better understand the factors influencing the CO_2 emissions.

Carbon Flux in the Austrian Forestry and Timber Sector II

Authors: G. HALBWACHS, N. ARZL, M. GRABNER and R. WIMMER

The Austrian forest act as a reservoir for some 300 million metric tons of carbon. Another 475 million metric tons are bound up in the soil.

Semi-finished wood products (sawnwood, panel-shaped wood-based materials) bind more carbon within wood than is released through energy consumption during their production. The total amount of carbon used from our forests in the form of wood is approximately four times the amount of carbon released in the process of felling, transporting and processing the wood; i.e. if wood or wood products are used for a prolonged period of time, a carbon pool is created during their service life. The carbon is not released into the atmosphere again until the product either rots or is burned.

In drawing up ecological "balance-sheets" for certain products (e.g. windows, outside walls), wood is very often the most ecologically sensible material to use.

Increased and especially prolonged use of wood can contribute in a small way to reducing the CO_2 problem in Austria.

N_2O emissions in Austria: N_2O emissions from mobile sources

Authors: A. HACKL, and I. BAUER

The analyses in these projects yielded the following major results:

* N_2O emissions may reach high levels under certain operating conditions (low r.p.m.s and torques), especially from Otto engines with catalytic converters.

* The average values of N_2O emission factors (g N_2O/km) for petrol-powered motor vehicles equipped with a catalytic converter were markedly higher than those for petrol-powered vehicles without catalytic converters and diesel vehicles.

* Certain measures can be carried out on the engine to reduce the formation of N_2O by up to 75%.

* Petrol-powered vehicles with catalytic converters have lower levels of CH_4 emissions than like vehicles without catalytic converters.

A comparison of N_2O and CH_4 emissions from petrol-power vehicles with catalytic converters - based on CO_2 equivalents and calculated for an integration period of 20 years for these emissions - shows that decreasing CH_4 emissions can cut down the increase in N_2O emissions, but not offset it altogether.

Technological, structural and macroeconomic aspects involved in the evaluation of strategies to reduce CO_2

Authors: S. SCHLEICHER, I. WAGNER, A. GREYER, H. LECHNER, and W. RESSI

Industry is responsible for approx. 30% of the total Austrian CO_2 emissions. Of the 16 different branches of industry, four primary industries account for about 80% of the total industrial CO_2 emissions: iron and steel, rock and ceramic, paper, and chemicals. The net production value of Austrian industry increased by more than 50% between 1973 and the beginning of '90s while the amount of energy used remained virtually the same.

Changes in the intensity of energy and CO_2 are analysed here with regard to the changes in the efficiency of energy, the industrial structure and the energy mix. What emerges is the dominant role of structural effects and the efficiency effects triggered by energy prices.

Separation and disposal of carbon dioxide from flue gases generated in fossil-fuel fired power stations

Authors: A. HACKL and G. MAUSCHITZ

The investigations focused on technologies to separate carbon dioxide from flue gases generated in fossil-fuel fired power stations, which are large emitters of anthropogenic CO_2. A critical examination was made of numerous separation processes which are well known in the pertinent technical literature. These processes have already proven themselves as process techniques in other areas as self-contained energy systems and appear to be suitable as a means of converting existing power stations so they discharge less carbon dioxide.

In this analysis of various separation technologies such as a two-stage membrane process called gas permeation as well as absorption and cryogenic fractionation of the flue gas, it was found that the best technological solution is a chemical absorption process utilising suitable amine-based washing agents resistant to degradation.

As the situation now stands, it would be technically feasible to separate carbon dioxide from flue gases although each of the processes discussed would entail considerably higher operating and investment costs than has been the case with the conventional flue gas cleaning techniques currently used, such as dedusting, desulphuration or denoxing. An even greater consideration is that the installation of a chemical carbon dioxide washing stage in an existing conventional, coal-fired 500 MW power station would cut the overall efficiency of the plant from 35.4% (without district heat coupling) to 18.7%, even in a best-case scenario.

This study proves that removing carbon dioxide from flue gases generated by fossil-fuel fired power stations is indeed technically feasible, but also shows that this would increase by 89% the energy input for producing 1 kWh_{el} in a conventionally designed power station. Another reason a process like this would not be able to be used in Austria is the excessively small storage capacity for the separated carbon dioxide. For these reasons, the CO_2 reduction strategies for Austria should be carried out in the primary area.

N_2O emissions in Austria: Pyrogenic emissions from stationary sources

Authors: A. HACKL and W. VITOVEC

Based on these evaluations, the following approaches should be taken with regard to the reduction of N_2O emissions: No reductions are necessary in conjunction with conventional combustion since the emissions are very small in volume. In general, the higher the quality of combustion the lower the N_2O emissions in this area. An improvement in combustion (homogeneous combustion, better burn-out) reduces the already low N_2O emissions even further.

With regard to the fluidizing bed technique, the main influencing factors are combustion temperature and the nitrogen contents of the fuel.

In examinations of secondary $DeNO_x$ plants (SCR plants for the selective catalytic reduction of NO_x by injecting ammonia; SNCR plants for selective non-catalytic reduction of NO_x by injecting ammonia and urea) it was found that only the SNCR technique had any appreciable potential for N_2O formation. Ammonia should be given preference since urea was shown to cause much higher N_2O emissions with the reactants used than ammonia did. However, there is a great reduction potential in the optimisation of the actual plant with regard to injection nozzles, temperature level and mixing processes.

Possibilities for Carbon Dioxide Emission Reduction in Non-Energy Applications of Fossil Raw Materials in Austria

Authors; H. SCHNITZER and M. NARODOSLAWSKY

Apart from the widely known and discussed sources of CO_2 emission from the energy sector, the nitrogen industry also contributes to the accumulation of CO_2 in the atmosphere with its use of fossil raw materials. The emission in Austria from the main product classes plastics, solvents, pesticides and fertilisers is estimated at approx. 2.1 million metric tons of CO_2 a year or 7.3% of the output of CO_2 caused by the energetic use of fossil raw materials derived from crude oil.

In order to switch to raw materials derived from renewable resources and thus eliminate the CO_2 emissions mentioned above (or use them in a manner neutral to the climate), the technologies would have to be interconnected accordingly. In this study, an attempt was made to depict, quantitatively and qualitatively, the feasibility of implementing a change of this kind in the base material for product systems in the product categories solvents, plastics, pesticides and fertilisers.

The study found that switching to sustainable materials operations based on renewable resources was indeed possible. The key technologies necessary for this have been developed to the corresponding technical level and are available now. A switch to a sustainable materials operation would also bring major advantages and synergy effects by cutting down emissions from transport and by generally reducing the persistence of the products in the immediate environment.

Research Projects in 1993

Climate-Relevant Emissions of Methane Gas and Carbon Dioxide from the Supply Systems for Fossil Fuels

Authors: A. HACKL and G. MAUSCHITZ

The study presents the Austrian chains of processes for supplying imported fossil fuels and fossil fuels extracted in Austria (i.e. coal, natural gas, oil) and reports energetic and emission-related characteristic values for the individual segments of the supply chain in the form of emission factors for carbon dioxide and methane, two noxious gases relevant to the climate. The process chains are defined to include all essential systems from the extraction of the energy carriers to their delivery into storage in Austria (extraction, processing, long-distance transport).

The calculation of the energy amounts involved in supplying the individual fuels also reveals a good deal about the energy raw material systems in the countries from which Austria purchases the main share of its raw materials for energy purposes (Poland, Czech Republic, Germany, USA, CIS and Hungary).

Scenarios to increase the carbon reservoir in forests

Authors: G. HALBWACHS, N. ARZL and R. WIMMER

A simulation program was used to try to determine the influence of various management strategies (conventional, selection felling and no use) on the carbon storage effectiveness of forests. The studies included growth and forest cropping parameters and investigated the ramifications of a change in them on the overall carbon reservoir.

The scenarios were created for three forest communities essential to the alpine region: the subalpine spruce forest, the montane mixed conifer forest, and the beech forest. These three communities differ in both their growth parameters and their forest cropping parameters (e.g. variable felling rates).

Aside from the long-term possibilities relating to shifting the methods of forest management mentioned above, the biomass curves of the model indicate that aforestation measures could yield net C binding rates of from 0.5 to 1.6 metric tons of C/ha/a depending on forest community and site class. Assuming an area of 500,000 ha, this would translate into 1.7% and 5.3%, respectively, of the annual emission.

According to yield table calculations (9. absolute site index), the net carbon binding rate achievable up to the age of 100 would be 2.1 metric tons of C/ha or, by area multiplication, 1.1 million metric tons of carbon (7% of the total emission).

Effects of the introduction of "3-litre" passenger cars on the CO_2 output in road traffic

Authors: H.P. LENZ and P. KOHOUTEK

According to the results of the calculations in the "initial scenario", carbon dioxide emissions in overall road traffic totalled $14.38*10^6$ metric tons/year in 1990 and will increase by 6.5% to $15.32*10^6$ metric tons/year by the year 2005.

The introduction of the "3-litre" car fleet beginning in the year 2000 is expected to reduce CO_2 emissions by $1.80*10^6$ metric tons/year by the year 2005. This corresponds to a reduction potential of some 22% in the CO_2 emissions of passenger cars as compared with the initial scenario and would reduce CO_2 emissions in overall road traffic by some 12%.

A similar savings potential could be achieved as early as 2003 from the introduction of the "5-litre" passenger car fleet beginning in 1997 plus the 3-litre fleet beginning in the year 2000. The reduction in CO_2 emissions expected from this would equal $2.1*10^6$ metric tons/year. This corresponds to a reduction potential of some 26% in CO_2 emissions from passenger cars as compared with the initial scenario and would reduce CO_2 emissions in overall road traffic by some 14%.

Solution to goal conflicts in CO_2 reduction

Author: H.P. AUBAUER

This study places the goals for reducing gases affecting the climate, such as the Toronto target, against two different backdrops: adopting environmental protection as a goal of economic policy and achieving "sustained development" of the current economy into a "sustainable economy". The conflicts in goals that emerge in the process are underscored and shown to be part of the "dilemma of democracy".

Costs of CO_2 reduction by solar means

Authors: H. SCHNITZER, M. HOFER and G. JUNGMEIER

Using various types of solar energy is a promising approach to reducing anthropogenic CO_2 emissions. In this study, a number of solar technologies and several technologies for more rational use of energy (energy conservation) are subject to ecological/economic analysis. The ecological parameter here is the discharge of CO_2; the economic variables are investment costs and total costs for the year.

