REPUBLIC OF SLOVENIA
MINISTRY OF THE ENVIRONMENT, SPATIAL PLANNING AND ENERGY

# Slovenia's

# Second and Third National Communication to the Conference of the Parties of the United Nations Framework Convention on Climate Change

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1. Česen, Matjaž
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Communication was drafted and edited by:
Matjaž Česen, Leader of the Communication compilation
Andrej Kranjc, Project Director
Robert Špendl, M.Sc., Project Manager
Studies that were used in the compilation of the Communication and other co-workers:

| | |
|---|---|
| **Environmental Agency of the Republic of Slovenia** | |
| • Inventories of GHG Emissions, 1986, 1990–2002 | Matej Gasperič; Tajda Mekinda Majaron |
| • Climatology | Tanja Cegnar, M.Sc. |
| • Projections of Climate Change and Climate Change Vulnerability Assessment | Andreja Sušnik; Blaž Kurnik; Iztok Matajc; Damjan Rogelj; Gregor Gregorič, Ph.D. |
| **University of Ljubljana, Biotechnical faculty** | |
| • Projections of Climate Change and Climate Change Vulnerability Assessment | Lučka Kajfež - Bogataj, Ph.D; Klemen Bergant, Ph.D; Zalika Črepinšek, Ph.D |
| **Factum, Robert Špendl, s.p.** | |
| • Projections of GHG Emissions from Industrial Processes | Robert Špendl, M.Sc. |
| **Hidroinženiring, d.o.o.** | |
| • Assesment of Reduction Potential of GHG Emissions from Waste Disposal and Waste Water Treatment | Natalija Pivec Kegel, Željko Rečnik, M.Sc. |
| **Institut »Jožef Stefan«, Energy Efficiency Centre** | |
| • Analysis of Energy Strategies and Long Term Energy Balances of R Slovenia 2001–2020 | Stane Merše, MSc; Andreja Urbančič, MSc, Miha Tomšič, Ph.D.; Damjan Zagožen, MSc; Fouad Al Mansour, Ph.D.; Evald Kranjčevič, MSc; Tomaž Fatur, MSc |
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| **Ministry of the Environment, Spatial Planning and Energy** | |
| • Waste Management | Jani Zore, Ph.D. |
| • Action Plan for Reducing GHG Emissions | Alenka Burja, Nives Nared, MSc; Radovan Tavzes, MSc; Andrej Kranjc; Jani Zore, Ph.D. |
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# INTRODUCTION

*Slovenia, as a new member of the European Union, is determined to fulfil its commitment regardless to Kyoto Protocol entering into force or not.*

This Communication is an upgrade of Slovenia's First National Communication under the UN Framework Convention on Climate Change that was submitted to the Secretariat of the Convention in July 2002. This Communication includes the Second and the Third Communication, as we assumed that it would not be reasonable to compile and publish two separate National Communications in such a short period of time. The delay caused by Slovenian independence process in the early nineties and by the late accession to the Climate Change negotiation process is gradually diminished and is expected to disappear in a short time. Thus we plan to compile the Forth National Communication in time, and to deliver it to the Secretariat before the date determined by Conference of the Parties to the Convention.

The experience gathered by compiling the First Communication was very useful when compiling the present one and have considerably contributed to better Communication quality, especially in the following chapters: Greenhouse Gas Inventory Information, Policies and Measures, and Projections of Emissions and Assessment of Impacts of Policies and Measures. There are two reasons for this – first, in 2003 a permanent group of experts was established in the Environmental Agency for compilation of GHG Emission Inventories, which means a great progress in this area. This expert group completed Emission Inventories in CRF format up to the year 2002 in a relatively short period of time, so that we are up-to date now, and they also recalculated all the inventories for the year 1986 and for the period 1990–1996. Secondly, the Action Plan for Reducing GHG emissions was compiled last year in which we indicated financially evaluated emission reduction measures and estimated their effects. The Slovenian Government adopted the Action Plan in July 2003.

I would like to point out a major difference between the chapters dealing with Climate Change Vulnerability and Adaptation in the First and the present National Communications. In the First Communication we worked briefly on a variety of sectors (Agriculture, Forestry, Water Cycle, Biological Diversity, Alpine World, Sea and Coastal Zones, Tourism, Energy, Human Health and Well-being), while in the Second and Third Communication we focused on Agriculture and Forestry and analysed them in details. In the next Communications we plan to gradually present other individual areas in the same way.

The data about GHG emissions show that Slovenia shall make significant effort to achieve Kyoto Protocol emission reduction target. As a rather well developed country that has finished its transition to a marked economy, Slovenia has decided to join Annex I Countries of the Convention on Climate Change, and thus accept corresponding responsibilities. This decision was confirmed with a resolution 4/CP.3 at COP3 in 1997 in Kyoto. Slovenia, as a new member of the European Union, is determined to fulfil its commitment regardless to Kyoto Protocol entering into force or not.

Janez Kopač, MSc

Minister of the Environment,
Spatial Planning and Energy

# 1. EXECUTIVE SUMMARY

## 1.1 Introduction

The climate is changing due to the human activities that have increased concentrations of greenhouse gases (GHG) in the atmosphere. In the last century global mean temperature rose by 0.6 °C, the main part of it in the last 25 years. At the same time frequency of extreme weather and climate events has increased. Extreme weather conditions, like storms and droughts, are more frequent. The quantity and annual distribution of precipitation has changed as well, which results in frequent and longer drought periods.

Modern society is facing a great challenge when trying to mitigate climate change. Efforts to reduce the impact of human activities on the environment became a world project in Rio de Janeiro in 1992 with the UN Framework Convention on Climate Change, first internationally binding instrument that addresses this issue. The ultimate goal of the Convention is to achieve stabilisation of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. The next step represents the Kyoto Protocol which outlines concrete GHG emissions reduction targets below the levels of the base year in the first commitment period 2008–2012. While 1990 is the base year for most countries, the base year for Slovenia is 1986 [1]. Slovenia ratified the Kyoto Protocol in June 2002.

Slovenian Kyoto Protocol commitment is to achieve an 8 % GHG emission reduction target below the base year level. To reach this target Slovenia is allowed to use 1.68 Tg $CO_2$ of sinks. Due to the uncertainty with asserting the allowed quota of sinks, the conservative estimate of sink utilization of 840 Gg $CO_2$ was made. The national emission level for 2002 is calculated at 20.38 Tg $CO_{2\ eq}$ considering the sinks this number is reduced to 19.54 Tg $CO_{2\ eq}$. With these emissions Slovenia is now 0.54 Tg $CO_{2\ eq}$ (2.8 %) above the projected emissions (19.01 Tg $CO_{2\ eq}$), or 15 Gg $CO_{2\ eq}$ (0.1 %) above the linear approach to the Kyoto goal. The main obstacles for reaching Kyoto target are: relatively high energy intensity, caused by a high share of energy intensive sectors and less favourable fuel structure in energy sector; Slovenian exposition to transit transport and increasing transport work. Despite the obstacles, Slovenia has decided to reach the target of 8 % emission reduction in the first commitment period with implementation of wide variety of measures.

Preparation of national communications is one of the basic commitments of the Parties to the Convention. Due to the delay in submitting the first national communication, Slovenia merged its second and third communications in one document.

## 1.2 National Circumstances

Slovenia became an independent state on 25th June 1991 following the break-up of the former Socialist Federal Republic of Yugoslavia. Political system of Slovenia is parliamentary democracy. The President of the Republic is elected on direct, general elections. The Prime minister is responsible to form the Government. Environment protection, that includes fulfilment of international commitments like Kyoto Protocol, is a responsibility of the Ministry of the Environment, Spatial Planning and Energy (MOPE). In order to reach Kyoto goals, the Ministry co-operates with Ministry of Finance (MF), Ministry of the Economy (MG), Ministry of the Agriculture, Forestry and Food (MKGP) and Ministry of Transport (MP).

In 2002, Slovenia had 1,964,036 inhabitants. Its 20,273 km$^2$ make it a small, but still exceptionally diverse country in Central Europe. In the northern part, Slovenian mountain territory progressively flattens, and ends in the Pannonian Plain. The coastal south-west zone of the Adriatic Sea is separated from the mainland by the northern slopes of the Dinaric mountain range. The central region is mountainous with numerous valleys and basins. Slovenia's exceptional biotic diversity is the result of climate, orographic and pedological variability and large forest areas (56.5 % of the national territory is covered with forests). Slovenian territory represents the crossroads of three climate zones: mediterranean, moderate continental and alpine. In the lower land summers can be very hot. Winters in coastal areas are quite mild, while in the other areas they are still rather cold. The annual precipitation in Slovenia indicates a great spatial and time diversity. The mountain area of Julian Alps gets most of precipitation annually, approximately 3000 mm, and the north-eastern area of the country gets least of the precipitation annually, up to 800 mm. Most of the years after 1990 were warmer than on the average in the reference period 1971–2000 and had less precipitation than the average. This phenomenon is especially distinctive in the warm part of the year. Although the trends in precipitation quantity are insignificant, it is possible to assess that the most probable future climate development in Slovenia leans towards warm and slightly drier summers and mild winters with rather unchangeable annual quantity of precipitation.

Due to the world economy crisis in the last two years, Slovenian economy faces lower economic growth (2.9 %). In 2002, Slovenia reached GDP of 5,275,827 Mio SIT (23,321 Mio EUR). The service sector share accounts for 61.8 % of the added value, industry 29.6 %, construction 5.6 % and agriculture 3.0 %. The small size of the domestic market has forced Slovenian economy to become firmly embedded in international economic flows. The most important Slovenian economy partner is European Union (EU).

In 2002 Slovenia's energy intensity came to 337 toe/Mio $EUR_{1995}$. In the 1995–2000 period this intensity declined by 16 %. Smaller production of hydro power plants and the extension of energy intensive sectors caused increase in energy intensity in 2001 and small decline in 2002. Increasing energy efficiency and a great share of renewable energy sources in the consumption of primary energy (8.6 % in 2002) are also Slovenian characteristics. In 2002 the primary energy consumption reached 269.5 PJ. Liquid fuel accounts for more than one third of the total primary energy consumption, and is followed by solid fuels, nuclear energy, natural gas and renewable sources, within which water energy and wood biomass are the most important. The share of liquid fuel in final energy consumption (183.9 PJ) accounts for 49.3 %, and is followed by electricity, district heat and solid fuel.

Slovenia has a high and increasing level of motorization. In the period 1990–2001 the number of registered cars increased by 50 % and thus influenced a decrease in public passenger transport, especially notable in public road passenger transport, while in the railway passenger transport a positive trend of the last years is noted. In the last years road cargo transport is on increase. Since 1997 the railway freight transport share basically remained unchanged, but the increase in 2002 is encouraging.

The most important industrial sectors in Slovenia are production of metals and metal products, production of non-metal mineral products, food and beverage production and fibres and pulp production. The extent of production increased by 24 % in the period 1993–2001 period due to the increased production of electrical and optical equipment, chemicals, chemical products and artificial fibres. In the same period productivity increased by 68 %.

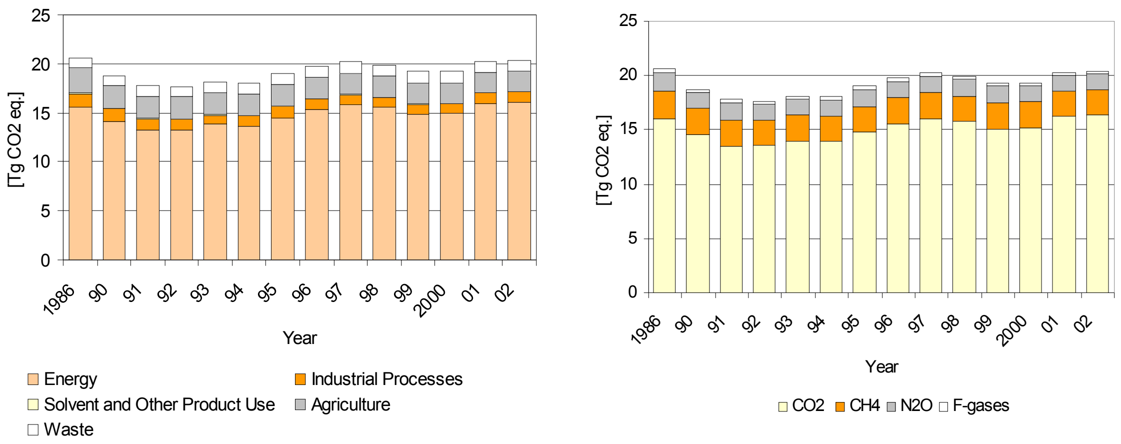



Figure 1-1: Emission inventories by sector and by gas for the year 1986 and for the period 1990–2002

The dominating way of handling the waste is disposing. In 2001 Slovenia produced 837 kg of waste per capita. Municipal and other similar waste accounted for 430 kg per capita. By the end of 2003 a system of separate waste collection started in the whole country. At three major landfills, systems for landfill gas capture were activated. The amount of 32 kt of the total no municipal waste were thermically treated or removed. Due to the new legislation that was put into force, a great progress in systematic waste regulation has been made after the year 1998.

The settlement pattern of Slovenia is characterised by an extensive dispersity and small settlements compared to the number of inhabitants or the size of the country. 90 % of the settlements have less than 500 inhabitants and just 7 cities have more than 20,000 inhabitants. In the period 1991–2002 the number of apartments increased by 13.9 %, the average apartment area increased as well, by 2.2 % (in 2002; 74.6 m$^2$). The largest share in the building stock belongs to the individual buildings (60 %). Most of the buildings were built in the period 1961–1980.

Natural circumstances for agriculture manufacturing in Slovenia are relatively unfavourable. The country is characterised by a lot of wooden areas, a small share of agriculture land in a total national surface, unfavourable relief (a great part of agricultural land is situated in areas with difficult cultivation conditions), big share of grassland areas and a small share of fields in a structure of agriculture land cultivation. The most important sector is cattle breeding. The consumption of mineral fertilisers is reasonable. In the last few years the great increase in the number of ecological farms has been noted.

Forests cover more than half of the country. Annually biomass rate in Slovenia accounts for 6.06 m$^3$/ha, in which a contribution of 5 % stands for afforestation. The share of conifers and hardwoods in a wood inventory is almost the same.

## 1.3 Greenhouse Gas Inventory Information

Inventories of greenhouse gas emissions for all gasses and sectors were calculated on the basis of IPCC methodology (IPCC 1997) [2], except for the transport sector and in some other cases where CORINAIR methodology was used instead. Inventories for the year 1986 and for the period 1990–1996 were corrected by using different emission factors, higher quality input data, and by correction of mistakes made in inventory calculation for the first Communication. Inventories corrections are presented in details in the Chapter 4.2.

In 2002 total GHG emissions accounted for 20.38 Tg $CO_{2\ eq}$. The largest share among gases belongs to $CO_2$ (80.2 %), and is followed by $CH_4$ with 11.2 %, $N_2O$ with 7.6 % and F–gases with 1.0 % of GHG emissions. The largest share in emissions among the sectors belongs to the energy sector (78.9 %), agriculture accounts for 10.2 % of total GHG emissions, waste for 5.4 %, industrial processes for 5.2 % and solvent and other product use for 0.4 %. The most important emission source in energy sector with 97.9 % of emissions is fuel combustion sub-sector, which is split further on energy supply (40.8 %), transport (25.2 %), other sectors[3] (18.7 %) and industry and construction sectors (15.3 %) Due to the land use change and forestry, $CO_2$ emission sinks are ascribed to be 5.6 Tg.

As a result of economy restructuring and independence process, the lowest emission level was reached in 1992. The first peak was reached in 1997 due to the low fuel prices in Slovenia, that increased motor fuel purchases by foreigners and the second peak in 2002, due to lower electricity production from hydro power plants, replaced by increased thermal power plants electricity production. In 2002 GHG emissions were 1.1 % below the emissions in 1986.

## 1.4 Emission Reduction Policies and Measures

The first Communication presents strategy measures and a short-term Action plan of Reducing GHG Emissions measures. Further policies are included in the inter-sectorally harmonized document Slovenia's Action Plan for Reducing GHG Emissions from 2003 which defines key instruments to reach the Kyoto targets, individual sector commitments for implementing these instruments and the adaptation of instruments to reach the demanded target. During the Slovenian accession process and adaptation to the EU, most of the legislation, foreseen as Slovenian Kyoto Protocol implementation instruments, present a legitimate law order. $CO_2$ emission tax and waste landfilling tax stand out among specific domestic instruments for reducing GHG emissions. In 2010, total potential of introduced measures accounts for 4.5 Tg $CO_{2\ eq.}$. Total cost assessment, with investment and production costs considered accounts for 14.6 millions EUR per year (3.5 billions SIT per year) according to more favourable scenario, while according to less favourable one it accounts for 34.5 millions EUR per year (7.9 billion SIT per year). Different ministries are responsible for implementing the measures: Ministry of the Environment, Spatial Planning and Energy, Ministry of the Agriculture, Forestry and Food, Ministry of the Economy, Ministry of Transport, Ministry of Finance, and municipalities.

The adoption of the Energy Law in 1999 presented a great step towards GHG emission reduction in the area of energy use and supply. The key element of the law is a market oriented sustainable energy development with increasing efficient energy use and the use of renewable sources. Additional confirmation and directions could be ascribed to the National Energy Programme (NEP) compiled in 2003, which emphasises the dimension of sustainable energy development. Measures presented in this Communication and Action Plan are originate from documents mentioned above. The following measures have already been carried out: the stimulation of electricity production from renewable sources and from combined heat and power production by implementing fixed purchased electricity price; opening of electricity and natural gas market; incentives for carrying out measures in efficient energy use and for investing in renewable energy sources (refers to activities of and the Ecological Development Fund); actions done in the field of education and promotion, energy labelling of household appliances, regular monitoring of small combustion installations, construction of big hydro power plants on the Sava river and other rivers, and the extension of some existing hydro power plants; heat cost accounting according to the consumption; new order on thermal protection and efficient energy use in buildings, that allows building certification of energy characteristics; and introduction of framework for third part financing for contractual decreasing of energy costs. In the following years additional contribution to emission reduction is planned to be made by the following measures: energy source certification that will enable a consumer to choose electricity produced from different fuels, introducing the excise on fossil fuels and electricity that will encourage consumers to more efficient energy use and implementation of energy efficiency measures for consumers carried out by energy supply companies.

In the Transport sector the compilation of the Transport Policy Strategy is in its final stage. Measures, presented in the Action Plan for Reducing GHG Emissions, are mainly the result of a harmonisation between Slovenian and EU legislation. Two measures were carried out up to 2003: fuel excise increase, which increased the price of fuel, and control over the structure of exhaust gases and vehicle motor adjustment that came into force on 1st December 2003. There were also two additional measures adopted: promotion of biodiesel use by decreasing the excise tax level down to 0 % and informing consumers on fuel consumption and $CO_2$ emissions of motor vehicles. The future measures plan to stimulate the public passenger transport use, to increase railway passenger and cargo transport share increase and a sustainable orientated regional and spatial development.

Due to the competition, industry is forced to perform efficient energy use measures. Additional stimulation are subsidiaries for energy audits and feasibility studies granted by Agency for Energy Efficiency and Renewable Energy (AURE). Introduction of the environment handling systems ISO 14001 that will be upgraded with inclusion of companies into the EMAS system contributes to environment burdening reduction as well. ECO-labelling scheme, which promotes ecological products, is at the beginning of implementation process. Among adopted measures there is IPPC directive that will bind companies to use best available techniques (BAT).

Agriculture policy within the Slovenian Agriculture Environment Programme encourages environment protection, and is not directly headed toward GHG emission reduction, but still has a great indirect impact. Other Agriculture and Forestry policy measures are: good agriculture fertilising practice by optimising fertilisers use, stimulation of different state financial mechanisms biogas usage for electricity and heat production and sustainable forest management. A measure for stimulating the manufacture of agriculture plants for biodiesel production is planned in the future.

Apart from the progress in efficient energy use and renewable energy sources, the greatest progress made so far was in the waste sector. Noticeable condition improvement has to do mostly with the systematically organised areas, but still not all of the confirmed measures were brought to life. The framework of systematically organized area consists of waste landfilling practice and waste management practice. Two measures exist for the waste reduction. Reducing the waste by its source will influence separate waste collection that includes the implementation of the separate waste collection systems, waste sorting centres and performance of the Packing Management Programme. The waste disposal tax, paid by the owners of landfills, will contribute to waste reduction. Very important GHG emission reduction measure is the commitment of landfill owners to organize landfill gas capture and its combustion or energy utilisation. Future plans in the waste sector are headed toward the construction of incineration plants that would cause a radical waste reduction.

No measure was implemented or performed so far to reduce F- gases [4], but in the future F-gases regulation will be binding for EU countries, which will establish many emission reduction measures.

Among specific domestic instruments for GHG emission reduction $CO_2$ tax implemented in 1996 takes a special place besides the waste disposal tax. The $CO_2$ tax accounts for 3 SIT/kg $CO_2$ (15 EUR/t $CO_2$). This tax is supposed to become assigned to finance the realization of measures concerning the reduction of air burdening by $CO_2$ emissions and tax relief or reduction for operators of plants included in emission trading scheme.

Besides domestic emission reduction measures, there are three Kyoto mechanisms available as well. The most important flexible mechanism is Emission Allowance Trading, which enables the polluters to reduce their emissions in the most cost effective way. European Union Emission Allowance Trading System will start functioning in 2005 while the global Emission Trading will take place in the period 2008–2012. Other two flexible mechanisms are clean development mechanism and joint implementation.

## 1.5 Projections of Emissions and Assessment of the Impacts of Policies and Measures

Two GHG emission projections were made on the basis of two basic scenarios. In the scenario "with measures" the continuation of the present policy in the field of reducing GHG emissions has been anticipated, which is characterized by a lower intensity of measures realization. In the "with additional measures" scenario a higher implementation intensity of realizing of the already implemented and adopted measures and the realization of all planned measures has been anticipated. "without measures" projection, presented in the Figure 1-2, was done as an indication on the basis of estimated potential of implemented and adopted measures, which was added to "with measures" projection.

Projections are made separately for each individual sector. Projections for energy sector were made by using a system of models that enables the integrated presentation of energy supply and consumption. Projections for waste and agriculture sectors were calculated on the basis of IPCC methodology, for industrial processes $CO_2$ emissions were assessed on the basis of expected manufacture index flow, F-gases emissions were assessed on the basis of aluminium production anticipations, HFC–134a gas use and $SF_6$ gas management.

According to the "with measures" projection, GHG emissions would account for 21.58 Tg $CO_{2\,eq}$ in 2010, which is 4.7 % more than in 1986. Thus in 2020, the emissions will be 0.7 % higher than in the base year. According to the "with additional measures" scenario emissions will account for 20.06 Tg $CO_{2\,eq}$ in 2010 (2.6 % less than in the base year), and 18.92 Tg $CO_{2\,eq}$ in 2020 (8.2 % less than in 1986). According to the "with additional measures" projection, in the first Kyoto commitment period 2008–2012 the average emissions, without considering the sinks, account for 19.85 Tg $CO_{2\,eq}$. To reach Kyoto target, Slovenia is allowed to use 1.68 Tg $CO_2$ of sinks. Due to the uncertainty with asserting the allowed quota of sinks, the conservative estimate of sink utilization 840 Gg $CO_2$ was made. Considering the sinks, GHG emissions account for 19.01 Tg $CO_{2\,eq}$ in the first commitment period, which is 8 % less than emissions in the base year. In conclusion, GHG emis-

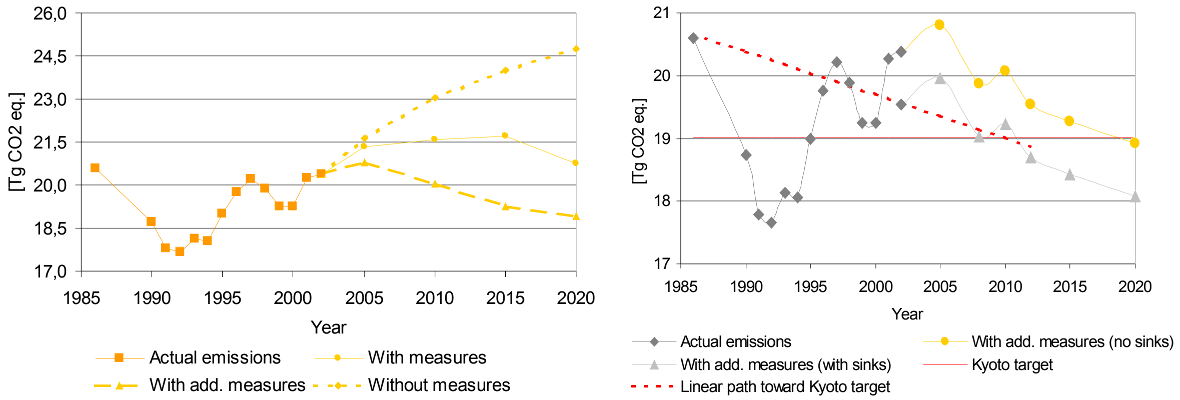



Figure 1-2: Slovenian GHG Emissions according to the "without measures" projection, "with measures" projection and "with additional measures" projection, without considering the sinks (left) and an analysis of fulfilment of the Kyoto Protocol commitment according to the "with additional measures" projection (right)

sion reduction trend foreseen by the "with additional measures" projection and the consideration of the allowed quota of sinks (840 Gg $CO_2$) in the first commitment period is indicating that Slovenia shall fulfil the emission reduction commitment under the Kyoto Protocol.

## 1.6 Vulnerability Assessment, Climate Change Influence and Adaptation Measures

The most probable climate development in Slovenia in the future is headed towards warm – a bit drier – summers, warm winters with approximately unchangeable average quantity of precipitation and increased number of extreme events. Climate change influence is extremely wide. Due to higher temperature, changed water balance and increased number of extreme conditions, agriculture will suffer consequences, forests will be posed to a grater stress, biotic diversity will be endangered, flood threat will increase, problems with drinking water will appear, the risk in the Alps and the rest of mountain world will increase, due to the sea level and sea temperature increase coastal area will be affected, negative direct and indirect influence on health and wellbeing of people is expected (example: increased thermal load and increase of vector borne disease), energy use patterns will change, energy supply can become a problem due to the rivers drying, tourist sector will be affected – especially winter-sport tourism. This Communication includes a detailed analysis of the Climate Change impact and adaptation measures for agriculture and forestry, while in following Communications other sectors will be analyzed as well.

Temperature rise will influence the prolongation of the vegetation period and faster plant development, which will result in lower quality of the crops. On the other hand cultivation of those plants will be enabled, that need more warmth for their growth. The plant cultivation will need to be adapted to the following measures: sowing date change, replacing the earlier sorts with the later ones, watering or sort selection not sensitive to the draught and possibly more intensive fertilization to compensate a shortened growth period and water stress. In the field of plant protection from the increased number of infections and pests a good observation network needs to be restored and proper prognostic models need to be introduced.

Possible responses of the forest ecosystem on climate change are the following: forest location change, change in the forest structure and production. Damage due to the climate change will be extensive because of lower mitigation possibilities in clean forest structures (spruce forest) and in isolated forests with poor environment conditions. By changing the forest structure general conditions in forest ecosystems will change as well. Due to the higher temperatures and longer dry periods the danger of fires will increase. Climate change will influence biotic diversity, especially the highland habitat types. The mitigation measures for climate change impact reduction in the forest are the following: attention to forest vegetation maintenance, prevention of halting the forest succession on the deserted agricultural sites as well as redirecting artificial forest renovation from conifers to hardwoods, determination of the sensitivity of forest structures and its woodland on the anticipated climate change, restoration and maintenance of the proper fire prevention areas and continuation of directing the wood stocks care to their increase.

In 2003 analysis study of Slovenian agriculture vulnerability on water balance change was prepared. It was found out that in the 1961–2000 period the amount of the water available decreased all over Slovenia due to the increased water consumption and climate change ability. Increase in the daily use of water from the ground and plants is particularly noticeable in the last ten years. In the field of supplying agriculture plants with water the following measures were proposed: preparation of prevention measures, preparation of dry condition management measures, on-line analysis of the climate change impact on Slovenia and upgrade of the methodology of assessing the damage caused by the draught, change of the sowing structure and production orientation on farms and the cultivation technology, rotation of crops, improvement of the ground state in dry conditions by increasing quantity of humus in the ground, construction of watering systems, controlled watering with watering models and by taking meteorological circumstances and weather forecasts and insurance of the agricultural crops for the extreme conditions into account.

## 1.7 Research and Systematic Observation

In Slovenia, research on climate change has been conducted by three institutions: Environmental Agency of the Republic of Slovenia (ARSO), Meteorology department of the Faculty of Mathematics and Physics and Agrometeorology department of the Biotechnical Faculty of the University of Ljubljana. Researches from the Anton Melik Geographical Institute and the Marine Biology Station also take part in this research area. The researches performed cover climate changes, climate processes, orographic rainfall and small-scale processes and analyses of climate change impacts on different areas. Many of the researches also cover efficient energy use and renewable energy sources in different organizations and companies. Research institutions are co-operating within international programmes, especially EU research programmes.

Slovenia has been performing systematical meteorological observations and measurements since 1850. The meteorological network currently consists of 39 climatological stations (out of which 13 are synoptic), 180 rainfall stations, a radiosonde station, sodar and a meteorological radar station. Majority of the 30 automatic meteorological stations operate within the climatological meteorological stations. The problem of meteorological data sets in Slovenia is that they are inhomogeneous due to various reasons. Besides meteorological observations Slovenia performs air quality observations, regular hydrological monitoring, observation of two glaciers, phenological observations and observations of the meteorological parameters and sea characteristics of the Trieste gulf. International cooperation is carried out on different project: GCOS, GAW, EMEP, WWW and GPCC.

## 1.8 Education, Training and Public Awareness

Within all the education levels, from kindergartens to high schools, climate education is present. In kindergartens children are taught to observe and recognize the nature and to develop positive relation towards the nature. In elementary and high schools climate education is included in different main subjects and particularly discussed by selective subjects and within activity days (mostly natural science), experience week in nature, by-school activities within different projects in which schools take part autonomously (e.g. “ECO” school projects, “UNESCO” schools, and “healthy” schools) and youth research activities. Integrated undergraduate study of environment protection is organized by the School of Environmental Sciences that works within the Polytechnics Nova Gorica. Particular environmental areas, that include environmental care are treated in individual study programmes. Post-graduate study is organized within University of Ljubljana and Polytechnics Nova Gorica.

Ministry of the Environment, Spatial Planning and Energy actively works on public awareness and information release by publishing a Bulletin, occasional publications and by cooperating with media. Public awareness on climate change has improved a lot in the last years. Due to a more evident climate change consequences in Slovenia, media are showing greater interest in the problem of climate change and thus more articles are presented to the public. Agency for Energy Efficiency and Renewable Energy is very active in Slovenia in the area of efficient energy use. In the transport sector Slovenian municipalities are cooperating in European Car-free Days project.

Consultations for the inhabitants about renewable energy sources and efficient use of energy are organized by a network of 33 consulting offices called ENSVET. First consulting offices started to work in 1993 and in the period 1997–2002 approximately 14.000 advices were given to inhabitants. Efficient use of energy and renewable energy sources are a part of the most intensive expert education, organized in the form of seminars and workshops by different institutions. A great part of consulting and education is carried out within international projects. Important role in the terms of education and public awareness in energy sector is assigned to Energy Fair.

In the area of climate change 130 non-governmental organizations are active, with a local level share of 60 %, are active. More than two-thirds of NGO's perform other activities as well, within the field of environment they mainly organize educational and qualification activities, collecting and passing of information about environment. Cooperation between NGO's and Ministry of the Environment, Spatial Planning and Energy is organized within of the Programme of Partnership and Environment. Further more, NGO representatives cooperate in ministry bodies as well.

[1] The base year for $CO_2$, $CH_4$ and $N_2O$ is 1986 and for F gases it is 1995

[2] IPCC Greenhouse gas inventory reference manual. Revised 1996 IPCC guidelines for national greenhouse inventories (Houghton et al., ed.), Bracknel , IPCC, 1997

[3] Other sectors represent emissions that are caused by fuel combustion in households, commercial sector, services and agriculture.

[4] Hydrofluorocarbons (HFC), Perfluorocarbons (PFC) and Sulphur hexafluoride ($SF_6$)

# 2. NATIONAL CIRCUMSTANCES

## 2.1 Government Structure

The Republic of Slovenia became an independent state on the 25th June 1991, following the disintegration of the former Socialist Federal Republic of Yugoslavia. The Constitution of the Republic of Slovenia was adopted on 23 December 1991. The political system of Slovenia is parliamentary democracy. The President of the Republic is elected for a maximum two consecutive five-year terms on direct, general elections. The National Assembly, which is the highest legislative authority in Slovenia, is composed of 90 deputies with a four-year term in office. The Prime Minister proposes members of the government (14 ministers), who must be approved by the National Assembly.

The Ministry of the Environment, Spatial Planning and Energy, is a supreme body of the executive power of the state environment protection. The ministry consists of different agencies: Office for the environment, Office for water management, Office for spatial planning, Energy office and Office for European affairs and international relations. The Ministry is in charge of some other professional institutions: Agency of the Republic of Slovenia for the Efficient Use of Energy and Renewable Energy Sources (AURE), Environmental Agency (ARSO), Surveying and Mapping Authority (GURS), Inspectorate for the Environment and Spatial Planning (IRSOP), and Nuclear Safety Administration (UJV).

On the environment protection area two other particular bodies are active: Sustainable Development Council chaired by the Prime minister, and Environmental Protection Council, founded by the National Assembly. Besides that, Government of the Republic of Slovenia founded the Slovenian Climate Change Committee with minister of environment as a chairman. The committee is responsible for directing Slovenian representatives working within UN Framework Convention on Climate Change and monitor the fulfilment of the convention commitments [8].

Slovenia consists of 193 municipalities which have their own administration and own income. 11 have a status of the city municipality. Local communities have jurisdiction over different areas that have impact on the greenhouse gas emissions. Their jurisdiction includes spatial planning and local transport arrangements, public passenger transport, the preparation of local energy concept designs, and compulsory public utility waste management services. City municipalities are obliged to assure the emission monitoring and prepare Local environmental action plans. The municipality of Domžale compiled the first local environmental action plan in 1996. Until today, 11 other municipalities (8.6 % of Slovenian total surface and 17.3 % of all Slovenian inhabitants) compiled their local environmental action plans.

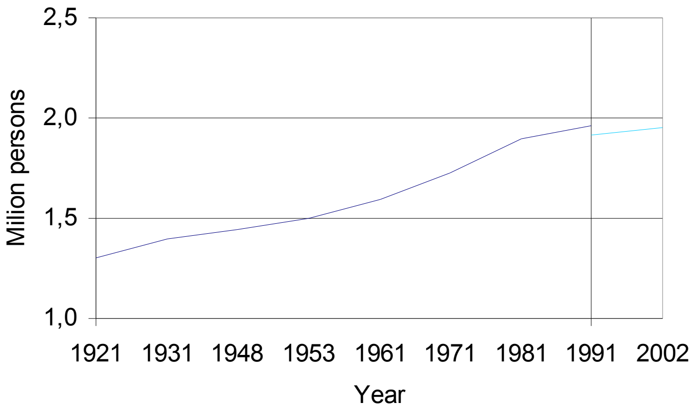
## 2.2 Population Profile

1,913,355 people were living in Slovenia in 1991; in 2002 this figure was 1,964,036 (male: 48.5 %, female: 51.5 %) [17]. The population projections show that the average annual growth coefficient / 1000 inhabitants will be: 1.9 in the period 2007–2012, 0.9 in 2012–2017 and 0.3 in 2017–2020 [15]. As the average natality rate between 1991–2002 was negative (–0.1 / 1000 inhabitants), the population increased because of immigration from abroad and legalisation of residence of people who immigrated to Slovenia before the population registration in 1991. The natality rate has been negative since 1997. Figure 1-1 shows population flow between 1921 and 2002. Life expectancy is 72 years for men and 80 for women. Decreasing number of births and longer life expectancy are causing ageing of population. The share of people over 60 is approaching to one-fifth (19.6 %). In 1991 the average household had 3.0 members and in 2002 it had 2.8 members. In the period 1991–2002 number of households increased by 8.3 %.

Population density is moderate, amounting to 98 inhabitants/km$^2$ [17]. Characteristics of Slovenia are dispersed settlements and growing trend of moving to bigger cities. 13 % (260,807 inhabitants) of the total population of Slovenia live in the capital Ljubljana [15].

arate northern hills of the Dinaric mountain range. To the Northeast, Slovenian territory gradually flattens into the Pannonian Plain. The coast length is 46.6 km. Average height of the entire territory is 550 m above sea level, while the mountainous structure of the land gives it an average incline of 25 %.

Half of the Slovenian surface area is covered by forests (56.5 %). Agricultural areas cover 38 %, settled areas 2.5 % and transport infrastructure covers 0.5 % of the total surface. Forested areas have been




Source: SURS

Figure 2-1: Changes of Slovenian population. On the 2002 census different methodology was used, according to which the outcome of the 1991 census was recalculated as well

## 2.3 Geographic Profile

Slovenia is situated in central Europe, at approximately 46° North and 15° East. It covers 20,273 km$^2$. It has borders with Italy, Austria, Hungary and Croatia, with which it has the longest national border. Though small in size, Slovenia is a very diverse country. Three types of landscape can be found. In the north we can find Julius Alps, with the highest peak of Slovenia, Triglav with 2864 m, Karavanke Alps and Kamnik-Savinja Alps. Towards South land lowers toward Adriatic Sea. The central part is mountainous with numerous valleys and basins. Ljubljana, the capital city of Slovenia lies in one of those basins. Coast of Adriatic Sea and central part sep-

increasing at the expense of agricultural land. Diversity of climatic, orographic and pedological variability, large forest areas subjected to co-natural management, and traditional methods of management of cultural landscape influence the biotic diversity, now endangered due to the possible climate changes. In Slovenia 3000 of ferns and blossoms grow and 50.000 different animal species live. The increased number of protected areas point out concern for biotic diversity. The protected areas are: Triglav National Park, The Škocjan Caves Regional Park, Kozjanski park and 40 land parks covering 7.4 % of the total Slovenian surface [10].