A comparison was made between solar technologies and conventional technologies based on fossil fuels. Three major findings emerged:
(1) Even at the low energy price level now prevailing, many of the CO_2 reduction technologies are still competitive with the conventional ones. In fact, these technologies could reduce carbon dioxide while at the same time cutting (business) costs.
(2) The specific costs of reduction (i.e. costs incurred to reduce CO_2 by 1 kg) using these solar technologies vary greatly: The cheapest and the most expensive options differ by a factor of more than 100. In other words: one Austrian schilling invested in the most reasonably priced technology would yield a reduction of CO_2 100 times as great as one schilling invested in the most expensive alternative.
(3) Appropriate steps must also be taken to push solar technologies which might create a less favourable economic situation. Concrete recommendations for action are given.

Estimation of GCM Temperature Trends for Different Emission Scenarios with the Help of the Integrated Model to Assess the Greenhouse Effect (IMAGE)

Author: IIASA - International Institute for Applied Systems Analysis

This project attempted to calculate temperature trends for various emission scenarios by combining global circulation models with the IMAGE Model, a model with which results can be broken down to a regional level more quickly and in greater detail. This combination makes it possible to provide political decision-makers with additional information and assistance relating to both global and regional aspects of the problem.

The project is part of a series of IIASA projects on global and regional climate research. The long-term strategy is to find answers to political questions based on the results of integrated quantitative scientific models, i.e. models which do not compete with the major scientific models (like GCMs) but rather reproduce their results in their overall findings and which allow for experimentation so the conceivable climate scenarios can be run through with just a fraction of the computations required for the large models.

Measures to Reduce Greenhouse Gas Emissions in the Transport Sector

Author: Institute for Combustion Engines and Thermodynamics at the
Technical University of Graz (Univ. Prof. Dr. Pischinger)

In this study for the IPCC, the transport sector was found to account for approx. 22% (or 4,576 million metric tons) of the world-wide CO_2 emissions arising from the use of energy. Within the transport sector, truck and bus traffic was found to cause the largest share of emissions, approx. 40%, followed by passenger motor vehicle traffic, approx. 31%. Air traffic and navigation accounted for approx. 12.5% and 9.5% of the CO_2 emissions, respectively. The remaining 7% was attributed to emissions from rail traffic. Unless countermeasures are undertaken, CO_2 emissions in the transport sector are expected to increase by some 58% by the year 2005.

Possible measures which could reduce greenhouse gas emissions are as follows:
Technological measures
to reduce specific energy consumption in existing drive designs and to develop and optimise alternative fuels and drives with lower specific emissions or consumption values.
Traffic planning measures
to achieve an optimum modal split among the means of transportation. In this area, the development or creation of infrastructure for conveying passengers and goods on public transport could shift transport demand to means of transportation with more favourable emissions.
Pricing measures
to accelerate and reinforce the effects of the technological and traffic-planning options. The variable costs in the transport sector would be increased to support and reinforce all other measures.

The study was conducted within the framework of the IPCC's former Working Group III, with Dr. Pischinger as the lead author on the topic of the transport sector.

4.2.5.2. Systematic observation

Austria has been particularly active in the following programs:

- Intensive involvement in international data exchange as part of the WWW (World Weather Watch) of the WMO.

- A GAW station (Global Atmospheric Watch Program of the WMO) is being established on the mountain Hoher Sonnblick (3105 meters). In conjunction with this project, a 'Sonnblick Task Force" has been set up, consisting of representatives from various government agencies and university organisations. Part of the necessary measures have already been carried out; co-operating with Switzerland and Germany has been initiated ("GAW Station for the Alps").

- Winter snow cover studies involving chemical analysis of snow have been conducted on the *Wurtenkees* in the Sonnblick region since 1983 as part of the EUROTRAC Subproject ALPTRAC. Profiles of various anions, cations, OH and pH values and conductivity are measured each year in May (at the height of the winter accumulation). These studies are currently proceeding as part of an FWF project within the scope of ALPTRAC. A summary of the past 11 years of measurement is now under preparation.

- The "Climate Fluctuations Task Force" at the Central Institute for Meteorology and Geodynamics is conducting time series analyses of Austrian climate stations. Thus far, approx. 50 homogeneous series have been established and analysed for temperature, precipitation and snow. Present efforts are focused on expanding the studies to other elements of the climate and on establishing co-operative arrangements with other European countries.

4.2.6 Education, training and public information

Since the greenhouse issue has led the Austrian government to commit itself to reducing CO_2 emissions, appropriate public information efforts are needed - in addition to administrative and legislative policies - to lay the groundwork for these measures. Strategies to protect the environment depend on the co-operation of everyone involved (citizens, business community, institutions, etc.). The form this co-operation takes can be shaped by "hard policies" (legislative instruments) and by "soft policies" (public information efforts and motivation).

"Soft measures" such as information, problem presentation and motivation are especially important here given the nature of the climate issue.
Citizens must first be brought to recognise the issues involved in anthropogenic climate change before they will be willing to take the initiative and more readily accept even far-reaching measures.

The final goal of a project of this kind is to make behaviour based on long-term environmental awareness (i.e. energy awareness and climate awareness) a socially accepted and desirable behaviour.

To achieve this objective, credible information must be conveyed about the climate situation and energy consumption (also in the transport sector), about the important contribution of the individual's own action, and about the common benefit that can be gained if the atmosphere is subject to lower emissions.

The Federal Ministry of Environment, Youth and Family Affairs is therefore planning a climate information campaign organised and structured to do the things mentioned above. It is hoped this campaign will raise the awareness of the population on this issue and increase its willingness to change behaviours that contribute to increasing emissions of the gases affecting the climate.

A communications concept has already been developed and will be the basis for further considerations on this issue, especially by the Austrian environmental ministry.

The contents of the communications concept:
The planned campaign is to be addressed to two target groups:
- the general public (average citizens)
- the institutional public (opinion leaders, journalists, politicians, teachers...)
Since concrete measures can only be fully effective if they meet with a public which has been "prepared", a multi-stage approach will be taken to communications. Step one is to create an awareness of the problem at various levels before instruments are even discussed. If the measures prove to be effective, efforts must be undertaken to ensure that the effect is sustained and does not simply dissipate after the initial measures are carried out.

Based on these considerations, a four-stage communications concept has been developed:
I. To make people generally aware of the problem
II. To make people aware that the problem affects them personally
III. To achieve social acceptance
IV. To bring about lasting changes in attitudes and behaviours

The proposed instruments for carrying out the project are brochures, periodicals, "seminars", presentations, public events, billboards, radio spots, a climate newspaper and a campaign phone line. A success survey might then be conducted to determine the effect of these public information efforts.

For a public awareness campaign of this kind to actually succeed, it is very important that comprehensive data be collected first so an appropriate stock of basic information is on hand.

The reason for collecting this data is not simply for analysis but above all to establish arguments to be used in the information efforts. The primary social data needed has already been compiled in Austria. The data from this initial phase of a possible climate information campaign is now being evaluated.

The findings from the opinion poll must be in first before one can proceed with concrete actions on the problem or even decide whether a broad-based public awareness campaign is necessary and - if it is - how it should be conducted.

A task force was charged by the environmental ministry to draw up a catalogue of measures aimed especially at helping local politicians deal with climate protection issues.

The goal of this project is to provide political decision-makers - especially in smaller communities - with concrete, implementable, attractively designed suggestions for reducing the emissions of climate-relevant gases and to protect the forests as a greenhouse gas reservoir.

The product of these efforts will be a "Guideline for Climate Protection at the Municipal Level", a handbook which contains an easy to understand analysis of implementable measures to protect the climate as well as instructions for concrete action.

This project conforms to the planned climate information campaign, focusing on the basis for political action, the municipalities, as the target for its efforts to increase sensitivity and awareness on this issue.

Austria has also been supporting the Climate Alliance Project, a project initiated and primarily sponsored by NGOs at the international level.

The climate alliance involves European cities and municipalities entering partnerships with the inhabitants of the rain forests. The European co-ordination office for the alliance is in Frankfurt/Main. On joining the alliance, cities and municipalities agree to reduce their emissions of CO_2 by one-half by the year 2010 and to further reduce them incrementally thereafter. They also agree to halt the production and use of CFCs immediately.

There are also plans to adopt an active information policy on why the forests are being destroyed and on ideas and financial means to support the peoples of the Amazon in their efforts to save the areas in which they live.

Thus far, 62 cities and municipalities and eight (of nine) *Länder* have joined the alliance.

Information is, in general, an important instrument of energy policy in an *eco-social market* economy and is especially important in the small consumer sector. The information traditionally offered at all institutional levels concentrates on the two priorities room heating and heating water requirements. The energy campaign ("Aktion Energie") conducted in 1990/91 by the Austrian Broadcasting Company (ORF) in co-operation with the government and with power supply companies will be repeated in 1993/94 with new priorities.

With regard to training for energy consultants (*Energieberaterausbildung EBA*), a task force has developed a two-part training concept consisting of a course A for basic training and a course F for "advanced" training. The A training course is more or less institutionalised and is already being conducted in all *Länder* with few exceptions. The contents for the F course were first introduced at the end of 1993 and the first F course consisting of 150 learning units was conducted in April of this year. The goal of the two courses is to develop uniform professional qualifications for energy consultants.

4.2.7 Financial Assistance and Transfer of Technology

Contributions to GEF, IDA and the regional develpment banks and funds

During the pilot phase of the Global Environment Facility (GEF) between 1991 and 1993, Austria made a voluntary contribution to the Core Fund of the GEF (=Global Environment Trust Fund - GET) of ATS 400 million.
According to calculations made by the GEF secretariat on the basis of the December 1993 exchange rates, the Austrian contribution accounted for 4.96% of total resources paid into GET and 3.43 % of the total funds of the GEF.

Within the framework of the replenishment of the Global Environment Facility, an Austrian contribution to GET of US $ 20 million has been promised, which is equivalent to 1% of the replenishment target. Moreover, subject to parliamentary approval, Austria intends to conclude a cooperation agreement with the Global Environment Facility providing for co-financing and parallel-financing schemes for deliveries of products and services as well as consultancy activities up to a total amount of SFR 6 million. In the course of the negotiations on the tenth replenishment of the International Development Association (IDA 10), Austria increased its contribution to the replenishment from 0.8% (for IDA 9) to 0.9%.

Austria also contributes to all capital increases and replenishments of the regional development banks and funds.

Aid to Eastern Europe

In view of the special situation in the reform countries of Eastern Europe and the successor states of the Soviet Union, Austria committed itself to provide financial assistance to this group of countries amounting to approx. ATS 11.3 billion in 1992. (Total commitments in 1991 had amounted to ATS 23 billionm but the sum included ATS 8.4 billion of degt relief granted to Poland in accordance with the relevant Paris Club agreed minute, whereas the 1992 amount does not include such debt relief). Payments made in 1992 on the basis of commitments undertaken in 1992 and 1991 amounted to ATS 5.6 billion. Austrian support measures include humanitarian assistance, environmental rehabilitation and improvements of the economic and social infrastructure, support for market-oriented sectoral reforms, transfer of know-how, macro-economic financial assistance, export credit and investment guarantees, etc.