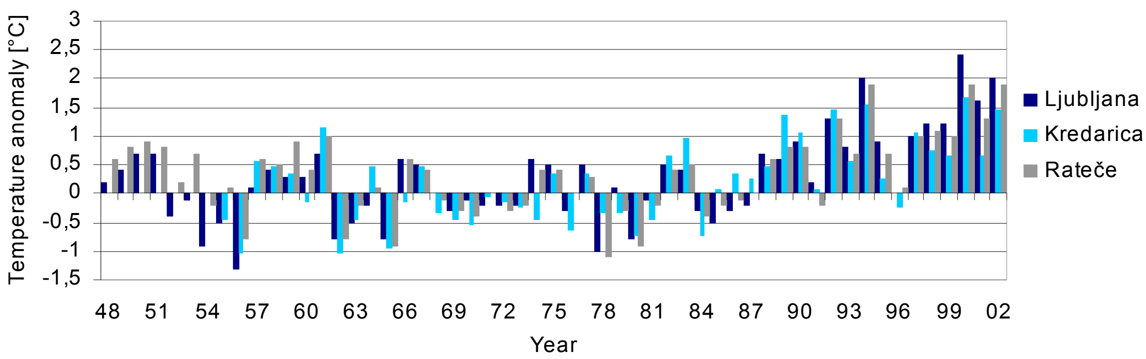
## 2.4 Climate Profile

Climate conditions are basically determined by a moderate geographic latitude and position in the eastern part of Alpine mountain ridge. Four seasons are well expressed. Diverse climate characteristics are noticeable on small distances. The coastal part is characterised by a submediterranean climate type, the mountains have all the characteristics of the Alpine climate and the flat parts of the eastern Slovenia are characterised by the continental climate component. The above mentioned climate types interact and create a wide range of local climate conditions together with local impacts.

### 2.4.1 Temperature

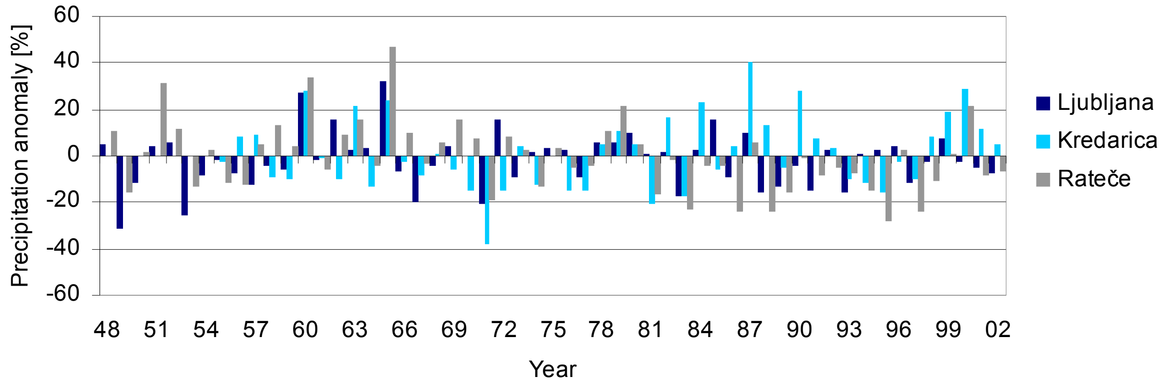
The coastal region is the warmest with the average annual temperature of 12.8 °C, the main part of the flat surface behind the Alpine-Dinaric barrier has the average annual temperature between 9 and 10 °C, only in larger towns such as Ljubljana and Maribor the average is a bit higher due to the heat island. Average temperature falls with altitude and distance from the sea. Kredarica, the highest positioned meteorological observatory in Slovenia, has the average annual temperature –1.3 °C. These averages are valid for the 1971–2000 period. Summers are warm in the flat parts, sometimes even sultry. Winters are mild in the coastal parts and quite cold elsewhere, in mountains due to their heights and in flat parts due to their frequent temperature inversions. In the flat parts the coldest month is January, high in the mountains it is February. In the flat parts July is the warmest. The biggest differences between maximum and minimum temperatures are in northeastern Slovenia with the strongest continental impact. In the coastal region the temperature amplitude is smaller due to the influence of the sea. [2].

Average annual air temperature increase in the last 50 years in Slovenia (1.1 ± 0.6 ° C) is statistically significant ($p < 0.05$). The temperature has increased the most in the urban settlements (Maribor 1.7 ± 0.6 °C, Ljubljana 1.4 ± 0.6 °C), where increasing heat island contributed to the positive trend, while it increased less in rural areas (Kočevje and Rateče 0.8 ± 0.6 ° C, Postojna 0.7 ± 0.6 °C). Major increase of air temperature is notable in higher positioned stations as well, where the urbanization impact is insignificant. For instance, Kredarica (2514 m) experienced a 1.2 ± 0.6 °C increase in the annual air temperat-




Source:ARSO

Figure 2-2: Mean annual temperature anomaly from 1961–1990 average, for the period 1948–2002




Source:ARSO

Figure 2-3: Average annual precipitation anomaly from the 1961–1990 average for the period 1948–2002

ure in the last 47 years. Particularly intensive air temperature increase took place after 1980 (Figure 2-2). Warming up is most obvious during the winter and springtime [6]. The summer of 2003 was extremely hot and such a hot summer would not be expected according to the usual temperature variability, June and August were exceptional, while in a lot of places the highest monthly air temperature ever was recorded.

### 2.4.2 Precipitation

Precipitation distribution in Slovenia reveals a major spatial and temporal diversity, which is a consequence of the impact of geographic position of Slovenia its surface diversity and characteristics of individual climate types. The annual precipitation maximum belongs to the northwestern part in the Julian Alps with more than 3000 mm of precipitation annually, second maximum, a bit lower is in Kamnik-Savinja Alps, and the third one on Pohorje. The coastal parts usually do not get more than 1000 mm of precipitation, while this quantity increases up to the top of the Alpine Dinaric barrier and then it starts decreasing with the distance from the sea. The northeast usually gets less than 800 mm of precipitation annually. The least precipitation falls in the first two months of the year. Areas under the greater sea influence get more rainfall in the autumn; the wettest months are November and October. In Ljubljana basin June is the wettest month and the second is October. In the northeastern part of the country with predominantly continental climate type the precipitation maximum takes place in summer.

In the coastal area precipitation are declining, similar trend is in the upper Sava valley, in Soča valley a slight repeated increase is notable, while on Kredarica the period with less precipitation took place in the second half of the 60's and at the beginning of the 70's (Figure 2-3). Precipitation in Prekmurje does not show a relevant trend. Trends of annual precipitation-for most of the Slovenian areas are not statistically significant.

Slovenia belongs to the areas with the highest number of storms in the European context. Every year there are few heavy storms with more than 100 mm rainfall in an hour. In Soča valley extreme daily precipitation can exceed 400 mm. The share of intensive rainfall in Slovenia is on increase or remains unchanged, although most of the changes are not statistically significant; mainly cyclic changes are present. Draughts represent another extreme. Longer dry periods appear at the end of winter and in spring, while summer draughts cause much more problems due to faster evaporation. The worst summer draughts so far took place in 2003 and 2001, and they harmed agriculture significantly and in some parts even threatened the drinking water sources. Summer draughts in 2000, 1993 and 1992 had catastrophic consequences while in coastal areas drought appears almost every summer.

### 2.4.3 Duration of the Sun Radiation

All over Slovenia an increase in the sunny weather was noticed in the last 20 years. The increase of sunny weather in Ljubljana is additionally connected to the decrease of fog frequency due to the urbanisation, change of land use and decrease of the nearby moor humidity and improvement of the air quality in the last decades. [2].

## 2.5 Economic Profile

In the late 1990's Slovenian economy faced variety of shocks caused by the transformation of political and economic systems. The crisis was intensified by the loss of former Yugoslav markets. All this resulted in fall of GDP, fall in the employment rate and investments and high inflation rate. As early as 1993 the Slovenian economy began to revive, on average exceeding an annual growth rate of 4 % between 1993 and 2000. Due to the world crisis in 2001 and 2002 the annual growth rate fell to 2.9 %. In 2002 GDP came to 5,275,827 million SIT (23,321 million EUR) or 2,648 million SIT (11,690 EUR) per capita.

In 2002, added value shares (in current prices) of different sectors were the following: service sector 61.8 %, industry (mining industry, electricity, gas and water maintenance) 29.6 %, construction 5.6 % and agriculture, fishery and forestry 3.0 %. Since 1995 the share of service sector has increased by 3.9 % and the share of construction by 0.6 %. Shares of other sectors decreased [19].

The small size of the domestic market has forced the Slovenian economy to become firmly embedded in international economic flows. Slovenian export of services and products accounted for 57.9 % of GDP in 2002, which is the same as the year before. Import accounted for 56.5 % of GDP (in 2001 58.5 % of GDP) [19]. European Union is the most important Slovenian trading partner. Total Slovenian export to EU accounts for 59.5 % and total import for 67.9 %. The most important Slovenian trading partners among the EU countries in the 2001 were: Germany, Italy, France and Austria, and were followed by former Yugoslavia countries with 17.8 % of Slovenian exports and 5.0 % of imports [17].

Table 2-1 illustrates basic indicators of economic development in the period 1995–2002.

Table 2-1: Basic indicators of economic development in the period 1995–2002

| Year | GDP in current prices [$10^9$ SIT] | GDP in current prices [$10^9$ EUR] | Annual growth rate [%] | GDP / capita in current prices [EUR] | Inflation (year average) [%] | Added value by Sector in current prices [%] Agriculture | Added value by Sector in current prices [%] Industry and Construction | Added value by Sector in current prices [%] Services | Share of exports in GDP [%] | Foreign debt as share of GDP [%] |
|---|---|---|---|---|---|---|---|---|---|---|
| 1995 | 2221.5 | 14.5 | 4.1 | 7696 | 12.6 | 4.5 | 37.6 | 57.9 | 55.2 | 15.8 |
| 1996 | 2555.4 | 15.1 | 3.5 | 7994 | 9.7 | 4.4 | 37.6 | 58.1 | 55.6 | 21.1 |
| 1997 | 2907.3 | 16.1 | 4.6 | 8552 | 9.1 | 4.2 | 37.4 | 58.4 | 57.4 | 22.6 |
| 1998 | 3253.8 | 17.5 | 3.8 | 9267 | 7.9 | 4.1 | 37.6 | 58.3 | 56.6 | 25.1 |
| 1999 | 3648.4 | 18.8 | 5.2 | 9997 | 6.1 | 3.6 | 37.4 | 58.9 | 52.5 | 26.9 |
| 2000 | 4222.4 | 20.6 | 4.6 | 10.352 | 8.9 | 3.4 | 36.1 | 60.4 | 56.5 | 32.8 |
| 2001 | 4741.0 | 21.8 | 2.9 | 10.957 | 8.4 | 3.2 | 36.0 | 60.8 | 57.9 | 34.4 |
| 2002 | 5275.8 | 23.3 | 2.9 | 11.690 | 7.5 | 3.0 | 35.2 | 61.8 | 57.9 | 40.1 |

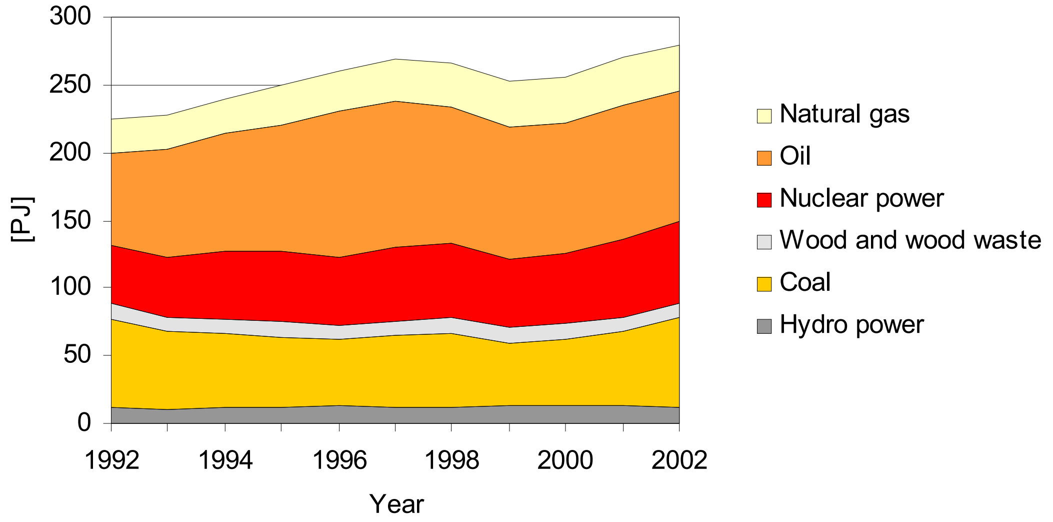
Source: SURS, UMAR. Development report 2003)

## 2.6 Energy

Slovenia is one of the energy intensive countries, yet conditions are improving. In 2002 Slovenia needed 337 toe (tonnes of oil equivalent) of primary energy for one million Euro of GDP (in fixed currency EUR 1995). That is 74 % more energy than EU in 2001 (194 toe of primary energy per million Euro$_{1995}$). Between 1995 and 2000 the energy intensity in Slovenia declined by 16.1 %, in 2001 it increased by 1 % and in 2002 it decreased by 0.6 %. The increase of energy intensity in 2001 and a slight decrease in 2002 happened due to the substitution of low production in hydro power plants with higher primary use of coal and due to the expansion of energy intensive sectors [12]. Energy efficiency grew from 64.9 % in 1995 to 70.2 % in 2000 [4].

Primary energy consumption was 269.5 PJ in 2002. The largest share goes to liquid fuels with 35.6 %, followed by nuclear energy (22.4 %), solid fuels (24.4 %), natural gas (12.7 %) and renewable sources (8.6 %) where hydro energy contributes 4.4 % and wood with wood residues (wood biomass) 4.2 %. In the last four years crude oil and petroleum derivatives consumption in primary energy slightly decreased, while the consumption of nuclear energy and solid fuels increased. The consumption of natural gas was on increase up to 2001, but than decreased in 2002 (the same happened with hydroenergy). Up to 2001 wood consumption was constant, but increased a bit in 2002. The average annual increase of primary energy consumption between 1992–2001 accounted for 2.2 % (Figure 2-4) [3].

The only fossil fuel available in Slovenia is coal (brown coal and lignite). The mining of brown coal is likely to stop in 2007, and the lignite will be intended only for Thermal power plant Šoštanj. Liquid fuels and natural gas are completely imported. The total petroleum derivatives consumption in 1992 was 1.8 million of tones and in 2001 it was 2.3 million of tones.




Source: MOPE. RS Energy balance for the year 2003

Figure 2-4: Primary energy consumption, by fuel in the period 1992–2002

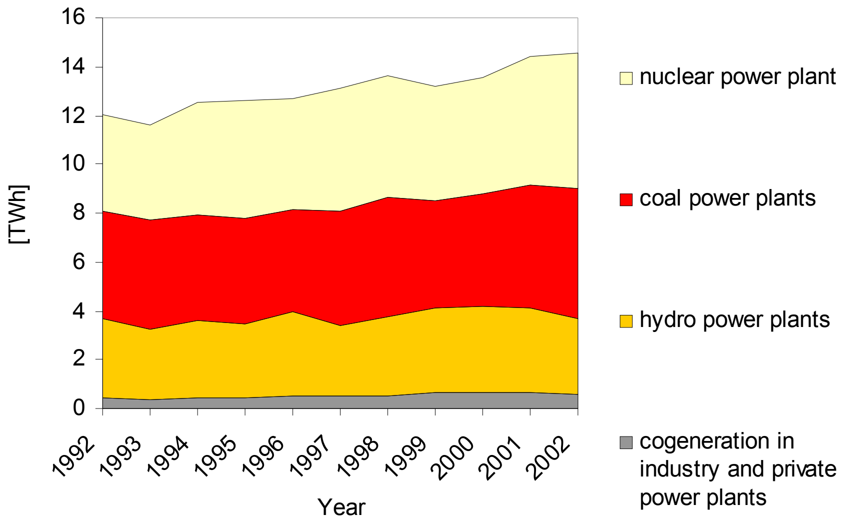
Table 2-2: Primary energy consumption and use of final energy by source and by sector in 1992 and in the period 1995–2002

| Year | Primary energy use [PJ] | Use of final energy | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Total [PJ] | By source [%] | | | | | By sector use [%] | | |
| | | | Electricity | Solid fuels | Liquid fuels | Gas fuels | District heating | Industry | Trans-port | Other use |
| 1992 | 218.01 | 150.40 | 21.2% | 12.8% | 45.4% | 15.0% | 5.3% | 36.8% | 24.4% | 38.8% |
| 1995 | 244.91 | 173.27 | 19.8% | 9.5% | 52.4% | 13.5% | 4.6% | 32.5% | 31.7% | 35.8% |
| 1996 | 254.37 | 189.15 | 18.3% | 8.6% | 54.8% | 13.5% | 4.5% | 29.0% | 32.5% | 38.4% |
| 1997 | 263.66 | 189.93 | 18.9% | 8.1% | 54.2% | 14.3% | 4.3% | 28.1% | 34.1% | 37.8% |
| 1998 | 259.62 | 182.19 | 20.2% | 8.5% | 51.1% | 15.5% | 4.5% | 28.9% | 31.3% | 39.8% |
| 1999 | 248.96 | 182.48 | 20.6% | 8.4% | 50.7% | 15.6% | 4.4% | 28.4% | 29.8% | 41.8% |
| 2000 | 251.82 | 181.00 | 21.3% | 8.2% | 50.6% | 15.5% | 4.0% | 29.0% | 31.3% | 39.7% |
| 2001 | 264.02 | 183.70 | 21.7% | 8.2% | 50.0% | 15.4% | 4.4% | 28.2% | 31.5% | 40.3% |
| 2002 | 269.48 | 183.91 | 42.03% | 15.77% | 90.61% | 27.76% | 7.73% | 28.8% | 31.7% | 39.5% |

Source: MOPE. Energy balance of Republic of Slovenia for the year 2003

Consumption of final energy amounted to 183.9 PJ in 2002, which is 22.3 % more than in 1992. Liquid fuels had the biggest share, followed by electricity, gas fuels, solid fuels and district heating. The peak in final energy consumption was in the 1996–1997 period. After 1998 liquid fuels consumption decreased, electricity consumption increased, while the gas fuel consumption, solid fuels and district heating did not change. Consumption in final energy increased in transport and other consumption, but decreased in industry sector. (Table 2-2) [3].

In 2002, 37.9 % of electricity was produced by nuclear power plant Krško (NEK), 36.6 % by thermal power plants, 20.9 % by hydro power plants and 4.1 % by industry cogeneration and by private hydro power




Source: MOPE. SLEG 2001

Figure 2-5: Structure of the electricity production in the period 1992–2002 plants (Figure 2-5). Electricity production increased approximately by 20.8 % in the 1992–2002 period. Slovenia is a net exporter of electricity. In 2002 the net export accounted for 1250 GWh. There was 1434 GWh imported and 2684 GWh of exported electricity [18].

By introducing Energy Law in 1999, harmonised with EU directives and European Energy Charter, the Slovenian liberalization process of electricity and natural gas markets began. At the beginning of 2003 electricity market was opened for all installations with a minimum threshold of 41 kW (approximately 8000 installations with 65 % market share). Natural gas market has been opened for all the consumers with a minimum sale of 25 million $m^3$ per year. Slovenia adopted the new directives on EU internal market rules (2003/54/EC in 2003/55/EC) into its legal order by changing its Energy Law in 2004 that will bring a market opening for all energy consumers except households from 1st July 2004 and a 100 % market opening from 1st July 2007. The change of the law enables a regulated access to the third party also for gas networks. Price for the network use is regulated by independent regulator (Energy Agency of the Republic of Slovenia), the government is regulating prices for tariff consumers of electricity and natural gas (using a model of forming a price of natural gas from a transmission network, which enables adaptation to global market price flows). In other markets (liquid fuels, district heat) the state administrative price control is gradually decreasing (use of models for determining the highest prices of petroleum derivatives, which enables control of motor gas prices with the crude oil price and the US dollar rate, while a similar model is used for district heating.

## 2.7 Transport

Due to the life standard improvement, lifestyle change and the development of road network, Slovenian level of population motorization has gradually increased in the last decade (Table 3-3). In the period 1990–2001 the number of registered cars per 1,000 people increased from 289 to 432 [17]. The share of more powerful motor vehicles and diesel vehicles increased by 1 %. In 1999, the average car age was 6.8 years and the share of vehicles with catalyst accounted for 60 % [13]. Public passenger transport has decreased from 6440 down to 1470 million passenger kilometres in the 1990–2001 period due to low prices of motor fuels, low parking costs and undeveloped public transport (transport by private buses and taxis is not included). The decrease in railway passenger transport is lower, from 1429 million passenger kilometres in 1990 down to 815 in 1991, and 547 in 1992. From 1992 the railway passenger transport is on increase and reached the figure of 715 million passenger kilometres in 2001 (Figure 2-6; left).

Total volume of freight transport decreased significantly in 1990–1993 period, positive trend is noted after the year 1996. The volume of railway freight transport in 1990–1993 period decreased from 4209 to 2262 million tkm. The increase followed and remained steady after 1997, and another increase in 2002 accounted for 3078 million tkm. Road public cargo transport was on decrease until 1996, when the trend switched. In 2001 it was 2276 million tkm (transport of individual transporters and for the internal use of organisations is not included). Traffic rides for internal use of organisations have decreased after 1990 as well, and have increased after 1996 e.g. in 2001 5.8-times more tkm were made than in 1996. (Figure 3-6; right) [17]. In addition to domestic transport, transit transport through Slovenia forms a substantial share of total transport, given that Slovenia is the crossroads of important European transport routes. Transit transport through Slovenia accounts for 36 % of all GHG emissions from heavy freight vehicles [1]. In future we can expect a further growth in transit

Table 2-3: The registered motor vehicles figures in years 1990 and 1995–2001

| Year | 1990 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 |
|---|---|---|---|---|---|---|---|---|
| Motorcycles | 15,842 | 8,430 | 8,022 | 8,342 | 9,213 | 9,978 | 11,308 | 11,723 |
| Motorcars | 578,268 | 698,211 | 727,554 | 764,788 | 797,855 | 829,674 | 847,941 | 862,648 |
| Buses | 3,077 | 2,467 | 2,408 | 2,372 | 2,327 | 2,319 | 2,257 | 2,212 |
| Freight vehicles | 30,767 | 37,739 | 40,239 | 42,520 | 44,060 | 46,162 | 48,548 | 50,409 |
| Other vehicles[1] | 17,513 | 17,187 | 17,302 | 17,586 | 18,715 | 20,665 | 22,968 | 23,557 |
| Total[2] | 684,911 | 814,513 | 801,191 | 894,166 | 933,796 | 974,169 | 1,001,963 | 1,023,012 |

Source: SURS

[1] Number of registered special cargo vehicles, special vehicles and combined vehicles

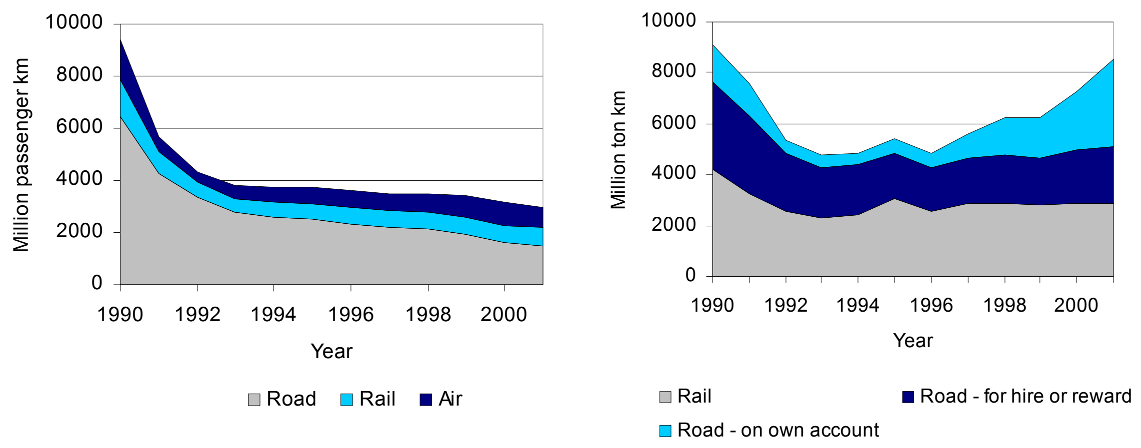
[2] The total number of registered motor vehicles takes also a number of registered agriculture tractors into account, therefore the number under Total is not the same as the sum of categories below it

transport, as a result of the stabilisation of conditions in the Balkans and completion of the Slovenian highway network, thus it is necessary to divert as much transit transport as possible to the railway.

Fuel consumption increased by 2.1 % in 2001 compared to 2000. Motor petrol consumption increased by 0.5 % and diesel fuel consumption by 4.9 % [13]. In 2000–2002 period, the trend of higher average speed is noted, especially on highways (AC) and motorways (HC), for all types of vehicles, with mid-weight freight vehicles as an exception. The biggest rise in speed happened due to the personal cars [7].

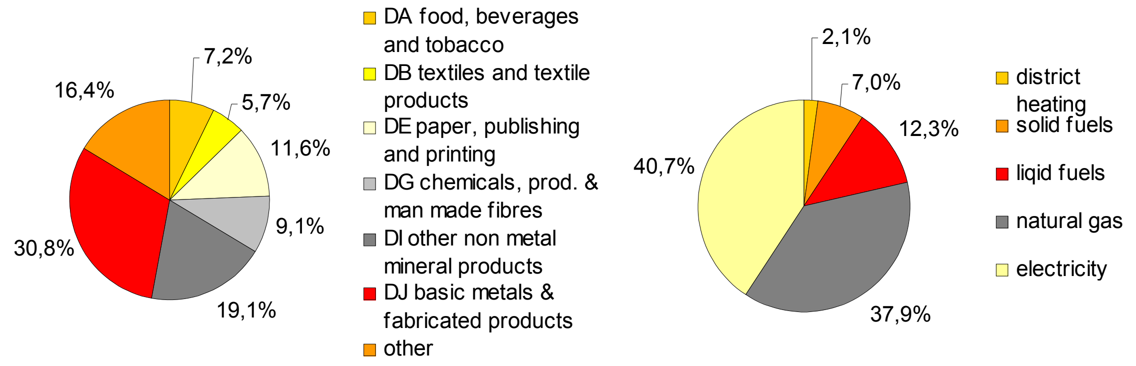
## 2.8 Industry

Slovenia is one of the most successful countries in transition. In the first stage of the transition Slovenian economy had to adapt to new markets and to new owner relationships. During this transition process, unprofitable manufactures were abolished, while other manufactures, especially industrial, were subscript to pres-




Source: SURS

Figure 2-6: The development of the public passenger transport (left) and freight transport (right) in the 1990–2001 period




Source: MOPE. SLEG 2001

Figure 2-7: Shares of final energy consumption in manufacturing sectors by type (left) and by energy source (right) in 2001

sures to increase the productivity, caused by extension to the demanding European market. Between1993–2001 industry production volume increased by 24 %, while the productivity increased by 68 %. The greatest increase in production was due to the electricity production, the optical equipment, and the production of chemicals, chemical products and artificial fibres. The greatest decrease in production volume was in leather industry, wood manufacturing and pulp industry. Due to the closing of mines and the abolishment of production in Lendava refinery, in 2001 the volume of coke production, petroleum derivatives and nuclear fuel accounted for just 8.9 % of 1993 production. The share of manufacturing sectors in added value in current prices is decreasing. In 1995 this share accounted for 28.3 % and in 2001 it was 26.5 % [17].

The most important industrial branches in Slovenia are production of metal and metal products, production of non-metal mineral products, food and beverage production and fibre and pulp production. Production of metal and metal products accounts for one-third of all final energy consumption, used in production sectors, where the greatest share goes to aluminium production (in 2001 approximately 1/10 of all electricity consumption in Slovenia). Electricity (40.7 %) and natural gas (37.9 %) have the largest share in energy consumption of production branches [18].

## 2.9 Waste

The waste related legislation was modernised in the recent years. But the legislation has not yet been implemented satisfactorily mostly due to prolonged compliance periods. The basic regulation is Rule on waste management from 1998 with several additional rules, decrees and instructions for separate waste collection, waste disposal, packaging waste management etc.

In 2001 1.7 million t of waste was produced, within which hazardous waste account for 58,000 t. Municipal waste from households accounted for 550,000 t, and waste similar to municipal from industry, handy-crafts and service sector accounted for 290,000 t. Total quantity of municipal and similar waste accounted for 430 kg per capita [13]. Due to the Decree on handling with separately collected fractions of waste from 2001, the data collection method has changed. As a consequence, the data from 1995 and 1998 are not comparable to the data from 2001. In 1998, 1.29 million t of waste was disposed on the landfills, of which municipal waste accounted for 1.06 million t. According to 1995, annual quantity of waste disposed on landfills increased by 12 %. The hazardous waste quantity increased by 17 % [17]. Total quantity of package waste accounted for 170,000 t in 1998, of which 100,000 t came from households (municipal waste) and 70.000 t from non-municipal waste. The share of pulp was 44 %, plastics 15 %, glass 14 %, wood 14 %, metal 7 % and of other materials 6 %. The share of recycled packages accounted for 29 %. In 2001 separate collection of waste was performed by 70 % of waste management companies [13].

Landfilling is a predominant form of residual (after separate collection) waste disposal in Slovenia. According to the waste disposal tax records, 951,000 t of municipal, inert and other non-hazardous waste was disposed to municipal landfills in 2000. In Slovenia 51 landfills of municipal waste are active, among them 27 are representing different types of risk. Implemented legislation predicts closing of 21 landfills by the end of 2003, and 13 more by 2008.

Systems for using landfill gas are installed on three largest landfills: Ljubljana–Barje, Maribor–Pobrežje and Celje–Bukovžlak. Due to high costs of remediation, adaptation or extension of landfills municipalities are building common regional centres for municipal waste management. There are no municipal waste incinerators in Slovenia, but there are five devices for co–incineration and two waste incinerators in which waste chemicals, agro-chemical waste, medical waste, waste oils, waste from oil traps, mud from technological waste water treatment plants, some waste from the health and veterinary service, waste colours, varnishes, solvents and waste package are burnt. 15,997 tons of hazardous waste and 15,739 tons of non-hazardous waste were burnt in 2001.

## 2.10 Building Stock and Urban Structure

There were 5712 settlements with 10 or more inhabitants in Slovenia according to the 2002 census by the existing administration spatial division, 16 settlements had more than 10,000 inhabitants. 17.9 % of all the inhabitants in Slovenia lived in Ljubljana and Maribor, two largest settlements, which is 1 % less than in 1991. In the period 1991–2002 the number of inhabitants increased especially in the settlements with 500–5000 inhabitants (by 1.6 %) as well as in small settlements (up to 500 inhabitants), in which more than a third of inhabitants of Slovenia live (34.4 %) [11].

In the 1991–2002 period a number of apartments increased by 13.9 % (94,635). Most of the apartment buildings were built in 1971–1980, i.e. 23.8 %, 17.1 % in 1961–1970 and 16.4 % in 1981–1990 [17].

Individual houses prevail among the apartment buildings. They account for 60 % of the total apartment surface and present a 66 % share in the required useful heat for heating [1]. In the last years a noticeable trend of increasing average apartment surface which increased from 73 $m^2$ in 1991 to 74.6 $m^2$ in 2002. The average surface of apartments, built in 1991–2002 period accounted for 93.6 $m^2$ [17]. Average energy number[1] of family houses was 156 kWh/$m^2$ and 108 kWh/$m^2$ for apartments in blocks of flats. For sanitary water warming and heating liquid fuels were mainly used (50 %), followed by wood (18 %), district heating (12 %) and natural gas (10 %) [1].

## 2.11 Agriculture and Forestry

Agricultural land in use, excluding overgrowing agricultural land and unutilised land, accounts for 505,734 ha. 61 % of

1 Annual energy consumption per unit of heated ground-plan surface of the building.

Slovenia's agricultural land consists of pastures and grassland, 33 % of fields and gardens, 3 % of vineyards and 2.6 % of orchards. Agriculture share in added value in 2002 accounts for 3.0 %, that is 1.5 % less than in 1995 [17]. 6 % of the active population is employed in agriculture. In 2000 96,669 family farms and 132 company farms were registered. More than 90 % of all land is owned by family farms, less than 6 % of the land is owned by company farms. The average size of agriculture land accounts for 4.8 ha (family farms) and 220.7 ha (company farms) [16].

The dominant Slovenian agricultural branch is stock breeding, which accounts for more than two-thirds of the structure of the total agriculture production. Cattle breeding has the largest share in stock breeding, and is followed by poultry-farming and breeding of pigs. In the period 1995–2002 the number of cattle decreased by 4.5 % and the number of pigs increased by 10.7 %. In 2002 production per capita totals 79.1 kg of meat and 354 l of milk, that is 6.4 % less and 19.3 % more than in 1995. In the total agriculture structure production farming accounts for 14 %. The share of fodder plants in sowing structure accounts for 28 %. In 2002 production totals 371.4 kt of corn and 174.9 kt of wheat, that results as 25.3 % and 12.4 % less than in 1995. 93 % of grassland are pastures [17]. The grassland surface has been on decrease in the last decade due to the fast over growth of not used grassland.

In 2002 177,000 tons of mineral fertilisers were used in Slovenia, which makes 407 kg/ha of agricultural ground in use. Consumption of the three most relevant macro-nutrients (NPK), that is nitrogen, phosphorus and potassium accounted for 70,000 tons, mainly nitrogen (47.8 %), potassium (29.7 %) and phosphorus (22.6 %). The used quantity of NPK fertilisers per unit of agricultural land was on increase in the period 1995–1998, and was decreasing until 2000. After 2000 the use of mineral fertilisers slightly increased again. In 2002 it was higher by 18.2 % than in 1990 [17]. Consumption of mineral fertilisers per hectare of agricultural land in use is almost three times lower on family farms than in agricultural companies [14].

Number of farms included in the control of the ecological farms increased by 30 times in the 1998–2002 period. In 2002 there were 1150 of such farms, which represents 1.3 % of all farms. Ecological farmers cultivated 3.4 % of all the agricultural land. Among them grasslands with 93 % are the most common since the cattle breeding prevails. Increased interest in ecological farming takes place in highlands and among smaller and medium sized family farms [9].

In 2001 forest was covering 56.5 % of the surface of Slovenia. Share of the protected forest and reserves in the total forest surface accounts for 6.4 %. Since 1990 the coverage of Slovenia with forests has increased by 2 %. Annual increase of wood mass accounts for 6.06 $m^3$/ha, i.e. 2.73 $m^3$/ha of annual increase of conifers and 3.33 $m^3$/ha of hardwoods. Wood stock accounted for 234 $m^3$/ha in 2001 and increased by 21 % since 1990. Shares of conifers and hardwoods in wood stocks are basically equal, i.e. 48.1 % and 51.9 % [17]. 68 % of the total forest area is private-owned, 31 % state-owned, while a small share is owned by legal entities (local communities or other organisations). Since the process of denationalization still lasts, the ownership over the forests will keep changing. Increase in the share of the private owned forests is expected up to 80 % of the total forest area. The surface of private forests is very dispersed as forest properties of private owners are mostly divided into several separated parcels. The size of an average forest property accounts for less than 3 ha. Larger forest properties are located in highlands [5].

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# 3. GREENHOUSE GAS INVENTORY INFORMATION

This chapter presents emission inventories of greenhouse gases (GHGs) $CO_2$, $CH_4$, $N_2O$, halogenated hydrocarbons (HFC, PFC and $SF_6$) and indirect greenhouse gases $SO_2$, $NO_x$, CO and NMVOC. Gases like $CO_2$, $CH_4$ and $N_2O$ are natural atmosphere compounds while the presence of halogenated hydrocarbons in atmosphere is exclusively the consequence of human activities. GHGs cause temperature change on the Earth surface through changing the energy balance of the Earth. Indirect GHGs do not have direct impact on the temperature rise, but they do take part in photochemical processes of tropospheric ozone production, which is a GHG. Sulphur dioxide, which is also a part of the indirect GHG group, has a negative greenhouse effect. Inventories were prepared for 1986, which is a base year for Slovenia, and for 1990–2002 period. This chapter includes a short presentation of the emissions alteration only, while more detailed inventory tables are presented in the Annex B.

## 3.1 Methodology of Preparation of the Emissions Inventories

Inventories of GHG emissions were presented on the basis of the IPCC (IPCC 1997) methodology for all the gases and sectors, except in few cases where they were presented separately. Some emission sources that were registered and assessed were not a part of the IPCC methodology. Due to the importance of the source and accessible data different approaches were used (Tier) within the IPCC methodology. National emission factors were used for assessment of emissions from domestic coal (Tier 2), while for other fuels mainly default IPCC emission factors were used.