Other contributions

In 1992 a total amount of ATS 200 million for the period from 1993 to 1995 was made available for the promotion of sustainable forestry in the developing countries.

In 1993 and 1994 Austria contributed US $ 1 million to UNDP for the implementation of Agenda 21.

Austria has up to now contributed more than US $ 100,000 in total to the INC/FCCC Special Voluntary Fund to support the participation of developing countries in the negotiation and implementation process of the FCCC. Austria has made US$ 12,500 available in 1994 to facilitate the work of the Interim Secretariat of the FCCC.

From almost the very beginning Austria has contributed to the Special Voluntary Fund of IPCC to support the participation of developing countries in IPCC meetings. These and other contributions amount to more than US$ 120,000 in total.

4.3. Summary of Global Greenhouse Gas Emission Scenarios

The purpose of this chapter is to give a brief account of the assumptions underlying the projections of the expected future greenhouse gas emissions carried out by the Intergovernmental Panel on Climate Change (IPCC) in 1992 (Houghton et al., 1992; Döös, 1994).

Indeed, there are many factors having an influence on the future anthropogenic emissions of the greenhouse gases and their resulting atmospheric concentrations. As examples of such factors can be mentioned: the future growth of the world population, socio-economic developments, tropical deforestation, technological advancements (in particular with regard to energy production and saving) as well as the interest and willingness of governments to implement response measures aiming at reducing environmental degradation. Since all these factors have a very limited predictability, it must be recognized that the predictions of the future emissions and concentrations of these gases are bound to be very uncertain.

An indication of the awareness of the limited predictability of the greenhouse gas emissions caused by human activities is demonstrated by the fact that the calculations of the future emissions estimated by the IPCC are not even called predictions. Instead, a number of scenarios of the future greenhouse gas emissions (IS92a - IS92f) have been constructed based on a variety of assumptions about socio-economic and technological developments (Legett et al., 1992). With regard to the first one of these scenarios (IS92a), which is being characterized as the best estimate scenario, the following assumptions have been made (s. also Tables 4.2 and 4.3):

IPCC scenario IS92a:

* The world population will have increased from 5.3 billion in 1990 to 11.3 billion by 2100.

* The average economic growth will be 2.9 % during the period 1990-2025, and 2.3 % during the period 1990-2100.

* The global energy supply will mainly be obtained from conventional oil (12,000 EJ) and from natural gas (13,000 EJ).

* Partial compliance with the Montreal-London Protocol on substances that deplete the ozone layer. Technological transfer results in gradual phase-out of chlorofluorocarbons (CFCs) in non-signatory countries by 2075.

* Certain reductions of emissions of sulphur oxides (SOx), nitrogen oxides (NOx), carbon monoxide (CO) and non-methane volatile organic compounds (NMVOC).

In addition to this scenario, five other scenarios were constructed in order to examine the sensitivity of the computed future greenhouse gas emissions to the various assumptions made. Greatly simplified, these other five scenarios may be characterized in the following way in relation to this base scenario:

IPCC scenario IS92b: Global compliance with the scheduled phase-out of CFCs according to the Montreal-London Protocol.

IPCC sceanrio IS92c: Slower population growth: 6.4 billion by 2100. Slower economic growth: 2.0 % during the period 1990-2025 and 1.2 % during the period 1990-2100. Less energy supply: 8,000 EJ conventional oil and 7,300 EJ natural gas.

IPCC scenario IS92d: Population growth as in c. Economic growth slightly lower as in a: 2.7 % during the period 1990-2025 and 2.0 % during the period 1990-2100. Oil and gas as in c. CFC production phase-out for industrial countries by 1997.

IPCC scenario IS92e: Faster economic growth: 3.5 % during the period 1990-2025 and 3.0 % during the period 1990-2100. Higher oil consumption: 18,400 EJ. Gas as in a. Phase-out of nuclear energy by 2075. CFC production the same as in d.

IPCC scenario IS92f: Faster population growth: 17.6 billion by 2100. Oil and gas as in a.

Based on the assumptions given for these six scenarios, the annual emissions of the major greenhouse gases have been calculated for the period up to 2100. Scenario IS92e results in the greatest radiative forcing and thus produces the strongest effect on climate, and scenario IS92c produces the weakest effect, while scenario IS92a is considered to be the best estimate. This range of estimated expected future emissions of greenhouse gases can of course not be considered as a measure of the uncertainty of the expected emissions. It does, however, provide an indication of the difficulties encountered in attempts to predict future greenhouse gas emissions.

Of all greenhouse gas emissions CO_2[1] is the most studied. Of all the sources of CO_2 emissions fossil fuel use is the most studied. This interest arises from the fact that fossil fuel CO_2 emissions contribute more to a potential change in climate than any other of the greenhouse gases induced by human activities (Grübler, 1994).

Grübler has compared the IS92 energy-related emissions to other reference and policy scenarios developed independently. Because of the limited literature on non-CO_2 greenhouse gases, he considers the global aggregates of only three out of the complete set of radiatively active gases: CO_2, CH_4 and N_2O.

The global fossil fuel carbon emissions in the year 1990 are 6 ± 0.5 Gt C for the IS92 scenarios, which is in good agreement with recent estimates of non-IPCC scenarios (e.g., Boden et al., 1992). As Grübler makes clear, in almost all scenarios emissions increase over time (cf. Figure 4.1). A notable exception is the IS92c scenario. For the year 2025 non-IPCC scenario emissions range from 6.7 Gt C in Ausubel et al. (1988) to 19.8 Gt C in Lashof and Tirpak (1990). The IS92 scenarios range between 7.4 (IS92c) to 13.5 (IS92e) Gt C. As an indication of a consensus view of the energy community, Grübler reports the 16th and 84th percentile range of the poll of energy scenarios assembled by the International Energy Workshop (IEW; Manne et al.,1991, 1993, 1994). This range is between 6.9 and 10.9 Gt C for the year 2020.

By the year 2100 the range of reference scenarios expands substantially. The IPCC scenario range is from 4.6 to 35 Gt C, a factor somewhat more than 7. The lowest non-IPCC scenario examined is given by Ausubel et al. (1988), 1.2 Gt C, while the highest is given by Ogawa (1990) with 60 Gt C, a factor of 50.

The range of cumulative emissions, by way of contrast, is not so wide (cf. Figure 4.2). For the period 1990 to 2100 they vary by a factor of 7 (from 492 Gt C in Ausubel et al., 1988, to 3,447 Gt C in Lashof and Tirpak, 1990) for the set of non-IPCC reference scenarios and by a factor of 3 between IS92c (700 Gt C) and IS92e (2078 Gt C). For the set of policy scenarios cumulative emissions are obviously lower, ranging from 290 Gt C (Lazarus et al., 1993) to 600 Gt C (Lashof and Tirpak, 1990) in the scenarios reviewed.

This implies that even on the low end of reference scenarios some additional 500 Gt C may be released into the atmosphere over the next 100 years, a figure that might be reduced to some 300 Gt C in the most optimistic policy scenario. For comparison, cumulative energy-related carbon emissions between 1850 and 1990 are estimated to total 215 Gt C (Houghton et al., 1990; Marland et al. 1989; Nakicenovic et al., 1993). Thus, even in the lowest of all global emission scenarios

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[1] Note that in this chapter the unit *C* is preferred following the standard practice of the IPCC, and not the unit CO_2 as preferred on the national level by Austria and other countries. The factor for the conversion from *C* to CO_2 is 44/12, with which C has to be multiplied.

reviewed, the committed increases in cumulative carbon emissions over the next 100 years exceed significantly the historical increase since the onset of the Industrial Revolution (Grübler, 1994).

With respect to CH_4 and N_2O Grübler compares the IS92 scenarios with a smaller set of alternative reference scenarios (taken from Alcamo et al., 1994; Edmonds,1993; Lashof and Tirpak, 1990; Matsuoka et al., 1993; Messner and Strubegger, 1991; and Nakicenovic et al., 1993). The IS92 scenarios provide a broad range of possible future trajectories for both CH_4 and N_2O (cf. Figure 4.3). By the year 2100 the difference between the high and low cases for CH_4 and N_2O is similar to that for CO_2 (that is, a factor of between 7 and 8). Of particular importance with regard to the CH_4 and N_2O scenarios is the presence of a significant uncertainty as to the initial base year emissions. This uncertainty is the consequence of an incomplete understanding of the relationships between human activities on the one hand and emissions or even energy on the other hand (Grübler, 1994).

Table 4.2., Table 4.3., Fig. 4.1., Fig 4.2. and Fig. 4.3. are not available electronically.

4.4 National CO_2 emission scenarios

According to the recommendations of the Toronto Conference, the CO_2 reduction goal for Austria is 44.1 million metric tons of CO_2 for the year 2005, taking into account combustion- and process-related CO_2 emissions.

The Austrian Institute for Economic Research IER (*WIFO*) was commissioned to develop scenarios for energy consumption and CO_2 emission which could be used as a basis for developing measures (Bundesministerium f. wirtschaftl. Angelegenheiten, 1993; Musil 1991, 1993). The two-fold purpose of these scenarios is to assess the future development of energy requirements and to respond to the need to limit energy consumption and with it the discharge of climate-relevant gases.

To cover all possible developments, the IER came up with three scenarios each for energy consumption and combustion-caused CO_2 emissions: a reference scenario (Ref), a reduction scenario (Red) and a stabilisation scenario (Stab) set up. The combustion-related CO_2 emissions contribute the most to the anthropogenic greenhouse effect. Measures to reduce the combustion-related CO_2 emissions generally help to reduce other greenhouse gases and to solve other environmental problems. All scenarios covered the time period from 1990 to 2005.

The assumptions for the individual scenarios and their results are described in the sections below. Wherever possible, the *IER* scenarios are supplemented by alternative scenarios (not described in detail), which were developed by the Austrian Federal Environmental Agency FEA (*UBA*) or in conjunction with the Austrian National Environmental Plan NEnvP (*NUP*). The FEA scenario for 1992 is another reference scenario, also covering the period from 1990 to 2005; the NEnvP scenario is another reduction scenario, but covers the period from 1990 to 2025.

4.4.1 The IER reference scenario

The IER based the calculations of its energy forecasts up to the year 2005 on the following assumptions (refer to Musil, 1991, 1993):

- Real economic growth of between 3% (1990-1995) and 2.5% (1995-2005).
- Structural shift in industry away from energy-intensive primary industries.
- End of crude aluminium production, major reduction in pig iron production.
- Marked growth in population, disproportionately large increase in the number of households.
- Only a slight increase in crude oil prices on the world market; constant consumer prices for energy in real terms in Austria.
- Sustained efforts to improve energy utilisation; preferential treatment of less environmentally damaging and renewable resources as opposed to fossil fuels.

Based on the above assumptions, the calculations regarding total energy consumption for the year 2005 yield the following major results (see also Figs. 4.4 to 4.7 and table 4.4):[1]

- If progress in rationalising the amount of energy used in the overall economy fails to proceed as quickly as assumed, the amount of energy required is expected to increase by 13% by the year 2000 and by 20% by the year 2005 as compared with 1990 (1,220.8 PJ and 1,291.3 PJ respectively, as compared with 1,079.8 JP).

- The amount of energy per unit of total economic production will improve on average by about 1.5% per year (1990 to 2000: about 1.5% per year).

- The largest increases in consumption as compared with 1990 are expected to take place in the small consumer sector (+27%), in the transport sector (+19%) and for the generation of electrical energy and district heat (+38% and +70%, respectively; not reported in the above depictions). Long-term changes in the production structure and better utilisation of energy are likely to largely offset the product-related growth in energy consumption in industry (+3%).

- A breakdown of the prognosis figures by categories of useful energy shows a marked increase over 1990 in energy requirements for heating (+19%) and for mobility (+19%) and particularly high growth rates especially for mechanical work (+38%) and lighting (+51%; includes electronic data processing).

- The requirement of utilities for energy production, conversion and distribution will increase by 26%.

- The additional energy requirements as compared with 1990 will be covered primarily by natural gas (+54%) and in part by oil (+11%) and hydroelectric energy [2] (24%). Electricity and district heat will make substantial gains in market shares in the energetic final consumption sector (+38% and +72%, respectively).

- Domestic energy production will not be able to keep pace with the consumption trend; the additional requirements will have to be covered primarily by imports.

In view of the goal to reduce pyrogenic CO_2 emissions, CO_2 emission balance sheets were drawn up for the past (1988 and 1990) and for the end point of the forecast period (2005). IER based the emission factors (see Appendix II) and the calculation method (see Appendix II) largely on the experiences and conventions of the Austrian Federal Environmental Agency.

The following CO_2 emissions were determined for 1990 and 2005, first for 1990 (see also figures 4.8 to 4.11 and tables 4.4 and 4.5):

- Combustion-related CO_2 emissions in 1990 totalled 57.8 million metric tons (1988: 53.7 million metric tons).

- Final consumers and energy production and conversion by utilities accounted for 70% and 30%, respectively, of the total CO_2 discharge in 1990.

- Transport operators directly caused the most CO_2 emissions among consumers in 1990. However, after proportional pollutant emissions by the energy production and conversion sector were taken into account, the small consumers led the industrial companies:

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[1] The figures relating to the *WIFO* scenarios, here and in the following sections, refer to the year 2005, i.e. the end point of the *WIFO* scenarios. Several important figures are also interpolated for the year 2000 as well. Special mention is made in the text when this is done.

[2] Includes foreign trade in electrical energy.

	Share of CO_2 emissions in 1990	
	without	with
	Share in emissions of conversion plants	
Industry	21%	32%
Transport sector	28%	31%
Small consumers	22%	37%

- In an evaluation by type of useful energy, room heating, process heat and mobility accounted for the largest shares of pyrogenic CO_2 emissions in 1990. The use of energy for mechanical work and lighting, including electronic data processing, contributed substantially less to emissions:

	Share of CO_2 emissions in 1990	
	without	with
	Share in emissions of conversion plants	
Room heating	23%	32%
Process heat	20%	24%
Mobility	26%	30%
Mechanical work	1%	11%
Lighting/EDP	0%	3%

- Well over half of the CO_2 emissions in 1990 were caused by the combustion of petroleum products; a bit less than one third by the combustion of coal; and the rest by natural gas and combustible wastes (other energy carriers):

	Share of CO_2 emissions in 1990
Petroleum products	51%
Coal	29%
Natural gas	19%
Combustible wastes	1%

CO_2 emissions are expected to develop as follows up to the year 2005 (see also figures 4.8 to 4.11 and tables 4.4 and 4.5):

- The combustion-related CO_2 emissions will increase by the years 2000 and 2005 to 63.7 and 66.6 million metric tons, respectively. This represents a increases of 10% and 15% over the figure at the beginning of this decade (1990: 57.8 million metric tons).

- CO_2 emissions per unit of total energy consumption will decrease on average by 0.3% per year (1990 - 2000: also approx. 0.3% a year).

- In a break-down by consumer group, the additional emissions as compared with 1990 will stem largely from the transport sector (+18%) and the small consumer sector (+10%). A decrease is expected in industrial CO_2 emissions (-10%).

- In a break-down by types of useful energy, mobility and heating, in particular, are expected to generate higher emissions than 1990 (+18% and +5%, respectively) mostly due to the increased amount of energy used. A decrease in CO_2 emissions is even anticipated in process heat (-7%). Mechanical work and lighting will grow at high rates (+36% and +34%, respectively), but will play a secondary role due to their low absolute CO_2 emission rates.

- CO_2 emissions in the energy production and conversion sector are expected to increase rapidly (+34% over 1990 levels) due to the disproportionately high growth anticipated in the demand for electricity and district heat.

- The reference scenario already takes into account the definite change in the consumption structure toward natural gas and renewable energy sources and away from coal and oil as compared with 1990. In a breakdown of the most important fuels in terms of CO_2 emissions, CO_2 emissions from coal will have decreased by 4% as compared with the 1990 figure, oil and natural gas by 9% and 60%, respectively.

- All other things being equal, the effect of deviations of up to 10% in the prognosis values would translate into the following deviations in the overall CO_2 balance: 2 million metric tons for mobility, 2.5 million metric tons in the heating sector and 4 million metric tons with regard to electricity consumption.

4.4.2. The IER reduction scenario

The IER also calculated a reduction scenario according to the stipulations of the Austrian Federal Ministry for Economic Affairs. Its goal is to cut combustion-related CO_2 emissions to approx. 43 million metric tons of CO_2/year by the year 2005. That would be about 20% less than in 1988 (53.7 million metric tons according to IER data) and about equal to the amount at the end of the '60s.[3]

The stipulations made by the Federal Ministry for Economic Affairs with regard to the calculations are based on internationally and nationally available studies about economically usable energy potentials and about of energy policy instruments for improving the use of energy and accelerating the substitution process desired in environmental policy. However, it should be noted that the IER reference scenario assumes impressive successes in energy utilisation in the reference scenario from the outset; a new set of measures is therefore needed which exceeds the available instruments.

The basic assumptions of the reduction scenario are that there will be a push to shift the structure of energy consumption away from coal and oil and that district heat and renewable energy carriers will gain a much larger share of the room heating market. The basic conditions of the overall economy are the same as those in the IER reference scenario.

Based on these assumptions, the calculations for the year 2005 yielded the following major results with regard to total energy consumption (see also figures 4.4 to 4.7 and table 4.4):

- If the rationalisation targets are achieved, total energy consumption in the year 2000 and 2005 will total just 959.2 and 898.9 PJ, respectively. This would represent respective decreases of 11% and 17% as compared with the 1990 figure (1,079.8 PJ) and 6% and 11% as compared with 1988 (1,024.7 PJ).

- According to the reduction scenario, the amount of energy used per unit of total economic production will have to improve on average by some 3.8% per year (1990-2000: also some 3.8% per year).

- Thanks to the more efficient utilisation of energy in the overall economy as compared with 1990, the amount of energy used by consumers will decline by between 10% and 19% (industry: -15%; transport sector: -10%; small consumers: -19%) and for the various categories of use by between 9% and 22% (heating: -22%; process heat: -13%; mobility: -9%; mechanical work: -14%; lighting: -12%). The amount of energy consumed for producing electrical energy will fall by 14% and that for producing district heat will increase by 44%.

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[3] If the process-related CO_2 emissions from the cement industry are taken into account, the total emissions for Austria increase. According to the Austrian Environmental Protection Agency (*UBA*, 1992), the process-related CO_2 emissions from 1988 amounted to about 2.1 million metric tons of CO_2/year and will remain right around that figure in the future. According to the UBA (1992), total emissions in 1988 amounted to 55.1 million metric tons, making the Toronto target for Austria 44.1 million metric tons of CO_2 by the year 2005. However to achieve comparability between the various scenarios, especially with the *WIFO* reduction scenario, a Toronto target is used here which has been reduced by the process-related CO_2 emissions: (55.1 - 2.1) million metric tons CO_2/year x 0.8 = 42.4 million metric tons of CO_2/year. In actual fact, the *WIFO* reduction scenario would have to set a target of reducing CO_2 emissions by 21% to achieve this goal.

In its latest publication (ACC, 1994), the Austrian CO_2 Commission also released initial information on seasonal factors (temperature, production processes) influencing the Austrian CO_2 emissions. Emissions would have to achieve a level even further below the Toronto target, i.e. below the fluctuation range defined by such seasonal influences, for the target to be able to be reached despite these influences.

- Due to the decline in final energy consumption, the requirement of utilities for energy production, conversion and distribution will also shrink (-21% as compared with 1990).

- According to the reduction scenario, lower amounts of coal (-36%), oil (-24%) and natural gas (-19%) will be used in the year 2005 than in 1990 while the amounts of other energy carriers (+12%) and hydroelectric power (+10%) will increase. The use of district heat in the final consumer sector will increase by 24% over 1990 levels while the final consumption of electric energy will fall by 10%.

CO_2 emissions are expected to develop as follows up to the year 2005 (see also figures 4.8 to 4.11 and tables 4.4 and 4.5):

- The combustion-related CO_2 emissions will decrease by the year 2000 and the year 2005 to 47.8 and 42.8 million metric tons, respectively, representing respective decreases of 17% and 26% as compared with 1990 (57.8 million metric tons) and 11% and 20% as compared with 1988 (53.7 million metric tons).

- CO_2 emissions per unit of total energy consumption will decrease on average by 0.8% per year (1990 - 2000: approx. 0.7% a year).

- With regard to consumers, the CO_2 emissions as compared with 1990 will drop by between 12% and 41% (industry: -21%; transport sector: -12%; small consumers: -41%). However, only industry and small consumers will fall at least 20% below their 1988 CO_2 emission levels while the transport sector will not. A lower CO_2 reduction here is at the expense of the other consumers.

- In a breakdown by type of useful energy, CO_2 emissions are expected to be reduced from 1990 levels by between 11 and 43% (heating: -43%; process heat: -18%; mobility: -11%; mechanical work: -30%; lighting: -31%). Among the most important sources of CO_2 emissions in this group, namely heating, process heat and mobility; only heating and process heat will fall at least 20% below their 1988 CO_2 emission level. Savings here will have to offset the lower CO_2 reduction in the mobility sector.