Quantity of fuels and used fuel energy values were taken from energy annual registries, prepared by MOPE, based on the data of the statistical office of the Republic of Slovenia. Additional data on the energy use of some sorts of waste (waste tyres, oils and solvents) were acquired. Data on the fuel consumption in agriculture and forestry refer to mobile sources only, while the rest of the fuel consumption of those sub-sectors is included into the public and service sub-sector. Default IPCC emission factors and shares of oxidation were used for the energy consumption of liquid fossil fuels. Due to the greater share of methane in natural gas used in Slovenia, the appropriate, a bit lower $CO_2$ emission factor than the default was used for the whole period. $CH_4$ and $N_2O$ emissions in the road motor traffic were determined according to a more specific methodology and CORINAIR emission factors. From the possible emissions for diesel vehicles we subtracted carbon which was included in emitted solid particles, while for oil vehicles we anticipated a 100 % fuel oxidation. For the $CO_2$ fugitive emissions in the energy sector those emissions were used, that were released by desulphurisation of flue gases in thermal power plants and were estimated on the basis of the data on calcium carbonate consumption. $CO_2$ emissions in post-mining activities were not assessed due to lack of data on desorption. They seem to be greater than the ones that are released directly at the excavation of coal. The emission factors of $CH_4$ fugitive emissions in mining activities were determined on the basis of methane concentration measures in ventilating shafts of mines and assessments of released methane quantities. Determined in this way, the emission factor has a lower value than the default IPCC value. Regional default IPCC emission factor for transmission and distribution of natural gas does not correspond to the conditions in Slovenia, that is why the data of the company that manages the mobile network were used for assessing the $CH_4$ emissions for the natural gas transmission. Distribution losses were assessed according to the length of individual sorts of gas pipelines by the type of the pipe and by using specific losses per length unit as they were noted in the German Communication to the Conference of the Parties, which is logical according to the maintenance level and a short average age of gas pipeline network.

Emissions from industrial processes were determined mainly on the basis of statistical data on production and consumption of raw materials and by using the prescribed emission factors. After 1997 the Statistical Office of RS partly changed the methodology of collecting and presenting those data that is why some data were acquired from companies. The consumption of anode and other reductants were taken into account for the production of metals. Therefore also consumption of coke was included into the steel and iron production since 1997, while for ferrous alloys production the consumption of coke and petrol coke were used. Emissions from primary aluminium production were estimated from anode consumption and from PFC emissions, which were determined on the basis of the number and duration of anode effects. When determining the actual emissions caused by the use of HFCs, data were acquired by companies that use those materials as well as data on the export and import of refrigerators. For $SF_6$ emissions release of this gas from sound-insulating windows and switching devices in energy sector were assessed.

NMVOC emissions from solvents use were assessed primarily on the basis of the CORINAIR methodology. In accordance with the principle on intentional double counting, NMVOC emissions of fossil origin were assigned corresponding $CO_2$ emissions, since those substances are transformed into it after few months in the atmosphere.

In agriculture the emissions of methane were determined particularly in detail due to the enteric fermentation with cattle, and the Tier 2 approach was upgraded by dividing the cattle into 18 categories according to the intensity of breeding. For the emissions from manure handling Tier 2 approach was used for pig and cattle breeding. Tier 1 approach was used for breeding of other animals that represent a smaller share in methane emissions. For $N_2O$ emissions from manure handling and for indirect emissions from fertilisation with animal fertilisers those input data were used that were acquired when methane emissions were assessed. For $N_2O$ emissions the default IPCC factors were used, which determine nitrogen transformation into $N_2O$.

Methane emissions from solid waste management were determined by using the default IPCC methodology, which does not take into account the time dynamics of methane release. The emissions of $N_2O$ from waste water were determined according to the use of proteins in human nutrition, which according to the assessments of the studied period did not change.

## 3.2 Main Changes in Inventories From the Previous Communication

When assessing GHG emissions we corrected few smaller calculation errors in all sectors as they became obvious especially with gases with significant global warming potential (GWP).

### 3.2.1 Energy

In regard to the previous Communication, national emission factors based on actual content of carbon in domestic coal were used for domestic coal consumption instead of default IPCC emission factors. Recalculation of emissions was carried out in all sectors of domestic coal consumption for the whole period 1986 and 1990–2002. That is how the method of calculating the emissions was improved from the current level Tier 1 to the level Tier 2. The change took place in the Fuel Consumption in Coal Mining sector in which the existing emission factor was replaced with the newly calculated. In the Fuel Consumption in the Oil Industry sector a non-energy use of natural gas was reassessed and the share of carbon maintained in products was corrected. The base year emissions were added a reported self-use of natural gas which was not included into any of the consumption segments so far. Since 1996 inventories do not take into account the total consumption of natural gas for non-energy needs (methanol production). It was improper not to consider this segment in the Fuel Consumption in the Chemical Industry sector. For 1999 the net calorific value of natural gas in manufacturing was corrected and harmonised with other consumption sectors.

### 3.2.2 Industrial Processes

$CO_2$ emissions were added to the iron and steel production due to the limestone consumption, which were not considered in the base year. At the same time more detailed methodology was used for the calculation which takes into account also the differences in the content of carbon in raw materials in products. The production data on fuel consumption as a reduction means were improved for the ferrous alloys. In the previous inventories we did not consider the coke and petrol coke consumption for these purposes, and at the same time the consumption of chopped wood (wood) that must not be taken into account in $CO_2$ emission inventories as a biomass. Emissions caused by production and consumption of carbides were assessed more specifically by considering the carbide import and export data acquired by the Statistical Office of RS. At the same time the data on production were replaced by more detailed data acquired by the TDR Company which is the only producer of calcium carbide in RS.

### 3.2.3 Solvent and Other Product Use

The assessed values on solvent consumption in 1999 were replaced by data of the Statistical Office of RS.

### 3.2.4 Waste

The differences between the values in inventories and in the Action Plan for Reducing GHG Emissions were caused by the fact that methane emissions from solid waste were calculated by a more specific methodology in the Action Plan than in the inventories. In the next year we will improve our methods in inventories and harmonise the emissions with those that were used for the Action Plan.

### 3.2.5 Agriculture

In 2003 the Statistical Office of RS published new, more specific values on the number of livestock and plant cultivation in Slovenia since 1991. The agriculture emissions were therefore reassessed for the 1991–2002 period.

## 3.3 Emissions of $CO_2$

$CO_2$ is the most significant GHG since it represented 80.2 % of all the GHG emissions in 2002 (Table 3-5) with 16.35 Tg of emissions. Within the Energy sector in which 94.6 % of all the $CO_2$ were produced, the main share of emissions comes from fuel combustion. The major part of emissions from fuel combustion in 2002 was represented by Energy Supply with 39.2 % of all the $CO_2$ emissions, Transport with 23.2 %, Other Sectors which includes emissions from household, services and commercial sector, and agriculture with 17.3 %, and Manufacturing Industries and Construction with 14.6 %. Those are followed by emissions from the Industrial Processes, which accounted for 838.7 Gg or 5.1 % of all $CO_2$ emissions in 2002 (Table 4-1). Emissions from the Energy sector determined by the reference approach were 0.8 % lower than the emissions determined by the sectoral approach.

Emissions from the Fuel combustion sub-sector which accounted for 15.42 Tg in 2002 can be divided by fuel. Solid fuels accounted for 6.90 Tg (44.8 %), liquid fuels 6.86 Tg (44.5 %), gas fuels 1.64 Tg (10.6 %) and other fuels 10.7 Gg (0.07 %).

An evident emission reduction at the beginning of the 90's is a consequence of economic shocks connected with a transition to a new social system and with the independence. The maximum emission level in 1997 is a consequence of a low price of motor fuel in Slovenia which caused a significant sale growth to the foreigners, while the maximum in 2002 is mainly a consequence of the increased production of electricity in thermo-power plants, of a lower production in hydro-power plants, and of increased electricity consumption. Total $CO_2$ emissions were 2.2 % higher in 2002 than in 1986 (Table 3-1 and Figure 3-1). In the Energy sector emissions increased by 3.6 %, especially due to increased emissions in the Transport sector caused by increased road traffic (in 2002 $CO_2$ emissions in the Transport sector were 1.83 Tg higher than in 1986). Increase in the Other Sectors also contributed to the emissions increase (emissions higher by 691 Gg), which is mainly a consequence of increased emissions in households (by 637 Gg). Emissions decreased especially in the Manufacturing Industries and Construction sub-sector, i.e. 1.74 Tg.

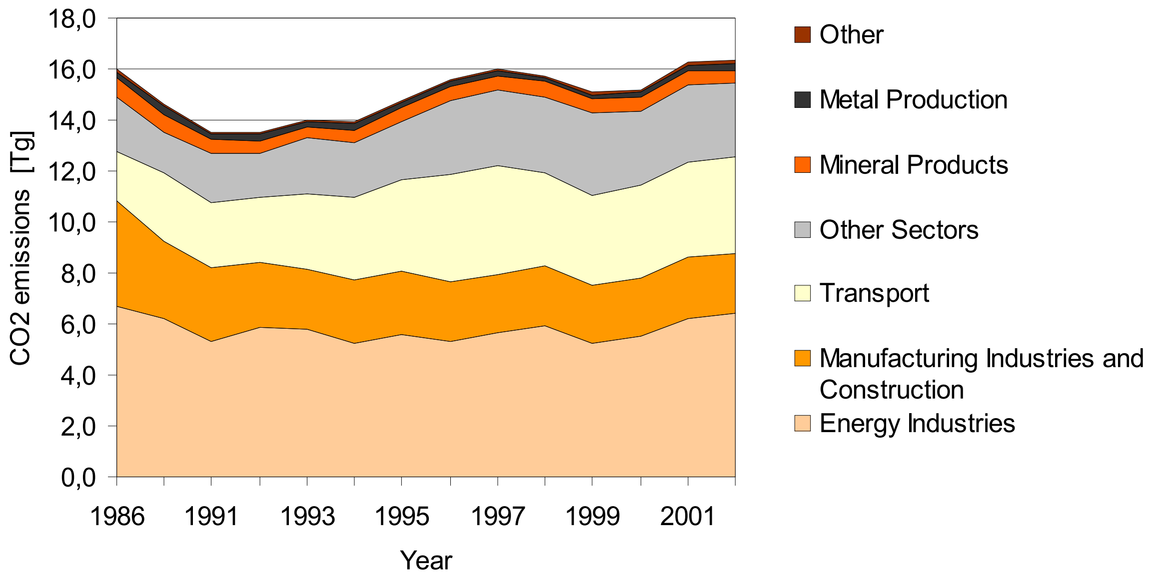
$CO_2$ sinks were accounted for 5.56 Tg in 2002. That was an 88.5 % increase according to 1986. Increase of sinks is mainly a consequence of increased wood stocks in the existing forests. In the future, sinks assessments presented above will be corrected due to the more detailed methodology presented in the Good Practice Guidance for Land Use, Land Use Change, and Forestry.

Table 3-1: Emissions of $CO_2$ in 2002 and comparison with emissions in the base year (1986)

| TYPE OF SOURCES AND SINKS OF $CO_2$ | 1986 [Gg] | 2002 [Gg] | 2002 [%] | 2002 / 1986 [%] |
|---|---|---|---|---|
| Total National Emissions and Removals | 13,494.68 | 10,787.75 | 66.0 | 82.7 |
| Total National Emissions without Removals | 15,997.73 | 16,349.17 | 100.0 | 102.2 |
| 1. Energy[1] | 14,929.89 | 15,473.75 | 94.6 | 103.6 |
| A. Fuel Combustion (Reference approach) | 15,038.38 | 15,289.39 | | |
| (Sectoral approach) | 14,929.89 | 15,415.65 | 94.3 | 103.3 |
| 1. Energy Supply | 6,700.55 | 6,401.83 | 39.2 | 95.5 |
| 2. Manufacturing Industries and Construction | 4,119.36 | 2,383.53 | 14.6 | 57.9 |
| 3. Transport | 1,970.94 | 3,799.98 | 23.2 | 192.8 |
| 4. Other Sectors | 2,139.04 | 2,830.30 | 17.3 | 132.3 |
| B. Fugitive Emissions | 0.00 | 58.11 | 0.4 | |
| 1. Solid fuels | 0.00 | 58.11 | 0.4 | |
| 2. Industrial Processes | 1,021.66 | 838.71 | 5.1 | 82.1 |
| A. Mineral products | 746.22 | 532.50 | 3.3 | 71.4 |
| B. Chemical industry | 56.86 | 54.66 | 0.3 | 96.1 |
| C. Metal production | 218.58 | 251.56 | 1.5 | 115.1 |
| 3. Solvent and other product use | 46.19 | 36.70 | 0.2 | 79.5 |
| 5. Land use change and Forestry | -2,950.39 | -5,561.42 | -34.0 | 188.5 |

Source: ARSO

[1] Numbering of sectors is consistent with the IPCC methodology.




Source: ARSO

Figure 3-1: Emissions of $CO_2$ in 1986 and 1990–2002.

## 3.4 Emissions of $CH_4$

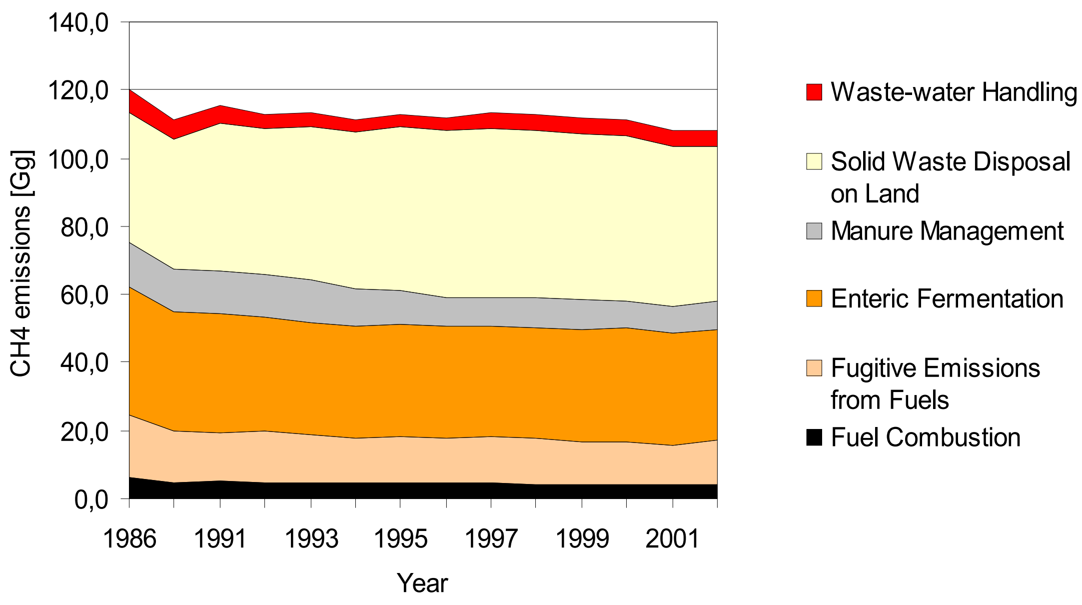
Methane emissions in 2002 accounted for 108.6 Gg (Table 3-2). The main methane emission sources were the Waste sector (46.6 % of all $CH_4$ emissions) and Agriculture (37.3 %). Within the Waste sector the solid waste disposal on landfills contributed most to the emissions (42.0 % of all the $CH_4$ emissions), in the Agriculture sector enteric fermentation (29.9 % of all $CH_4$ emissions) was the most important source of emissions.

Total methane emissions decreased by up to 9.8 % in 2002 compared to 1986 (Table 3-2 and Figure 3-2). The reduction of $CH_4$ emissions was mainly a consequence of the decrease of emissions in Agriculture sector (emissions in 2002 were lower by 211.6 Gg compared to 1986), which was the consequence of lower cattle stock, and in the Energy sector due to lower solid fuel consumption in households and the Service sector (emissions lower by 151.2 Gg). In the Waste sector emissions increased by 112.2 Gg, while in Waste water handling they decreased by 37.8 Gg. Due to the increased quantity of waste, the emissions from waste disposal on land increased by 150 Gg.

Table 3-2: Emissions of $CH_4$ in 2002 and comparison with emissions in the base year (1986)

| TYPE OF $CH_4$ SOURCES | 1986 [Gg] | 2002 [Gg] | 2002 [%] | 2002 / 1986 [%] |
|---|---|---|---|---|
| Total National Emissions | 120.50 | 108.64 | 100.0 | 90.2 |
| 1. Energy | 24.42 | 17.23 | 15.9 | 70.6 |
| A. Fuel Combustion (Sectoral approach) | 6.12 | 4.02 | 3.7 | 65.7 |
| 4. Other Sectors | 5.02 | 3.00 | 2.8 | 59.8 |
| B. Fugitive Emissions | 18.30 | 13.21 | 12.2 | 72.2 |
| 1. Solid Fuels | 17.09 | 12.56 | 11.6 | 73.5 |
| 2. Industrial Processes | 0.18 | 0.24 | 0.2 | 133.3 |
| 4. Agriculture | 50.61 | 40.53 | 37.3 | 80.1 |
| A. Enteric Fermentation | 37.70 | 32.51 | 29.9 | 86.2 |
| B. Manure Management | 12.91 | 8.02 | 7.4 | 62.1 |
| 6. Waste | 45.29 | 50.64 | 46.6 | 111.8 |
| A. Solid Waste Disposal | 38.54 | 45.68 | 42.0 | 118.5 |
| B. Waste Water Handling | 6.75 | 4.95 | 4.6 | 73.3 |

Source: ARSO




Source: ARSO

Figure 3-2: Emissions of $CH_4$ in 1986 and 1990–2002.

## 3.5 Emissions of $N_2O$

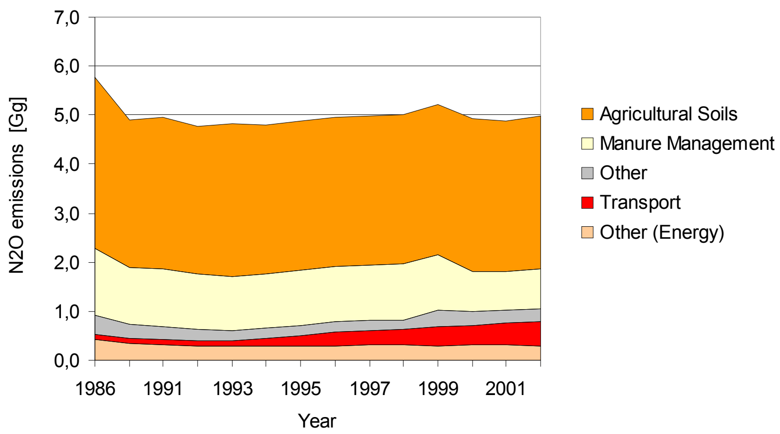
$N_2O$ emissions in Slovenia in 2002 accounted for 4.99 Gg (Table 3-3). The most important emission sources were the following sub-sectors: Agricultural Soils with 3.13 Gg (62.7 % of all the $N_2O$ emissions), Manure Management with 1.35 Gg (16.1 %) and Transport with 0.49 Gg (9.8 %).

$N_2O$ emissions decreased by 0.79 Gg (13.6 %) in the 1986–2002 period. The reduction is mainly a consequence of reduced emissions in the Agriculture sector (emissions in 2002 were lower by 0.91 Gg compared to the base year) within which emissions from manure management decreased by 0.55 Gg and by 0.37 Gg in the Agricultural Soils sub-sector. In the Transport sector emissions increased by 0.41 Gg due to the increase in the share of vehicles with catalytic converter.

Table 3-3: Emissions of $N_2O$ in 2002 and comparison with emissions in the base year (1986)

| TYPE OF $N_2O$ SOURCES | 1986 [Gg] | [Gg] | 2002 [%] | 2002 / 1986 [%] |
|---|---|---|---|---|
| Total National Emissions | 5.77 | 4.99 | 100.0 | 86.4 |
| 1. Energy | 0.52 | 0.79 | 15.8 | 153.0 |
| A. Fuel Combustion (Sectoral approach) | 0.52 | 0.79 | 15.8 | 153.0 |
| 1. Energy Supply | 0.09 | 0.09 | 1.7 | 100.0 |
| 2. Manufacturing Industry and Construction | 0.13 | 0.07 | 1.4 | 54.0 |
| 3. Transport | 0.08 | 0.49 | 9.8 | 585.0 |
| 4. Other Sectors | 0.21 | 0.14 | 2.9 | 66.9 |
| 3. Solvent and other product use | 0.26 | 0.12 | 2.4 | 44.6 |
| 4. Agriculture | 4.84 | 3.93 | 78.8 | 81.1 |
| B. Manure Management | 1.35 | 0.80 | 16.1 | 59.4 |
| D. Agricultural Soils | 3.49 | 3.13 | 62.7 | 89.5 |
| 6. Waste | 0.15 | 0.15 | 3.0 | 100.0 |
| B. Waste Water Handling | 0.15 | 0.15 | 3.0 | 100.0 |

Source: ARSO




Source: ARSO

Figure 3-3: Emissions of $N_2O$ in 1986 and 1990–2002.

## 3.6 Emissions of HFCs, PFCs and $SF_6$

F–gas emissions are very insignificant but due to their high global warming potential (GWP) their contribution to the global warming can not be neglected. Their share in total GHG emissions accounts for 1.0 %. The base year for F–gases is 1995. Hydrofluorocarbons (HFCs), Perfluorocarbons (PFCs) and Sulphur hexafluorid ($SF_6$) belong to F-gases.

HFCs came to use in Slovenia in 1993 as CFC supplement. Their 2002 emissions accounted for 69.2 Gg $CO_{2\ eq.}$ (33.5 % of total F-gas emissions). The main source was HFC-134a as a cooler in air-conditioning and cooling devices (99.0 % of HFC emissions), use of the same gas as a foam in the production of the polyurethane products (0.7 %), and in fire extinguishers (0.3 %). In the 1995–2002 period emissions increased by 8.6 Gg $CO_{2\ eq.}$ (125.8 %) due to the increased consumption of the gas in air-conditioning and cooling devices (Table 3-4).

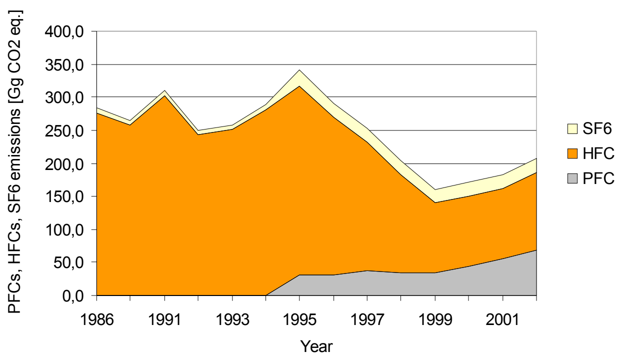
The only registered source of PFC emissions in Slovenia is aluminium production. In 2002 116.4 Gg $CO_{2\ eq.}$ (56.3 % of all the F–gas emission) were emitted. Despite the increase in the aluminium production the emissions in the 1995–2002 period decreased by 169.2 Gg $CO_{2\ eq.}$ or 59.2 % (Table 3-4) due to the improved technology (Table 3-4).

$SF_6$ emissions accounted for 21.0 Gg $CO2_{eq.}$ in 2002 and were 4.3 Gg $CO_{2\ eq.}$ (17.0 %) lower compared to 1995. The only source is the use of switching devices in the Energy sector (Table 3-4).

Table 3-4: Emissions of F–gases in 2002 and comparison with emissions in the base year (1995)

| EMISSIONS OF F-GASES | 1995 | 2002 | | 2002 / 1986 |
|---|---|---|---|---|
| | [Gg $CO_{2\ eq}$] | [Gg $CO_{2\ eq}$] | [%] | [%] |
| Total National Emissions | 341.66 | 206.67 | 100.0 | 60.5 |
| HFC | 30.65 | 69.19 | 33.5 | 225.8 |
| HFC–134a | 30.65 | 69.19 | 33.5 | 225.8 |
| PFC | 285.68 | 116.44 | 56.3 | 40.8 |
| $CF_4$ | 250.26 | 100.62 | 48.7 | 40.2 |
| $C_2F_6$ | 35.42 | 15.82 | 7.7 | 44.7 |
| $SF_6$ | 25.33 | 21.03 | 10.2 | 83.0 |

Source: ARSO




Source: ARSO

Figure 3-4: Emissions of F–gases in 1986 and 1990–2002.

## 3.7 Total Direct GHG Emissions

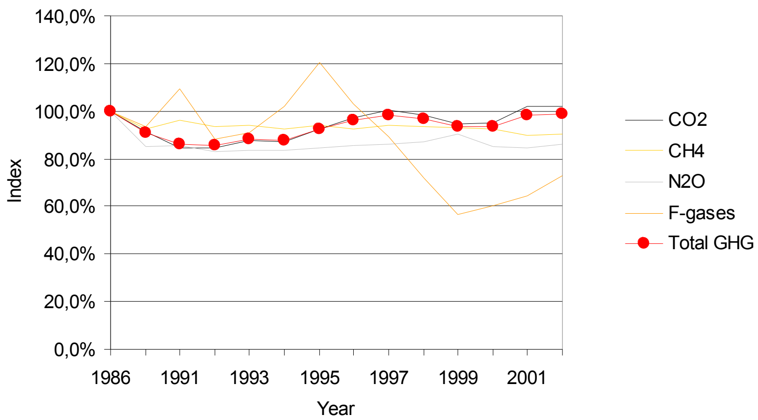
Total direct GHG emissions in 2002 accounted for 20.38 Tg $CO_{2\ eq.}$. Among gases the greatest share goes to $CO_2$ with 16.35 Tg (80.2 %). It is followed by $CH_4$ with 2.28 Tg $CO_{2\ eq.}$ (11.2 %), $N_2O$ with 1.55 Tg $CO_{2\ eq.}$ (7.6 %) and F–gases with 0.21 Tg $CO_{2\ eq.}$ (1.0 %). The largest share of emissions in 2002 was contributed by the Energy sector (16.08 Tg $CO_{2\ eq.}$, 78.9 %), followed by Agriculture (2.07 Tg $CO_{2\ eq.}$, 10.2 %), Waste (1.11 Tg $CO_{2\ eq.}$, 5.4 %), Industrial Processes (1.05 Tg $CO_{2\ eq.}$, 5.2 %) and Solvent and Other Product Use (0.07 Tg $CO_{2\ eq.}$, 0.4 %) (Table 3-5).

In the 1986–2002 period total GHG emissions decreased by 1.1 %, mainly as a consequence of emission reduction in Agriculture by 0.49 Tg $CO_{2\ eq.}$ and in Industrial Processes by 0.26 Tg $CO_{2\ eq.}$. Emissions increased in the Energy sector by 0.48 Tg $CO_{2\ eq.}$ and in Waste sector by 0.11 Tg $CO_{2\ eq.}$

Table 3-5: Total direct GHG emissions by gas and sector in 1986 and 2002

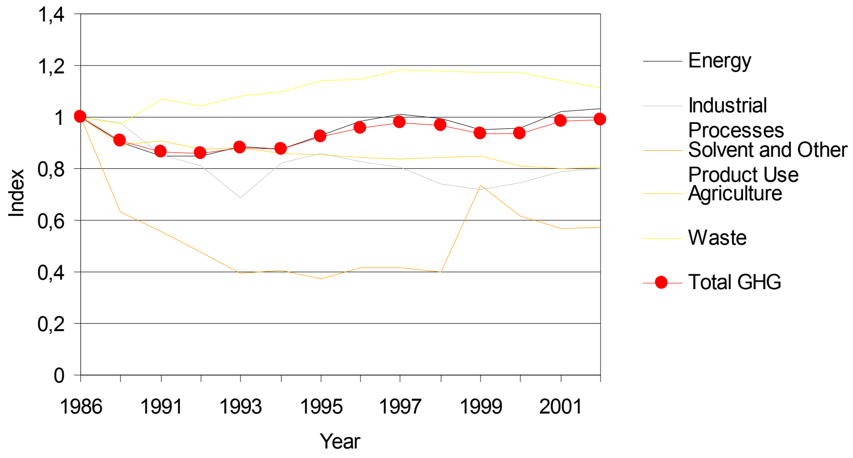
| GHG Emissions | 1986 | | 2002 | | 2002/1986 |
|---|---|---|---|---|---|
| | [Tg $CO_{2\ eq.}$] | [%] | [Tg $CO_{2\ eq.}$] | [%] | [%] |
| $CO_2$ | 16.00 | 77.7 | 16.35 | 80.2 | 102.2 |
| $CH_4$ | 2.53 | 12.3 | 2.28 | 11.2 | 90.2 |
| $N_2O$ | 1.79 | 8.7 | 1.55 | 7.6 | 86.4 |
| F-gases | 0.28 | 1.4 | 0.21 | 1.0 | 72.9 |
| Total GHG emissions | 20.60 | 100.0 | 20.38 | 100.0 | 98.9 |
| Sectors/sources of GHG emissions | | | | | |
| 1. Energy | 15.60 | 75.7 | 16.08 | 78.9 | 103.1 |
| 2. Industrial processes | 1.31 | 6.4 | 1.05 | 5.2 | 80.3 |
| 3. Solvent and other product use | 0.13 | 0.6 | 0.07 | 0.4 | 57.2 |
| 4. Agriculture | 2.56 | 12.4 | 2.07 | 10.2 | 80.7 |
| 6. Waste | 1.00 | 4.8 | 1.11 | 5.4 | 111.2 |

Source: ARSO




Source: ARSO

Figure 3-5: Change of total GHG emissions (Land Use Change and Forestry are not included) and change of emissions by gas in the period 1990–2002 compared to 1986




Source: ARSO

Figure 3-6: Change of GHG emissions (Land Use Change and Forestry are not included) and change of emissions by sector in 1990–2000 compared to 1986

## 3.8 Total Indirect GHG Emissions

Sources, which contributed most to the $NO_x$ emissions in 2002 with 59.9 Gg, were the Transport sub-sector (57.4 % of all the $NO_x$ emissions) and Energy Supply (29.0 %). They are followed by Manufacturing Industries and Construction (6.6 %) and Other Sectors (6.5 %).

CO emissions in 2002 accounted for 103.1 Gg. Transport with 51.5 %, Other Sectors with 32.0 % and Production of metals with 13.0 % contributed mainly to it.

NMVOC emissions in 2002 accounted for 54.5 Gg. Their main sources were Transport (27.5 % of all NMVOC emissions), Solvent and Other Products Use (21.1 %), Industrial Processes (18.7 %) and Other Sectors (17.2 %).

Total $SO_2$ emissions in 2002 accounted for 72.4 Gg, its main source being Energy Supply sector (80 % of all $SO_2$ emissions).

In the 1986–2002 period the $NO_x$ and $CO_2$ emissions increased by 3.3 % and 30.8 %, respectively, while NMVOC and $SO_2$ emissions decreased by 2.4 % and 71.3 %, respectively.

# 4. POLICIES AND MEASURES

In this chapter we present main policies and measures that will be used to reach GHG emission reduction level demanded by the Kyoto Protocol. Measures are summarized from the Slovenia's Action Plan for Reducing GHG Emissions, which is the key document in the process of emission reduction. The greatest emphasis is given to measures which will increase energy efficiency and the share of renewable sources because the Energy sector holds the greatest reduction potential. Also an important role will be played by the measures for the reduction of car traffic and the reduction of waste quantity.

## 4.1 The Action Plan for Reducing GHG Emissions

The first Communication presented measures and policies included in the Short-Term Action plan for Reducing GHG Emissions, which is a part of the Strategy for Reducing GHG Emissions. This short-term plan consisted of 30 measures and activities, which represented the basis for complying with the guidelines of the Kyoto Protocol. The next level in the process of measure preparation which would help us achieve the demanded level of GHG emissions is presented by the Action Plan for Reducing GHG Emissions, prepared and adopted by the Government in 2003. The Action Plan is a document harmonized among the Ministries, which defines the key instruments for achieving the Kyoto targets, obligations of individual sectors by adopting those instruments and adjustment of the instruments in order to reach the demanded targets. Most of the legal acts as instruments for carrying out the Kyoto Protocol in Slovenia represent the adjustment to the EU Aquis Communautaire in the process of Slovenian accession. $CO_2$ emission tax and waste disposal tax stand out among specific domestic instruments for GHG emission reduction.

The Action Plan for Reducing GHG Emissions takes into account three key elements of the emission reduction process: technical or other measures, i.e. realistic opportunities for GHG emission reduction, bodies that carry out those measures, and instruments which enable or motivate the measure realization. Qualification and motivation of diverse actors, governmental and public services, economic subjects, non-governmental organizations, as well as awareness of all Slovenian inhabitants, are of significant importance to the efficient measure realization. The role of the bodies is indispensable also in the reverse effect for improvement of the Action Plan up to the commitment fulfilment. One of the key instruments for GHG emission reduction is environmental public finance reform (so called green tax reform) which consists of a connected and balanced system of gradual fiscal burden reduction or labour taxes and capital transactions by increasing fiscal burden (taxes, excise duties) for environmental goods use (soil, water, air, energy, raw materials, etc.) or environment degradation. It is also about the change of public finance expenses or reduction of those expenses for non-sustainable purposes / programmes by increasing the expenses for (new) purposes / programmes which are in accordance with sustainable development criteria, engagement of unused budget sources for sustainable development projects and programmes and for putting sustainable development criteria in the public order system into force. It is not possible to anticipate all the details for the whole adjustment period to the Kyoto commitments until 2012 from the Action Plan, that is why monitoring the process of performing and adjusting the intensity of instruments is one of the components of Action Plan for Reducing GHG emissions [1].

In the first Communication there were also the following measures mentioned among the planned ones which are not included in this Communication: excise duty proportional to the normative fuel consumption by buying new cars; Road Toll increase for freight vehicles; Voluntary agreements for PFC and $SF_6$ emission reduction. Those measures were still in the stage of studying while the first Communication was written. Later on they were abolished due to the EU measure adjustment and adoption, obligatory for all the EU members and cover the same fields.

### 4.1.1 Responsibility of the Government

Our government gave the competent bodies, ministries and other bodies of the executive power a task of preparing narrow sectorial programmes for activating the most favourable measures in their fields of activities as identified in the Action Plan for Reducing GHG Emissions and other documents. The existing regulations and their possibilities for the further regulation harmonization between Slovenia and EU will be taken into account, as well as the most favourable combination of economic, guidance and stimulation instruments by individual measures. The government will make constant adjustments of the intensity of the instruments employed, including proposed amendments to laws that could have an impact on greenhouse gas emissions, in so far as the results in reducing greenhouse gas emissions based on the Action Plan do not meet the Kyoto targets. By 2006 the government will carry out detailed analysis of the effectiveness of the Action Plan and its implementation, in which it will give particular consideration to the implementation and results in 2005, which is the preliminary control year by which each Party included in Annex I of the Convention shall have made demonstrable progress in achieving its commitments under the Kyoto Protocol. The revised Action Plan that should be adopted up to 2007 will enable efficient goal reaching in first Kyoto commitment period 2008–2012 [1].

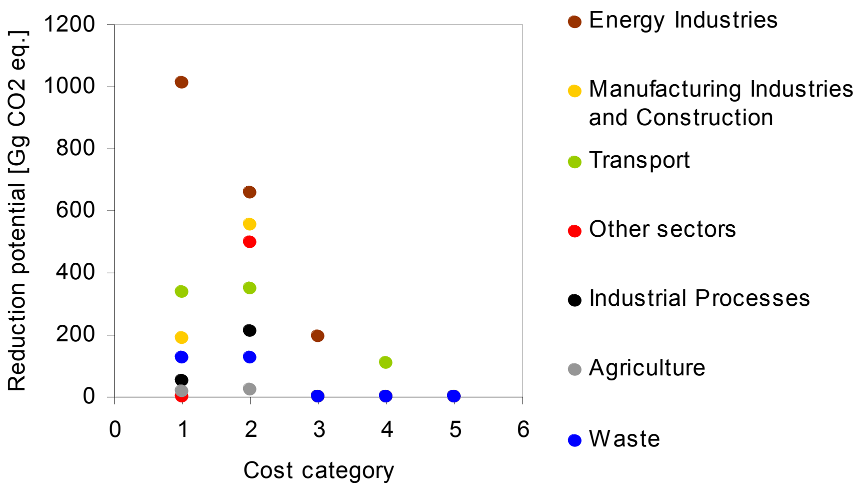
## 4.2 Cost Assessment

The cost assessment takes into account investment and production costs in such manner that investment costs are expressed as annuities (by 8 % interest rate and economic lifetime), net annual production costs are added, and total costs are divided by the annual impact of emission reduction so that the measures with different costs structures are equalized. The costs are shown in comparison to the reference technology: for example, those for electricity are compared to production in a combined cycle gas/steam power station. Uncertainty of the cost assessment is a consequence of the fact that some measures are used due to other reasons as well, such as other environmental benefits or technological / regional development.

Two estimates of costs were prepared according to different calculations of the reference development and selection of instruments. The total costs are 14.6 million EUR (3.5 billion tolars) per year in the more favourable case, and 34.5 million EUR (7.9 billion tolars) per year in the less favourable case [1].

Table 4-1: Categories of measure costs for GHG emission reduction.

| Cost category | Category range [EUR / t $CO_2$] |
|---|---|
| 1 | < 5 |
| 2 | 5–20 |
| 3 | 20–50 |
| 4 | 50–100 |
| 5 | > 100 |




Source: [1]

Figure 4-1: Potentials of measures for reducing GHG emissions by sector according to costs needed for performing the measure.

## 4.3 Policies and Measures and Their Impacts

Measures presented in this chapter are included in the Action Plan for Reducing GHG Emissions, i.e. in its 22 instruments which will help to achieve GHG emission reduction to a level demanded by the Kyoto Protocol. In most of the cases the represented instruments are a consequence of EU directives implementation, which are directed towards emission reduction and have already been transposed to the Slovenian legislation or are in the process of transposition.

Assessment of the potentials of measures in the Action Plan for Reducing GHG emissions was prepared with the help of models used for emission projections calculation. Due to the alternative manner of presenting measures in the National Communication, the measure potentials from the Action Plan, prepared on the basis of model calculations made for the NEP, were redistributed. Due to the overlapping of the effect of several measures potentials were not possible to quantify for all the measures. Estimated total potential of all the measures in 2010 is 4.5 Tg $CO_{2\ eq.}$.