- CO_2 emissions in the energy production and conversion sector are expected to decrease by 32% as compared with 1990. However, a reduction of the 1988 level by 20% will not be achieved; the shortfall here will have to be offset by savings on the consumer or use side.

- CO_2 reductions of from 21 to 37% as compared with 1990 levels have been calculated with regard to the energy carriers most responsible for CO_2 discharge (coal: -37%; oil: -23%; natural gas: -21%). Coal and oil will drop to at least 20% below their 1988 CO_2 emission level in this scenario. Natural gas does not meet this goal, because of the push for a structural change in energy use in favour of this energy carrier.

4.4.3 The IER stabilisation scenario

The IER also created a stabilisation scenario according to the stipulations of the Austrian Federal Ministry for Economic Affairs. Its goal is to cut CO_2 emissions to approx. 58 million metric tons by the year 2005. That would make the CO_2 discharge in the year 2005 approximately the same as it was in 1990.

The calculations assume that only about one-third of the rationalisation potential deemed utilisable in the reduction scenario (based on national and international studies on economically feasible energy savings) is in fact utilised, not 100%. The substitution process in favour of renewable energy carriers proceeds just slightly more slowly than in the reduction scenario. Otherwise, the stabilisation and reference scenarios make the same assumptions about the overall economy.

Based on these assumptions, the calculations yielded the following major results with regard to total energy consumption (see also figures 4.4 to 4.7 and table 4.4):

- If the stabilisation target is achieved, energy consumption in the year 2005 would be 1,172.7 PJ, making it 9% higher than in 1990 (1,079.8 PJ).

- The *IER* stabilisation scenario expects the amount of energy used per unit of total economic production to improve on average by approx. 2.1% per year.

- Unlike the reduction scenario, energy consumption in the stabilisation scenario increases, not decreases. However, the increase is less than in the *IER* reference scenario. Thanks to the more efficient utilisation of energy in the overall economy, growth in the amount of energy used by the individual consumer groups (base year 1990) will be able to be kept at between 10 and 13% (transport sector: +10%; small consumers: +13%). Industry will even report a 2% reduction in energy consumption. The amount of energy utilised for the various categories of use will range between -4 and +31% (heating: +8%; process heat: -4%; mobility: +10%; mechanical work: +20%; lighting: +31%). The amounts of energy consumed for producing electrical energy and for district heat will increase by 19% and 62%, respectively.

- Due to the increase in final energy consumption and the consumption shift to electricity and district heat, the requirement of utilities for energy production, conversion and distribution will also increase (+11% as compared with 1990).

- According to the stabilisation scenario, lower amounts of coal (-17%) and oil (-3%) will be used in the year 2005 than in 1990 while greater amounts of natural gas (+31%), other energy carriers (+31%) and hydroelectric power (+25%) will be used to cover overall energy needs. The use of district heat in the final consumer sector will increase by 56% over the 1990 figure while the final consumption of electric energy will increase by 23%.

CO_2 emissions are expected to develop as follows up to the year 2005 (see also figures 4.8 to 4.11 and tables 4.4 and 4.5):

- The combustion-related CO_2 emissions will decrease by the year 2005 to a level comparable to that of 1990, 57.8 million metric tons.

- CO_2 emissions per unit of total energy consumed will decrease on average by some 0.5% per year.

- With regard to consumers, the CO_2 emissions as compared with 1990 will range from -14% to +9% (industry: -14%; transport sector: +9%; small consumers: -6%).

- In terms of uses, CO_2 emissions are expected to range from -11 to +14% (heating: -10%; process heat: -11%; mobility: +9%; mechanical work: +10%; lighting: +14%).

- CO_2 emissions in the energy production and conversion sector are expected to increase by 6% as compared with 1990.

- With regard to the energy carriers most responsible for CO_2 discharge, emissions will be reduced for coal (-18%) and oil (-2%) as compared with 1990 and will increase for natural gas (+30%).

4.4.4. Other national CO_2 emission scenarios

Two other scenarios have been developed for Austria which supplement the IER scenarios described above: an additional reference scenario FEA '92 (*UBA*) which covers the time period until 2005 and an additional reduction scenario NEnvP (*NUP*) which covers the time period until 2025. The first scenario was developed by the Austrian Federal Environmental Agency (*UBA*), the second was commissioned by the Federal Ministry of Environment, Youth and Family Affairs in conjunction with the National Environmental Plan (*NUP*).

The FEA '92 reference scenario is identical with the IER reference scenario except for one point: it is based on an earlier version of the IER energy statistics whereas the IER scenario is based on slightly updated statistics. However, the demographic data on which even the latest version of the IER energy statistics is based do not take into account such potential effects as Austria's decision to join the EU.

The NEnvP reduction scenario also utilises the updated IER energy statistics but unlike the IER scenarios and the FEA '92 scenario, it is based on certain liberal assumptions on how the needed energy services will develop. For example, its assumptions for Austria for the period from 1990 to 2005 are that the population will grow by 15%, the residential areas will increase by 10% and mobility (in kilometres per capita) will increase by 44%. The scenario is also based on certain liberal assumptions with regard to how energy application and transformation technologies will develop, taking into account only technological options which will realistically be available.

* Based on the NEnvP scenario, the Austrian CO_2 emissions will be reduced by the years 2000 and 2005 by approx. 46.2 and 41.2 million tons per year, respectively. This would be a reduction in the magnitude of 18 and 27%, respectively based on the 1990 figure (56.4 million metric tons of CO_2 in this scenario).

  The average annual energy and carbon intensities would be approx. -1.9 and -1.2% annually (annual growth rates between 1990 and 2000) or -2.0 and -1.3% annually (annual growth rates between 1990 and 2005) if the NEnvP scenario is to be realised by 2000 and 2005, respectively.

Figure 4.8 contains both the FEA '92 scenario and the NEnvP scenario. Since these scenarios are also based on the IER energy statistics, they can be considered as the first test of the sensitivity of the statistical energy data used in the IER reference and reduction scenarios.

The Institute for Energy Management and Rational Energy Use (*IER*) at the University of Stuttgart is currently conducting a study entitled "Cost Effectiveness Analysis of CO_2 Reduction Measures in Austria" for the Association of Electricity Supply Companies in Austria (*VEÖ*), the Austrian Industrialists' Association and the Economic Chamber of Austria.

4.5 National trends of other greenhouse gases

The latest estimates for CH_4 emissions from landfills for the year 2000 can be found in Steinlechner et.al, 1994; they will total some 230,000 metric tons. Based on the findings of Orthofer and Hackl, 1993, CH_4 emissions in Austria in the year 2000 are expected to be approx. 600,000 metric tons, which would mean a stabilisation of the methane emissions at the 1990 level.

Orthofer and Knoflacher, 1994, have estimated the probable N_2O emissions in Austria for the year 2000; they will total some 4,200 metric tons. This is approximately the same figure as the one for 1990.

Fig. 4.4., Table 4.4., Table 4.5., Fig. 4.5., Fig. 4.6., Fig. 4.7., Fig. 4.8., Fig.4.9.a, Fig. 4.9.b, Fig. 4.9.c, Fig. 4.9.d., Fig. 4.10. and Fig. 4.11. are not available electronically.

ANNEX I:

Basic data

The country and its people

Austria is a federal state with a total area of 83,855 km² and consists of nine provinces - Burgenland, Carinthia, Lower Austria, Salzburg, Styria, Tyrol, Upper Austria, Vienna and Vorarlberg. Austria has common borders with no fewer than eight other countries. The neighbours are Switzerland, Liechtenstein, Germany, Slovakia, Czech Republic, Hungary, Slovenia and Italy.

These neighbouring states have varying social and economic systems. Their inhabitants belong to the major European ethnic groups: the Germanic, Neo-Latin and Slav peoples (the Magyars of Hungary are an exception, deriving from the Ural-Altaic group).

Austria' s border has an overall length of around 2,700 km.

The federal capital of Austria is Vienna and at the same time a federal province in its own right. The provincial capitals are Eisenstadt (Burgenland), St. Pölten (Lower Austria), Linz (Upper Austria), Salzburg (Salzburg), Innsbruck (Tyrol), Bregenz (Vorarlberg), Graz (Styria) and Klagenfurt (Carinthia). Vienna is the seat of the federal legislative bodies, the federal government, the central authorities and the supreme courts.

Austria is situated in the heart of Europe, covering a part of the eastern Alps and the Danube region; although it is land-locked, it borders on the Mediterranean area.

The country has a wide variety of landscape, vegetation and climate and, due to the geographical situation, it has always been a junction for communications links between the trade and cultural centres of Europe.

Austria's land surface is exploited as follows (data of 1990): 42.8 % for forestry, 26.4 % grassland, 20.1 % farming and horticultural land and 10.7 % other areas (e.g. human settlements, desert-land, glaciers) (see Fig. I.1).

Important demographic data

At present Austria is populated by around 7.812 million inhabitants living on an area of 83,855 km^2 which represents 92 inhabitants per km^2. More than half of the population (57 %) live in cities. The federal capital and largest city is Vienna with 1.533 million inhabitants.

The extremely slow growth of the population (0.37 % per year) reflects its age structure: 17 % under 15 years, 62 % between 15-59 years, 21 % 60 years and over. Infant mortality (in the first year of life) is 0.8 thousandth; the average life expectancy is about 75 years (Fig. I.2); the immigration rate (asylum speakers and immigrants) is currently at a yearly average of 20,000 (0.4 % of the population). More than 10 % of the population currently living in Austria were born outside the present borders of the Austrian Republic. Around 4 % of the population do not possess Austrian citizenship. Since the Second World War, Austria has become a de facto immigration country.

The proportion of school children in the population is 15 % (of which 3.5 % are school children of foreign citizenship; the proportion of university students among the population is 2.4 %. The proportion of academics in the Austrian population over 15 years is almost 5 %.

About 90 % of Austria's population belong to one of the two major Christian religious communities (84.2 % catholics, 4.9 % protestants).

Climate

Austria belongs to the central European transitional climatic zone between oceanic and continental climate. The oceanic influence of the Atlantic Sea is felt more strongly in the western, the continental influence more strongly in the eastern parts of Austria. In many parts of Austria winds from the west and from the northwest are predominant.

Austria as a whole can be divided into three climatic zones; the East has a Continental Pannonian climate (mean temperature for July usually above 19^{o}C, annual rainfall often less than 800 mm). The central Alpine region shows the characteristic features of the Alpine climate (high precipitation, short summers and long winters). The remaining parts of the country belong to the transitional central European climatic zone (wet, temperate, man temperature for July 14-19^{o}C, annual precipitation 700-2,000 mm depending on location, exposure and altitude.

Parliamentary Democracy

Austria is a democratic republic. Legislative power is in the hands of the people.

The head of the Austrian state is the federal president. The head of state holds office for six years. Re-election for the term of office immediately following is admissible once only. The federal president represents the republic internationally. Among the presidential duties are the signing of treaties, the swearing in of provincial governors and the verification of laws passed by parliament. The head of state is also commander-in-chief of the Austrian armed forces.

Parliament

The National and the Federal Assembly, the two houses of Parliament, are the country's main legislative bodies and therefore the central element of the government system. The National Assembly is elected for a four year term by proportional representation on a basis of equal, direct, secret and personal suffrage for anyone who is aged eighteen or over on the day of the election. Candidates are eligible for election if they are aged twenty one or over. The political parties, that are represented in the National Assembly (183 members), are the Austrian Social-Democratic Party (SPÖ), the Austrian People's Party (ÖVP), the Austrian Freedom Party (FPÖ), the Greens and the Liberal Forum (LIF). The Federal Assembly currently comprises 63 members. The number of delegates sent by each province depends on the relative size of the population.

The federal government is headed by the chancellor, who along with the vice-chancellor and the cabinet ministers conducts any government affairs which are not the responsibility of the president. If necessary, ministers may be aided by state secretaries. Each province is administered by own government, headed by a governor elected by the provincial parliament. Delegates to these parliaments are elected according to the same principles as those to the National Assembly and their numbers are decided in accordance with the population figures for each province.

At a lower level of regional administration comes the Bezirk, or district, which is in the charge of a specially appointed government official and the local community, which has a considerable degree of independence in matters of local importance. Each community has its local council, which is responsible for the election of a mayor.

Jurisdication

Of paramount importance in the field of Austrian jurisdication is the fact that the administration of justice should be completely independent. The constitution states specifically that judges are independent in the exercise of their judicial function and that they can be neither dismissed nor transferred.

A special characteristic feature of Austria's socio-political life since 1945 has been the "social-partnership". It consists in a voluntary collaboration of employers and trade unions and plays an important role in the pre-parliamentary decision-making process.

Economy, trade and industry

Austria has a free market economy, which takes the form of a social market economic system witha a substantial public benefit and co-operative sector. The economic and social partnership, a body which was established and which operates on a voluntary basis, is a major factor in regulation the relationship between wages and prices.

The Austrian ecomomy functions on a private law basis. This also applies to the country's nationalised sector, which includes industrial and public transport enterprises and banks.

In 1991 the primary sector (agriculture and forestry, mining) accounted for a mere 3.4 % of the country's GDP, while the secondary sector (manufacturing industries, energy) accounted for a 39.8 % and the tertiary sector (services such as transport, trade, tourism, monetary transactions and the civil service) for 56.8 %.

Although only 5.7 % of the Austrian population earn their livelihood from farming, Austria's self-sufficiency in agricultural production comes to 100 %.

Austria has rich resources of raw materials and energy. There are large deposits of iron ore, non-ferrous metals, valuable minerals and earths, although the steady growth of industry is to an ever greater extent necessitating supplementary imports. This is also true of fuels and energy materials and of electricity. On the other hand, Austria has its own oil and natural gas resources, and its potential for hydro-electric power generation - currently 53,400 million kWh per annum - is steadily growing.

Medium-scale enterprisess account for a large proportion of Austria's industrial and commercial sectors. Austra's industry covers every field, from primary production to labour-intensive finished goods. Plant construction (which involves the planning, delivery and installation of turn-key manufacturing plants inclusive of know-how) is gaining in importance and has high export ratio. Another major economic sector is electronics, notably the production of integrated printed circuits.

Austrian crafts products - especially delicate hand-made articles and fashion jewellery, pottery, porcelain and glassware - are known in the world over.

Tourism is one of the foremost growth industries in the tertiary sector. It accounts for a sizeable currency revenue (1993: 156,200 million Austrian Schillings), a sum which exceeds currency earnings from, for instance, the export of machinery and vehicles.

As an export-oriented country, Austria has established an extensive and comprehensive network of trading relations. Its trading partners wordl-wide total some 150 countries. Two thirds of Austria's foreign trade are accounted for by the countries of the European Community, while 9 % of its total exports went to the former COMECON countries in 1991. Transit trading is an important aspect of Austria's trade. It goes hand in hand with brokering East-West trade (Fig. I.3).

For many years now Austria has enjoyed a high level of employment. The mean unemployment rate in 1991 was 5.8 %. In the same year average gross monthly earnings for dependently employed person in Austria came to 23,467 Austrian Schillings.

The Austrian currency, the Schilling, is fully convertible and ranks amongst the world's hardest currencies. 100 ATS (Austrian Schillings) are approximately 9 US$.

Austria belongs to the OECD and will be a EU-member from 1995 on.

Table I.1: Important economic data for Austria

Workforce (Austrians):	2,997,400 persons (1991 av.)		
Men:	1,752,200 persons		
Women:	1,245,200 persons		
GDP based on current values in 1993:		ATS million	2,109,700
Agriculture and forestry:		ATS million	47,400
Mining, manufacturing:		ATS million	508,600
Electricity, gas, water:		ATS million	59,100
Construction:		ATS million	157,200
Whole sale, retailed trade, rest. and hotels:		ATS million	341,400
Transport and communication:		ATS million	139,200
Finance, insurance, real estate, business serv.:		ATS million	394,300
Other services:		ATS million	95,300
External Trade:	Exports:	ATS million	467,000
	Imports:	ATS million	565,000
Gross currency revenue from tourism:		ATS million	156,200

Austria spends a remarkable share of the GDP on activities for the protection of the environment; this share is continuously growing since the beginning of the eighties. Austria takes the leading role within the OECD-countries with its share of 1.94 % of the GDP spent on expenses to protect the environment. Environmental policy is one of the cornerstones in the political discussion in Austria; this is the reason for having high expenses in this area (and not at all a bad condition of the environment in Austria).

Table I.2: Expenses to protect the Environment (share of the GDP in %)

OECD-country	1980	1986	1990	1991
Austria	1.12	1.50	1.88	1.94
Germany	1.45	1.53	1.62	1.74
Netherlands	1.10	1.25	1.47	1.46
USA	1.62	1.47	1.37	1.36
Canada	2.04	1.59	1.33	1.30
Finland	1.30	1.16	1.05	1.05
Japan	1.80	1.34	1.33	1.02
UK	1.54	1.24	0.94	0.93
France	0.87	0.88	0.95	0.91
Sweden	1.09	0.92	0.86	0.87
Denmark	1.52	0.98	0.88	0.78
Norway	1.10	0.81	0.63	0.57

Source: Institute of the German Economy, IW-Trends 2/1992

Agriculture and Forestry

Agriculture and forestry consist of primarily small and medium enterprises in Austria. On the occasion of a recent census of enterprises approx. 300,000 agricultural and forestry enterprises with an exploitable area of more than one ha was registered. A total of 3.5 mio ha are cultivated by these enterprises (1.4 mio thereof is farmland, some 50,000 hectars are vineyards, 1.1 mio ha meadows and pastures, 0.9 mio alpine grassland and 3.9 mio ha forests).

Agriculture and forestry in Austria render a GDP and a share in national income of approx. 3 % each. Value creation in agricultural and foresty production attains a figure of some ATS 70 mio annually, ATS 60 mio thereof accruing in agriculture. The agricultural proportion amounts to 7 % at the end of the eighties, annual drift of labour ranges at 2 to 3 %. Approx. 70 % of end production in Austrian agriculture are animal products and 30 % vegetables.

Since almost 60 % of exploitable agricultural surface is grass land, cattle breeding is the most important type of production. Approx. 150,000 enterprises are engaged in cattle breeding with altogether some 2.6 mio heads being kept. Some 4 mio pigs are kept in more than 160,000 enterprises; more than 5,100,000 pigs are consumed per annum. Approx. 82,000 tonnes of poultry and more than 110,000 tonnes of eggs per annum are produced in Austrian farms.

Corn is grown on more than approx. 70 % of Austrian fields. A quantity of approx. 1 mio tonnes exceeding indigenous demand of 4 mio tonnes is exported.

Corn fields grow 41 % of bread grain (wheat, rye) and 59 % fodder (30 % thereof barley and 21 % grain maize). On about 6 % of fields root crops, sugar beet and potatoes are grown.

There is much alpine farming in Austria. On 1.66 mio ha 13,500 alpine farms are looked after by 12,800 herdsmen and dairymaids. Alpine farm areas reach greatest dimensions in Tyrol, Styria, Salzburg and Carinthia. Approx. 76,000 cows and 130,000 sheep and goats are taken to alpine farms during the summer months. Approx. 114,000 of the altogether 300,000 agricultural and forestry enterprises are mountain farms in Austria.

Total exports in agriculture rose from ATS 3.7 mio in 1970 to 12.7 mio in 1987. Agricultural imports rose from ATS 9.9 mio to ATS 28.1 mio during the same period. The share of agricultural imports in total imports amounted to 10.7 % then, in 1986 it was only 6.8 %. The share of agricultural exports dropped from 5.0 % to 3.7 %.

Almost half of the entire Austrian territory, 38,600 km², consists of forests, or 0.5 ha per inhabitant.

Energy

As a consequence of the two oil crises, Austria was able to cut down the increase in energy consumption in the period 1980-1988 to a yearly average of 0.3 % while achieving an annual average economic growth of 1.7 %. In this period Austria was also able to reduce the share of mineral oil in the total energy consumption from 51 % to 42 %.

An improved employment of energy, through the abandonment of especially energy-intensive methods of production and investment in modern plants in the period 1975 to 1990, made it possible to disengage growth in the industrial production from energy consumption. Industrial production increased by around 70 % whereas energy consumption arose by a mere of 5.3 %. This signifies a decline of energy use per unit of production of almost 40 % (Fig. I.4).

In the period 1980-1988 the contribution of renewable forms of energy to the total energy supply could be increased from 16 % to 20 %. Austria can cover over 70 % of its electricity need from hydro-electric power (average over some years). The capture of energy from biomass and solar energy also grew increasingly in importance in the last few years. In this connection it may be pointed out that Austria has taken decision steps in its use of biogenic forms of energy (C-4 plants, vegetable oil or oil seeds for rape-methylesther production, bioalcohols etc.).

With the referendum against nuclear energy on 5th November 1978 and the Law Against Nuclear Energy of 15th December 1978, Austria achieved an exemplary democratic renunciation of nuclear energy eight years before the Chernobyl accident.

Energy-consumption 1980-1993

In the following tables and figures the development of the coal, oil and gaseous fuels consumption since 1980 for the sectors of industry, traffic, small consumers, power and heating plants, own-energy use and district heating as well as the total consumption of coal, oil and gaseous fuels is shown. Table I.3 and fig. I.5 show, that the total final energy consumption has decreased by about 3 % between 1980 and 1993.