### 4.3.1 Energy

*Implemented measures*

#### 4.3.1.1 Promotion of electricity production from renewable sources and combined heat and power generation (1)[2]

*Implementing entity:* ***MOPE***
*GHG affected:* ***$CO_2$***
*Type of measure:* ***economic, regulatory***

Energy law[3] introduced a new term, i.e. qualified production of electricity defined as production from renewable sources, waste and in power-plants with extra high efficiency of combustion of fossil fuels (Combined heat and power plants – CHP). Decree on prices and rules for purchasing electricity from qualified producers established the feed-in tariff system. The purpose of this measure is to create favourable environment for the construction of systems that use renewable energy

2 Numbering of the measures in table
3 O. G. RS, No. 79/99, 08/00

sources and combined heat and power generation plants by favourable fixed purchase prices of electricity determined by the government of Slovenia. In 2002 qualified producers produced 4.8 % of the produced electricity [23]. Resolution on strategy of energy use and supply[4] adopted by the National Assembly in January 1996 defined the goal according to which the share of electricity produced in qualified production should be doubled until 2010.

Emission reduction potential is assessed at 500 Gg $CO_2$ in 2010 due to performed measures for promotion of electricity production from renewables and combined heat and power generation.

#### 4.3.1.2 Electricity Market Opening (2)

*Implementing entity:* ***MOPE***
*GHG affected:* ***$CO_2$***
*Type of measure:* ***regulatory***

On 1st January 2003 electricity market opened outwards with a limitation of the size of import at 25 % of domestic production for all the eligible customers above 41 kW threshold (65 % of all the consumption) according to the Energy law. Market opening influences the GHG emissions indirectly through the change of electricity production structure and greater import possibilities in case domestic production is not competitive or ecologically suitable. The market will be influenced by the command and control measures which can have a relevant impact on flow of production from individual power-plant types and consequently on total $CO_2$ emissions. Decisions on the emission trading functioning will have significant impact as well, since all major power-plants and heating stations will be included into obligatory European Trading scheme since 2005 [1].

Estimated emission reduction potential is 800 Gg $CO_2$ in 2010 due to change in structure of electricity production, that will be influenced not only by the electricity market opening but also by natural gas market opening and Emission Trading [1].

#### 4.3.1.3 Natural Gas Market Opening (3)

*Implementing entity:* ***MOPE***
*GHG affected:* ***$CO_2$***
*Type of measure:* ***regulatory***

The First stage of the market opening took place in 2003 when the market opened for customers that use more than 25 mio $m^3$ natural gas annually. In EU and Slovenia monopoly is on decrease due to creating internal competition market and increasing the uniform economic area which consequently influences the prices (decrease or slower growth), which causes greater competitive ability of natural gas users and producers of electricity from natural gas. Therefore natural gas should substitute other fossil fuels (coal, heating oils) to a greater extent. Competitive market in Slovenia will be formed after 2007 according to the monopoly position of one distributor and signed contracts between suppliers and consumers, that is why we can expect a postponed effect of this measure on $CO_2$ emissions, which is why the assessment of this measure is difficult.

If natural gas prices were lower it would be realistic to expect the switching of thermo-power plant and heating station Ljubljana (TE–TOL) and possibly thermo-power plant Trbovlje (TET) and thermo-power plant Šoštanj (TEŠ) from coal to natural gas, which would reduce $CO_2$ emissions by 1350 Gg annualy [1].

#### 4.3.1.4 Construction of Large Hydro-power plants (4)

*Implementing entities:* ***MOPE, Holding Slovenian Power Plants (HSE)***
*GHG affected:* ***$CO_2$***

Energy gross potential of Slovenian river-flow is assessed to be 19,400 GWh annually, out of which 9100 GWh annually is

4 ReSROE, O. G. RS, No. 9/96

technically feasible and 7000 to 8500 GWh annually is economically feasible. At the moment 3970 GWh or 43 % of the potential is being used.

Project of construction of five large hydro power plants on lower Sava is taking place at the moment. The project started in November 2002 with a construction of the first hydropower plant Boštanj. The whole project will be finished in 2018. Hydropower plants on lower Sava will produce 720 GWh of electricity annually which represents 6 % of the present energy consumption [29]. Besides that a renovation of two hydro-power plants on Drava river (HPP Zlatoličje – increase of installed power by 24 MW and HPP Formin) between 2006–2011 and reconstruction of HPP Medvode on the river Sava (increase of installed power by 31 MW). Until 2015 a construction of a new HPP is planned in the Soča river valley [22].

#### 4.3.1.5 Incentives for carrying out the EEU measures and for investment in RES (5)

*Implementing entities:* ***MOPE, Government***
*GHG affected:* ***$CO_2$***
*Type of measure:* ***economic, promotion***

**Agency for Energy Efficiency and Renewable Energy (AURE)**

*Financial Incentives for investments and preparation of investments*

AURE dedicated 110 million SIT for financial investment incentives to EEU and the use of RES in households in 2002, and 495 million SIT for investment incentives in households, companies and Public sector in 2003. The following investments were supported: investment in energy efficiency increase of older apartment buildings (window replacement), investment in use of RES in households, companies and Public sector (installation of solar systems and thermal pumps, use of geothermal energy) and within carrying out the Programme of Energy Use of Wood Biomass investments in energy use of wood in households, companies and Public sector. The estimated energy savings due to investments in EEU in 2002 account for at least 4700 MWh annually, while annual saving of burdening air with $CO_2$ is 1 Gg. Due to investments in RES and EEU in 2003 consumption of fossil fuels will decrease by 77,590 MWh, $CO_2$ emissions on the other hand will decrease by 26 Gg annually.

AURE also performs a programme of promoting energy check-ups, preparation of feasibility studies and municipal energy planes. The Programme of promoting energy check-ups has been in place since 1993 and is dedicated to informing and awareness raising of energy consumers and preparing measures in the field of EEU. Through energy check-ups experts in charge of energy management get a detailed insight into the structure and costs of energy consumption and the draft of priority management and investment measures for EEU, which helps them prepare a Programme of reduction when realising the proposed measures. In 2002 11 energy check-ups in companies and Public sector were co-financed and 19 in 2003. On the basis of the results of energy check-ups it becomes possible to save-up to 10 GWh of energy by carrying out the EEU measures whose costs pay back after 3 years. That brings annual $CO_2$ emission reduction by approximately 3.4 Gg.

The goal of study of feasibility is evaluation of greater energy supply projects and EEU projects from technological, economical, environmental and financial perspective. AURE co-financed 10 studies of feasibility for RES and CHP projects in 2002 and 2003.

Municipal energy plan presents expert basis for the preparation of a municipal development in the field of energy supply and use, which is a commitment of the municipality according to the Energy law. The prepared energy plan is a precondition for municipality according to the Energy law to gain state incentives in the field of EEU and RES. Preparation of energy plans consists of a complete assessment of possible scenarios of energy development of one or more municipalities together and chances for their medium and short-term performance. Special attention needs to be dedicated to analysis of possibilities for exploiting local energy sources, especially renewables and energy management in the buildings owned by municipalities. In 2002 AURE supported the preparation of energy plans for 10 municipalities and for 6 in 2003 [27].

*Programme of Energy Use of Wood Biomass*

The Programme of Energy Use of Wood Biomass, that was described among the planned measures in the first Communication was not adopted, but inspite of that some activities described in it take place.

AURE supported the investment projects the Programme of Energy Use of Wood Biomass for Companies and Public Sector and the Programme of Energy Use of Wood Biomass for Households by financial incentives from the budget of RS in 2003. Within the Programme of Energy Use of Wood Biomass for Companies and Public Sector projects of building district heating network, installation of two larger boiler plants, installation of 12 smaller boilers and setting of district heating system were supported. Within the Programme of Energy Use of Wood Biomass for Households 104 boilers were installed for central heating on wood biomass. Emission reduction due to realisation of Programmes of Energy Use of Wood Biomass is estimated at 22 Gg $CO_2$ annually.

AURE also carries out the project 'Removing Obstacles to Increasing the Use of Wooden Biomass as an Energy Source'. The project financed by the state and the Global Environmental Fund (GEF) will last until 2005. The goal of the project is to promote and carry out three to five systems of wood biomass district heating and from experience on these projects to promote and balance the financing of similar ones, while at the same time to support sustainable development of domestic economy by creating new earnings and employments. In 2003 two such projects were supported in Kočevje and Vransko, while 23 feasibility studies for such systems were co-financed. Key persons education for preparation of projects was carried out [28].

*Efficient Energy Use Fund*

Investment fund for efficient energy use, established in 1998, is a common project of the Slovenian government and EU. It was founded with a purpose of making investments into EEU projects easier for companies and institutions by offering them loans with favourable interest rates. Loans are being approved for projects in Industry, Service sector and the field of buildings.

*Environmental Fund*

Environmental Fund of RS is a public financial fund with a task to promote development in the field of environmental protection by offering loans or guaranty for environmental investments and other forms of financing and to promote development in the field of environmental protection. Besides the basic activities of offering loans for environment protection investments, Eco-fund is also active as a financial transmitter for gaining and giving financial means of international financial institutions. In 2002 71 investments of legal entities and 327 of residents were co-financed by the Fund. Most of the investments of legal entities were dedicated to waste water drainage, energy saving and district heating, while with residents they were dedicated to replacing asbestos roof and energy saving. In order to offer loans to legal entities 113.6 million SIT was spent and 381.3 million SIT for residents [20].

#### 4.3.1.6 Education, Training and Public Awareness (6)

*Implementing entity:* ***MOPE***
*GHG affected:* ***$CO_2$***
*Type of measure:* ***promotion, education, information***

In the field of consulting AURE is carrying out "Energy Consulting for Residents" (ENSVET) Programme, intended for consulting, informing and awareness raising of residents in the field EEU and use of RES. Energy consulting and informing which is cost free for residents is performed by 51 qualified energy consultants in network of 33 consulting offices all over Slovenia [27]. In the 1993–2002 period a bit less than 14.000 consulting were carried out and they are on increase in the last years.

AURE performs informative and promotion programme through co-financing informative, awareness-raising and promotion activities and preparing and publishing various informative material (information papers, brochures, guides). A major part of supported projects are from the EEU field and were mainly realised in the form of conferences, consultations and workshops [27].

#### 4.3.1.7 Energy labelling of household devices (7)

*Implementing entity:* ***MOPE***
*GHG affected:* ***CO2***
*Type of measure:* ***information, regulatory***

Energy labelling of household devices enables an increase of energy efficiency in households through informing consumers about energy efficiency of appliances. At the same time demands for the minimum energy efficiency of the devices on the market are being realised. Refrigerators, freezers and their combinations, washing machines, dryers and dishwashers, light bulbs, electric ovens and air-conditionings (from this year on) are being labelled with a energy label. In EU in the future the energy efficiency labelling of office devices is expected, as well as the change of energy categories for some households appliances, especially refrigerators, freezers and washing machines, since the technological progress surpassed the existing categories.

Instrument of energy labelling of household devices will despite the increase of technical equipment pose positive effects of maximum 100 GWh, which accounts for 40 Gg of $CO_2$ equivalent in 2010, in case high public awareness is anticipated [1].

#### 4.3.1.8 Regular Check-Ups of Small Boilers and Air-conditioning Devices (8)

*Implementing entities:* ***MOPE, Municipalities***
*GHG affected:* ***$CO_2$***
*Type of measure:* ***regulatory***

By regular check-ups[5] of boilers their optimal functioning is enabled (better fuel combustion, decrease in thermal losses), which has an impact on smaller fuel consumption and consequently on emission decrease. The proposal of a new law on Environment Protection anticipates trans-

5 O. G. RS, No. 2/02.

fer of obligatory economic public service of checking, controlling and cleansing of boilers, smoke gases and ventilating fans from municipalities to the state due to stricter demands in the field of air pollution.

#### 4.3.1.9 Thermal protection and Energy labelling of buildings (9)

*Implementing entity:* ***MOPE***
*GHG affected:* ***$CO_2$***
*Type of measure:* ***regulatory, information***

A new Decree on Thermal Protection on EEU in buildings[6] which was adopted in 2002, requires stricter technical demands, which need to be achieved in the terms of thermal protection and EEU in new and renovated buildings. As a consequence of the new demands, at least 30 % reduction of energy use according to the former regulations is expected [1].

The Order enables energy certification of buildings. Energy ID of the building is a certificate of the quality of thermal characteristics of the building and the use of energy. The purpose of issuing the energy ID scheme lies in a tendency to promote market benefits of energy efficient construction on the real state market. The energy ID is not yet compulsory. In the process of introducing energy ID a pilot project was carried out within which four energy IDs were awarded, and they represents a basis of a non-obligatory certification scheme.

Estimated Emission Reduction in 2010 is 310 Gg $CO_2$.

#### 4.3.1.10 Cost Accounting for Heating According to Actual Consumption (10)

*Implementing entity:* ***MOPE***
*GHG affected:* ***$CO_2$***
*Type of measure:* ***Stimulative***

Heating costs are accounted approximately according to the heated size of the apartments in 95 % of units which are included in the district heating systems. In 2003 a Decree on distribution and calculation of costs for heating in apartments and other buildings with more users[7] was adopted. Its realization depends on apartment owners' decision. Cost calculation on energy use represents stimulation for the tenants to practice efficient energy use. The pilot project on two buildings revealed the possibility of lowering the energy use by 20 %. A saving of 19 Gg $CO_2$ would be achieved annually together with state incentives of 3 SIT/kg of saved $CO_2$ and by 30 % measure penetration [1].

#### 4.3.1.11 Third Party Financing ('Contracting') (11)

*Implementing entities:* ***Public sector, Government***
*GHG affected:* ***$CO_2$***
*Type of measure:* ***economic***

Contracting is a measure which represents a possibility of renovating old energy systems and improving living conditions and reducing harmful impacts on the environment in all cases where not enough means are available for investment into new or improved energy systems in the public sector and in small and medium sized companies, in particular. In 2001 a pilot project of contractual supply of energy save-up was put into force in the Town Municipality of Kranj which reveals the possibility of lowering energy use in public sector by 15 % [26]. Intensive introduction of Third Party Financing in Public sector could result in a 18 Gg $CO_2$ annual reduction up to 2010 taking a 30 % penetration of the instrument into account [1].

6 O. G. RS, No. 42/2002

7 O. G. RS, No. 49/2003

*Planned measures*

#### 4.3.1.12 Certification of Energy Source (12)

*Implementing entities:* ***MOPE***
*GHG affected:* ***$CO_2$***
*Type of measure:* ***regulatory***

In the future an introduction of a new system of energy source certification is planned. The advantages of green certificates are the following: ensuring efficient development of RES technologies with a goal to achieve the planned share, enabling the transition from governmental subsidiaries from the state budget to direct pay of users, enabling the market determination of added value of the 'green' electricity compared to the 'traditional' one, ensuring the energy source and enabling international trading. The success of this instrument is strongly linked to public awareness.

#### 4.3.1.13 Demand Side Management (13)

*Implementing entities:* ***MOPE, Energy Supply Companies, Electricity Distribution Company***
*GHG affected:* ***$CO_2$***
*Type of measure:* ***information***

Realizing the programmes of EEU for consumers by energy supply companies (Demand Side Management – DSM) is defined in the Energy law and more detailed in the Decree on manner of performance of economic public services in the field of electricity distribution[8], and represents one of the important instruments of energy and environmental policy for lowering GHG emissions, cost lowering and an increase in reliable energy supply. This instrument includes important bodies among the promoters of sustainable energy treatment characterized by high professional qualification, knowledge of the consumption patterns of certain consumer groups etc. At the moment 'programme of DSM introduction to Slovenia' is taking place within which proposal for legislative changes concerning DSM will be made. Annual reduction of electricity consumption due to this measure is estimated to 1 % [31].

8 O. G. RS, No. 54/2000, 31/2001, 99/2001, 96/2003

#### 4.3.1.14 Introduction to Excise Tax on Fossil Fuels and Electricity (14)

*Implementing entity:* ***Ministry of Finance (MF)***
*GHG affected:* ***$CO_2$***
*Type of measure:* ***fiscal***

EU directive on taxing energy products is in preparation. It will oblige the member states to tax other energy products with certain minimum levels, especially coal and electricity production as addition to the directive on minimum excise levels. Slovenia will have to adopt this Directive to its legal system in the transitional period until 2007.

### 4.3.2 Transport

*Implemented measures*

#### 4.3.2.1 Excise Tax on Fuels (15)

*Implementing entity:* ***MF***
*GHG affected:* ***$CO_2$***
*Type of measure:* ***fiscal***

The government influences reduction of the GHG transport emissions indirectly by the excise of the motor fuels. The level of excise is determined by government according to prices of petroleum derivatives, price flow of raw oil and American dollar rate. Excise on unleaded motor oil increased from 55.58 SIT/l to 90.90 SIT/l in the 1999–2002 period [13]. The results of the excise policy is the increased difference between the price of motor oils and gas oils and in narrowing the price of motor fuel to the European average. Impact of excise on emission reduction is hard to assess however higher fuel price certainly represent a greater stimulation for the environment-friendly driving as well as for buying a car with a diesel motor or with a smaller fuel consumption. Emission reduction in 2010 is estimated to be 150 Gg $CO_2$.

4.3.2.2 Control of exhaust fume structure and settings of motors in motor vehicles (16)

*Implementing entity:* ***MOPE***
*GHG affected:* ***$CO_2$***
*Type of measure:* ***regulatory***

The performers of technical check-ups started measuring exhaust fume emissions on 1st December 2003. This will help us achieve GHG emission reduction indirectly since the cars will not be allowed to exceed values defined from car manufacturers of those emissions. The measure will influence on better maintenance of vehicles as well, which will additionally cause emission reduction. $CO_2$ emissions will decrease by 185 Gg in 2010 according to assessments [1].

*Adopted measures*

4.3.2.3 Informing Consumers on Fuel Consumption and $CO_2$ Emissions of Motor Vehicles and Agreement between European Commission and Car Manufacturers (17)

*Implementing entity:* ***MOPE***
*GHG affected:* ***$CO_2$***
*Type of measure:* ***information***

The Rule on informing consumers about efficient fuel consumption and $CO_2$ emissions from personal vehicles[9] was adopted in 2003. According to this Order suppliers have to inform consumers about fuel consumption and $CO_2$ emissions of new personal vehicles at the time of sale. The Rule anticipates a preparation of the brochure on efficient use of fuel and $CO_2$ emissions, which will include advice to drivers and explanation of environmental consequences of traffic and greenhouse impact on environment besides the list of all the models of personal vehicles sold in Slovenia.

An important instrument of $CO_2$ emission reduction is also an Agreement on $CO_2$ emission reduction of new personal cars in which Associations of European, Japanese and Korean manufacturers take part. Emission reduction in 2010 is due to above mentioned measures assessed at 250 Gg $CO_2$.

4.3.2.4 Promotion of Biofuel Use (18)

*Implementing entities:* ***Government, MOPE, MF***
*GHG affected:* ***$CO_2$***
*Type of measure:* ***fiscal***

With the change of the Law on excise[10] from December 2003 biofuels as motor fuels are defined as excise free product with excise level at 0 %. In the future a new legal act needs to be adopted which will bind the producers and merchants of motor fuels to ensure certain market share and legal act, which will determine the quality of biofuels as motor fuels in a more detailed way. The planned share of biodiesel in the total fuel consumption for 2005 accounts for 0.5 % and 1 % for 2010 [22]. The expected GHG emission reduction in 2010 is assessed at 100 Gg of $CO_2$ equivalent [1].

*Planned measures*

4.3.2.5 Promotion of Public Passenger Traffic Use (19)

*Implementing entities:* ***Government, Ministry of Transport (MP), MOPE, Municipalities***
*GHG affected:* ***$CO_2$***
*Type of measure:* ***regulatory, promotion***

9 O. G. RS, No. 86/2003, 133/2003

10 O. G. RS, No. 84/1998, 52/1999, 57/1999, 2/2001, 33/2001, 99/2001, 5/2002, 126/2003 (7/2004 - corr.), 20/2004

In the future the trend of decreased share of public passenger transport needs to be reversed through the implementation of systemic measures targeted at providing bus transport with privileged status within traffic arrangements, consolidating links between bus and rail transport, pursuing an appropriate parking fee policy, and granting direct subsidies to public transport projects. The action plan policy for the 2002–2006 period is outlined in regional development programmes. The rough assessment of the direct potential of GHG reduction by a 10 % replacement of urban personal transport with public passenger transport accounts for 100 Gg $CO_{2\,eq.}$ annually. This assessment does not take the second level effects into account, such as decrease in traffic frequency due to decreased number of motor vehicles in towns [7].

#### 4.3.2.6 Increase in the Share of Railway Transport of Goods and Passengers (20)

*Implementing entities:* ***Government, MP***
*GHG affected:* ***CO₂***
*Type of measure:* ***promotion, regulatory***

Compared to road transport, rail freight transport releases considerably smaller quantities of toxic and greenhouse gases per tonne per kilometre. This is why with the railways the GHG emission reduction can be achieved easier by replacing the greater share of cargo traffic, especially the transit one, which will strongly increase after the Slovenian entry to EU due to its position on the crossroads of the TEN corridors V. and X. and an increase in the number of passenger transported by train. A greater share of railways in the cargo transport will be achieved through investments in railway infrastructure (further construction of the fifth corridor is included among the priority tasks of EU), improved traffic quality and improved transport logistics of transport companies. In order to increase the number of transported passengers by trains, connections with other means of transport, an increase in the quality of offer and greater adaptability to the passengers and more active promotion of railway transport are of essential importance. $CO_2$ emissions will decrease by 50 Gg annually in case 50 % of the present traffic of foreign vehicles on state roads switched to railway [7].

#### 4.3.2.7 Strategy of the Regional and Spatial Development (21)

*Implementing entities:* ***MOPE, Municipalities***
*GHG affected:* ***$CO_2$***
*Type of measure:* ***regulatory***

Strategy of the regional as well as national spatial development are very important elements of the GHG emission reduction policy in the Transport sector. Daily migrations towards regional centres could decrease with the co-natural spatial planning, since those centres are the main source of emissions in transport. Besides that with the improved traffic infrastructure, the flew of the traffic would increase and travelling period would shorten. Sustainable spatial development of towns and settlements and a harmonious regional development are long-term measures therefore they are hard to assess. There are rough assessments that GHG emissions, as a consequence of both measures, should decrease by 56 Gg $CO_2$ annually [1]. Slovenia is building its highway system with speed at the moment so that the flow of the vehicles will be improved. In future the railway system needs to be renovated and further built.

### 4.3.3 Industry

*Implemented measures*

#### 4.3.3.1 Energy Efficiency in Industry (22)

*Implementing entity:* ***MOPE***
*GHG affected:* ***$CO_2$***
*Type of measure:* ***economic, promotion***

AURE organises a programme for large energy consumers on energy consulting which includes energy monitoring, an interview with management staff and informing the employees. Besides that, AURE offers subsidiaries to companies for energy monitoring and feasibility studies for investments in EEU and RES. Furthermore, the Agency published many of informative papers on good practice projects and guides for energy management and energy technologies. EEU measures are supported also by the Eco-development fund by loans with favourable interest rate.

#### 4.3.3.2 Promotion of Environmental Management Systems (ISO 14001 and EMAS) (23)

*Implementing entities:* ***MOPE, Chamber of Commerce and Industry of Slovenia (CCIS)***
*GHG affected:* ***$CO_2$***
*Type of measure:* ***promotion, economic***

The Environmental Management System (EMS) according to the standards of the ISO 14000 series represents an internationally recognised management approach for the companies and ensures all the perspectives of environment protection treatment from raw material use and energy, technological process management, to demands on product use (including a later removal or destruction) directed towards abolishing or at least diminishing the impacts on the environment. More than 200 Slovenian companies were awarded the ISO 14001 certificate of environment management [33]. Environmental management audit scheme (EMAS) stimulates organisations towards upgrading, greater efficiency and transparency of the existing systems of the environmental management (e.g. ISO 14001), and towards more responsible management in the direction of the sustainable development. The process of including organisations into EMAS system is stimulated through facilities and incentives which refer mainly to the reduction of frequency and the size of realization of the monitoring and reporting. Emission reduction due to greater energy efficiency in industry in 2010 is assessed at 400 Gg $CO_2$.

#### 4.3.3.3 Eco–labelling of Products (24)

*Implementing entity:* ***Government***
*GHG affected:* ***$CO_2$***
*Type of measure:* ***voluntary***

The measure will have indirect impact on GHG emissions since the demands for acquiring the environmental label refer partly to the procedure of the product production (decreased energy use, GHG emissions in the production stage), and partly also to the effects of the product on the environment in its life cycle. This measure is voluntary. Only limited number of production groups can be awarded the environmental label (EU ECO label) [31].

### *Adopted measures*

#### 4.3.3.4 IPPC Directive (25)

*Implementing entities:* ***MG, MOPE, CCIS***
*GHG affected:* ***$CO_2$***
*Type of measure:* ***regulatory***

EU formed equal procedures of functioning allowance of industrial pollution sources by introducing the IPPC Directive[11]. The emphasis is put to integrated approach of pollution controlling whose main aim is to prevent or to decrease emissions into air, water and ground to the lowest possible level, while taking the waste management into account at the same time. The Managers of plants will need to gain a complete environmental permit for functioning according to which harmonization with BREF reference documents (use of the BAT) on environment protection is anticipated, taking the demands concerning the efficient source use into account (preventing the waste creation, accelerating their transformation and recycling, using less hazardous substances). There are 170 in-

11 Directive 96/61/EC

dustrial departments active in Slovenia at the moment, for which it is obligatory to gain integral permission for environmental burdening by the IPPC Directive standards. It is assessed that the majority of those departments will adjust to the standards of BAT until the deadline (2007, or 2011 for some exceptions). By implementing IPPC directive the specific use of energy will decrease (depends on the activity) by 20 % per production unit, therefore according to assessments the $CO_2$ emission will be decreased by 60 Gg in 2010 [1].

### 4.3.4 Agriculture and Forestry

*Implemented measures*

#### 4.3.4.1 Slovenian Agricultural – Environmental Programme and Programme of Countryside Development (26)

*Implementing entities:* ***Government, MKGP***
*GHG affected:* ***$N_2O$, $CH_4$, $CO_2$***
*Type of measure:* ***economic***

Slovenian agriculture-environmental programme (SKOP) started with experimental functioning in 2001 and will last until 2006. This programme ensures direct payments to those farmers which take higher standards of environment protection and landscape characteristics maintenance into account. The programme is not directly orientated towards GHG emission reduction although some measures contribute to the emission reduction significantly, especially the following ones: reduction of burdening of cultivated landsites, eco-farming, promotion of highland pasture, sustainable breeding of domestic animals, maintenance of extensive grassland, integrated fruit-growing and integrated gardening. In 2003, SKOP consisted of 12,000 farms with 350,000 ha of land [1]. GHG emission reduction due to the increase in the pasture share which is one of the aims of the SKOP is assessed, at 9 Gg $CO_{2\ eq.}$ for 2010 [39].

Programme of countryside development for Slovenia in 2004–2006 period is being prepared. The main priorities of the programme are directed towards the co-natural, sustainable development and maintenance of countryside areas.

#### 4.3.4.2 Good Agricultural Practices on Fertilization (27)

*Implementing entities:* ***Government, MKGP, MOPE***
*GHG affected:* ***$N_2O$***
*Type of measure:* ***regulatory***

Basic documents in the field of fertilization which contributes mainly to the $N_2O$ emission reduction are the following: Decree on input of toxic substances and plant nutrition into ground[12] from 1996 and the Instruction on performing good agricultural practice on fertilization[13]. The changed Decree defines the whole Slovenian territory as a sensitive area, therefore the annual input of nytrogen is limited to 170 kg/ha. It also includes the paragraph on using fertilizers in accordance with the needs of the plants. By taking the rules of good agricultural practice with fertilizing the ground into account, margin values of the annual input of nutrition into ground are assured in accordance with the Decree. An important contribution to quality use of fertilizers and indirectly to emission reduction is represented by a professional and counselling work in this field. Due to reduction of mineral fertilizers use, $N_2O$ emissions will decrease by 11 Gg $CO_{2\ eq.}$ by 2010 [39].

#### 4.3.4.3 Promotion of Biogas Use for Electricity and Heat Production (28)

*Implementing entities:* ***Government, MOPE***
*GHG affected:* ***$CH_4$***
*Type of measure:* ***economic, regulatory***

12 O. G. RS, No. 68/96
13 O. G. RS, No. 34/2000

The acquisition and use of biogas from animal and agricultural waste is an important measure for increasing the RES share and reducing GHG emissions, especially methane. Methane emissions from animal manure are estimated at 67 Gg $CO_{2\,eq}$ annually in Slovenia, while the technical potential of biogas is estimated at minimum 56 million $m^3$. Biogas is gained from the manure by anaerobic digestors. Slovenian cattle breeding is characterized by many small farms what prevents construction of large anaerobic digestors and biogas devices due to great costs. Therefore the construction of common devices for several smaller users is recommended. The state promotes investments in biogas devices by various financial mechanisms, such as subsidies and favourable loans and with feed-in tariff. The first Slovenian private biogas device in agriculture started functioning in 2003 [32]. In the field of methane emission reduction the greatest achievement in the last year was the construction of modern devices for capture of manure and by introducing biogas acquisition on two large pig farms. Emission reduction due to installation of anaerobic digestors on large pig farms and pig- and cattle-breeding farms was assessed at 20 Gg $CO_{2\,eq.}$ in 2010 [39].

4.3.4.4 Co-Natural Forest Management (29)

*Implementing entities:* ***Government, MGKP,***
*GHG affected:* ***$CO_2$***
*Type of measure:* ***regulative***

In 1996 adopted Programme of forest development in RS[14] determines the national policy of co-natural forest treatment, orientation towards maintenance and development of forest, and conditions for their exploitation or multi-purpose use. This programme sets the foundations for maintenance and development of all forest and its functions. It formed the development strategy in certain fields of forest treatment and it also indicates the expert orientations on co-operation with activities linked to forestry. The programme is dedicated especially to the care of the existing forests and to better use of their growing potential and maintenance, forming of individual trees and groups of forest trees within the forests due to relatively great share of forests in Slovenia (56 %)

$CO_2$ binding due to the change of wood biomass stocks in Slovenian forests will account for 3800 Gg $CO_2$ until 2010 according to the IPCC methodology, which exceeds the allowed quota of 1320 Gg $CO_2$ annually according to the Kyoto Protocol commitment fulfilment for the first target period by almost three times [1].

*Planned measures*

4.3.4.5 Incentives for Agricultural Plants Cultivation for Biodiesel Production (30)

*Implementing entities:* ***Government, MGKP***
*GHG affected:* ***$N_2O$ , $CO_2$***
*Type of measure:* ***regulative, economic***

Cultivation of agricultural plants for biodiesel production is interesting from many perspectives taking GHG emission reduction into account. Including oil rape in the crop cycle influences the GHG emissions through lesser use of fossil fuels in Transport and through maintaining humus in the ground what influences on better fertility of the ground what lowers fertilization needs [39].

### 4.3.5 Waste

*Implemented measures*

4.3.5.1 Regulation on Waste Disposal and Waste Management ( 31)

*Implementing entity:* ***MOPE***
*GHG affected:* ***$CH_4$***
*Type of measure:* ***regulatory***

14 O. G. RS, No. 14/1996

Rule on landfilling waste[15] and Rule on waste management[16] regulate those two fields in a legal formal manner and introduce systematical problem solving. Rule on landfilling waste determines obligatory handling and other conditions for waste landfilling and conditions and measures connected to planning, construction, functioning and closing of the landfills and their treatment after closing. Rule on waste treatment determines the classification list of waste and hazardous waste, its treatment, other conditions for collecting and transporting, transformation and removal of the waste and introduces the obligation of reporting and forbids the waste mixing. Those two Rules represent the basis for improvement of the field conditions.

#### 4.3.5.2 Waste Disposal Tax (32)

*Implementing entity:* ***MOPE, MF***
*GHG affected:* $CH_4$
*Type of measure:* ***fiscal***

In 2001 Regulation on taxing the environment burdening due to waste disposal was adopted[17]. The tax is paid by landfill owners according to the quantity of the landfilled inert, non-hazardous or hazardous waste. The amount of the tax depends on the waste type. The tax consists of tax on the waste quantity and the tax on landfill gas emissions. The second part is approximately three times higher than the first one. The tax is lowered in case the landfill has a settled capture and combustion or energetic use of landfill gas and in case of reducing the quantities of landfilled waste, including the biodegradable part. It is possible to use it in the construction of buildings and devices (infrastructure) which lessen the quantity of landfilled waste, and in infrastructure on landfills, including the capture and consumption of the landfill gas. The tax will help to build a complete system of waste treatment devices in conjunction with additional funds. The tax on environment burdening represents one of the main instruments for 50 % emission reduction in a ten year period in the field of waste treatment.

15 O. G. RS, No. 5/2000
16 O. G. RS, No. 84/1998, 45/2000, 20/2001, 13/2003
17 O. G. RS, No. 70/01

*Adopted measures*

#### 4.3.5.3 Separate Waste Collection and Packaging Waste Management (33)

*Implementing entity:* ***Municipalities, MOPE, CCIS***
*GHG affected:* $CH_4$, $CO_2$
*Type of measure:* ***regulatory***

In 2001 adopted Decree on treatment of separately collected fractions for public services dealing with municipal waste treatment[18] determines that the local public utility needs to ensure separate collection and takeover of separated fractions in collecting centres, collection of bulky waste, sorting of municipal waste in the sorting place and separate collections of hazardous fractions. The Decree demands obligatory inventories management on separately collected fractions and promotional and awareness-raising actions. Systems of separate waste collections needed to be restored all over the country by 1st January 2004. The separate waste collection will according to expectations result in drastic reduction of the quantity of landfilled waste. The target is to reduce landfilled waste by half.

In 2002 Operative Programme of Packaging and Packaging Waste Management was prepared. It represented the measures and dynamics of achieving the targeted goal which is in compliance with the demands of the Decree on package and waste package management according to which 50 % of the total mass of waste package is supposed to be transformed and 25 % of the total mass of the waste package is supposed to be recycled, and at least 15 % by

18 O. G. RS, No. 21/2001

individual materials. The programme of measures for achieving the goals of this Operative programme for the period from 2001 to the end of 2007 is presented from the perspective of individual fields of activities, i.e. forming the policies in the field of package and waste package treatment, institutional organising, planning and restoring buildings and devices, monitoring, controlling and reporting, and including the targeted public [24].

Estimated reduction of methane emission in 2010 due to separating of waste is 42 Gg $CO_{2\,eq.}$ [41].

#### 4.3.5.4 Landfill Gas Extraction and Combustion, Energy Exploitation or Use of Landfill Gas (34)

*Implementing entities:* ***MOPE, Municipalities***
*GHG affected:* ***$CH_4$, $CO_2$***
*Type of measure:* ***economic, regulatory***

The Rule on landfilling waste requires that landfills settle capture and proper treatment of landfill gas until the end of 2005 for all landfills. In 2003 capture and the use of landfill gas where arranged on three largest landfills only (Ljubljana–Barje, Maribor–Pobrežje, Celje–Bukovžlak), which represent approximately 30 % of the total population in the proportional share of the population. In 2003 15 % of the landifll gas was captured and energetically used. Until the end of 2005 a 200 % increase in capture and use of landfill gas is anticipated, since the degassing systems will not function completely. In the 2006–2010 period a linear increase in the quantity of the captured and used gas is anticipated from 30 to 50 % (4 % annual growth rate). Waste water cleansing in purification facilities is also an important source of biogas. In the future the setting of additional purification facilities and biogas powerplants is planned.

Methane emission reduction due to capture, combustion and energy use or consumption of gas, according to the emissions in case the measure would not take place is assessed at 126 Gg $CO_{2\,eq.}$ in 2010 [41].

*Planned Measures*

#### 4.3.5.5 Thermal Waste Processing (35)

*Implementing entity:* ***MOPE***
*GHG affected:* ***$CH_4$ , $CO_2$***
*Type of measure:* ***regulatory***

Thermal waste processing is the most effective way of reducing the waste volume. Combustion enables energy use of waste and use of warmth for district heating systems as well. The drawback of waste incinerations is a release of toxic substances harmful for humans and a subsequent demanding spatial setting. Slovenia plans the to install two incinerations which are supposed to start functioning until 2008.

Setting of one municipal waste incineration will according to assessments influence the emission reduction by 44 Gg $CO_{2\,eq.}$ in 2010, while setting of two would reduce them by 88 Gg $CO_{2\,eq.}$ [41].

### 4.3.6 F–gases

*Planned Measures*

#### 4.3.6.1 Directive on F–gases (36)

*Implementing entity:* ***Government***
*GHG affected:* ***F–gases***
*Type of measure:* ***regulatory***

In EU a Directive on F-gases[19] is in preparation. Its aim is to contribute to EU endeavour for decreasing the GHG emissions within the Kyoto Protocol. The proposal of the Directive includes the following categories:

– Ensuring all the conditions for emission reduction by planning, producing, setting, functioning and removing the equipment,

19 EC Directive on fluorinated gases

– Annual reporting of producers, importers, exporters and users on the quantities of F-gases that are put on the market, exported and used,
– Limiting traffic and use of F-gases for certain purposes.

F-gas emission reduction is assessed at 1.0 % of all annual GHG emissions until 2010 due to the directive. The impact of the regulation will increase after 2010 since some limitations in trading and consumption will come into force in 2008–2012 period [1].