The consumption of coal in the above mentioned sectors dropped by about 26 % (1980: 123,851 TJ; 1993: 91,364 TJ). Because of the increased use of oil and gaseous fuels the consumption of coal in the sector small consumers could be reduced by about 50 %, in the sector of industry by about 25 % (see table I.4 and fig. I.6).

The consumption of oil has dropped by 12 % in total since 1980 (see table I.5 and fig. I.7). The oil consumption could be reduced in the sectors industry, small consumers and power- and heating plants by about 54 %, 25 % and 62 %, respectively.

Because of the upward trend in the number of newly registered motor-vehicles as well as in the annual amount of kilometres driven by cars the oil consumption in the sector traffic increased by about 28 % between 1980 and 1993.

In the last years the consumption of gaseous fuels has increased steadily (1980-1993: + 34 %) with the highest increase-rates in the sectors power and heating plants (+ 74 %), small consumers (+ 80 %) and district heating (+ 296 %) (see table I.6 and fig I.8).

Transport

Austria is of central importance for the European economy and transport by virtue of its geographical position as an important transit land between northern and southern as well as eastern and western European countries and as a holiday goal for many tourists.

Within the last 40 years, the number of private motor vehicles increased from around 260,000 (1950) to about 4.2 million (1990). With the rapid increase of private automobiles, motorised road transport developed into the most important mode of transportation in terms of traffic volume and transport capacity: Thus in the case of passenger transit, road transport was allocated about 70 % of the traffic volume; in goods transport the figure is about 75 % of the traffic volume and about 45 % of transport capacity (tonnes/km).

A considerable rise in the enviromental pollution caused by traffic is connected with the mass-motorisation process (about 384 automobiles per 1,000 inhabitants) and with the increase of transport of goods by road. Thus road transport is the predominant source for nitrogen oxides, contributing around 75 % to the total NO_x emissions; for carbon monoxide the figure is around 50 % and for volatile organic carbons 35 %.

Since the seventies, transport of goods crossing over the Alps (North-South route) has grown quickly, indeed more rapidly than the Austrian GDP. The growth results almost exclusively from the increase in private motor vehicle transport; the share of the railway sank from 71 % of the volume of goods in 1970 to only 31 % in 1987.

In 1987 the volume of goods transported on the Danube reached 7.4 million tonnes (7 % of the total amount of transport); 70 % were imports, 21 % exports and 9 % inland traffic.

History

Austrian history has been determined primarily by the country's geographical position, which is at the meeting point of three cultures - Romanic, Germanic and Slav.

As long ago as the early Iron Age, between about 1000 and 400 BC, the Indo-European Illyrians established a high level of civilisation. The Illyrians were followed in turn by the Celts. The Romans made the Alpine and Danube regions a part of their empire around the time of Christ. Around 300 AD, Christianity began to spread throughout the area.

About a hundred years later, these regions were overrun by Germanic tribes, and during the era of mass migration the territory covered by the Austria of today was subject to repeated devastation as Teuton supremacy gave way to that of the Huns, the Avars, the Slavs and then the Magyars. Between 500 and 700 AD, the region was taken over by the Bavarian tribes, who eventually succeeded in establishing themselves firmly. Towards the end of the 8th century, Charlemagne succeeded in driving out the Avars and established a "Markgrafschaft", or border province, to defend his empire in the east.

The Babenbergs

For almost a thousand years following this, the course of Austrian history was determined by two dynasties, the Babenbergs, who ruled for 270 years, and the Habsburgs, who held power for the next 640 years. In 976 AD, Leopold von Babenberg was made Margrave of Austria and his successors gradually moved their capital further eastwards until in the 12^{th} century Heinrich II built his Hofburg, the imperial palace, in Vienna. Austria was proclaimed a hereditary duchy within the Holy Roman Empire. Under Babenberg rule Austria experienced a long period of peaceful development. Gold, silver and salt were mined; religious orders established their monasteries further and further towards the east and these soon became centres of cultural life. The year 996 AD brought the first documentary mention of "Ostarrichi", the name under which the region was already known to its inhabitants and which gave way to the present German name for Austria, Österreich.

The last of the Babenbergs, Friedrich the Quarrelsome, was killed in a battle against the Magyars in 1246, after which Austria went to King Przemysl Ottokar II of Bohemia and Styria to King Bela of Hungary. Later however Styria was taken over by Ottokar, along with Carinthia and Carniola.

The Habsburgs

The year 1273 brought the end of the interregnum in the Holy Roman Empire with the appointment by the Electors of Count Rudolf von Habsburg, King of the Germans. Ottokar of Bohemia was called on to deliver an oath of allegiance in return for his rights in Austria, Styria, Carinthia and Carniola, but he refused. In 1278, Rudolf emerged victorious from the Battle of Marchfeld, in which Ottokar was killed, and the rise of the House of Habsburg began.

During the 640 years of rule by the "Casa d' Austria" or the House of Austria, there were 20 emperors and kings. The Habsburgs ruled over the Holy Roman Empire in almost unbroken succession until its abolition in 1806.

The Austrian rulers were able to extend their possessions elsewhere, not merely by war but also by peaceful means, in particular by carefully chosen marriages. The union of Bohemia and Hungary with Austria in 1526 was also the result of treaties and marriages between the ruling houses. From the 1520's onwards, there were two distinct Habsburg lines, one ruling over the Austrian lands, the other over Spain and the Netherlands.

In 1529 and again in 1683, vast Turkish armies laid siege to Vienna, but without success. The Turks were gradually pushed back and Austria began to emerge as a major power. This was the Baroque era and the specific note with which the style was invested by Austrian architects is to be seen in any number of magnificent castles, monasteries and churches, especially in Vienna and Salzburg.

Maria Theresa's State Reforms

In the meantime the male line of the Habsburgs had died out and the task of leading Austria through these trying times fell to a woman. Empress Maria Theresa ruled from 1740 to 1780 and must count as one of the outstanding women of world history. She married Franz Stephan of Lorraine in 1736, thus founding the house of Habsburg-Lorraine. A feudal agglomeration of states was transformed into a single, centrally administered unit; the financial system was brought up to date and industry and trade were promoted, in keeping with the new spirit of mercantilism. The legal system was separated from the administration, while torture and other severe punishments were abolished. There were also sweeping reforms in the field of education. Elementary schooling was introduced while the universities were removed from ecclesiastical control and made state institutions.

The empress's work was continued in the same spirit by her son, Joseph II. Among his most significant and most lasting changes were the abolition of serfdom and the introduction of complete freedom of religion. Among the major cultural developments of this period was the advent of the great age of Austrian classical music with such composers as Gluck, Haydn and Mozart.

The New Europe

At the turn of the 18^{th} and 19^{th} centuries, the principal aim of Austrian policy was to counter Napoleon's expansionism. After Napoleon's disastrous Russian campaign his opponents closed ranks once again and his fate was sealed at the Battle of Leipzig in 1813, where the allied armies were led by the Austrian general Prince Karl Schwarzenberg.

1814 saw the start of the Congress of Vienna, presided over by the Austrian state chancellor Prince Klemens Metternich. Attended by most of Europe's crowned heads and leading diplomats, the meeting paved the way for a relatively long period of peace and introduced a completely new European order.

During the first half of the 19th century, there was immense industrial progress in Austria and a corresponding increase in technical and economic development.

Austria did not escape the wave of middle-class revolution in 1848 and the original issues were complicated by the empire's multinational structure. Metternich's police-based system of order at home collapsed. The Hungarians sought independence from the Habsburgs.

One of the principal results of the 1848 revolution had been the drawing up of an Austrian constitution, but this still had distinctly absolutist elements.

In the relatively peaceful years before the first world war, Austro-Hungary, which was economically virtually self-sufficient, underwent rapid development, but the emergence of nationalism led to major tensions within the multinational empire. A series of governments was unable to solve these tensions, which were further complicated by social problems as the working classes began to demand better pay and working conditions.

The Republic

On June 28^{th} 1914, the heir to the Austrian throne, Archduke Franz Ferdinand, was assassinated in Sarajevo by Serbian conspirators. This was the immediate cause of the first world war, which was to end with the disintegration of the Austro-Hungarian monarchy. Emperor Franz Joseph's successor, Karl, issued a statement on November 11^{th}, 1918, in which he renounced all part in conducting the business off the state and a day later the provisional national assembly declared the Republic of Austria.

The treaties of Saint Germain led to the establishment of the successor states: Austria, Hungary and Czechoslovakia; the Kingdom of Serbia made considerable territorial gains and later became the kingdom of Yugoslavia; Romania and Poland were also granted large areas which had been parts of the dual monarchy. The collapse of the empire also meant the breakdown of a major economic bloc.

On February 12th 1934, civil war broke out. The Chancellor Engelbert Dollfuß established Austria as an authoritarian corporative state. On July 25th 1934, Dollfuß was murdered in the course of an abortive National Socialist coup.

On the 12th March 1938 German troops crossed the border. By the 13th, the "Anschluß" was complete in every way and occupied Austria was incorporated into the "German Reich". Eighteen months later the second world war began. Any resistance to the political and military dictatorship of Nazi Germany seemed doomed to failure, but resistance movements did emerge and they were to be active towards the end of the war.

The liberation of Austria began in the last days of March 1945, with Soviet troops entering the country from the east and American and British forces approaching from the west. There was hunger and chaos throughout the country. A provisional government under Karl Renner was formed as early as April 27th. As chancellor he had played a major role in the setting up of the First Republic. Austria's democratic constitution had been in force again since May 1st 1945.

In October 1945, the four occupying powers - Britain, France, the Soviet Union and the United States - recognised the provisional government on condition that general elections were to be held in the same year. For ten years the Austrian government did everything about the signing of an agreement restoring the country's complete sovereignity.

In May 1955 the ambassadors of the four powers met in Vienna for a conference, which was also attended by an Austrian delegation. The final text of the agreement was drawn up on May 15th 1955, the State Treaty of Vienna was signed at a ceremony in Vienna's Belvedere Palace. In the State Treaty the four powers recognise the restoration of Austria as a sovereign, independent and democratic state and declare that they will respect independence and territorial integrity.

On October 26th 1955, the National Assembly passed the Federal Constitutional Law on the Neutrality of Austria; since 1965 October 26th has been celebrated as Austrian National Day.

Austria has always lent its active support to UN efforts to maintain world peace. Since 1960 Austria has contributed to UN peace-keeping missions in the Congo, on Cyprus and in the Middle East. In 1988 Austrian contingents were deployed in Afghanistan and Pakistan as well as in Iran and Iraq, in 1989 in Namibia. At the end of March 1990 a total of 29,000 Austrian troops werde involved in such missions.