### 4.3.7 Cross-Sectoral Measures

*Implemented measures*

#### *4.3.7.1* $CO_2$ Tax (37)

*Implementing entities:* ***MF, MOPE***
*GHG affected:* ***$CO_2$***
*Type of measure:* ***fiscal***

In 1996 a tax on air burdening was introduced on the basis of the Environmental Protection Act[20]. The purpose of the tax is to reduce emissions through direct fiscal pressure on polluters and to acquire additional means for the budget so that the labour tax rate will be reduced. The tax is paid for fuel consumption and combustion of burning organic substances. At the moment the tax accounts for 3 SIT/kg $CO_2$ (13 EUR / t $CO_2$). The emission tax contributes 1 % of budget means. Partial exemptions for Power Plants (92 %), industry (66 %) and local thermal production and natural gas distribution (50 %) were introduced. Private producers of electricity have special exemptions on paying the tax. Tax payment reduction is possible also by measures of efficient energy use. In the future the tax is planned to become an intentional source of financing the realisation of the measures on reducing the air burdening with $CO_2$ emissions [1].

20 O. G. RS, No. 32/93, 1/96

### 4.3.8 Kyoto Mechanisms

*Implemented measures*

#### 4.3.8.1 Emission Trading Scheme (38)

*Implementing entity:* ***MOPE***
*GHG affected:* ***$CO_2$ (later also other gases)***
*Type of measure:* ***economic***

Emission trading does not cause emissions reduction nevertheless it enables pollutants included into the scheme to achieve emission reduction by a cost most effective way. Due to the functioning of emission permits market, emission reduction will happen where it is cost most attractive. Buyers buy permits cheaper as their own measures of emission reduction are and sellers sell more expensively as costs of their own measures of emission reduction are. As an EU member Slovenia will be included into the EU emission coupons trading scheme which will start to function in the period 2005–2007. Global trading is foreseen in the period 2008–2012. Between 50 and 100 devices will be included in trading with GHG emitting rights in Slovenia [1].

*Planned measures*

#### 4.3.8.2 Clean Development Mechanism (CDM) and Joint Implementation (JI) (39)

*Implementing entitys:* ***MOPE***
*GHG affected:* ***GHG gases***
*Type of measure:* ***regulatory, economical***

Kyoto Protocol foresees two assistant mechanisms as a supplement to domestic measures: clean development mechanism (CDM) and joint implementation (JI). The goal of CDM is to help these countries to ensure sustainable development by investments of developed countries in developing countries in projects resulting in GHG emissions reduction and thus acquire corresponding quantities of emission reduction as a help for fulfiling Protocol obligations. Projects of JI are in the same way meant for developed industrialised countries which can achieve additional emission reduction by investing money of their companies in emission reduction in other industrialized countries. Joint implementation is interesting for Slovenia from the point of view of a performer of projects in other countries of Annex I. In principle a two-way instrument must be allowed but giving away of emission permits, where other countries of Annex I would invest in suitable projects in Slovenia, is not reasonable because Slovenia will need emission reduction to fulfil its obligations. Projects based on JI, from which Slovenia would acquire emission rights, would enable also technological penetration of the Slovenian economy [1].

Table 4-2: Policies and Measures – Summary (Assessment of the Measure Impact is made for 2010)

| Name of policy or measure | Objective and/or activity affected | GHG affected | Type of instrument | Status | Implementing entity/ies: | Emission Reduction in 2010 [Gg $CO_2$] |
|---|---|---|---|---|---|---|
| **Energy** | | | | | | **2697** |
| 1. Promotion of Electricity Production from Renewable Sources and Combined Heat and Power Generation | Increased share of RES and combined heat and power generation | $CO_2$ | Economic, Regulatory | Implemented | MOPE | 500 |
| 2. Electricity Market Opening | Change in the structure of electricity production, wider import possibilities | $CO_2$ | Regulatory | Implemented | MOPE | 1350 |
| 3. Natural Gas Market Opening | Switching from coal to natural gas (TE, TE–TO) | $CO_2$ | Regulatory | Implemented | MOPE | |
| 4. Construction of Large Hydro-Power Plants | Increased share of RES in electricity production | $CO_2$ | | Implemented | HSE, MOPE | 400 |
| 5. Incentives for Carrying out the EEU Measures and for Investment in RES | Higher energy efficiency and increased share of RES | $CO_2$ | Economic, Promotion | Implemented | MOPE Government | Not estimated |
| 6. Education, Training and Public Awareness | Higher level of public awareness and information release | $CO_2$ | Promotion, Education, Information | Implemented | MOPE | 100 |
| 7. Energy Labelling of Household Devices | Higher energy efficiency | $CO_2$ | Information, Regulatory | Implemented | MOPE | |
| 8. Regular Check-Ups of Small Boilers and Air-Conditioning Devices | Higher energy efficiency due to the better effectiveness of boilers and air-conditioning devices | $CO_2$ | Regulatory | Implemented | MOPE Municipalities | Not estimated |
| 9. Thermal Protection and Energy Labelling of Buildings | Higher energy efficiency | $CO_2$ | Regulatory, Information | Implemented | MOPE | 310 |
| 10. Cost Accounting for Heating According to Actual Consumption | Stimulation of inhabitants for efficient energy use | $CO_2$ | Information | Implemented | MOPE Government | 19 |
| 11. Third Party Financing ('Contracting') | Incentive for investments in efficient energy use | $CO_2$ | Economic / Voluntary | Implemented | Public sector, Municipalities | 18 |
| 12. Certification of Energy Source | Stimulation of electricity production from renewable energy sources | $CO_2$ | Regulatory | Planned | MOPE | Not estimated |
| 13. Demand Side Management | Stimulation of efficient energy use for consumers | $CO_2$ | Promotion | Planned | MOPE | Not estimated |
| 14. Introduction to Excise Tax on Fossil Fuels and Electricity | Increase of energy efficiency in households and public sector | $CO_2$ | Fiscal | Planned | MF | Not estimated |

Table 4-2: Continued

| Name of policy or measure | Objective and/or activity affected | GHG affected | Type of instrument | Status | Implementing entity/ies: | Emission Reduction in 2010 [Gg $CO_2$] |
|---|---|---|---|---|---|---|
| **Transport** | | | | | | **900** |
| 15. Excise Tax on Fuels | Reduction of fuel consumption and as a consequence lower $CO_2$ emissions | $CO_2$ | Fiscal | Implemented | MF | 150 |
| 16. Control of Exhaust Fume Structure and Settings of Motors in Motor Vehicles | Emission reduction due to the technically improved vehicles | $CO_2$ | Regulatory | Implemented | MOPE | 185 |
| 17. Informing Consumers on Fuel Consumption and $CO_2$ Emissions of Motor Vehicles and Agreement between European Commission Car Manufacturers | Emission reduction due to the improved energy efficiency of vehicles | $CO_2$ | Promotion, Information | Adopted | MOPE | 250 |
| 18. Promotion of Biofuel Use | GHG emission reduction due to the use of environment friendly fuel | $CO_2$ | Fiscal | Adopted | MF, MOPE | 100 |
| 19. Promotion of Public Passenger Traffic Use | Emission reduction and reduction of air pollution in towns | $CO_2$ | Promotion | Planned | MOPE, MP, Municipalities | 100 |
| 20. Increase of the Share in Railway Transport of Goods and Passenger | GHG emission reduction due to the transport of goods and passengers with trains | $CO_2$ | Promotion, Regulatory | Planned | Government, MP | 50 |
| 21. Strategy of the Regional and Spatial Development | GHG emission reduction due to the smaller transport distance | $CO_2$ | Regulatory | Adopted / Planned | MOPE, Municipalities | 65 |
| **Industry** | | | | | | **460** |
| 22. EEU in Industry | Higher energy efficiency in industry | $CO_2$ | Promotion, Economic | Implemented | MOPE | 400 |
| 23. Promotion of Introducing the Systems of Handling with Environment according to ISO 14001 and Joining to EMAS System | Higher energy efficiency and an increase of efficiency in industry | $CO_2$ | Promotion, Economic | Implemented | MOPE, MG | |
| 24. Eco–Labelling | Higher energy efficiency | $CO_2$ | Voluntary | Implemented | Government | Not estimated |
| 25. IPPC Directive | Higher energy efficiency and an increase of efficiency in industry | $CO_2$ | Regulatory | Adopted | MOPE, MG, GZS | 60 |

Table 4-2: Continued

| Name of policy or measure | Objective and/or activity affected | GHG affected | Type of instrument | Status | Implementing entity/ies: | Emission Reduction in 2010 [Gg $CO_2$] |
|---|---|---|---|---|---|---|
| **Agriculture and Forestry** | | | | | | 40 [1] |
| 26. Slovenian Agriculture – Environmental Programme and Programme of Countryside Development | Stimulation of sustainable practice in agriculture | $N_2O$, $CH_4$, $CO_2$ | Economic | Implemented | MKGP | 9 |
| 27. Quality Agricultural Practices on Fertilization | $N_2O$ emission reduction due to the lower level of fertilization | $N_2O$ | Regulatory | Implemented | MKGP, MOPE | 11 |
| 28. Promotion of Biogas Use for Electricity and Heat Production | GHG emission reduction due to the energy exploitation of animal and rural waste | $CH_4$ | Economic, Regulatory | Implemented / Planned | MOPE | 20 |
| 29. Co-Natural Forest Management | Conservation of biodiversity, productivity, regeneration ability, volume and vitality of forest | $CO_2$ | Regulatory | Implemented | MKGP | 840[2] |
| 30. Incentives for Agricultural Plants Cultivation for Biodiesel Acquisition | Fossil fuel reduction in transport and conservation of humus in the ground and ground fertility – less fertilizing | $CO_2$, $N_2O$ | Regulatory, Economic | Planned | MKGP | Not estimated |
| **Waste** | | | | | | 256 |
| 31. Regulation on Waste Disposal and Waste Management | Emission reduction due to the regulation and closure of dumping areas and better waste handling | $CH_4$ | Regulatory | Implemented | MOPE | Not estimated |
| 32. Waste Disposal Tax | Reduced quantity of waste | $CH_4$ | Fiscal | Implemented | MOPE, MF | Not estimated |
| 33. Separate Waste Collection and Packagin Waste Management | Reduced quantity of waste by source | $CH_4$, $CO_2$ | Regulatory | Adopted | Municipalities, MOPE, GZS | 42 |
| 34. Landfill Gas Extraction and Combustion, Energy Exploitation or Use of Landfill Gas | GHG emission reduction due to the methane exploitation | $CH_4$, $CO_2$ | Economic Regulatory | Adopted | MOPE | 126 |
| 35. Thermal Waste Processing | Reduced quantity of waste and exploitation of waste energy | $CH_4$, $CO_2$ | Regulatory | Planned | MOPE | 88 |

Table 4-2: Continued

| Name of policy or measure | Objective and/or activity affected | GHG affected | Type of instrument | Status | Implementing entity/ies: | Emission Reduction in 2010 [Gg $CO_2$] |
|---|---|---|---|---|---|---|
| **F–Gases** | | | | | | **200** |
| 36. Directive on F–gases | F–gases emission reduction | HFC, PFC, $SF_6$ | Regulatory | Planned | Government | 200 |
| **Inter-Sectoral** | | | | | | Not estimated |
| 37. $CO_2$ Tax | More efficient energy use | $CO_2$ | Fiscal | Implemented | MOPE, MF | Not estimated |
| **Kyoto Mechanisms** | | | | | | Not estimated |
| 38. Emission Trading Scheme | It enables more cost effective manner of emission reduction to polluters | $CO_2$ | Regulatory, Economic | Adopted | MOPE | Not estimated |
| 39. Clean Development Mechanism (CDM) and Joint Implementation (JI) | GHG emission reduction | All GHG | Economic | Planned | MOPE | Not estimated |
| **TOTAL** | | | | | | **4553** |

[1] Sinks are not taken into account in the total potential of measures for sector Agriculture and Forestry.

[2] Allowed sinks are estimated at 1680 Gg $CO_2$ annually for 2008–2012. A conservative assessment of sinks exploitation has been made at 840 Gg $CO_2$ since they need to be presented as the consequence of direct human activities in order to be used as a fulfilment of country's obligations.

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# 5. PROJECTIONS AND THE TOTAL EFFECT OF POLICIES AND MEASURES

Greenhouse gas (GHG) emission projections are an important source of information on effectiveness of measures and consequently on correct orientation of the country in the field of reducing GHG emissions. In order to assess the reduction of GHG emissions until 2020 two scenarios have been prepared. The "with measures" scenario anticipates the continuation of the present policy in the field of reducing GHG emissions, which is characterized by a lower intensity of measures realization. On the other hand, the "with additional measures" scenario anticipates a higher implementation intensity of the already adopted and implemented measures and the realization of all planned measures. By assessing potentials of implemented and adopted measures a "without measures" projection was made that shows a flow of emissions in case if no measures for emissions reduction are taken.

Table 5-1: GHG emission projections by gas for Energy sector

| | 1986 | 1990 | 1995 | 2000 | 2002 | With measures 2005 | With measures 2010 | With measures 2015 | With measures 2020 | With additional measures 2005 | With additional measures 2010 | With additional measures 2015 | With additional measures 2020 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Tg ($CO_2$) ; Gg ($CH_4$, $N_2O$) | | | | | | | | | | | | |
| $CO_2$ | 14.93 | 13.55 | 13.96 | 14.36 | 15.47 | 16.27 | 16.36 | 16.64 | 15.70 | 15.84 | 15.27 | 14.71 | 14.48 |
| $CH_4$ | 24.42 | 19.89 | 18.17 | 16.71 | 17.23 | 22.08 | 20.16 | 18.02 | 17.34 | 22.26 | 20.54 | 18.11 | 18.10 |
| $N_2O$ | 0.52 | 0.44 | 0.51 | 0.71 | 0.79 | 0.59 | 0.69 | 0.75 | 0.75 | 0.56 | 0.63 | 0.67 | 0.65 |
| | Tg $CO_{2\ eq.}$ | | | | | | | | | | | | |
| $CO_2$ | 14.93 | 13.55 | 13.96 | 14.36 | 15.47 | 16.27 | 16.36 | 16.64 | 15.70 | 15.84 | 15.27 | 14.71 | 14.48 |
| $CH_4$ | 0.51 | 0.42 | 0.38 | 0.35 | 0.36 | 0.46 | 0.42 | 0.38 | 0.36 | 0.47 | 0.43 | 0.38 | 0.38 |
| $N_2O$ | 0.16 | 0.14 | 0.16 | 0.22 | 0.24 | 0.18 | 0.21 | 0.23 | 0.23 | 0.17 | 0.20 | 0.21 | 0.20 |
| Total | 15.60 | 14.10 | 14.50 | 14.93 | 16.08 | 16.92 | 17.00 | 17.25 | 16.30 | 16.48 | 15.90 | 15.29 | 15.06 |

## 5.1 Emission Projections

### 5.1.1 Energy

Emission projections in energy sector were calculated as a part of preparation of the National Energy Programme [22], [23], and were corrected later on when new emission[21] inventories were made. According to the "with measures" projections GHG emissions will increase by 8.9 % up to 2010 compared to the base year 1986 and will continue to increase until 2015 when they will be drastically reduced. In 2020 GHG emissions will be 4.5 % higher than in the base year. According to "with additional measures" projections, emissions in 2010 will increase by 1.9 % with regard to the base year, while in 2020 emissions will decrease by 3.5 %. (Table 5-1, Figure 5-1).

"With additional measures" projection differs from "with measures" projection due to a higher implementation intensity of efficient energy use in industry (reduction of energy intensity in industrial processes), households and public sector (measures on buildings and heating systems, structure of household appliances) and transport (reducing energy intensity of vehicles, changes in vehicle structure, and changes in passenger and cargo transport structure). Projections differ also in the intensity of use of RES (renewable energy

21 Corrections of emission factors for lignite and a bit increased projections in the energy sector due to the emission increase in the previous years (after 2000) and higher emissions in the base year were made.

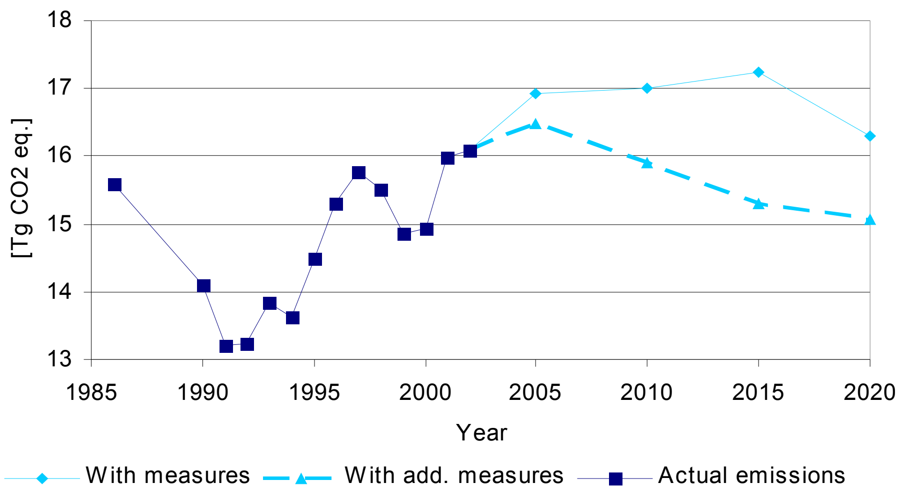


Figure 5-1: GHG emission projections in $CO_{2\ eq.}$ for Energy sector

sources) in households and public sector, in the share of electricity produced from RES, the share of co-generation and amount of used lignite due to different levels of intensity of replacing coal with natural gas in thermal power plants and CHP plants. Common assumptions in both projections are: a further development of the market, priority dispatching of Trbovlje Thermal Power Plant until 2007, the reconstruction of hydro power plants on Drava and Sava rivers, construction of a chain of hydro power plants on lower Sava, 50 % of the Krško Nuclear Power Plant production on the Slovenian electricity market and the use of lignite according to the market conditions. The model assumptions, which determine the intensity of implemented measures, are presented in Appendix B.

Table 5-2: GHG emission projections by IPCC subsector for Energy sector

| [Tg $CO_{2\ eq.}$] | | | | | | With measures | | | | With additional measures | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1986 | 1990 | 1995 | 2000 | 2002 | 2005 | 2010 | 2015 | 2020 | 2005 | 2010 | 2015 | 2020 |
| 1 Energy | 15.60 | 14.10 | 14.50 | 14.93 | 16.08 | 16.92 | 17.00 | 17.25 | 16.30 | 16.48 | 15.90 | 15.29 | 15.06 |
| A. Fuel combustion | 15.22 | 13.79 | 14.18 | 14.63 | 15.74 | 16.53 | 16.65 | 16.94 | 16.00 | 16.09 | 15.55 | 14.99 | 14.76 |
| 1.Energy supply | 6.73 | 6.27 | 5.59 | 5.51 | 6.43 | 6.65 | 6.13 | 6.18 | 5.10 | 6.62 | 5.73 | 5.18 | 5.04 |
| 2. Industry and construction | 4.17 | 3.06 | 2.50 | 2.33 | 2.41 | 2.28 | 2.41 | 2.33 | 2.32 | 2.26 | 2.37 | 2.27 | 2.26 |
| 3. Transport | 2.01 | 2.71 | 3.71 | 3.79 | 3.96 | 4.34 | 4.71 | 4.96 | 5.06 | 4.06 | 4.31 | 4.46 | 4.47 |
| 4. Other Sectors | 2.31 | 1.75 | 2.38 | 2.99 | 2.94 | 3.26 | 3.39 | 3.48 | 3.52 | 3.14 | 3.14 | 3.08 | 3.00 |
| B. Fugitive emissions | 0.38 | 0.31 | 0.32 | 0.30 | 0.34 | 0.39 | 0.35 | 0.31 | 0.30 | 0.39 | 0.35 | 0.30 | 0.30 |

Emission projections in subsectors show a clear picture in what fields the reduction of emissions is the most difficult to achieve. According to the "with measures" projection emissions will in comparison to 2002 increase in subsectors Transport (0.75 Tg $CO_{2\,eq.}$) and Other Sectors (0.46 Tg $CO_{2\,eq.}$) until 2010, and will be reduced in subsector Energy Supply (0.30 Tg $CO_{2\,eq.}$), while in subsector Industry and Construction emissions will be reduced after 2005 and in 2010 will reach the level of 2002. According to the "with additional measures" projection emissions will be reduced in Energy supply (for 0.70 Tg $CO_{2\,eq.}$) and Industry and Construction (for 46 Gg $CO_{2\,eq.}$), and will be increased in Transport (for 0.35 Tg $CO_{2\,eq.}$) and in subsector Other Sectors (for 0.20 Tg $CO_{2\,eq.}$) (Table 5-2) [22].

### 5.1.2 Industrial Processes

$CO_2$ emissions in industrial processes are directly linked to the amount of physical production. Since a growth of industrial production is anticipated in the future, the GHG emissions from industrial processes are increasing as well [37]. Methane emissions are produced during the methanol production, which is supposed not to change, therefore $CH_4$ emissions are constant [36]. Projections "with measures" and "with additional measures" differ in implementation of measures for reduction of F-gases emissions. Within the "with measures" projection no measures are taken into consideration, except for the influence of aluminium production modernization. Within the "with additional measures" projection the following measures have been taken into consideration: replacement of HFCs with other substances; EU directive on air-conditioning devices that have to be in new cars filled with a gas whose global warming potential (GWP) must be lower than 150 after 1st January 2008, improved maintenance of devices and capture of HFC out of used devices; capture of $SF_6$ out of high-voltage devices and use of devices with a lower level of leakage [36], [38]. According to the "with measures" projection GHG emissions will increase by 3.2 % in 2010 compared to the base year, while according to the "with additional measures" projection they will be reduced by 11.6 %. In 2020 emissions should be 25.3 % higher or 0.8 % lower, respectively (Table 5-3, Figure 5-2).

Table 5-3: GHG emission projections for Industrial Processes sector

| | | | | | | With measures | | | | With additional measures | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1986 | 1990 | 1995 | 2000 | 2002 | 2005 | 2010 | 2015 | 2020 | 2005 | 2010 | 2015 | 2020 |
| | Gg | | | | | | | | | | | | |
| $CO_2$ | 1021.7 | 1015.3 | 782.0 | 799.7 | 838.7 | 889.9 | 975.8 | 1061.7 | 1147.7 | 889.9 | 975.8 | 1061.7 | 1147.7 |
| $CH_4$ | 0.18 | 0.16 | 0.19 | 0.26 | 0.24 | 0.24 | 0.24 | 0.24 | 0.24 | 0.24 | 0.24 | 0.24 | 0.24 |
| | Gg $CO_{2\,eq.}$ | | | | | | | | | | | | |
| $CO_2$ | 1021.7 | 1015.3 | 782.0 | 799.7 | 838.7 | 889.9 | 975.8 | 1061.7 | 1147.7 | 889.9 | 975.8 | 1061.7 | 1147.7 |
| $CH_4$ | 3.7 | 3.4 | 3.9 | 5.4 | 5.1 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 |
| HFC | 0.0 | 0.0 | 30.6 | 44.7 | 69.2 | 152.1 | 286.0 | 354.9 | 412.1 | 75.4 | 107.8 | 92.4 | 82.7 |
| PFC | 276.3 | 257.4 | 285.7 | 105.6 | 116.4 | 116.4 | 44.4 | 44.4 | 44.4 | 116.4 | 44.4 | 44.4 | 44.4 |
| $SF_6$ | 7.2 | 7.2 | 25.3 | 21.0 | 21.0 | 37.0 | 119.5 | 28.7 | 31.1 | 22.7 | 23.9 | 21.5 | 19.1 |
| Total | 1308.8 | 1283.3 | 1127.5 | 976.5 | 1050.5 | 1200.5 | 1430.8 | 1494.8 | 1640.3 | 1109.5 | 1157.0 | 1225.1 | 1298.9 |

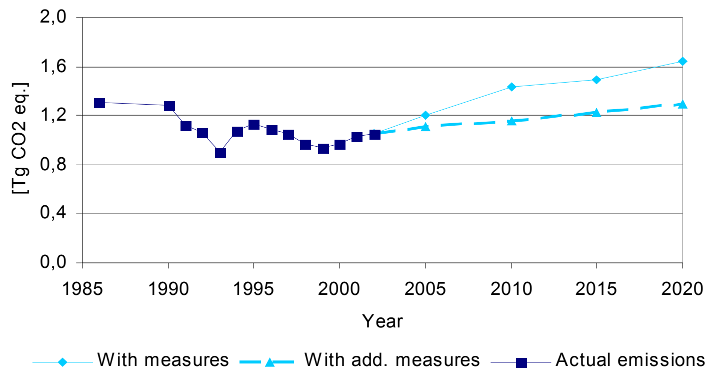


Figure 5-2: GHG emission projections in $CO_{2\ eq.}$ for Industrial Processes sector

### 5.1.3 Waste

In the Waste sector methane emissions contribute most to the GHG emissions. In the "with measures" projection two measures have been taken into consideration: separate collection of waste and packaging waste recycling that would result in reducing the amount of waste, and removal of landfill gas and its burning or energy use. In the "with additional measures" projection the construction of two incineration plants was assumed. Besides solid waste, waste water treatment contributes to emissions as well. In the "with measures" projection a continuation of the existing practice of waste water treatment was anticipated. In the "with additional measures" projection the following measures were considered for waste water: an increase in municipal waste water collection and treatment, an increase in municipal water treatment, reconstruction of existing municipal biological waste water treatment plants in accordance with EU standards, an increase of treatment of organically loaded industrial waste water, and thermal treatment of Biological waste water treatment plants sludge.

GHG emissions in the Waste sector after 2002 are on decrease according to both projections. Until 2010 they are supposed to decrease by 8.3 % compared to the base year (1986) according to the "with measures" projection, while according to the "with additional measures" projection by 17.6 %. In 2020 emissions will be reduced by 40.8 % in comparison to the base year according to the "with measures" projection and by 60.4 % according to the "with additional measures" projection (Table 5-4, Figure 5-3) [41].

Table 5-4: GHG emission projections for Waste sector

| | | | | | | With measures | | | | With additional measures | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1986 | 1990 | 1995 | 2000 | 2002 | 2005 | 2010 | 2015 | 2020 | 2005 | 2010 | 2015 | 2020 |
| | | | | | | Gg | | | | | | | |
| $CO_2$ | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| $CH_4$ | 45.29 | 44.00 | 51.87 | 53.46 | 50.64 | 47.58 | 42.27 | 33.63 | 26.87 | 47.58 | 38.08 | 27.05 | 18.39 |
| $N_2O$ | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 | 0.07 | 0.04 | 0.03 |
| | | | | | | Tg $CO_{2\ eq.}$ | | | | | | | |
| $CO_2$ | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| $CH_4$ | 0.95 | 0.92 | 1.09 | 1.12 | 1.06 | 1.00 | 0.89 | 0.71 | 0.56 | 1.00 | 0.80 | 0.57 | 0.39 |
| $N_2O$ | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.02 | 0.01 | 0.01 |
| Total | 1.00 | 0.97 | 1.14 | 1.17 | 1.11 | 1.03 | 0.91 | 0.73 | 0.59 | 1.03 | 0.82 | 0.58 | 0.40 |

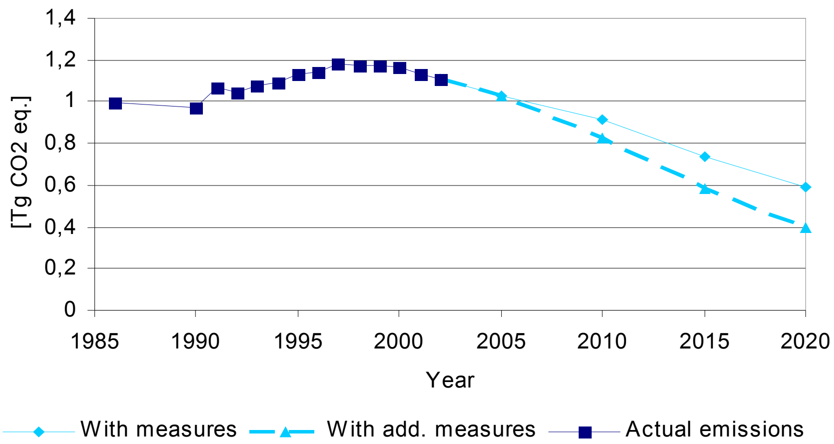


Figure 5-3: GHG emission projections in $CO_{2\,eq.}$ for Waste sector

### 5.1.4 Agriculture

As GHG emission projection "with measures" for Agriculture was made, the following measures were taken into account: the construction of new anaerobic digesters for gas capture on pig and cattle farms, a decrease in amount of extensive pig breeding, an increase of the pasture share and reduction of fertilization with mineral fertilizers. "With additional measures" projection is additionally reduced by 50 Gg $CO_{2\,eq.}$, which was determined in the Action Plan for Reducing GHG Emissions for the Agriculture sector by the Slovenian Government. GHG emissions in the Agriculture will according to "with measures" projection slightly increase after 2002 and will be reduced by 14.3 % in 2010 compared to the base year, while according to the "with additional measures" projection they should be reduced by 16.2 %. In 2020 emissions are supposed to be 15.0 % or 16.9 % lower in comparison to the base year (Table 5-5, Figure 5-4). Emission increase is the consequence of cattle breeding change, an increase in the number of cattle in accordance with quotas that Slovenia received in the negotiations with EU and increase in production of grainy legumes [39], [40].

Table 5-5: GHG emission projections for Agriculture sector

| | | | | | | With measures | | | | With additional measures | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1986 | 1990 | 1995 | 2000 | 2002 | 2005 | 2010 | 2015 | 2020 | 2005 | 2010 | 2015 | 2020 |
| | | | | | | | Gg | | | | | | |
| $CO_2$ | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| $CH_4$ | 50.61 | 47.57 | 42.86 | 41.29 | 40.53 | 42.41 | 43.99 | 43.54 | 43.59 | 42.41 | 42.99 | 42.55 | 42.59 |
| $N_2O$ | 4.84 | 4.17 | 4.15 | 3.92 | 3.93 | 4.03 | 4.11 | 4.09 | 4.08 | 4.03 | 4.02 | 4.00 | 3.99 |
| | | | | | | | Tg $CO_{2\,eq.}$ | | | | | | |
| $CO_2$ | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| $CH_4$ | 1.06 | 1.00 | 0.90 | 0.87 | 0.85 | 0.89 | 0.92 | 0.91 | 0.92 | 0.89 | 0.90 | 0.89 | 0.89 |
| $N_2O$ | 1.50 | 1.29 | 1.29 | 1.22 | 1.22 | 1.25 | 1.28 | 1.27 | 1.27 | 1.25 | 1.25 | 1.24 | 1.24 |
| Total | 2.56 | 2.29 | 2.19 | 2.08 | 2.07 | 2.14 | 2.20 | 2.18 | 2.18 | 2.14 | 2.15 | 2.13 | 2.13 |

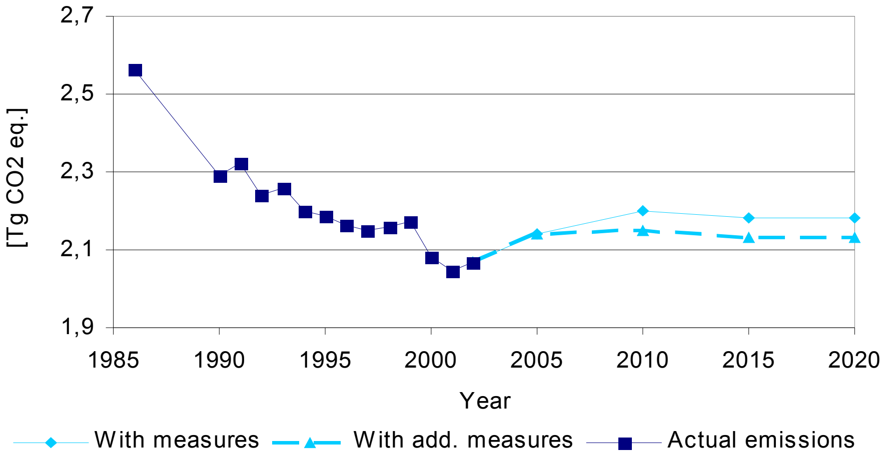


Figure 5-4: GHG emission projections in $CO_{2\ eq.}$ for Agriculture sector

### 5.1.5 Total GHG Emissions

Total GHG emission projection is calculated as a sum of emission projections of separate sectors. Emissions of the solvent and other product use sector were also taken into account, although its projections were not presented separately. A projection made for the First National Communication was used for these emissions. According to "with measures" projection the amount of total emissions in 2010 will be 21.58 Tg $CO_{2\ eq.}$ which is 4.7 % higher than emissions in 1986, while according to the "with additional measures" projection they will make 20.07 Tg $CO_{2\ eq.}$, which is 2.6 % less than in 1986 (Table 5-6).

Figure 5-5 shows a trend of GHG emissions according to different projections. Projection "without measures" was obtained by adding the potentials of implemented and adopted measures (Table 5-8) to the "with measures" projection.

According to the Kyoto protocol Slovenia should reduce its average emissions in the commitment period 2008–2012 by 8 %, according to gas emissions of $CO_2$, $CH_4$, and $N_2O$ in 1986, and F–gas emissions in 1995.

Table 5-6: Total GHG emission projections

| | | | | | | With measures | | | | With additional measures | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1986 | 1990 | 1995 | 2000 | 2002 | 2005 | 2010 | 2015 | 2020 | 2005 | 2010 | 2015 | 2020 |
| | Tg ($CO_2$) ; Gg ($CH_4$, $N_2O$) | | | | | | | | | | | | |
| **$CO_2$** | 16.00 | 14.60 | 14.77 | 15.20 | 16.35 | 17.18 | 17.35 | 17.72 | 16.87 | 16.75 | 16.26 | 15.78 | 15.64 |
| **$CH_4$** | 120.50 | 111.62 | 113.09 | 111.72 | 108.64 | 112.32 | 106.66 | 95.43 | 88.03 | 112.49 | 101.85 | 87.94 | 79.32 |
| **$N_2O$** | 5.78 | 4.90 | 4.87 | 4.92 | 4.99 | 4.17 | 4.95 | 4.99 | 4.98 | 4.73 | 4.78 | 4.77 | 4.73 |
| | Tg $CO_{2\ eq.}$ | | | | | | | | | | | | |
| **$CO_2$** | 16.00 | 14.60 | 14.77 | 15.20 | 16.35 | 17.18 | 17.35 | 17.72 | 16.87 | 16.75 | 16.26 | 15.78 | 15.64 |
| **$CH_4$** | 2.53 | 2.34 | 2.37 | 2.35 | 2.28 | 2.36 | 2.24 | 2.00 | 1.85 | 2.36 | 2.14 | 1.85 | 1.67 |
| **$N_2O$** | 1.79 | 1.52 | 1.51 | 1.52 | 1.55 | 1.29 | 1.53 | 1.55 | 1.54 | 1.47 | 1.48 | 1.48 | 1.46 |
| **F-gases** | 0.28 | 0.26 | 0.34 | 0.17 | 0.21 | 0.31 | 0.45 | 0.43 | 0.49 | 0.21 | 0.18 | 0.16 | 0.15 |
| Total | 20.60 | 18.73 | 19.00 | 19.24 | 20.38 | 21.14 | 21.58 | 21.69 | 20.75 | 20.79 | 20.06 | 19.27 | 18.92 |

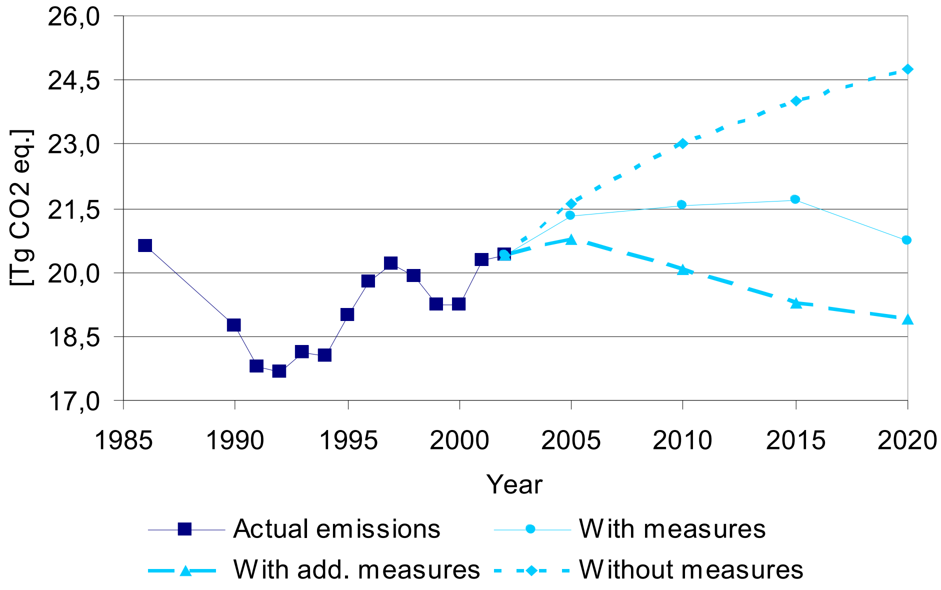


Figure 5-5: Total GHG emission projections in $CO_{2\,eq.}$ with no sinks considered

That means that average GHG emissions in Slovenia in this period may reach a maximum of 19.01 Tg $CO_{2\,eq}$. Emissions according to the "with additional measures" projection make 19.85 Tg $CO_{2\,eq.}$ in the commitment period without taking sinks into account. Sinks which Slovenia is allowed to use, are estimated to 1.68 Tg $CO_2$[22]. A conservative assessment of sinks exploitation has been made at 840 Gg $CO_2$ since they need to be presented as the consequence of direct human activities in order to be eligible for the fulfilment of country's obligations. If emissions are reduced according to the projection 'with additional measures' and 840 Gg $CO_2$ of sinks are added, then that makes 19.01 Tg $CO_{2\,eq.}$ in the first commitment period, which is in accordance with the demand of Kyoto protocol. Slovenia will therefore reach the emission reduction demanded by the Kyoto protocol.

Figure 5-6 shows the trend of GHG emissions by 2002 and the predicted emissions from 2002 to 2020 according to the "with additional measures" projection without sinks and with sinks in amount of 840 Gg $CO_2$. This figure shows that Slovenia was 536 Gg $CO_{2\,eq.}$ (2.8 %) above the Kyoto goal in 2002 and was 15 Gg $CO_{2\,eq.}$ (0.1 %) above the linear approach towards the Kyoto goal taking sinks (840 Gg $CO_2$) into account. This figure also shows that Slovenia will reach the Kyoto level of emissions for the target period 2008–2012 despite the increase of emissions in 2005.

22 For Slovenia allowed sinks from the forestry sector are 1.32 Tg $CO_2$ in accordance with the decision 11/CP.7 adopted at COP 7 in Marrakesh, and other allowed sinks are 0.36 Tg $CO_2$ (land use and land use change).

Table 5-7: Average emissions in the period from 2008 to 2012 according to "with additional measures" projection and emissions in the base year

| Gg $CO_{2\ eq.}$ | Emissions in the base year[1] | Average emissions 2008–2012 | Deviations from the base year |
|---|---|---|---|
| $CO_2$ | 15,998 | 16,061 | 0.4% |
| $CH_4$ | 2,531 | 2,130 | -15.8% |
| $N_2O$ | 1,790 | 1,479 | -17.3% |
| F–gases | 342 | 178 | -48.0% |
| **Total** | **20,660** | **19,847** | **-3.9%** |
| | | | |
| Energy | 15,603 | 15,689 | 0.6% |
| Industrial processes | 1,367 | 1,164 | -14.9% |
| Solvent and other product use | 128 | 36 | -72.2% |
| Agriculture | 2,564 | 2,145 | -16.4% |
| Waste | 997 | 815 | -18.3% |
| | | | |
| Sinks | | 840 | |
| **Total emissions with sinks** | | **19,007** | **-8.0%** |

[1] The base year for $CO_2$, $CH_4$ and $N_2O$ is 1986, while for F–gases it is 1995

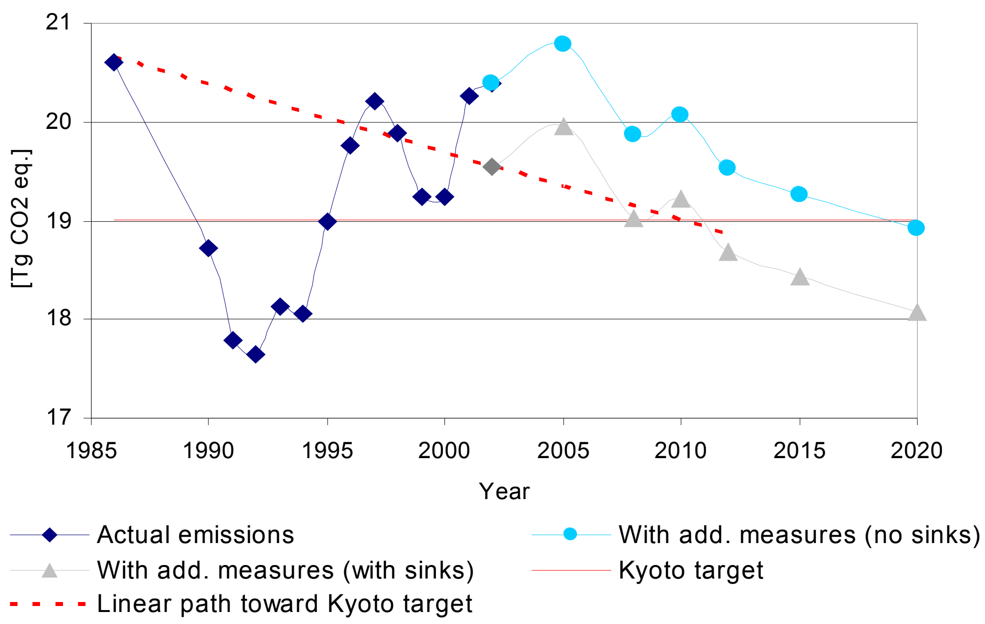


Figure 5-6: GHG emissions without sinks and projected GHG emissions according to "with additional measures" projection with and without sinks

## 5.2 Methodology

### 5.2.1 Energy

In order to prepare emission projections in the IPCC sector Energy a set of models whose main tool is a reference energy ecological model called REES-SLO, made in the MESAP environment, was used. Besides the REES-SLO model this set of models consists of other models as well: market penetration of energy-saving final use technologies assessment model (PET-SLO), simulation of an electrical load curves model (ELAM-SLO) and model of calculating electricity production balance on a free market (ELBIVIM).

The main information flow between programme packages takes place in the following order:

1. Firstly, market shares of certain energy-saving technologies with final users are calculated using a PET-SLO model as a response to the changed price signals, financial stimulation and an information campaign. The assessment of market shares of certain technologies and their costs serve as an input data for the basic model of the reference energy system (REES-SLO) in MESAP.
2. MESAP calculates perspective balances of final energy use and assesses the local production of electricity based on shares of different technologies in the structure of final use and connections with influential parameters (levels of economic activity in different sectors, number of households, etc.). The final use of electricity divided to sectors by intention, and production in local supply systems (in industrial, distribution and private units) is transferred to the treatment of the analysis of the load shape programme.
3. ELAM-SLO simulates the course of hourly demand on the electricity transmission level taking into account typical users and local producers load shapes and annual electricity demand[23].
4. By using ELBIVIM model, electricity production balances can be calculated on the free electricity market, based on domestic demand, available transmission import/export capacities, international prices of electricity and other presumptions.
5. Shares of electricity production in individual units calculated in 4. and its costs are transferred to MESAP / REES-SLO model. By the MESAP model other balances are calculated for the whole planning period: primary and secondary energies, balances of emissions ($CO_2$, $CH_4$, $N_2O$, $SO_2$ in $NO_X$) and total costs.

*Reference energy ecological model REES-SLO*

Technically orientated REES-SLO model was developed in a MESAP environment[24] in a form of linear network model of processes and connections (reference energy system), which enables consistent modelling of energy use based on needs of energy services and energy supply according to the Integrated Resource Planning method. A calculation of emissions, costs and other influential phenomena is being made simultaneously. The logical process-technological model enables simulation and evaluation of anticipated instruments and their influences, as the set of instruments are connected within strategies. The calculating model with a transparent model

23 When preparing strategies the tool was not used, while diagrams of burdens were made with a similar tool on the Electro Institute Milan Vidmar (EIMV).

24 MESAP environment – Modular Energy Systems Analysis and Planning was developed on a Institute of Energy Economics and Rational Use of Energy at the University of Stuttgart (MESAP is now being developed and to market by a company Seven2one, www.seven2one.de).

presentation prevents double counting and unconnected consideration of effects and serves as a frame for consistent and equal access to the identification of instruments, measures and final effects in different sectors and subsectors[25]. The model has been used before for the preparation of energy strategies and the National Energy Programme, as well as for expert groundwork for assessing potentials on GHG emission reduction and when the Action Plan for Reducing GHG Emissions was prepared [22].

### 5.2.2 Industrial Processes

Projection of $CO_2$ emissions in industrial processes was made on the basis of industrial production growth projection, taking into account different emission factors for different activities [37]. $CH_4$ emissions were constant, since the only source, the ethanol production, was considered to be constant [36]. When preparing F-gases projections a study of the only aluminium producer, Talum, which is also the only source of $CF_4$ and $C_2F_6$ emissions, was taken into account. Projections were summarized after the first national report, while HFC emissions in the projection with additional measures were additionally reduced due to a EU directive on filling air-conditioning in new cars with a gas with GWP less than 150 [36], [38].

### 5.2.3 Waste

Solid waste emission projections were made by using IPCC methodology. Emissions for waste, deposited before 1977, that were mainly in disorganized or poorly compressed condition with landfill covering only after the landfills were closed, were estimated according to the simplified IPCC methodology. When assessing landfills emissions with waste landfilled after 1977, that was partly compressed and compacted and most of the landfills were regularly covered at the time, a more accurate IPCC methodology, using time series, was used. Therefore a constant amount of the waste produced in 2001 and a gradual reduction of the amount of the landfilled waste was anticipated. The composition of waste and the structure of biologically degradable part was constant and was summarised according to the results of some sowing analyses in Slovenia and international data [41].

For waste water emissions calculation the IPCC methodology was used[26]. In order to assess $CH_4$ emissions the following input data were taken into account: planned biological treatment of municipal and industrial organically loaded waste water up to 2015 in Slovenia, organic load, the share of actually decomposed organic substances, conversion factor and use of produced gas. According to the IPCC methodology $N_2O$ emissions were assessed on the presumption that all of the nitrogen from waste water ends up in water environment [35]. Original projections for waste water were postponed for a few years due to a still not adopted operative programme on waste treatment and a slow dynamics of drainage system construction and waste water treatment as foreseen in a study, within which the projections were made.

### 5.2.4 Agriculture

Agriculture emission projections[27] were done according to the methodology, regulated by IPCC (1997). IPCC methodology anticipates agriculture emission projections based on statistical data about the extent of production and an increase in breeding taking into account some specific

25 The Slovenian model was made within the PHARE project: Integrated Resource Planning for the Rational Use of Energy in Slovenija, 1997, and was upgraded and improved later on. This model shows the whole use of energy in Slovenia with all the sectors of final use included (secondary industry, households, services, other activities in transport) and local and central energy supply

26 »IPCC Guidelines for National Greenhouse Gas Inventories« (1996)

27 Assessment of reduced GHG emissions potentials in the Agriculture sector, with quotas form the preaccession negotiations with EU taken into account, KIS, Ljubljana 2003

procedures characteristic of particular countries or areas. Data on the extent of production and cattle breeding are despite their interdependence treated separately. Therefore the model based on IPCC methodology does not enable optimization on the level of the entire agriculture, but only on separate segments. Slovenian Statistical Office data and information obtained from experts in agricultural sector were used for the assessment [39].

## 5.3 Assessment of Projections Uncertainty

Slight changes in basic input assumptions can have significant impact on the final result of projections, which can be assessed quantitatively with the analysis of the impact of changes on the result. Uncertainty of the projections causes uncertainty in implementing measures, since it is difficult to anticipate to what extent certain measures will actually be implemented. This chapter will also deal with the quantitative assessments of the impact of input parameters on projection.

An outcome of Energy emission projections depends especially on the realisation of measures taken into consideration in the field of RES and EEU where availability of budget finances will be a major factor and where in recent years a large gap between the planned and implemented activities has been noticed. The dynamics of transition to natural gas in electricity production depends on future market trends and social problems with reducing the domestic coal production. As a consequence of the uncertainty of future coal mining development fugitive emission projections are uncertain.

Despite the stabilization in transport emissions in recent years, projections are still rather uncertain due to uncertain development scenarios of transport work in Slovenia, potential increase in transit transport and possible important influence of neighbouring countries.

Among the input data the most important foreseen development is in the field of economy and service industry. Emission comparison with projections in the Energy sector according to the higher scenario of economic development, which anticipates a 4 % GDP growth in the 2000–2020 period (1.2 % higher than in the development scenario used and a subsequent higher manual product in industry and services) and faster growth of residential area and the number of residences (+0.22 % / a) shows the span of GHG emissions between 16.0 in 17.2 Tg $CO_{2\ eq.}$ in 2010, which reflects the uncertainty of the performed projections.

Uncertainty of emission assessments in agriculture was assessed according to IPCC (2000)[28]. Uncertainties were assessed by individual sources of emissions, while the combined uncertainty was estimated by the rule A if additive quantities were used, or by rule B when assessments were a product of activity data and emission factors (IPCC, 2000). When assessing uncertainty of input data and emission factors an EMEP/CORINAIR (2002) reference book was used as well. Methane emission uncertainty was estimated at 19 %, while nitrous oxide emissions at 230 %. Uncertainty with emissions for both gases in agriculture was assessed at 135 % [40].

## 5.4 Assessment of Total Measures Potential

Assessments of measure potentials presented in this chapter were made for the needs of the Third National Communication and differ in terms of the IPCC Energy sector from the measure potentials presented in the Action Plan for Reducing

28 IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (Penman et al., ed.), IPCC, 2000

Table 5-8: Assessment of a total effect of implemented and adopted measures (measures used in a "with measures" projection), by sector and gas

| [Gg $CO_{2\,eq.}$] | 2005 | 2010 | 2015 | 2020 |
|---|---|---|---|---|
| Energy | 242 | 1234 | 1923 | 3489 |
| Ind. processes | 0 | 0 | 0 | 0 |
| Agriculture | 20 | 39 | 59 | 62 |
| Waste | 40 | 176 | 337 | 470 |
| $CO_2$ | 232 | 1193 | 1852 | 3369 |
| $CH_4$ | 55 | 226 | 416 | 585 |
| $N_2O$ | 14 | 30 | 50 | 68 |
| F–gases | 0 | 0 | 0 | 0 |
| **Total** | **301** | **1449** | **2319** | **4021** |

Table 5-9: Assessment of a total effect of planned (additional) measures (measures taken into account in a "with additional measures'), by sector and gas

| [Gg $CO_{2\,eq.}$] | 2005 | 2010 | 2015 | 2020 |
|---|---|---|---|---|
| Energy | 440 | 1098 | 1955 | 1237 |
| Ind. processes | 91 | 274 | 270 | 341 |
| Agriculture | 0 | 50 | 50 | 50 |
| Waste | 0 | 93 | 152 | 178 |
| $CO_2$ | 432 | 1089 | 1933 | 1223 |
| $CH_4$ | -4 | 101 | 157 | 183 |
| $N_2O$ | 12 | 51 | 67 | 59 |
| F–gases | 91 | 274 | 270 | 341 |
| **Total** | 531 | 1515 | 2427 | 1806 |

GHG Emissions and in the chapter Policies and Measures. The difference appears due to the time lag by performing the measures. The consequence is that measure potentials for 2010 according to the new assessment are half lower compared to older assessments, while the measure potentials for 2015 by the new assessment are comparable to measure potentials for 2010 by the old assessment. The total potential assessment of the implemented, adopted and planned measures was made as a sum of potentials of individual measures. The assessments of individual measures potential were made by using models that were used for calculating projections. In order to calculate the measures, year 2000 was anticipated as the starting year for their implementation.

Table 5-8 shows total potentials of realised and adopted measures by sector and gas. We can see that emission reduction measures in the Energy sector are the ones that will contribute most to the emission reduction according to the with measures projection. The least will decrease emissions from the Agriculture sector. Among the gases $CO_2$ emissions will decrease most. Table 5-9 shows potentials of planned measures. The total potential of all measures (implemented, adopted and planned) makes 3.0 Tg $CO_{2\,eq.}$ in 2010 and 4.8 Tg $CO_{2\,eq.}$ in 2015.

## 5.5 Key Assumptions

In order to interpret the results of projections correctly the key assumptions that were taken into account for running the models need to be clear. Some of them are presented in Table 5-10. Assumptions used in emission projections for the Energy sector can be divided into three levels. General data include basic parameters of model calculation and adopted assumptions, such as population growth, projection of traffic work in passenger and freight traffic, adopted technological development and a scenario of international oil and energy prices. The following parameters are used as scenario data: assumptions about GDP growth, added value, physical product of industry and other sectors and area, and a number of dwellings. A complex of strategic instruments for GHG emission reduction represents the third level. The key assumption in the agricultural sector projections is the number of livestock.

Table 5-10: Basic assumptions for projection calculation

| | Unit | 1990 | 1995 | 1997 | 2000 | 2005 | 2010 | 2015 | 2020 |
|---|---|---|---|---|---|---|---|---|---|
| Population[1] | 1000 inhabitants | 1998 | 1988 | 1987 | 1990 | 1985 | 1980 | 1975 | 1964 |
| GDP growth | % | no data (n.d.) | 4.1 | 4.6 | 3.4 | 3.4 | 3.7 | 2.3 | 2.1 |
| Dwelling area | 1000 $m^2$ / a | 47,511 | 47,810 | 49,094 | 50,630 | 54,142 | 58,114 | 61,7334 | 65,163 |
| Number of personal cars | 1000 / a | 578.3 | 698.2 | 764.8 | 847.9 | 930.1 | 993.8 | 1037.4 | 1057.7 |
| Number of passenger km | Mpkm / a | n.d. | 16,578 | 24,295 | 25,772 | 28,435 | 31,088 | 33,491 | 35,374 |
| Number of freight km | Mtkm / a | n.d. | 6385 | 7600 | 8593 | 10,967 | 13,344 | 15,847 | 17,930 |
| Total consumption of energy | | | | | | | | | |
| With additional measures | Mtoe | 6.18 | 6.10 | 6.49 | 6.33 | 7.00 | 7.13 | 7.10 | 7.17 |
| With measures | Mtoe | | | | | 7.09 | 7.32 | 7.50 | 7.39 |
| Energy intensity | | | | | | | | | |
| With additional measures | toe / Mio $EUR_{1995}$ | | 402.5 | 397.5 | 348.7 | 327.0 | 278.3 | 247.3 | 225.2 |
| With measures | toe / Mio $EUR_{1995}$ | | 402.5 | 397.5 | 348.7 | 331.0 | 285.6 | 261.3 | 232.3 |
| Petrol prices | | | | | | | | | |
| Oil | $USD_{2000}$ / barrel | | | 20 | 28 | 23 | 21 | 24 | 28 |
| Natural gas | $USD_{2000}$ / GJ | | | 2.8 | 2.6 | 2.8 | 2.7 | 3.1 | 4.0 |
| Coal | $USD_{2000}$ / t | | | 47 | 34 | 47 | 47 | 47 | 47 |
| Import of electricity | EUR/MWh | | | | 46.0 | 34.0 | 33.0 | 41.5 | 48.0 |
| Number of animals | | | | | | | | | |
| Cattle | | 546,048 | 495,535 | 445,724 | 493,670 | 491,566 | 520,269 | 527,700 | 527,700 |
| Pigs | | 557,878 | 592,034 | 578,193 | 603,594 | 657,819 | 661,410 | 665,000 | 665,000 |

Source: IJS–CEU, Agriculture Institute of Slovenia

[1] Information on the number of inhabitants used in the model differs from the one presented in a National circumstances chapter due to different sources. In the chapter over national circumstances the results of censuses from 1991 and 2002 by methodology of the 2002 census are presented, the model uses the data on number of inhabitants published on the basis of a balance calculation of the number of inhabitants (from 1920 until 1953), municipal registers of permanent inhabitants (from 1954 until 1984), Central register of inhabitants (from 1985 until 1994) and a changed definition of inhabitants (since 1995).

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# 6. VULNERABILITY ASSESSMENT, CLIMATE CHANGE IMPACTS AND ADAPTATION MEASURES

Due to its orographic and climatic features, Slovenia falls within the group of countries highly vulnerable to climate change. Based on the results of General Circulation Models, a 1 to 4 °C temperature increase and a change in the amount of rainfall (from -20 % to +20 % according to the average amount in the period 1961–1990) are expected in Slovenia in the first half of the 21st century. The most probable climate development in Slovenia in the future is directed towards warm and slightly drier summers, warm winters with a rather unchanged average level of rainfall and an increased frequency of extreme weather events. The impact of climate change will be very extensive. Higher temperatures, changed water balance and more frequent extreme events will affect agriculture, forests will be exposed to increased stress, biodiversity will be endangered, threats with floods will be increased, drinking water supply problems will emerge, risks in Alps and other highlands will be increased, coastal areas will be affected due to the rise of sea level and sea temperatures. Indirect and direct negative impacts such as increased thermal burden and increase in population of disease hosts and transmitters are expected on the health and well-being of people, energy use patterns will be changed, energy production problems will arise due to smaller flow of rivers, tourist activities will be affected, particularly winter sport tourism.

A detailed assessment of vulnerability, impact of climate change and identification of mitigation measures in the Agricultural and Forestry sectors were made in this Communication. The following Communications will in turn expose these issues in other fields as well.

## 6.1 Impacts of Climate Change on Agriculture

Physical impacts of climate change and increased concentrations of $CO_2$ in the atmosphere on plants and animals will be numerous. Increased concentration of $CO_2$ with its physiological effects will be important for plant cultivation and increment of the forest, while changed weather circumstances will be crucial. Changed water balance will also have a decisive effect on agricultural cultivation. Economic impacts of climate change on Slovenian agriculture are barely predictable, since they are connected to political decisions; especially when it comes to changing centres and focuses of agricultural production, increased risks with agricultural production, different subsidies, food import and export, etc. Global assessments anticipate a 10–20 % rise in the prices of agricultural production due to climate changes. Studies reveal that certain risks, which accompany agriculture, will increase considerably, especially the probability of damages done by the weather, such as drought, storms and floods. Climate change impacts on agriculture can be divided into three categories (Table 6-1).

### 6.1.1 Impact of Air Temperature Rise on the Length of Vegetation Period

In the case of a 1 °C temperature rise, the beginning of the period above temperature band between 5 °C and 10 °C arrives one week earlier in spring and ends 6 days later in autumn. The length of the period above the 5 °C temperature limit extends for more than 5 % and for 7 % above the 10 °C temperature limit. Absolute prolonging of the vegetation period above the mentioned limits is higher at lower geographic locations, while relative prolonging is higher at higher locations. The results at 3 °C warming-up show that the be-

Table 6-11: Some impacts of the changed climate on agriculture

| Positive impacts | Conditionally positive impacts | Negative impacts |
|---|---|---|
| • the fertilising impact of increased $CO_2$ concentration<br>• a longer vegetation period<br>• more suitable temperature circumstances for fertilisation of thermally demanding plants | • spatial shifts of agricultural production<br>    • shift of vegetation zones, change in cultivation areas volume, shift to higher sites<br>    • improvement/aggravation of thermal characteristics of areas that are now too warm/too cold<br>• change in crops quality<br>• change in selection of sorts<br>• change of agrotechnical practice<br>    • change of dates for sowing, planting, harvest,...<br>    • other manners of ground cultivation, changed fertilisation | • shortening of the growing time (enhanced plant development)<br>• more intensive evapotranspiration<br>• increased frequency of extreme weather events<br>    • storms with wind, hail, heavy rain<br>    • increased damage due to spring frosts<br>    • droughts, fires<br>    • floods, land-slips<br>• changed frequency and intensity of pest attacks and diseases<br>    • enhanced development of insects and fungus<br>    • new pests and diseases |

ginning of the year period above the temperature level of 5 °C or 10 °C will in average come 20 days earlier, while in autumn the period will end 18 days later. The length of the period above the temperature limit of 5 °C extends by 16 % at the 3 °C warming-up, and by 22 % above the temperature limit of 10 °C.

### 6.1.2 Changes of Temperature Sums

In agrometeorology thermal conditions on a location can be presented by temperature sums, degree-days. Accumulated warmth of cultural plants has a significant impact on their phenological development, while the quality of the crop also depends on the time within which the needed degree-days are achieved. In the case of 1 °C warming-up sums of active temperatures increase on average by 14 %, which makes around 390 °C on an absolute scale; at 3 °C warming-up we get a relative difference of 38 % (absolute around 1100 °C). Relative increase grows, while absolute increase falls with increasing sea-level height. The impact of average warming-up by 1 °C is a 26 % increase of the sum of effective temperatures above the 10 °C threshold (which makes 250 °C on an absolute scale), while at a 3 °C warming-up there is a 77 % relative difference, which makes around 730 °C on an absolute scale.

Plants with higher needs for warmth, such as tobacco, cotton, watermelons, kiwi or a selection of sorts now growing at higher altitudes could potentially be grown in Slovenia. However, we need to be aware of the combination of higher air temperatures in July and August with inconvenient phenomena of meteorological or even physiological drought. Positive impacts will take place only if other growth factors are not in deficit.

### 6.1.3 Impacts of Air Temperature Rise on the Length of the Growth Period

The expected temperature rise will cause a faster rate of development and will therefore shorten the length of the growth period. The duration of the growth period with the double concentration of $CO_2$ in corn should, by some anticipations, shorten for 15–30 days, depending on the scenario. Shortening of the growth period, i.e. the number of days from the beginning of the growth until the maturity, and early crop maturation linked to it, especially shortened phase of corn grain filling, can be taken as a negative consequence of global warming. Too rapid transition of plants from the vegetative to the generative stage means there are fewer days for assimilation and a smaller leaf surface.

In Slovenian conditions the growth period for corn lasts from 150 to 160 days, the shortening of the growth period for hybrids, which need 1600 °C–1700 °C of effective temperatures, takes 2 weeks at the 1 °C warming level and from 4 to 5 weeks at 3 °C. At 1 °C warming, the shortening of the growth period for summer cereals will be the shortest – 2–3 days for the sorts with the shortest growth period (70 days), while shortening depends on the amount of accumulated warmth that a certain sort needs for its development from germination to maturity. For summer cereals with the longest growth period (150 days) shortening of the growth period at 1 °C warming level is estimated at 10 to 13 days, at 3 °C temperature rise the shortening of the growth period is estimated at 4 weeks for the sorts with the most extensive warmth demands. Assessments of the growth period shortening for winter cereals, with the growth period between 200 and 290 days, show much larger differences than for summer cereals. The shortening of the growth period for hops at a 1 °C temperature rise for varieties whose growth period is between 150 and 160 days, and which need a sum of active air temperatures between 2400 °C and 2500 °C (e.g.. species 'Savinjski golding'), takes from 9 to 10 days, and from 23 to 27 days at a 3 °C warming. Vine has more extensive warmth demands for its development than most other agricultural plants, and when warmed up for 1 °C the shortening of the period from the beginning of growth until maturity will be 1–2 weeks for sorts with a growth period of 150–200 days and a sum of needed active temperatures between 2300 °C and 3000 °C. In case of a 3 °C temperature rise, the estimations predict a 3-week-growth-period shortening for the sorts with the shortest growth period and a 5-week shortening for those with the longest growth period.

Certain adjustments will have to be made at the plant cultivation, particularly the following ones: change of the sowing dates, changed varieties (replacing earlier sorts with the late ones), irrigation or selection of sorts that are not too sensitive to drought and probably more intensive fertilisation in order to compensate for shortened growth periods and water stress. As for the plant protection, we can conclude that it will only be possible to cope with an increased number of infections or an increased number of development circles of pests with a good observation net and the use of suitable forecast models will be paramount for suggesting a suitable time and appropriate measures. However, we need to be aware that supposedly higher air temperatures in the future will lead to favourable circumstances for an extensive and faster development of diseases and pests. That is also the reason the costs of plant protection from pests and diseases and presumably the costs of entire plant cultivation will increase.

All adjustment measures are not economically equal. Replacing sowing dates with an earlier date is connected to the risk of late spring white-frosts, while irrigation is possibly too expensive. Therefore, it is recommendable to think about new plant varieties and a changed fertilisation practice. Possible adjustments ought to be searched in new technologies, such as biotechnology.

## 6.2 Impacts of Climate Change on Forest Ecosystems

Possible reactions of forest ecosystems to the climate change are:

- **Changes in the location of the forest** – due to the climate change, huge forests with the characteristics of many species can move to new locations
- **Changes in forest structure** – structure of species in some forests is different today from that in the past. With time certain species changed their areas with a high degree of independence. For instance, the areas of species were changed into different distribution patterns with a different speed, the size of population has been increasing and decreasing. These processes can contribute to new combinations of species and categories of forests.
- **Changes in forest production** – climate change will change temporal temperature patterns and rainfall, i.e. the factors greatly influencing the forest production. Increased concentration of $CO_2$ in the atmosphere might influence the water balance of plants and the speed of photosynthesis, which will also have an impact on forest production

How the forest ecosystems will respond to climate change is very important for Slovenia. First assessments, connected with numerous uncertainties, are the following: Slovenia has diverse forest-ecological structures, therefore the spatial consequences of the climate change will therefore be diverse. In the zone of deciduous and mixed highland woods it is likely for climate change to be within the tolerance limits of the existing forests. Worse adjustment possibilities will exist in pure forest structures (e.g. spruce forest) and in isolated woods with poorer environment conditions (dry areas, poor ground, and terrain slope). It is anticipated that conifers, especially fir and spruce, will be affected first and most. The shares of these two sorts in the wood stocks of our forests are not to be neglected (spruce 33 %, fir 10 %). A significant damage can be expected in Slovenian forests, but the effects will be strongly differentiated due to orographic modifications. Fir trees from basins and submountain zone (~10 % of the surface of our forests) will also be affected. Damages could also spread to mountain, altimountain and subalpine zone with lower intensity and a time delay. Together with the change of tree structure in the woods, general conditions in forests ecosystems will also change (floristic structure, quantitative relations among plants, production, energy currents, etc.). The threat of forest fires will be increased in basins, submountain and lower parts of mountain zone. Quantitative assessment of economic consequences is still not possible due to numerous uncertainties, but the costs for forest care will most probably increase (sanitary clearings, additional investments in guardianship, protection and cultivation of forests).

Due to the climate change, Slovenia will be faced with a threat to biodiversity in forest ecosystems. Mountain habitat types (Alpine and subnival plants and animals) will be particularly endangered and will be able to survive only in extreme circumstances. Similarly, all extreme growth areas, which serve as a shelter to cold-loving species, and all smaller, fragmented remains of ecosystems, that do not possess a genetic, spatial and ecological potential to move to a different location.

To a certain extent forests can adapt to climate changes. Care for the forest vegetation, enabling progressive forest succession on abandoned agricultural lands as well as diverting the man-induced forest restoration from conifers to deciduous, for this purpose new technologies will have to be developed for nursery plant production of deciduous trees. Methodologies for the categorisation of forest stands and their growth areas by sensitivity on the anticipated climate change and cartography of forest sward and their growth areas according to their sensitivity on the anticipated climate change need to be prepared as soon as possible. Due to an increased fire threat in forests it is reasonable to plan, restore and maintain the suitable fire protection zones especially in those forest areas, where conifers represent an important share in the structure and composition of forest stands. In the field of wood stocks care we will continue with the orientation that enables their increase. More wood biomass will bind more carbon which would otherwise increase the greenhouse effect in the atmosphere. All of the measures for increased forest dynamics would be useful, although the forests in Slovenia are highly natural or close to natural growth.

## 6.3 Vulnerability of Agriculture to the Change of Water Balance of Agricultural Sites in Slovenia

Climate change projections forecast increased frequency of meteorological droughts in certain regions. According to World Meteorological Organisation (WMO, 2003) there were long lasting, disastrous and very intensive droughts in the recent years all over the globe. Also Slovenia faces droughts more frequently even in areas in which they were not noticed before. Water deficit from April until the end of September shows that in the majority of Slovenia drought harmed agricultural plants eleven times in the last forty years: 1967, 1971, 1973, 1977, 1983, 1992, 1993, 1994, 2000, 2001 in 2003.

Average annual potentially available quantity of water in Slovenia is 32.1 $km^3$. This quantity includes all the inflow from neighbouring countries, as 41 % of water that goes through Slovenia derives from Austria. On average an inhabitant has 16,000 $m^3$ of water per year available, which is far above the European average. If only internal outflow from Slovenia, without the inflow from other countries, is taken into account, Slovenia has 9350 $m^3$ of water per inhabitant potentially available.

In the last 40 years oscillations of the available water were huge. In 1971 less than half of the quantity of the outflow from Slovenia in 1965 was recorded, whereas 49 $km^3$ was a maximum in the 1961–2000 period. The downward slope of the trend line is 0.15 $km^3$ per year, representing a 6 $km^3$ decrease of the water that was at disposal in that period. Such a decrease is not only a consequence of the increased use of water, but especially a consequence of changeable climate conditions, particularly those that have an impact on the quantity and temporal rainfall distribution. Trend lines for chosen water metering stations on river basins that represent different regions show a decrease of mean annual flow rate on all river basins, the same is true of minor flow rates, whereas there is a decrease of major flow rates only on river basins of Adriatic rivers and Drava.

In order to prepare a vulnerability analysis, a draft of daily data from Slovenian meteorological stations the 1961–2000 period was used. The stations were divided to four regions:

- Central and South-eastern Slovenia: Ljubljana (LJ), Celje (CE), Novo mesto (NM) and Postojna (POS);
- North-eastern Slovenia: Maribor (MB) and Murska Sobota (MS);
- Northern and North-western Slovenia: Slovenj Gradec (SG) and Rateče (RAT);
- South-western Slovenia: Portorož (PO) and Bilje (BI).

Water balance circumstances were estimated by years for the vegetation period on all stations. Vulnerability assessments by regions are average values of included stations within the region. In order not to make mistakes due to unstable assessments of the input variable variability for the deficit calculation, the data of previous vegetation periods were used. Based on the results of regional climate scenarios for Slovenia those years were chosen, when the average air temperature in the vegetation period in Slovenia was 1 °C and 3 °C higher and by the unchanged or 20 % reduced quantity of rainfall according to the 1961–1990 reference period. That is how four climate scenarios were made:

- Scenario A: 1 $^0$C temperature rise and an unchanged rainfall regime
- scenario B: 3 $^0$C temperature rise and an unchanged rainfall regime
- scenario C: 1 $^0$C temperature rise and a 20 % decrease of rainfall
- scenario D: 3 $^0$C temperature rise and a 20 % decrease of rainfall

All four scenarios were used for the calculation of water use of grasses using IRRFIB[29] model. The deficit was calculated according to the amount of water reachable for the plant at an average soil type. Grass with a 15 cm rooting depth was used as a hypothetical plant. That is why only the upper layer of the ground was used in the analysis. The deficit analysis took a linear time trend, which was characterised by an absolute and relative change of deficit for 10 years in the 1961–2000 period. The trend quality is described by a correlation coefficient ($r^2$). Due to a statistical characteristic of the trend the $r^2$ value needs to make at least 0.097 (**bold** in the table) taking into account the required 95 % significance.

29 Slovenian irrigation-prognostic simulation model

Table 6-12: Trends of average deficit by Slovenian regions

| Slovenian region | Absolute deficit change [mm/10 years] | Relative deficit change [%] | Correlation coefficient $r^2$ |
|---|---|---|---|
| Central | 15 | 8 | 0.26 |
| NE | 4 | 2 | 0.01 |
| N | 26 | 19 | 0.53 |
| SW | 14 | 6 | 0.20 |
| Whole | 15 | 8 | 0.31 |

All the regions are characterised by the increase of the deficit, most evident in Northern Slovenia and least in north-eastern Slovenia. Other regions have similar trends, 6 % in 10 years on average. Trends are statistically significant, except for the north-eastern Slovenia. Increase in the daily use of water from the ground and plants is noticeable as well, especially in the last ten years.

### 6.3.1 Change of Water Balance with Climate Change Taken into Account

Although we do not know for sure how the climate change will affect the regional water resources, it is clear that the water resources are already vulnerable. Every additional stress caused by the climate change or increased variability will strengthen the competition for water use in different sectors. Warmer climate can cause more frequent, severe and longer droughts and floods. The foreseen higher air temperatures will increase the reference evapotranspiration, which further leads to more frequent and more intensive droughts.

For the supply of agricultural plants with water the following measures will need to be taken due to the anticipated changes: preparation of preventive measures (i.e. monitoring of the agricultural drought with indicators), preparation of dry condition management measures (interdisciplinary approach), instant analyses of the climate change impact on Slovenia (new models of general circulation (MSC), regional analyses and after-treatment of methodologies of drought damage assessment within the Regulation on natural disaster assessment methodology (ZOPNN, 2003). Numerous approaches for dry condition adjustment and change of water supply for plants were tested also by using technological measures and changes in agriculture. Assessments show that the following measures will have to be taken: change of sowing structure and production orientation of farms and technologies of cultivation, improvement of ground state by increasing humus in the ground in case of droughts, construction of irrigation systems in such a manner that there will not be any negative impact on the environment and that irrigation water sources will be provided, guided irrigation with irrigation models and by taking into account meteorological circumstances and weather forecasts for an optimal water use in order to ensure a permanent and naturally adjustable cultivation of agricultural plants on irrigated areas, and last but not least, insurance of agricultural cultivation for extreme circumstances.

## 6.4 Guidelines for Further Work

One of the main tasks is the modernisation of an agro-meteorological information system for users. Information from the existing monitoring systems should be more user-friendly. While developing new products, the need for modernising the communication methods will become even more necessary. Further work needs to be done on the following three segments:

- Channelling the data flows and use of modern information technologies for transmitting information and the existing analyses to users.
- Studying the alternative data resources for preparation of analyses. Elaboration and implementation of methods for connecting meteorological forecasts (short-term, middle-term, long-term and climate) and agro-meteorological parameters.
- More emphasis on data, acquired by remote sensing systems.

Adaptation to variability and climate change are significantly dependent on citizen awareness. Numerous problems in connection with the above mentioned fields demand education in fields of long-term planning, which includes analyses of climate risks, impact of climate change and variability, methodological recommendations (management and water quality, micro climate, ...) and operative decisions (anticipations of crop, water irrigation, disease control and pests, ...). That is the only way to adopt efficient measures to prevent or mitigation of the climate change consequences.

# 7. RESEARCH AND SYSTEMATIC OBSERVATION

## 7.1 General Policy on Research and Systematic Observation

The central position in the field of research and development activities (RDA) is granted by the Ministry of Education, Science and Sport, and Ministry of Economy. The former is in charge of co-ordination and financing of university research and study, and financing of public research agencies and organisations, while the latter is active especially in the field of promoting research and development activities in the economy. The basic RDA act is the Research and Development Activities Law, further development of RDA is outlined in the National Research and Development Programme, dealing with the 2003–2007 period. The expert consulting body of the Slovenian Government in the field of RDA is the Science and Technology Council.

Despite its relatively highly developed science Slovenia has problems with a low intensity of connection between economy and science, as well as low rate of transfer and use of advanced knowledge. One of the reasons for the existing state is the fact that the research and development (RD) sector is not organised as a whole on the national level, since it does not have a head organisation. There are also no head non-governmental organisations that would connect the larger number of RD organisations and whose policy would be based on supporting connections with a wider environment. There are 86 research institutions and 48 faculties or colleges active in the field of research and development in Slovenia. An important position is dedicated to the Slovenian Academy of Sciences and Arts. RDAs are actually even more dispersed than those data show, since all organisations have an internal organisational structure. Within the institutes there are around 290 final units of the academic sector which cooperate independently with their environment, while there are more than 800 departments, institutes, laboratories and groups active in this field within the faculties [44]. During the 1996–2000 period the average in Slovenia was 4.5 researchers per 1000 active inhabitants [9].