Permanent international seats in Austria are the UNIDO, the OPEC, CSCE and the IAEA.

In mid-July 1989 Austria submitted its application for membership in the European Community. Negotiations started in 1993 and were finished on March 31, 1994. In a referendum on June 12th, 1994, a two-thirds majority voted in favour of joining the EU by January 1st, 1995.

Table I.3: Development of final energy consumption in the sectors Industry, Traffic, Small Consumers, Power and Heating Plants. Own-Energy Use and District Heating 1980 - 1993.

	Industry	Traffic	Small Consumers	Power and Heating Plants	Own-Energy Use	District Heating	Total
	TJ	TJ	TJ	TJ	TJ	TJ	TJ
1980	191393	176688	208551	116342	46116	17659	756749
1981	177649	173130	179872	108983	43437	17103	700174
1982	169484	172509	174660	101668	39421	19700	677442
1983	162328	173819	166849	102549	39156	18340	663041
1984	169964	171051	169111	112046	38016	18729	678917
1985	167797	174899	187345	112856	34585	21113	698595
1986	155761	180532	186988	111876	36068	20272	691497
1987	153499	181320	195003	116459	36721	23904	706906
1988	155073	193441	166965	102583	36868	25469	680399
1989	154850	200652	158553	116811	36622	25675	693163
1990	154313	205042	166709	149493	35262	25546	736365
1991	150618	226360	189371	158657	33439	29996	788441
1992	141773	226838	175692	124545	31069	28600	728517
1993	141694	224842	189902	118235	32776	29218	736667

Table I.4: Development of coal consumption in the sectors Industry, Traffic, Small Consumers, Power and Heating Plants. Own-Energy Use and District Heating 1980 - 1993.

	Industry	Traffic	Small Consumers	Power and Heating Plants	Own-Energy Use	District Heating	Total
	TJ	**TJ**	**TJ**	**TJ**	**TJ**	**TJ**	**TJ**
1980	49645	1102	42316	27367	121	3030	123581
1981	48602	1079	41697	30723	102	3467	125670
1982	45845	954	40816	29539	112	3591	120857
1983	50192	854	37536	33577	90	3524	125773
1984	57937	898	42240	39562	76	4008	144721
1985	60355	884	38284	39598	60	3822	143003
1986	48865	859	36840	34640	60	3221	124485
1987	44678	864	39457	42118	43	2379	129539
1988	46424	772	31260	34823	47	3215	116541
1989	46588	319	27926	38807	48	2736	116424
1990	44464	316	26358	60368	46	2755	134307
1991	44341	316	28139	66175	35	3282	142288
1992	40830	316	24031	39946	14	1902	107039
1993	37380	318	21439	30856	10	1361	91364

Table I.5: Development of oil consumption in the sectors Industry, Traffic, Small Consumers, Power and Heating Plants. Own-Energy Use and District Heating 1980 - 1993.

	Industry	Traffic	Small Consumers	Power and Heating Plants	Own-Energy Use	District Heating	Total
	TJ	TJ	TJ	TJ	TJ	TJ	TJ
1980	68057	174747	123719	49735	22990	11362	450610
1981	61504	171257	99691	38531	22404	10386	403773
1982	57437	170667	96679	33936	20014	12380	391113
1983	48558	172067	92856	27630	17894	10182	369187
1984	43500	169266	86143	22773	15860	8966	346508
1985	37469	173070	102263	18299	15990	9239	356330
1986	40520	178705	102461	22354	20508	9378	373926
1987	41365	179414	103742	20756	20177	12231	377685
1988	40673	191791	87403	16150	20286	12487	368790
1989	37639	199455	81619	15215	19205	12654	365787
1990	33398	203826	87846	17065	20303	11916	374354
1991	30612	225144	98708	20761	18233	14566	408024
1992	29063	225622	85555	17064	18580	13952	389836
1993	31352	223624	92283	19113	19485	14929	400786

Table I.6: Development of gaseous fuel consumption in the sectors Industry, Traffic, Small Consumers, Power and Heating Plants. Own-Energy Use and District Heating 1980 - 1993.

	Industry	Traffic	Small Consumers	Power and Heating Plants	Own-Energy Use	District Heating	Total
	TJ	TJ	TJ	TJ	TJ	TJ	TJ
1980	73691	839	42516	39240	23005	3267	182558
1981	67543	794	38484	39729	20931	3250	170731
1982	66202	888	37165	38193	19295	3729	165472
1983	63578	898	36457	41342	21172	4634	168081
1984	68527	887	40728	49711	22080	5755	187688
1985	69973	945	46798	54959	18535	8052	199262
1986	66376	968	47687	54882	15500	7673	193086
1987	67456	1042	51804	53585	16501	9294	199682
1988	67976	878	48302	51610	16535	9767	195068
1989	70623	878	49008	62789	17369	10285	210952
1990	76451	900	52505	72060	14913	10875	227704
1991	75665	900	62524	71721	15171	12148	238129
1992	71880	900	66106	67535	12475	12746	231642
1993	72962	900	76180	68266	13281	12928	244517

Fig.I.1, Fig.I.2, Fig. I.3, FigI.4, Fig.I.5, Fig.I.6, Fig.I.7 and Fig.I.8 are not available electronically.

ANNEX II:

SUMMARY REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES (Gg)						
GREENHOUSE GAS SOURCE AND SINK CATEGO	CO2	CH4	N2O	NOx	CO	NMVOC
Total (Net) National Emission	59200	602.8	4.1	225.5	1682.5	415.4
1 All Energy (Fuel Combustion + Fugitive)	57100	116.1	1.36	212.3	1382	240
A Fuel Combustion	57100	24.3	1.36	212.3	1382	224.2
Energy & Transformation Industries	13700	0.1	0.255	11.6	6.3	0.4
Industry (ISIC)	12300	1.2	0.305	36.83	27.11	10.5
Transport	16200	15.2	0.462	152.1	568.0	113
Commercial/Institutional	12100	7.8	0.401	11.74	780.3	100.3
Residential	*	*	*	*	*	*
Agriculture/Forestry	n.a.	n.a.	*	*	*	*
Other	2) 2800	0	*	*	*	*
Biomass Burned for Energy		n.e.	*	*	*	*
B Fugitive Fuel Emission	n.e.	91.8	n.a.			15.79
Oil and Natural Gas Systems	n.e.	n.a.	n.a.			12.79
Coal Mining	n.e.	n.a.				3.0
2 Industrial Processes	2100		0.616	12.5	241	7.7
A Iron and Steel	1)			3.96	211	1.501
B Non-Ferrous Metals	n.e.			0.03	16	0.370
C Inorganic Chemicals	n.a.		0.616	2.58	5.6	n.e.
D Organic Chemicals	n.a.		0	n.a.	n.a.	n.e.
E Non-Metallic Mineral products	2100			n.a.	n.a.	n.a.
F Other	n.a.			5.9	8.4	5.9
3 Solvent Use						130
A Paint Application						32
B Degreasing and Dry Cleaning						n.a.
C Chemical Products Manufacture/Processing						98
D Other						n.a.
4 Agriculture		258.5	2.031		60	11.9
A Enteric Fermentation		230.6	n.a.			
B Animal Wastes		27.9	n.a.			
C Rice Cultivation		0	0		0	0
D Agricultural Soils		n.a.	2,0			
E Agricultural Waste Burning		n.a.	0.031		60	11.9
F Savannah Burning		0	0		0	0
5 Land Use Change & Forestry	n.e.		0		n.a.	n.a.
A Forest Clearing & One-Site Burning of Cleared	n.e.		0		n.a.	n.a.
B Grassland Conversion			n.a.			
C Abandonment of Managed Lands			n.e.			
D Managed Forests			n.e.			
6 Waste	3)	228.2	n.a.	0.7	0.2	25.8
A Landfills		214	n.a.			0.8
B Wastewater		14.2	n.a.			25.0
C Other: Waste burning	3)	n.a.	n.a.	0.7	0.2	0.02

* Included in Commercial/Institutional
n.a. Not available
n.e. Not estimated, but considered to be small
1) Included in IA1 Energy & Transformation Industries
2) Energy consumption from own-energy use at power plants and refineries
3) Included in IA Fuel Combustion

CO_2 emission factors [1]

		metric tons / TJ
COAL		
	hard coal	95
	brown coal	
	conversion	110
	others	97
	brown coal briquets	99
	coke	104
	peat	97
OIL		
	crude oil	78
	other refinery use	78
	petrol	78
	paraffin	78
	gas oil	78
	fuel oil	78
	liquid gas	78
	other products	78
	refinery residue gas	78
GAS		
	town gas	60
	natural gas	55
	furnace gas	104
	coke oven gas	95
OTHER ENERGY SOURCES		
	wood	0
	combustible waste [2]	100
	district heating	0
HYDROPOWER AND ELECTRICITY		
	hydropower	0
	electricity	0

[1] The pyrogenic emission factors to convert the IER energy statements into CO_2 statements have been drawn up by the Austrian Federal Environmental Agency. It is assumed, that transmission losses and non-energetic use of energy sources do not cause CO_2 emissions. The CO_2 emissions are recorded on the consumer side. Therefore the consumption of electric power and district heating does not produce a CO_2 discharge; it will be registered at the transformation facilities. Therefore the CO_2 discharge refers to their total energy use. On the other hand the energy statements consider the total energy consumption at the consumers side and therefore at the transformation facilities the transformation losses only.

[2] It was assumed, that only 10% of combustible waste, which is used energetically, has to be considered.

<u>Basic Assumptions for the Development of the CO_2 Emission Statements</u>

(BMwA, 1993; Musil, 1993)

The energy consumption statements divided into useful energy types and energy sources have formed the basis for the computations.

Only pyrogenic CO_2 emissions have been determined; process-related CO_2 emissions (e.g. cement plants) have not been considered.

It has been assumed, that the non-energetic use of energy sources and the transmission losses does not release CO_2. Especially when using natural gas it has to be taken into account, that the specific CO_2 emissions are small, but due to leakages of transmission systems methane may be released, which can cause harmful effects to the environment.

Per definitionem the use of biogenic energy sources has not been considered in the CO_2 emission statements because of its CO_2-neutrality. It has been assumed, that 90% of the combustible waste are biogenic energy sources.

The CO_2 emissions are recorded on the consumer side. Therefore the consumption of electric power and district heating does not produce a CO_2 discharge on the consumer side; it will be registered at the transformation facilities. Therefore the CO_2 discharge refers to their total energy use. Th energy statements of the end users contain electric power and district heating use, but not the CO_2 statements. For the development of the total energy statements only the transformation losses are added for the transformation facilities.

ANNEX III:

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