Slovenian international cooperation in research activities is mainly taking place within the European programmes. Slovenia took part in the COPERNICUS programme, 4$^{th}$ EU Frame Programme of scientific-development and technological-development activities in the 1994–1998 period and in all specific programmes of the 5$^{th}$ EU Frame Programme in the 1998–2002 period. At the moment the cooperation in the COST programme and preparations for the 5$^{th}$ EU Framework Programme are taking place. Besides, the cooperation in the EU Joint research centre, in which environment and sustainable development represent one of the main research areas, is taking place. Slovenian researchers are included in EUREKA programme, dedicated to enhancing technological development and high technologies, and in the UN Development Programme. Regional cooperation takes place within the Central European Initiative (CEI) [45].

Gross domestic expenditures for RDA are increasing ever since the independence. In 2001 they amounted to 74,379 million SIT, which is 21.1 % more than in 2000. The main financial sources were companies with 54.4 % of all the funds, which is 1.4 % more than in 2000. 35.9 % were direct governmental funds, while there was also 7.2 % of foreign funds. The main part of state funds for RDA in 2001, i.e. 71.4 %, were directed to fundamental research, 25.1 % to applied research and 3.5 % to experimental research [17]. In 1994 The Slovenian Science Foundation was established in order to promote the work of scientists and offer financial support.

Research in the field of climate change and climate systems is represented by a small share in RDA. This is a consequence of a small number of organisations that cover this field and lack of human resources. The main part of research in the field of climatology (climate processes, climate system, climate change impact,...) takes place at the Meteorology Office of the Environmental Agency of the Republic of Slovenia. When assessing climate change impact, especially in the agricultural sector, the Office co-operates with the Agrometeorology Department of the Biotechnical Faculty at the University of Ljubljana, where modelling and forecast of climate change is carried out. Research on orography impact on rainfall in the diverse relief in north-western Slovenia is performed at the Meteorology Department of the Faculty of Mathematics and Physics of the University of Ljubljana. Research on climate change impacts takes place at the Anton Melik Geographical Institute and at the Marine Biology Station. All of those institutions have strong international ties. The cooperation takes place within international programmes (COST, 5th European Framework Programme, MAP,...), World Meteorological Organisation (WMO) and the Intergovernmental Panel on Climate Change (IPCC). In the field of renewable energy sources (RES) and efficient energy use (EEU), the conditions are much better since the field is much better covered by research organisations. Organisations co-operate actively on an international level in this field as well, particularly within EU projects.

## 7.2 Research

### 7.2.1 Climate Processes and Systems

In the field of climate processes and climate systems the following research is performed: Geographical information systems in climatology and meteorology (within the COST 719 programme), analysis of characteristics of long observation data sets, especially from the perspective of variability and trends and their homogenization, regional climate variability (urban meteorology), synoptic climatology, the variability and development of orographic precipitation in Julian Alps, also within the MAP international project, forecasting in micro scale, seasonal weather forecasts and use of data, acquired through remote sensing [43].

In the field of paleoclimatology, research on climate change was made based on temperature measures in bores, global climate and tectonic changes on Carpathian and Badenian microforamifera fauna in Slovenia, reconstruction of climate and ecological conditions in the lower and middle Miocene in Slovenia by analysing oraminireta ecosystems and mezoclimatography of Koper coastal areas and its changes in the last centuries [ ].

### 7.2.2 Climate Change Modelling and Forecasting

Climate change modelling and forecasting takes place in the Agrometeorology Department of the Biotechnical Faculty in Ljubljana. For modelling General Circulation Models (GCM) are being used, which most accurately describe climate conditions in the 1961–1990 period. The aim of the latest research was to overcome the gap between results of the models on a global and regional scales. GCM work with low horizontal resolution ($2° \times 2°$ or more) which prevents them to recognise regional characteristics of the surface, that is why the reliability of its results is low on a regional scale. In order to overcome the gap empirical reduction of the scale was used in the research. This method uses different mathematical models, based on measured values from the past in order to connect climate variables on a local scale with climate variables on a global scale. The basic assumption here is that mathematical description of dependence between the local and the global climate variables is also valid in the changed climate conditions. In the future an improvement of scenarios of the precipitation is anticipated, especially for the warm half of the year, and a replacement of the empirical scale reduction with a computationally more demanding dynamic scale reduction with the use of modelling. Such an approach for the Slovenian territory and its wide surroundings would be worth testing in cooperation with one of major European centres which cover this area. [6].

### 7.2.3 Climate Change Impacts

Climate change impacts research takes place at several institutes, faculties and state organisations, and deals with a wide spectrum of problems. An integral assessment of the vulnerability of agriculture on climate change was prepared. Climate change impact on biotic diversity, phenological trends, plant diseases and pests, food production, ecosystems, geomorphological conditions, water regime of surface waters, increased threat of avalanches due to changes in slope overgrow size, change of land use. Climate change impact on forest ecosystems, ground structure and change of the forest ability to absorb $CO_2$ is also being studied. Sustainable development strategies of certain sectors on a national and regional levels were prepared. Studies of the climate change impact on tourism and health service were made as well.

### 7.2.4 Socio-economic Analyses

GHG emission reduction is among priority tasks in Slovenia. In order to achieve the Kyoto Protocol targets, measures in all sectors will be needed, which will influence the economic situation and social conditions in Slovenia. In public scientific agencies, institutes, agencies and other organisations, research has been made on suitability of different manners of renewable energy source use, cogeneration of heat and electricity, studies of different fiscal stimulation for an increased use of renewable energy sources and efficient energy use, decrease of waste, research on co-natural forms of agriculture, coal mine closing impact on the local population, green tax reform impact on the economic competitiveness, environment vulnerability from the spatial planning perspective.

In order to prepare GHG emission projections, also projections on the change of population, gross domestic product and other important parameters that influence energy use and have an indirect impact on GHG emissions have been made.

### 7.2.5 Research and Development of Technologies for Adaptation to and Mitigation of Climate Change Consequences

In the energy sector and the industry, research is being done which will enable better use of renewable energy sources and efficient energy use. Different options of renewable source use are studied, particularly biofuel (wood biomass and biogas) and wind energy. Active research is going on in the field of cogeneration systems (combined heat and power generation) and trigeneration (combined heat, power and cold generation). Researches in the field of production processes that will enable competitiveness and sustainable orientation of companies, products (eco design and a new concept of product servicing) and biotechnologies, are taking place in industry. IPPC directive represents also an additional stimulation. By assessing the climate change impacts on agriculture in the past and expected climate change a variety of measures has been prepared in order to enable optimal adaptation of agriculture to new climatic conditions.

## 7.3 Systematic Observations

In this chapter a short summary of the systematic observations is presented, while its complete version is presented in the appendix of the communication.

### 7.3.1 Meteorological and Atmospheric Observations

Systematic observations and measurements in Slovenia have been performed since 1850, when measurements in Ljubljana started. Nowadays the network of meteorological stations consists of 39 climatological stations (13 of them being synoptic), 180 precipitation stations, one radiosonde, sodar and a meteorological radar station. The majority of the 30 automatic meteorological stations operate at the climatological meteorological stations. The problem of measuring sequence in Slovenia is its non-homogeneity because of moving of measuring spots, change of observation protocol, instruments, and the surroundings of the measuring spots. Correction of the non-homogeneity of the data is done with a reanalysis method, based on a repeated weather analysis in the past: that helps us get a longer and more homogenous set than it would be if it was presented by measured data only. The drawback of this method is that it is useful only for the data after 1957 due to the lack of quality satellite, ground and height surveys. ARSO (Environmental Agency of the Republic of Slovenia) archive has to use more detailed methods of measured data homogenisation in order to define trends and climate change in Slovenia. Since there are no measuring stations in Slovenia with the same measuring method on a long-term in unchanged surroundings 5 to 6 reference meteorological stations are planned for climate change monitoring in the future.

International participation of Slovenia on data exchange takes place within different projects and programmes, mainly under the umbrella of the World Meteorological Organisation (WMO), whose member is also ARSO. Slovenia is included in the Global Climate Observing System (GCOS) with stations on Kredarica and in Ljubljana. Ozone measurements on measuring stations Krvavec and Iskrba take place within the Global atmosphere watch (GAW) and EMEP projects. Slovenia also takes part in the World Weather Watch (WWW) with data exchange from 13 synoptic stations and in the GPCC programme with data contribution from synoptic stations and archive data of precipitation stations.

Air quality measurements for Slovenia are done in several networks. The national network, which is under ARSO competence, comprises an automatic network and a 24-hour network. Additional networks of automatic stations operate around thermal power plants Šoštanj, Trbovlje and Brestanica and in town municipalities of Ljubljana, Maribor and Celje. $SO_2$ concentration measuring instrument is part of Nuclear Power Plant Ecological-information system in Krško.

### 7.3.2 Oceanografic Observations

Observation of meteorological variables above the sea, sea currents, salinity and sea temperature is exercised by the Marine Biology Station (MBS) of the National Institute of Biology (NIB) by a coastal oceanographic buoy, which is anchored at the southern entrance to the bay of Trieste. Additional observations of the Trieste Gulf are done by a research boat. MBS takes part in a MAMA[30] project which represents an important part of the oceanographic observation system in the Mediterranean (MedGOOS–Mediterranean Global Ocean Observing System). The goal of this project is to restore a network of observations and forecasts in the Mediterranean. Besides, they also take part of the EU projects MFSTEP[31] and ADRICOSM[32].

Observation of the sea level change and sea temperature goes on at the Monitoring

30 Mediterranean network to Assess and upgrade Monitoring and forecasting Activity in the region
31 Mediterranean Forecasting System Toward Environmental Predictions
32 ADRIatic sea integrated COastal areaS and river basin Management system pilot project

Office of the ARSO with two measuring stations.

### 7.3.3 Terrestrial Observations

In Slovenia observation of two mountain glaciers, the glacier of Triglav and the one under Skuta, takes place. They are the most south-eastern located alpine glaciers on a relatively low altitudes. Therefore they are particularly vulnerable for the climate change and as such an interesting object of scientific studies. Regular observations of the Triglav glacier have been performed since 1946, and for the Skuta glacier since 1948. The measurements are performed at the end of the melting period. The glacier observations are performed by the Anton Melik Geographical Institute.

Monitoring Office of ARSO regularly monitors water quality and other elements of the water cycle at 175 surface water measuring stations (streams, lakes, sea), 134 subterranean water stations and 6 spring stations.

Phenological observations take place at 61 measuring spots that are divided by the regional climatological key. Observations take place under professional surveillance of the Meteorological Office of ARSO. The turning point in the development of phenological activities in Slovenia happened in 1950/1951, when a network of special phenological stations was formed.

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# 8. EDUCATION, TRAINING AND PUBLIC AWARENESS

## 8.1 Introduction

Public knowledge of causes for and consequences of climate change and possibilities for their mitigation is weak in Slovenia, especially the knowledge on the lifestyle impact on GHG emissions and on options for the contribution of an individual to GHG emission reduction. It is necessary to understand the responsibility for the environment and nature management for future generations. More and more obvious consequences of climate change, revealed in Slovenia and elsewhere, are a good stimulation for stronger interest of the public, and consequently they direct people to think about an alternative behaviour. There is no systematic approach of the Government and the competent ministries for informing the public about issues related to GHG emissions. A general campaign of the government is needed, which would present the problem as a whole, the situation in Slovenia in this field and the needed contribution of Slovenia to GHG emission reduction. So far mainly the Ministry of the Environment, Spatial Planning and Energy has been dealing with those issues in the energy sector, whereas Ministry of Transport, Ministry of Agriculture, Forestry and Food, Ministry of Finance, and Ministry of Economy, which are the key actors for enacting the Kyoto protocol, have been less active. Since climate changes affect us all, a general introduction to the problem and measures, needed to prevent or mitigate those changes, are needed. Therefore execution of complete and continuous promotion, awareness raising and educational activities, targeting diverse parts of the public is needed. The main role for that lies on the Government to act as an example.

## 8.2 Education

Competence and responsibility for the development and functioning of the education system are divided between the Ministry of Education, Science and Sport, local communities (municipalities), expert councils established by the Ggovernment, and agencies established for the development and counselling in the field of education (The national education institute of Slovenia, Vocational education centre of Slovenia, Slovenian institute for adults education, National examination centre).

In Slovenia a curriculum renovation took place in the previous years so that according to its starting points also the environment education / environment studies are included in the national curriculum on all educational levels with a special emphasis. The groundwork for the accomplishment of environmental education goals are national curriculum documents, adopted and confirmed in an expert council (Expert council for general education, Expert council for vocational and professional education of the Republic of Slovenia).

Environmental education is present on all educational levels from kindergartens up to secondary schools. In kindergartens observation and introduction to the living species, introduction to natural habitat, creation of healthy and safe living environment and cooperation on different activities such as waste collection, their reuse and recycling take place. Environmental education is included in primary school programmes as an intersubject area which is performed within general educational subjects, as a selective subject in the last three years, within activity days (nature days), school in nature, extracurricular activities, within different projects in which schools can take part autonomously (e.g. »eco« school projects, »UNESCO« schools, »Healthy« school) and within youth research activities. Secondary schools include environmental education especially into nature science subjects, geography and sociology and within compulsory selective subject (Environmental studies subject). The curriculum of the selective subject is designed to offer the pupils an introduction to new topics that can be combined with topics from other subjects. The basic message of the course is that environmental problems do not demand only technical or technological solutions but also the need for change in the attitude.

In the field of vocational and professional education environmental education is included in a general educational part of the natural science courses and other general subjects of the programmes of secondary vocational education, professional theoretical courses and practical education, interest activities and activities outside school. Learning-educational work is based on a wide perspective on the problem through different contents. Learning is based on skill acquisition and practical use of the knowledge, so that the specific contents of the occupation and sensitivity development of pupils for dangers in the vocational field are included. Secondary schools, vocational and professional schools can autonomously take part in different projects (»Healthy« school projects, »Eco« school projects) and within youth research activities.

»Eco school as a way of life« project is a part of the European project of »Eco–Schools«, in which 21 countries take part. Slovenian schools have been included therein since 1996. »Eco School as a way of life« introduces a planned and complete environmental education in primary and secondary schools. 80 primary and 10 secondary schools are included in the project. A school that goes through 7 steps and achieves visible results in environmental improvement in their town, gets an ecoflag which is a visible state and international recognition of environmental activism. So far 54 primary schools and 2 secondary schools got it. This project stimulates cooperation in the field of nature protection among schools in Slovenia and with the ones abroad. Slovenia takes part in the »European net of healthy schools« since 1993. At the moment there are 40 countries with approximately 500 schools included in a network. The European network includes 12 Slovenian schools, while 118 schools are included in a »Slovenian network of healthy schools«. Schools, which promote health, are obliged to create a health-friendly environment in an active manner. They introduce changes to their functioning, which have a positive impact on health and life of pupils, teachers and parents. The third project, in which Slovenian schools take part, is »UNESCO schools« project (ASPNet – Associated Schools Project Network). »UNESCO« schools are dealing with four basic topics, one of them being »environmental problems«. This topic enables the pupils and teachers to combine international problems concerning global environment with the local or national situation. Among the activities in this field the following ones are included: environment pollution studies, energy use, forest maintenance, sea and climate research, erosion and natural resources maintenance, greenhouse effect, sustainable development, Agenda 21, etc.. [47].

University education in the environmental field takes place at Polytechnics in Nova Gorica within the School of environmental sciences. Interdisciplinary university study programme Environment covers all relevant contents in the field of environment, e.g. water, air and soil pollution, ecotoxicology, health service ecology, waste management, nature protection, impact assessment on environment, environmental economics and environmental law. Besides, education on certain segments of environment and environmental protection within different study departments at different subjects that are dealing with the issues of climate change, environment protection, efficient energy use and renewable sources takes place. Post-graduate studies within interdisciplinary and research orientated study programme Environmental science is enabled at Polytechnic in Nova Gorica, and at the University of Ljubljana within the university post-graduate study of Environment protection. Study is being organised in such a manner that students get as wide insight into the problems of environment protection as possible. The main goal of those study programmes is intensive post-graduate education in different fields of environment protection, such as nature science study, technology, spatial planning, nature protection, state and assessment of environment pollution, public health service, environmental law and management, education, research, cooperation with the public, exercise of integral projects, preparation of environmental impact assessments and similar.

## 8.3 Public Awareness

Ministry of the Environment, Spatial Planning and Energy is very active in the field of information release and public awareness. Annual tenders are issued to support projects for environment related information, awareness raising and educational activities. In 2001 presentation of organisation and work of the ministry and its departments was organised at the fair Eko, ecology and environmental protection. Among others Environment and Space (E&S) bulletin is published monthly in order to inform the public about different environmental contents and different publications whose aim is to present different aspects of the environmental problem to the public (Environment in Slovenia 2002, Admire me sustainable, Let's live with water, and others). Besides, it cooperates with different projects of public informing in the field of transport, EEU and RES. Their website offers all the information on the work of the Ministry, and all the legislation in the field of environment; ARSO and EIONET websites offer the data on the state of environment in Slovenia.

The public is recently much better informed on the climate change issue, since the interest of the media has strongly increased due to the obvious climate change consequences in Slovenia. Many articles and talks were prepared on this topic. The public was well informed on the world events as well (sessions of the Conference of the Parties to the UN Framework Convention on Climate Change (COP), especially COP3 and COP6, World Summit Rio+10 in Johannesburg and World Conference on Climate Change in Moscow). In 1997 Dr. Matjaž Ravnik's book Greenhouse – Climate change caused by a human being was published, and presented this topic in a manner that is friendly to non-experts along with rich picture material. An important role in awareness raising for wider audience have also the NGOs.

### 8.3.1 Energy

Agency for efficient use of energy (AURE) within the Ministry of the Environment, Spatial Planning and Energy performs numerous actions whose aim is to increase public awareness and information level. The Agency is regularly publishing an *Efficient with energy* bulletin, which includes various information on RES and EEU. It also publishes brochures, handbooks and information papers, e.g. Saving of Energy, Modern shop energy system, Municipal energy strategy guide, Efficient energy use guide in road cargo and bus transport and a collection of information papers Efficient use of energy which consist of five topic complexes, i.e. building heating systems, building thermal protection, household appliances, energy and environment, and renewable energy sources.

### 8.3.2 Transport

Several cities in Slovenia introduced a Car Free Days Project campaign in 2000. Eleven Slovenian towns or municipalities took part therein in the first year, and already 23 in 2002. Municipalities organise several activities in the field of promotion of public transport, cycling and walking, responsible use of cars, mobility and health within this project. Extended project European mobility week took place in 10 cities in 2002. While the project is being performed, most of the town centres are closed for traffic.

Besides, municipalities prepare projects to increase popularity of public passenger transport and other sorts of traffic tend to be achieved in order to decrease burdening of city centres caused by motor vehicles. A project of free bike rental, upgrading the cycling path system and informing the public on benefits of the public passenger transport were prepared as well.

### 8.3.3 Waste

Ministry of the Environment, Spatial Planning, and Energy carried out a communication project to support waste management in 1998 and 1999. Its purpose was to raise awareness of Slovenian people that waste is not a problem that only local communities and the state has to deal with, but each individual as well. In the beginning the project was intended for the public in general, but the lack of financial means changed its course to narrower groups. A communication strategy was prepared in support of performing the programme of waste management and on its basis in 2001 MOPE published a Reference on waste management intended for local communities [13]. Slovenia introduced a system of separated waste collection in the year 2003, including several actions of informing the population about the system and the benefits of such handling with commercial posters, brochures and through public media. The town municipality of Ljubljana prepared two information booklets on this topic and distributed them to pupils of all primary schools in Ljubljana.

## 8.4 Consulting

Within the »Energy consulting for households« (ENSVET in Slovenian) programme a network of 33 energy consulting offices was organised throughout the country. The first consulting offices began with their work in 1993. They offered professional and cost-free consulting on thermal protection of buildings, selection of the appropriate window glazing, appropriate heating system, use of renewable energy sources and a possibility of gaining financial subsidies. After four courses within the education for the needs of the consulting network 140 energy consultants are qualified today, and 51 of them are actively involved in the ENSVET net [27]. In the 1997–2002 period approximately 14,000 advice for the households were given [21].

Education of experts is most intensive in the field of efficient energy use and renewable energy sources prepared by various institutions as seminars or workshops. A major part of the counselling and educational activity takes place within international projects, such as OPET, Green Light, COGEN, etc. And within the bilateral cooperation.

The Energy fair has an important role in informing and counselling a wide circle of the public. The fair is dedicated to Slovenian and foreign experts active in the energy field and to the public that is in search of information from the field of installations (electric, water, air-conditioning, gas and central heating) as well as to users of products and services from the energy field. The fair also offers extensive programme of additional events, dedicated to environmental topics, efficient energy use, climate change problems and the Kyoto Protocol, the role of local energy sector and other topics.

## 8.5 Non-Governmental Organisations (NGO)

More than 110 organisations are active in the environmental field in Slovenia, 60 % of them on a local level. More than two thirds of them are involved in other activities as well; in the environmental field they mainly work on education and qualification, field work and collection and transmission of environmental information. In most cases NGO's are specialised for certain fields: nature protection, environment protection, sustainable development or climate change, which can cause problems at harmonizing different perspectives.

Cooperation programme between the Government and NGOs is outlined in a Strategy of the Government Cooperation with NGO's. This document exposes the importance of NGO's and restores a permanent groundwork for solving the problems, which they might have with their work and development. Besides, a Partnership for Environment has been established with the purpose of useful co-operation between the Ministry of the Environment, Spatial Planning and Energy and NGO's at solving the hot environmental issues. NGO representatives take part in the working bodies of the Ministry as well. The representatives of the Ministry and NGO's meet annually at an environmental forum, dedicated to opinion exchange on the role of NGO's and on the co-operation between both sectors in the environmental field.

Activities of NGO's:

- Public awareness (organising round tables, seminars, public tribunes, preparing information material, counselling, tracing ecological and learning paths, publication publishing...);
- Education (preparing camps, educating teachers, Eco school, school and kindergarten workshops, organising excursions...);
- Cooperation in preparing municipal spatial plans;
- Cooperation in drafting of relevant laws and national programmes (National Energy Programme, National Environment Protection Programme, Action Plan for Reducing GHG Emissions...);
- Promotion of local tourist attributes, organisation of various actions (selection of the tidiest village, farm...), placing tourist-information points and centres, organising tourist events [48].

### 8.5.1 Climate Alliance

Association for Climate is a global partnership organisation for world climate protection. It includes the representatives of indigenous rainforest people, connected in the FOIRN[33] association, and around 1500 local communities from Europe. Association for Climate tends to achieve a 50 % reduction of $CO_2$ emissions until 2010, supports the efficient energy use, and the FOIRN in its struggle for the preservation of the Amazon rain forest. An associate member of the Association for Climate is also Slovenski E-forum, Slovenian non-governmental organisation, while Gornji Grad municipality was the first local community from Eastern and Central Europe to become its member, and was also rewarded a European »Climate Star« prize for its endeavour in reduction of $CO_2$ emissions. Municipality of Slovenska Bistrica announced itself as a candidate as well [50].

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# Appendix A
## Abbreviations, terms and measure units

### Index of abbreviations

| | |
|---|---|
| AC | highway |
| ARSO | Environmental Agency of the Republic of Slovenia |
| AURE | Agency for Energy Efficiency and Renewable Energy |
| BAT | Best available techniques |
| BČN | Biological waste water treatment plant |
| BREF | BAT REFerence |
| CCIS | Chamber of Commerce and Industry of Slovenia |
| CEI | Central European Initiative |
| $CH_4$ | Methane |
| $CO_2$ | Carbon dioxide |
| COGEN | Association for the Promotion of Cogeneration |
| COP | Conference of the Parties |
| CORINAIR | Coordination d'information enviromentale project partiel air |
| COST | European Co–operation in the field of Scientific and Technical Research |
| CRF | Common reporting format |
| DSM | Demand side management |
| EEU | efficient energy use |
| EIMV | Electro Institute Milan Vidmar |
| EMAS | Environmental management and audit scheme |
| EMEP | European monitoring and evaluation programme |
| ENSVET | Energy consulting for residents |
| EU | European Union |
| F–gases | Hydrofluorocarbons (HFC), Perfluorocarbons (PFC) and Sulphur hexafluoride ($SF_6$) |
| GAW | Global Atmosphere Watch |
| GCM | Global circulation model – GCM |
| GCOS | Global Climate Observing System |
| GDP | Gross domestic product |
| GHG | greenhouse gas |
| GPCC | Global Precipitation Climatology Centre |
| GTN–G | Global terrestrial network–glaciers |
| HC | motorway |
| HE | hydro power plant |
| HSE | Holding Slovenske elektrarne – holding of major Slovene electricity producers |
| IPCC | Intergovernmental Panel on Climate Change |
| IPPC | Integrated Pollution Prevention and Control |
| MAMA | Mediterranean network to Assess and upgrade Monitoring and forecasting Activity in the region |
| MAP | Mesoscale Alpine Programme |
| MBP | Marine biology station |
| MedGOOS | Mediterranean Global Ocean Observing System |

| | |
|---|---|
| MF | Ministry of Finance |
| MFSTEP | Mediterranean Forecasting System Toward Environmental Predictions |
| MG | Ministry of Economy |
| mHE | Small hydro power plant |
| MKGP | Ministry of Agriculture, Forestry and Food |
| MOPE | Ministry of Environment, Spatial Planning and Energy |
| MP | Ministry of Transport |
| $N_2O$ | Nitrous Oxide |
| NEK | Nuclear power plant Krško |
| NEP | National Energy Programme |
| NGO | non-governmental organisation |
| NIB | National Institute of Biology |
| OPET | Organisations for the Promotion of Energy Technologies |
| RES | Renewable Energy Sources |
| RS | Republic of Slovenia |
| SAEP | Slovenian Agriculture-Environmental Programme |
| SURS | Statistical Office of the Republic of Slovenia |
| TE–TOL | Termoelektrarna–toplarna Ljubljana (CHP Ljubljana) |
| TEN | Trans-European Network |
| TEŠ | Thermal power plant Šoštanj |
| TET | Thermal power plant Trbovlje |
| toe | one tonne of oil equivalent |
| UMAR | Institute of Macroeconomic Analyses and Development |
| UN | United Nations |
| WGMS | World Glacier Monitoring Service |
| WMO | World Meteorological Organization |
| WWW | World Weather Watch |

**Units and exchange rate**

| | |
|---|---|
| k… | kilo ($10^3$) |
| M… | Mega ($10^6$) |
| G… | Giga ($10^9$) |
| T… | Tera ($10^{12}$) |
| P… | Peta ($10^{15}$) |

| | |
|---|---|
| g | gram |
| t | tonne |
| J | joule |
| ha | hectare |
| …/a | per annum (year) |

1 EUR = 226.2237 SIT[34]

34 Average annual exchange rate in 2002 (Source: Bilten Banke Slovenije)

# Appendix B

# GHG Emissions for Years

# 1986 and 1990–2002

Table B. 1: $CO_2$ emissions for 1986 and period 1990–2002 (CRF Table 10s1)

| TYPES OF GHG SOURCES AND SINKS | 1986 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | (Gg) | | | | | | | | | | | | | |
| **1. Energy** | **14,929.89** | **13,547.55** | **12,679.90** | **12,702.47** | **13,322.71** | **13,110.58** | **13,959.73** | **14,764.46** | **15,201.72** | **14,955.62** | **14,298.09** | **14,362.11** | **15,409.32** | **15,473.75** |
| A. Fuel Combustion (Sectoral Approach) | 14,929.89 | 13,547.55 | 12,679.90 | 12,682.67 | 13,307.19 | 13,094.48 | 13,929.73 | 14,734.66 | 15,167.92 | 14,927.47 | 14,263.13 | 14,325.39 | 15,348.96 | 15,415.65 |
| 1. Energy Industries | 6,700.55 | 6,238.48 | 5,321.23 | 5,840.03 | 5,762.00 | 5,230.32 | 5,564.41 | 5,284.44 | 5,680.17 | 5,918.69 | 5,212.87 | 5,487.22 | 6,233.03 | 6,401.83 |
| 2. Manufacturing Industries and Construction | 4,119.36 | 3,025.93 | 2,912.30 | 2,549.64 | 2,364.29 | 2,467.70 | 2,473.45 | 2,361.11 | 2,257.06 | 2,327.54 | 2,334.35 | 2,299.58 | 2,357.55 | 2,383.53 |
| 3. Transport | 1,970.94 | 2,660.38 | 2,514.02 | 2,589.57 | 2,990.14 | 3,297.69 | 3,624.50 | 4,199.26 | 4,267.53 | 3,687.13 | 3,507.39 | 3,653.30 | 3,786.21 | 3,799.98 |
| 4. Other Sectors | 2,139.04 | 1,622.75 | 1,932.35 | 1,703.42 | 2,190.76 | 2,098.77 | 2,267.38 | 2,889.85 | 2,963.17 | 2,994.11 | 3,208.52 | 2,885.29 | 2,972.17 | 2,830.30 |
| 5. Other | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| B. Fugitive Emissions from Fuels | 0.00 | 0.00 | 0.00 | 19.80 | 15.51 | 16.10 | 30.00 | 29.80 | 33.80 | 28.15 | 34.96 | 36.72 | 60.36 | 58.11 |
| 1. Solid Fuels | 0.00 | 0.00 | 0.00 | 19.80 | 15.51 | 16.10 | 30.00 | 29.80 | 33.80 | 28.15 | 34.96 | 36.72 | 60.36 | 58.11 |
| 2. Oil and Natural Gas | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **2. Industrial Processes** | **1,021.66** | **1,015.27** | **806.87** | **813.84** | **638.56** | **785.75** | **781.97** | **789.42** | **796.81** | **763.08** | **774.97** | **799.75** | **843.24** | **838.71** |
| A. Mineral Products | 746.22 | 680.37 | 567.23 | 490.06 | 396.39 | 507.81 | 522.87 | 542.26 | 559.54 | 572.64 | 573.69 | 575.72 | 603.96 | 532.50 |
| B. Chemical Industry | 56.86 | 44.92 | 33.66 | 25.59 | 34.68 | 39.77 | 36.99 | 38.70 | 37.90 | 40.52 | 39.88 | 52.88 | 62.09 | 54.66 |
| C. Metal Production | 218.58 | 289.98 | 205.98 | 298.19 | 207.48 | 238.17 | 222.11 | 208.46 | 199.37 | 149.92 | 161.41 | 171.15 | 177.19 | 251.56 |
| D. Other Production | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| E. Production of Halocarbons and SF6 | | | | | | | | | | | | | | |
| F. Consumption of Halocarbons and SF6 | | | | | | | | | | | | | | |
| G. Other | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **3. Solvent and Other Product Use** | **46.19** | **37.58** | **34.05** | **33.13** | **30.95** | **33.12** | **30.60** | **34.42** | **34.51** | **35.45** | **35.11** | **36.38** | **36.53** | **36.70** |
| **4. Agriculture** | **0.00** | **0.00** | **0.00** | **0.00** | **0.00** | **0.00** | **0.00** | **0.00** | **0.00** | **0.00** | **0.00** | **0.00** | **0.00** | **0.00** |
| A. Enteric Fermentation | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| B. Manure Management | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| C. Rice Cultivation | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| D. Agricultural Soils | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| E. Prescribed Burning of Savannas | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO |
| F. Field Burning of Agricultural Residues | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| G. Other | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

Table B. 1 – Continued

| TYPES OF GHG SOURCES AND SINKS | 1986 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | (Gg) | | | | | | | | | | | | | |
| **5. Land-Use Change and Forestry** | **-2,950.39** | **-4,338.58** | **-4,751.08** | **-5,088.42** | **-5,174.58** | **-5,332.25** | **-5,675.08** | **-5,561.41** | **-5,561.41** | **-5,561.41** | **-5,561.41** | **-5,561.42** | **-5,561.42** | **-5,561.42** |
| A. Changes in Forest and Other Woody Biomass Stocks | -1,631.30 | -3,039.67 | -3,452.17 | -3,789.50 | -3,879.33 | -4,037.00 | -4,398.17 | -4,284.50 | -4,284.50 | -4,284.50 | -4,284.50 | -4,284.50 | -4,284.50 | -4,284.50 |
| B. Forest and Grassland Conversion | IE | IE | IE | IE | IE | IE | IE | IE | IE | IE | IE | IE | IE | IE |
| C. Abandonment of Managed Lands | -223.67 | -220.00 | -220.00 | -220.00 | -216.33 | -216.33 | -216.33 | -216.33 | -216.33 | -216.33 | -216.33 | -216.33 | -216.33 | -216.33 |
| D. $CO_2$ Emissions and Removals from Soil | -1,095.42 | -1,078.92 | -1,078.92 | -1,078.92 | -1,078.92 | -1,078.92 | -1,060.58 | -1,060.58 | -1,060.58 | -1,060.58 | -1,060.58 | -1,060.58 | -1,060.58 | -1,060.58 |
| E. Other | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **6. Waste** | **0.00** | **0.00** | **0.00** | **0.00** | **0.00** | **0.00** | **0.00** | **0.00** | **0.00** | **0.00** | **0.00** | **0.00** | **0.00** | **0.00** |
| A. Solid Waste Disposal on Land | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| B. Waste-water Handling | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| C. Waste Incineration | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO |
| D. Other | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **7. Other** | **0.00** | **0.00** | **0.00** | **0.00** | **0.00** | **0.00** | **0.00** | **0.00** | **0.00** | **0.00** | **0.00** | **0.00** | **0.00** | **0.00** |
| | | | | | | | | | | | | | | |
| **Total Emissions/Removals with LUCF** | **13,047.34** | **10,261.81** | **8,769.74** | **8,461.03** | **8,817.63** | **8,597.21** | **9,097.22** | **10,026.89** | **10,471.63** | **10,192.74** | **9,546.75** | **9,636.83** | **10,727.68** | **10,787.75** |
| **Total Emissions without LUCF** | **15,997.73** | **14,600.40** | **13,520.82** | **13,549.44** | **13,992.21** | **13,929.45** | **14,772.30** | **15,588.30** | **16,033.04** | **15,754.15** | **15,108.17** | **15,198.24** | **16,289.09** | **16,349.17** |
| | | | | | | | | | | | | | | |
| **Memo Items** | | | | | | | | | | | | | | |
| **International Bunkers** | **97.49** | **79.26** | **27.54** | **34.27** | **48.35** | **53.86** | **57.53** | **53.28** | **56.23** | **51.76** | **61.80** | **71.09** | **80.27** | **82.64** |
| Aviation | 97.49 | 79.26 | 27.54 | 34.27 | 48.35 | 53.86 | 57.53 | 53.28 | 56.23 | 51.76 | 61.80 | 71.09 | 80.27 | 82.64 |
| Marine | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| **Multilateral Operations** | **NA** | **NA** | **NA** | **NA** | **NA** | **NA** | **NA** | **NA** | **NA** | **NA** | **NA** | **NA** | **NA** | **NA** |
| **$CO_2$ Emissions from Biomass** | **1,471.75** | **1,305.75** | **1,248.15** | **1,258.97** | **1,246.16** | **1,273.20** | **1,246.96** | **1,290.09** | **1,321.25** | **1,340.57** | **1,362.11** | **1,380.61** | **1,270.94** | **1,303.22** |

Table B. 2: $CH_4$ emissions for 1986 and period 1990–2002 (CRF Table 10s2)

| TYPES OF GHG SOURCES AND SINKS | 1986 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | (Gg) | | | | | | | | | | | | | |
| **Total emissions** | **120.50** | **111.62** | **115.70** | **112.96** | **113.35** | **111.60** | **113.09** | **111.70** | **113.35** | **112.87** | **112.15** | **111.71** | **108.36** | **108.64** |
| **1. Energy** | **24.42** | **19.89** | **19.14** | **19.99** | **18.73** | **17.92** | **18.17** | **17.69** | **18.40** | **17.95** | **16.98** | **16.71** | **15.79** | **17.23** |
| A. Fuel Combustion (Sectoral Approach) | 6.12 | 4.89 | 5.14 | 4.86 | 4.82 | 4.63 | 4.58 | 4.68 | 4.47 | 4.21 | 4.10 | 4.05 | 4.04 | 4.02 |
| 1. Energy Industries | 0.09 | 0.09 | 0.07 | 0.07 | 0.07 | 0.07 | 0.07 | 0.07 | 0.06 | 0.07 | 0.06 | 0.06 | 0.07 | 0.07 |
| 2. Manufacturing Industries and Construction | 0.50 | 0.38 | 0.31 | 0.28 | 0.27 | 0.26 | 0.26 | 0.27 | 0.29 | 0.30 | 0.30 | 0.31 | 0.29 | 0.31 |
| 3. Transport | 0.51 | 0.70 | 0.69 | 0.76 | 0.91 | 0.97 | 1.01 | 1.09 | 0.96 | 0.72 | 0.59 | 0.63 | 0.65 | 0.64 |
| 4. Other Sectors | 5.02 | 3.72 | 4.06 | 3.75 | 3.57 | 3.32 | 3.24 | 3.26 | 3.16 | 3.12 | 3.15 | 3.05 | 3.03 | 3.00 |
| 5. Other | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| B. Fugitive Emissions from Fuels | 18.30 | 15.00 | 14.00 | 15.13 | 13.91 | 13.30 | 13.59 | 13.00 | 13.93 | 13.74 | 12.87 | 12.66 | 11.75 | 13.21 |
| 1. Solid Fuels | 17.09 | 14.42 | 13.45 | 14.57 | 13.38 | 12.77 | 12.96 | 12.37 | 13.26 | 13.11 | 12.23 | 12.01 | 11.08 | 12.56 |
| 2. Oil and Natural Gas | 1.21 | 0.58 | 0.55 | 0.55 | 0.54 | 0.53 | 0.63 | 0.63 | 0.67 | 0.63 | 0.65 | 0.65 | 0.67 | 0.65 |
| **2. Industrial Processes** | **0.18** | **0.16** | **0.17** | **0.01** | **0.03** | **0.12** | **0.19** | **0.16** | **0.25** | **0.26** | **0.27** | **0.26** | **0.28** | **0.24** |
| A. Mineral Products | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| B. Chemical Industry | 0.18 | 0.16 | 0.17 | 0.01 | 0.03 | 0.12 | 0.19 | 0.16 | 0.25 | 0.26 | 0.27 | 0.26 | 0.28 | 0.24 |
| C. Metal Production | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| D. Other Production | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| E. Production of Halocarbons and SF6 | | | | | | | | | | | | | | |
| F. Consumption of Halocarbons and SF6 | | | | | | | | | | | | | | |
| G. Other | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **3. Solvent and Other Product Use** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **4. Agriculture** | **50.61** | **47.57** | **47.77** | **45.61** | **45.37** | **43.67** | **42.86** | **41.53** | **40.76** | **40.86** | **41.27** | **41.29** | **40.40** | **40.53** |
| A. Enteric Fermentation | 37.70 | 35.16 | 35.03 | 33.19 | 33.15 | 32.91 | 33.20 | 32.77 | 32.07 | 32.15 | 32.56 | 33.39 | 32.56 | 32.51 |
| B. Manure Management | 12.91 | 12.40 | 12.74 | 12.43 | 12.23 | 10.76 | 9.66 | 8.75 | 8.69 | 8.71 | 8.71 | 7.91 | 7.84 | 8.02 |
| C. Rice Cultivation | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO |
| D. Agricultural Soils | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE |
| E. Prescribed Burning of Savannas | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO |
| G. Field Burning of Agricultural Residues | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE |
| G. Other | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO |

Table B. 2 – Continued

| TYPES OF GHG SOURCES AND SINKS | 1986 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | (Gg) | | | | | | | | | | | | | |
| **5. Land-Use Change and Forestry** | **0.00** | **0.00** | **0.00** | **0.00** | **0.00** | **0.00** | **0.00** | **0.00** | **0.00** | **0.00** | **0.00** | **0.00** | **0.00** | **0.00** |
| A. Changes in Forest and Other Woody Biomass Stocks | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| B. Forest and Grassland Conversion | IE | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| C. Abandonment of Managed Lands | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| D. $CO_2$ Emissions and Removals from Soil | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| E. Other | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **6. Waste** | **45.29** | **44.00** | **48.62** | **47.35** | **49.21** | **49.89** | **51.87** | **52.33** | **53.94** | **53.80** | **53.63** | **53.46** | **51.89** | **50.64** |
| A. Solid Waste Disposal on Land | 38.54 | 38.03 | 43.31 | 42.83 | 45.25 | 46.17 | 48.19 | 48.73 | 49.47 | 49.11 | 48.75 | 48.40 | 47.04 | 45.68 |
| B. Waste-water Handling | 6.75 | 5.97 | 5.31 | 4.52 | 3.96 | 3.72 | 3.68 | 3.59 | 4.47 | 4.69 | 4.87 | 5.06 | 4.85 | 4.95 |
| C. Waste Incineration | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO |
| D. Other | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **7. Other** | **0.00** | **0.00** | **0.00** | **0.00** | **0.00** | **0.00** | **0.00** | **0.00** | **0.00** | **0.00** | **0.00** | **0.00** | **0.00** | **0.00** |
| | | | | | | | | | | | | | | |
| **Memo Items** | | | | | | | | | | | | | | |
| **International Bunkers** | **1.36** | **1.11** | **0.39** | **0.48** | **0.68** | **0.75** | **0.80** | **0.75** | **0.79** | **0.72** | **0.86** | **0.99** | **1.12** | **1.16** |
| Aviation | 1.36 | 1.11 | 0.39 | 0.48 | 0.68 | 0.75 | 0.80 | 0.75 | 0.79 | 0.72 | 0.86 | 0.99 | 1.12 | 1.16 |
| Marine | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| **Multilateral Operations** | **NA** | **NA** | **NA** | **NA** | **NA** | **NA** | **NA** | **NA** | **NA** | **NA** | **NA** | **NA** | **NA** | **NA** |
| **$CO_2$ Emissions from Biomass** | | | | | | | | | | | | | | |

Table B. 3: $N_2O$ emissions for 1986 and period 1990–2002 (CRF Table 10s3)

| TYPES OF GHG SOURCES AND SINKS | 1986 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | (Gg) | | | | | | | | | | | | | |
| **Total emissions** | **5.77** | **4.90** | **4.94** | **4.78** | **4.82** | **4.80** | **4.86** | **4.95** | **4.98** | **5.02** | **5.23** | **4.92** | **4.89** | **4.99** |
| **1. Energy** | **0.52** | **0.44** | **0.42** | **0.39** | **0.39** | **0.45** | **0.51** | **0.58** | **0.60** | **0.62** | **0.67** | **0.71** | **0.76** | **0.79** |
| A. Fuel Combustion (Sectoral Approach) | 0.52 | 0.44 | 0.42 | 0.39 | 0.39 | 0.45 | 0.51 | 0.58 | 0.60 | 0.62 | 0.67 | 0.71 | 0.76 | 0.79 |
| 1. Energy Industries | 0.09 | 0.08 | 0.07 | 0.08 | 0.08 | 0.07 | 0.08 | 0.07 | 0.08 | 0.08 | 0.07 | 0.07 | 0.08 | 0.09 |
| 2. Manufacturing Industries and Construction | 0.13 | 0.08 | 0.07 | 0.06 | 0.06 | 0.06 | 0.07 | 0.08 | 0.08 | 0.09 | 0.08 | 0.09 | 0.08 | 0.07 |
| 3. Transport | 0.08 | 0.11 | 0.10 | 0.09 | 0.10 | 0.15 | 0.21 | 0.29 | 0.30 | 0.31 | 0.38 | 0.40 | 0.45 | 0.49 |
| 4. Other Sectors | 0.21 | 0.17 | 0.18 | 0.16 | 0.15 | 0.16 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | 0.14 | 0.15 | 0.14 |
| 5. Other | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| B. Fugitive Emissions from Fuels | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 1. Solid Fuels | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 2. Oil and Natural Gas | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **2. Industrial Processes** | **0.00** | **0.00** | **0.00** | **0.00** | **0.00** | **0.00** | **0.00** | **0.00** | **0.00** | **0.00** | **0.00** | **0.00** | **0.00** | **0.00** |
| A. Mineral Products | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| B. Chemical Industry | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| C. Metal Production | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| D. Other Production | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| E. Production of Halocarbons and SF6 | | | | | | | | | | | | | | |
| F. Consumption of Halocarbons and SF6 | | | | | | | | | | | | | | |
| G. Other | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **3. Solvent and Other Product Use** | **0.26** | **0.14** | **0.12** | **0.09** | **0.06** | **0.06** | **0.06** | **0.06** | **0.06** | **0.05** | **0.19** | **0.14** | **0.12** | **0.12** |
| **4. Agriculture** | **4.84** | **4.17** | **4.25** | **4.14** | **4.22** | **4.15** | **4.15** | **4.16** | **4.17** | **4.20** | **4.21** | **3.92** | **3.86** | **3.93** |
| A. Enteric Fermentation | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| B. Manure Management | 1.35 | 1.17 | 1.17 | 1.12 | 1.11 | 1.11 | 1.12 | 1.13 | 1.13 | 1.13 | 1.14 | 0.80 | 0.79 | 0.80 |
| C. Rice Cultivation | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| D. Agricultural Soils | 3.49 | 3.00 | 3.09 | 3.02 | 3.11 | 3.04 | 3.03 | 3.03 | 3.04 | 3.06 | 3.08 | 3.12 | 3.08 | 3.13 |
| E. Prescribed Burning of Savannas | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO |
| G. Field Burning of Agricultural Residues | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE |
| G. Other | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO |

Table B. 3 – Continued

| TYPES OF GHG SOURCES AND SINKS | 1986 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | (Gg) | | | | | | | | | | | | | |
| **5. Land-Use Change and Forestry** | **0.00** | **0.00** | **0.00** | **0.00** | **0.00** | **0.00** | **0.00** | **0.00** | **0.00** | **0.00** | **0.00** | **0.00** | **0.00** | **0.00** |
| A. Changes in Forest and Other Woody Biomass Stocks | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| B. Forest and Grassland Conversion | IE | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| C. Abandonment of Managed Lands | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| D. $CO_2$ Emissions and Removals from Soil | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| E. Other | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **6. Waste** | **0.15** | **0.15** | **0.15** | **0.15** | **0.15** | **0.15** | **0.15** | **0.15** | **0.15** | **0.15** | **0.15** | **0.15** | **0.15** | **0.15** |
| A. Solid Waste Disposal on Land | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| B. Waste-water Handling | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 |
| C. Waste Incineration | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO |
| D. Other | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **7. Other** | **0.00** | **0.00** | **0.00** | **0.00** | **0.00** | **0.00** | **0.00** | **0.00** | **0.00** | **0.00** | **0.00** | **0.00** | **0.00** | **0.00** |
| | | | | | | | | | | | | | | |
| **Memo Items** | | | | | | | | | | | | | | |
| **International Bunkers** | **2.73** | **2.22** | **0.77** | **0.96** | **1.35** | **1.51** | **1.61** | **1.49** | **1.57** | **1.45** | **1.73** | **1.99** | **2.25** | **2.31** |
| Aviation | 2.73 | 2.22 | 0.77 | 0.96 | 1.35 | 1.51 | 1.61 | 1.49 | 1.57 | 1.45 | 1.73 | 1.99 | 2.25 | 2.31 |
| Marine | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| **Multilateral Operations** | **NA** | **NA** | **NA** | **NA** | **NA** | **NA** | **NA** | **NA** | **NA** | **NA** | **NA** | **NA** | **NA** | **NA** |
| **$CO_2$ Emissions from Biomass** | | | | | | | | | | | | | | |

Table B. 4: HFC. PFC in $SF_6$ emissions for 1986 and period 1990–2002 (CRF Table 10s4)

| TYPES OF GHG SOURCES AND SINKS | 1986 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | (Gg) | | | | | | | | | | | | | |
| **HFC Emissions - $CO_2$ equiv. (Gg)** | **0.00** | **0.00** | **0.00** | **0.00** | **0.00** | **0.00** | **30.65** | **30.27** | **37.60** | **33.92** | **34.06** | **44.68** | **55.74** | **69.19** |
| HFC-23 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| HFC-32 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| HFC-41 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| HFC-43-10mee | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| HFC-125 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| HFC-134 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| HFC-134a | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0236 | 0.0233 | 0.0289 | 0.0261 | 0.0262 | 0.0344 | 0.0429 | 0.0532 |
| HFC-152a | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| HFC-143 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| HFC-143a | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| HFC-227ea | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| HFC-236fa | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| HFC-245ca | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| **PFC Emissions - $CO_2$ equiv. (Gg)** | **276.29** | **257.44** | **302.58** | **243.02** | **251.14** | **281.60** | **285.68** | **239.53** | **194.41** | **149.30** | **105.61** | **105.61** | **105.61** | **116.44** |
| $CF_4$ | 0.0372 | 0.0347 | 0.0408 | 0.0328 | 0.0338 | 0.0380 | 0.0385 | 0.0323 | 0.0262 | 0.0201 | 0.0140 | 0.0140 | 0.0140 | 0.0155 |
| $C_2F_6$ | 0.0037 | 0.0035 | 0.0041 | 0.0033 | 0.0034 | 0.0038 | 0.0039 | 0.0032 | 0.0026 | 0.0020 | 0.0016 | 0.0016 | 0.0016 | 0.0017 |
| $C_3F_8$ | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| $C_4F_{10}$ | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| $c\text{-}C_4F_8$ | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| $C_5F_{12}$ | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| $C_6F_{14}$ | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| **$SF_6$ Emissions - $CO_2$ equiv. (Gg)** | **7.17** | **7.17** | **7.17** | **7.17** | **7.17** | **7.17** | **25.33** | **21.51** | **21.03** | **21.03** | **21.03** | **21.03** | **21.03** | **21.03** |
| $SF_6$ | 0.0003 | 0.0003 | 0.0003 | 0.0003 | 0.0003 | 0.0003 | 0.0011 | 0.0009 | 0.0009 | 0.0009 | 0.0009 | 0.0009 | 0.0009 | 0.0009 |

Table B. 5: GHG emissions in $CO_2$ equiv. for 1986 and period 1990–2002 (CRF IPCC Table 10s5)

| **GHG SOURCES** | **1986** | **1990** | **1991** | **1992** | **1993** | **1994** | **1995** | **1996** | **1997** | **1998** | **1999** | **2000** | **2001** | **2002** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **$CO_2$ equiv. (Gg)** | | | | | | | | | | | | | |
| Net $CO_2$ emissions/sinks | 13,047.34 | 10,261.81 | 8,769.74 | 8,461.03 | 8,817.63 | 8,597.21 | 9,097.22 | 10,026.89 | 10,471.63 | 10,192.74 | 9,546.75 | 9,636.83 | 10,727.68 | 10,787.75 |
| $CO_2$ emissions (w/o LUCF) | 15,997.73 | 14,600.40 | 13,520.82 | 13,549.44 | 13,992.21 | 13,929.45 | 14,772.30 | 15,588.30 | 16,033.04 | 15,754.15 | 15,108.17 | 15,198.24 | 16,289.09 | 16,349.17 |
| $CH_4$ | 2,530.54 | 2,344.01 | 2,429.71 | 2,372.07 | 2,380.30 | 2,343.64 | 2,374.96 | 2,345.74 | 2,380.35 | 2,370.37 | 2,355.09 | 2,346.01 | 2,275.55 | 2,281.38 |
| $N_2O$ | 1,789.59 | 1,518.40 | 1,532.44 | 1,481.25 | 1,493.74 | 1,489.24 | 1,508.06 | 1,535.95 | 1,545.02 | 1,555.49 | 1,620.43 | 1,524.39 | 1,515.70 | 1,545.68 |
| HFCs | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 30.65 | 30.27 | 37.60 | 33.92 | 34.06 | 44.68 | 55.74 | 69.19 |
| PFCs | 276.29 | 257.44 | 302.58 | 243.02 | 251.14 | 281.60 | 285.68 | 239.53 | 194.41 | 149.30 | 105.61 | 105.61 | 105.61 | 116.44 |
| $SF_6$ | 7.17 | 7.17 | 7.17 | 7.17 | 7.17 | 7.17 | 25.33 | 21.51 | 21.03 | 21.03 | 21.03 | 21.03 | 21.03 | 21.03 |
| **Total (with LUCF)** | **17,650.49** | **14,388.84** | **13,041.63** | **12,564.53** | **12,949.98** | **12,718.87** | **13,321.90** | **14,199.89** | **14,650.04** | **14,322.84** | **13,682.98** | **13,678.55** | **14,701.31** | **14,821.48** |
| **Total (without LUCF)** | **20,601.33** | **18,727.42** | **17,792.72** | **17,652.95** | **18,124.56** | **18,051.11** | **18,996.98** | **19,761.30** | **20,211.45** | **19,884.26** | **19,244.39** | **19,239.96** | **20,262.73** | **20,382.90** |

| **TYPES OF GHG SOURCES AND SINKS** | **1986** | **1990** | **1991** | **1992** | **1993** | **1994** | **1995** | **1996** | **1997** | **1998** | **1999** | **2000** | **2001** | **2002** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **$CO_2$ equiv. (Gg)** | | | | | | | | | | | | | |
| 1. Energy | 15,602.58 | 14,101.39 | 13,212.02 | 13,244.56 | 13,835.85 | 13,626.01 | 14,498.20 | 15,316.72 | 15,774.53 | 15,525.64 | 14,863.60 | 14,932.77 | 15,976.91 | 16,080.00 |
| 2. Industrial Processes | 1,308.83 | 1,283.25 | 1,120.28 | 1,064.22 | 897,55 | 1,077.12 | 1,127.54 | 1,084.16 | 1,055.14 | 972.71 | 941.41 | 976.55 | 1,031.49 | 1,050.52 |
| 3. Solvent and Other Product Use | 128.09 | 80.98 | 71.25 | 61.03 | 50.63 | 51.95 | 47.85 | 53.12 | 53.46 | 51.09 | 94.15 | 79.11 | 72.90 | 73.24 |
| 4. Agriculture | 2,564.45 | 2,291.52 | 2,322.04 | 2,242.66 | 2,260.95 | 2,202.23 | 2,187.88 | 2,162.26 | 2,149.48 | 2,158.75 | 2,172.90 | 2,082.76 | 2,045.47 | 2,069.59 |
| 5. Land-Use Change and Forestry (LUCF) | -2,950.39 | -4,338.58 | -4,751.08 | -5,088.42 | -5,174.58 | -5,332.25 | -5,675.08 | -5,561.41 | -5,561.41 | -5,561.41 | -5,561.41 | -5,561.42 | -5,561.42 | -5,561.42 |
| 6. Waste | 997.38 | 970.27 | 1,067.12 | 1,040.47 | 1,079.59 | 1,093.80 | 1,135.52 | 1,145.04 | 1,178.84 | 1,176.06 | 1,172.33 | 1,168.77 | 1,135.96 | 1,109.55 |
| 7. Other | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

Table B. 6: $NO_x$ emissions for 1986 and period 1990–2002

| $NO_x$ emission sources | 1986 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Gg | | | | | | | | | | | | | |
| **Total emissions** | **58.00** | **63.68** | **57.97** | **58.52** | **63.25** | **66.13** | **66.83** | **70.70** | **70.98** | **63.96** | **58.43** | **59.97** | **59.38** | **59.92** |
| **1. Energy** | **57.70** | **63.44** | **57.82** | **58.38** | **63.09** | **65.92** | **66.59** | **70.44** | **70.69** | **63.69** | **58.15** | **59.67** | **59.09** | **59.63** |
| A. Fuel Combustion (Sectoral Approach) | 57.70 | 63.44 | 57.82 | 58.38 | 63.09 | 65.92 | 66.59 | 70.44 | 70.69 | 63.69 | 58.15 | 59.67 | 59.09 | 59.63 |
| 1. Energy Industries | 19.70 | 17.06 | 14.52 | 16.86 | 16.59 | 15.99 | 16.52 | 16.30 | 16.30 | 16.99 | 15.11 | 15.34 | 16.38 | 17.35 |
| 2. Manufacturing Industries and Construction | 5.80 | 4.63 | 4.33 | 3.13 | 3.04 | 3.43 | 2.90 | 2.61 | 3.36 | 3.13 | 3.23 | 3.71 | 3.57 | 3.98 |
| 3. Transport | 30.70 | 40.21 | 37.41 | 37.13 | 41.69 | 44.58 | 45.13 | 48.87 | 48.25 | 40.75 | 36.74 | 36.67 | 35.09 | 34.39 |
| 4. Other Sectors | 1.50 | 1.54 | 1.57 | 1.27 | 1.77 | 1.92 | 2.04 | 2.67 | 2.79 | 2.82 | 3.07 | 3.96 | 4.06 | 3.91 |
| **2. Industrial Processes** | **0.30** | **0.24** | **0.14** | **0.14** | **0.16** | **0.21** | **0.24** | **0.26** | **0.28** | **0.27** | **0.28** | **0.30** | **0.29** | **0.29** |
| A. Mineral Products | 0.07 | 0.00 | 0.00 | 0.00 | 0.08 | 0.11 | 0.10 | 0.14 | 0.12 | 0.09 | 0.09 | 0.10 | 0.10 | 0.10 |
| C. Metal Production | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.02 |
| D. Other Production | 0.23 | 0.22 | 0.13 | 0.13 | 0.06 | 0.09 | 0.12 | 0.11 | 0.16 | 0.17 | 0.18 | 0.18 | 0.17 | 0.17 |

Table B. 7: CO emissions for 1986 and period 1990–2002

| CO emission sources | 1986 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Gg | | | | | | | | | | | | | |
| **Total emissions** | **78.82** | **93.85** | **78.79** | **89.57** | **97.82** | **102.82** | **101.52** | **105.23** | **102.83** | **87.36** | **80.29** | **109.11** | **103.28** | **103.11** |
| **1. Energy** | **77.90** | **80.57** | **67.04** | **78.50** | **87.22** | **92.85** | **91.43** | **95.39** | **92.82** | **77.32** | **70.21** | **99.01** | **93.21** | **89.09** |
| A. Fuel Combustion (Sectoral Approach) | 77.90 | 80.57 | 67.04 | 78.50 | 87.22 | 92.85 | 91.43 | 95.39 | 92.82 | 77.32 | 70.21 | 99.01 | 93.21 | 89.09 |
| 1. Energy Industries | 1.20 | 0.98 | 0.81 | 0.98 | 0.97 | 0.93 | 1.00 | 1.00 | 0.90 | 0.94 | 0.87 | 1.13 | 1.19 | 1.33 |
| 2. Manufacturing Industries and Construction | 1.80 | 1.19 | 1.10 | 0.78 | 0.74 | 0.73 | 0.68 | 0.68 | 0.76 | 0.68 | 0.73 | 1.55 | 1.57 | 1.72 |
| 3. Transport | 54.70 | 69.27 | 64.32 | 67.49 | 78.34 | 85.49 | 85.76 | 89.69 | 87.70 | 72.56 | 65.04 | 63.20 | 57.23 | 53.08 |
| 4. Other Sectors | 20.20 | 9.13 | 0.81 | 9.25 | 7.18 | 5.70 | 3.99 | 4.01 | 3.45 | 3.14 | 3.57 | 33.14 | 33.22 | 32.96 |
| **2. Industrial Processes** | **0.92** | **13.28** | **11.75** | **11.08** | **10.60** | **9.98** | **10.09** | **9.85** | **10.01** | **10.04** | **10.09** | **10.10** | **10.07** | **14.02** |
| A. Mineral Products | 0.03 | 0.00 | 0.00 | 0.00 | 0.03 | 0.04 | 0.04 | 0.06 | 0.05 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 |
| C. Metal Production | 0.02 | 12.44 | 11.27 | 10.60 | 10.34 | 9.59 | 9.59 | 9.38 | 9.38 | 9.38 | 9.38 | 9.38 | 9.38 | 13.33 |
| D. Other Production | 0.87 | 0.84 | 0.48 | 0.48 | 0.23 | 0.34 | 0.45 | 0.41 | 0.59 | 0.63 | 0.68 | 0.68 | 0.65 | 0.65 |

Table B. 8: NMVOC emissions for 1986 and period 1990–2002

| NMVOC emission sources | 1986 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Gg | | | | | | | | | | | | | |
| **Total emissions** | **55.83** | **44.20** | **40.64** | **40.44** | **42.55** | **45.49** | **46.21** | **49.83** | **50.47** | **45.95** | **44.52** | **56.34** | **54.66** | **54.48** |
| **1. Energy** | **35.46** | **26.52** | **24.77** | **25.37** | **28.54** | **30.57** | **30.91** | **32.96** | **32.59** | **27.72** | **25.23** | **35.38** | **33.61** | **32.79** |
| A. Fuel Combustion (Sectoral Approach) | 33.61 | 22.46 | 21.06 | 21.66 | 24.30 | 26.00 | 25.81 | 27.14 | 26.55 | 22.38 | 20.14 | 30.12 | 28.21 | 27.41 |
| 1. Energy Industries | 1.83 | 1.61 | 1.42 | 1.60 | 1.56 | 1.50 | 1.54 | 1.53 | 1.63 | 1.70 | 1.52 | 1.53 | 1.63 | 1.73 |
| 2. Manufacturing Industries and Construction | 1.72 | 0.20 | 0.18 | 0.13 | 0.12 | 0.13 | 0.12 | 0.11 | 0.13 | 0.12 | 0.13 | 1.60 | 1.20 | 1.32 |
| 3. Transport | 20.88 | 19.48 | 18.04 | 18.79 | 21.69 | 23.65 | 23.61 | 24.91 | 24.34 | 20.16 | 18.07 | 17.60 | 16.00 | 15.01 |
| 4. Other Sectors | 9.17 | 1.17 | 1.42 | 1.14 | 0.92 | 0.71 | 0.54 | 0.58 | 0.45 | 0.40 | 0.42 | 9.40 | 9.38 | 9.36 |
| B. Fugitive emissions | 1.85 | 4.06 | 3.71 | 3.71 | 4.24 | 4.57 | 5.10 | 5.82 | 6.04 | 5.34 | 5.09 | 5.26 | 5.40 | 5.38 |
| **2. Industrial Processes** | **5.89** | **5.90** | **5.20** | **4.68** | **4.31** | **4.54** | **5.71** | **6.08** | **7.06** | **7.11** | **8.28** | **9.56** | **9.60** | **10.19** |
| A. Mineral Products | 0.80 | 0.68 | 0.55 | 0.61 | 0.68 | 0.87 | 0.82 | 1.02 | 1.57 | 1.60 | 1.74 | 1.69 | 1.35 | 1.36 |
| B. Chemical Industry | 2.74 | 2.75 | 2.51 | 2.14 | 2.02 | 1.97 | 2.95 | 3.13 | 3.53 | 3.71 | 4.31 | 6.23 | 6.56 | 7.13 |
| D. Other Production | 2.35 | 2.47 | 2.15 | 1.93 | 1.61 | 1.70 | 1.94 | 1.93 | 1.96 | 1.80 | 2.23 | 1.64 | 1.69 | 1.69 |
| **3. Solvent and Other Product Use** | **14.48** | **11.78** | **10.67** | **10.39** | **9.70** | **10.38** | **9.59** | **10.79** | **10.82** | **11.11** | **11.01** | **11.40** | **11.45** | **11.51** |

Table B. 9: $SO_2$ emissions for 1986 and period 1990–2002

| SO2 emission sources | 1986 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Gg | | | | | | | | | | | | | |
| **Total emissions** | **252.54** | **203.72** | **184.08** | **191.17** | **187.02** | **181.35** | **129.67** | **116.20** | **123.08** | **128.08** | **109.45** | **99.70** | **69.75** | **72.40** |
| **1. Energy** | **246.80** | **196.27** | **179.77** | **186.28** | **182.54** | **176.51** | **124.73** | **111.60** | **118.12** | **122.67** | **103.94** | **96.32** | **65.93** | **68.20** |
| A. Fuel Combustion (Sectoral Approach) | 246.80 | 196.27 | 179.77 | 186.28 | 182.54 | 176.51 | 124.73 | 111.60 | 118.12 | 122.67 | 103.94 | 96.32 | 65.93 | 68.20 |
| 1. Energy Industries | 172.90 | 153.72 | 134.02 | 152.83 | 148.56 | 145.09 | 105.05 | 96.45 | 104.25 | 111.91 | 90.54 | 83.78 | 53.12 | 57.61 |
| 2. Manufacturing Industries and Construction | 41.00 | 21.05 | 18.78 | 14.73 | 13.12 | 12.88 | 8.28 | 5.78 | 6.01 | 4.05 | 6.65 | 6.42 | 6.77 | 6.46 |
| 3. Transport | 3.00 | 3.80 | 3.54 | 3.15 | 3.33 | 3.41 | 2.13 | 2.30 | 2.43 | 2.16 | 1.98 | 2.10 | 2.23 | 0.62 |
| 4. Other Sectors | 29.90 | 17.70 | 23.44 | 15.58 | 17.54 | 15.13 | 9.28 | 7.07 | 5.44 | 4.55 | 4.76 | 4.03 | 3.81 | 3.52 |
| **2. Industrial Processes** | **5.74** | **7.45** | **4.31** | **4.89** | **4.47** | **4.84** | **4.94** | **4.60** | **4.96** | **5.41** | **5.51** | **3.38** | **3.82** | **4.20** |
| A. Mineral Products | 0.47 | 0.37 | 0.29 | 0.24 | 0.33 | 0.42 | 0.44 | 0.51 | 0.47 | 0.46 | 0.47 | 0.50 | 1.10 | 1.17 |
| B. Chemical Industry | 4.14 | 4.14 | 1.71 | 2.44 | 2.28 | 2.54 | 2.47 | 2.16 | 2.33 | 2.75 | 2.77 | 0.58 | 0.48 | 0.33 |
| C. Metal Production | 0.05 | 1.89 | 1.71 | 1.61 | 1.57 | 1.46 | 1.46 | 1.43 | 1.43 | 1.43 | 1.43 | 1.46 | 1.44 | 1.88 |
| D. Other Production | 1.08 | 1.05 | 0.60 | 0.60 | 0.29 | 0.42 | 0.57 | 0.52 | 0.73 | 0.78 | 0.85 | 0.85 | 0.81 | 0.81 |

# Appendix C

## Model Assumptions, Defining Extent and Intensity of Measures in “with measures” and “with additional measures” Projections in Energy Sector

Table C. 1: Model assumptions, defining extent and intensity of measures in `with measures´ and `with additional measures´ projections in energy sector

| | **`With measures´ projection** | **`With additional measures´ projection** |
|---|---|---|
| **EFFICIENT ENERGY USE** | Continuation of the present policy and measures | - energy tax for households and services (20 %) and transport fuels (15 %)<br>- investment incentives and subsidies, etc. |
| **Industry** | | |
| Steel production electrical arc furnaces intensity decrease till year 2015 | 3.5 % (19 kWh/t) | 13.3 % (73 kWh/t) |
| Specific heat consumption decrease with improvements of thermal processes in paper production till year 2015 | 8 % | 31 % |
| Decrease of compressed air use by technical improvements till year 2015 | 6 % | 15 % |
| Implementation of variable speed drive for electrical motors (electricity savings up to 30%) | 5–8 % | 90 % |
| Market share of efficient (energy saving) electrical motors till 2015 (increased efficiency for ~5 %) | 8 % | 80 % |
| Realization of measures for industrial boilers efficiency improvements (increase of efficiency for 2–6 %) | 30 % | 90 % |
| Energy intensity decrease of all other processes | 0.5 %/a | |
| **Households and Services** | | |
| ***Measures on buildings*:** | | |
| Refurbishment of old dwellings (percentage of total dwelling stock) | 0.5 %/a | 1 %/a |
| Share of new constructed building with better performance as required standard: | | |
| Single family houses | 20 % | 55 % |
| Multi family houses | 15 % | 55 % |
| Measures on school buildings (decrease of specific heat consumption for 15%) - share of renovated area till 2015: | 16 % | 28 % |
| Measures on other buildings: | | 0.5 %/a |
| Energy efficient lighting (decrease of intensity for 70 %) – market share of energy saving lighting till 2015: | 23 % | 29 % |
| Efficient use of air-condition systems (decrease if intensity for 15 %) – market share till 2015: | 16 % | 26 % |
| ***Measures on heating system and structure of households appliances:*** | | |
| Energy efficiency improvement of wood biomass and natural gas boilers for central heating | | |
| Fuel switching: increased share of wooden biomass, natural gas, LPG, and heat pumps, stable share of district heating, decreased share of coal and light fuel oil. | | |
| Increased market share of improved energy efficient appliances | | |

Table C. 1 – Continued

| | | |
|---|---|---|
| ***Use of renewable energy sources*** | | |
| Increase of geothermal energy use till 2015 (compared to the year 2000): | 16 % | 32 % |
| Installation of new solar collectors till 2015 (hot water and heating) | | |
| Households | 35,000 $m^2$ | 70,000 $m^2$ |
| Services | 6,300 $m^2$ | 12,600 $m^2$ |
| **Transport** | | |
| Specific energy consumption decrease till year 2020 for: buses | 10 % | |
| trucks | 8–12 % | |
| Preserving bus market share in the area without railway connections | | |
| Increase of passenger railway transport till year 2020 (3% in year 2000) for : | 2 % | 5 % |
| Decrease of specific fuel consumption of new gasoline cars till year 2020 (from 7.7 l/100km in year 2000) for: | 1.4 l / 100km | 1.7 l / 100km |
| Decrease of specific fuel consumption of new diesel cars till year 2020 (from 6.4. l/100km in year 2000) for: | 1.2 l / 100km | 1.4 l / 100km |
| Increased share of diesel cars in total kilometers till year 2020 (11% vkm in year 2000) for: | 8 % | 14 % |
| Decrease of freight railway transport market share till year 2020 (33.2% in year 2000) for: | 6.2% | 3.2% |
| Load factor increase of freight trucks and trains for ~25% till year 2020 | | |
| **Local supply** | | |
| Increased electricity production from renewable energy sources till year 2015: | 430 GWh | 580 GWh |
| New installed capacities: wind mills | 35 + 60 MWe | 35 + 60 MWe |
| biogas CHP | 17 MWe | 33 MWe |
| small hydro PP | 9 MWe | 29 MWe |
| New CHP capacities in industry and local district heating till year 2015: | 60 MWe, 330 GWhe | 120 MWe,600 GWhe |
| **Electricity production (transmission level)** | further market development, preference dispatch of TPP Trbovlje till 2007, reconstruction of hydro PP on river Drava and Sava, new hydro PP chain on lower Sava, 50 % of Nuclear PP Krško on Slovenian market, market conditions based lignite consumption | |
| Natural gas for electricity production – new CC and gas turbine units: | CHP Ljubljana (higher coal share in electricity production) | CHP: Ljubljana and Maribor Thermal PP: Šoštanj, Trbovlje and Brestanica (lower lignite consumption due to lower electricity demand) |
| ***Lignite exploitation*** | 3.9–3.2 Mio t | 3.7–3.0 Mio t |

# Appendix D

# Energy Balances and Major Projection Indicators

Table D. 1: Energy balance and indicators for projection 'with measures'

| | 2000[1] | 2005 | 2010 | 2015 | 2020 | 2010/00 | 2010/00 |
|---|---|---|---|---|---|---|---|
| | | | | | | Index | Annual Growth |
| **Primary production [Mtoe]** | **3.04** | **3.50** | **3.17** | **3.13** | **3.01** | **104.31** | **0.4 %** |
| Solids | 1.42 | 1.59 | 1.30 | 1.23 | 1.10 | 91.1 | -0.9 % |
| Oil | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.0 | -86.6 % |
| Natural gas | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 102.5 | 0.3 % |
| Nuclear | 1.24 | 1.51 | 1.42 | 1.40 | 1.40 | 114.5 | 1.4 % |
| Hydro | 0.33 | 0.33 | 0.37 | 0.40 | 0.42 | 111.1 | 1.1 % |
| Geothermal | 0.03 | 0.04 | 0.04 | 0.04 | 0.04 | 113.4 | 1.3 % |
| Other renewable sources | 0.01 | 0.02 | 0.04 | 0.05 | 0.05 | 794.5 | 23.0 % |
| **Net imports [Mtoe]** | **3.29** | **3.70** | **4.18** | **4.37** | **4.40** | **127.1** | **2.4 %** |
| Solids | 0.25 | 0.33 | 0.43 | 0.44 | 0.21 | 169.4 | 5.4 % |
| Oil | 2.31 | 2.55 | 2.69 | 2.79 | 2.83 | 116.2 | 1.5 % |
| Crude oil | 0.15 | 0.00 | 0.00 | 0.00 | 0.00 | 0.0 | -86.6 % |
| Oil products | 2.17 | 2.55 | 2.69 | 2.79 | 2.83 | 124.1 | 2.2 % |
| Natural gas | 0.83 | 0.96 | 1.16 | 1.25 | 1.45 | 139.4 | 3.4 % |
| Electricity | -0.11 | -0.13 | -0.10 | -0.11 | -0.10 | 89.7 | -1.1 % |
| **Gross Inland Consumption (TPES) [Mtoe]** | **6.33** | **7.20** | **7.35** | **7.50** | **7.41** | **116.2** | **1.5 %** |
| Solids | 1.68 | 1.93 | 1.75 | 1.70 | 1.34 | 104.3 | 0.4 % |
| Oil | 2.32 | 2.55 | 2.69 | 2.79 | 2.83 | 116.2 | 1.5 % |
| Gas | 0.84 | 0.97 | 1.17 | 1.26 | 1.46 | 139.1 | 3.4 % |
| Other[2] | 1.49 | 1.76 | 1.74 | 1.75 | 1.78 | 116.6 | 1.6 % |
| **Electricity generation [TWh][3]** | **13.61** | **15.69** | **16.01** | **16.67** | **17.08** | **117.7** | **1.6 %** |
| Nuclear | 4.76 | 5.81 | 5.45 | 5.36 | 5.36 | 114.5 | 1.4 % |
| Hydro & wind | 3.83 | 3.90 | 4.43 | 4.89 | 5.11 | 115.6 | 1.5 % |
| Thermal | 5.01 | 5.98 | 6.13 | 6.42 | 6.60 | 122.2 | 2.0 % |
| **Generation capacity i[$GW_e$]** | **2.82** | **2.92** | **3.04** | **3.05** | **2.90** | 107.8 | 0.8 % |
| Nuclear | 0.68 | 0.68 | 0.68 | 0.68 | 0.68 | 100.0 | 0.0 % |
| Hydro&Wind | 0.82 | 0.91 | 1.05 | 1.19 | 1.24 | 127.7 | 2.5 % |
| Thermal | 1.32 | 1.34 | 1.31 | 1.19 | 0.99 | 99.3 | -0.1 % |
| **Average Load Factor [%]** | **55.2 %** | **61.3 %** | **60.2 %** | **62.4 %** | **67.1 %** | **109.1** | **0.9 %** |
| **Fuel inputs for Thermal Power Generation [Mtoe]** | **1.34** | **1.60** | **1.55** | **1.61** | **1.45** | **116.2** | **1.5 %** |
| Solids | 1.23 | 1.43 | 1.24 | 1.20 | 0.85 | 100.8 | 0.1 % |
| Petrol. products | 0.02 | 0.03 | 0.03 | 0.06 | 0.07 | 139.6 | 3.4 % |
| Gas | 0.07 | 0.10 | 0.24 | 0.30 | 0.48 | 351.0 | 13.4 % |
| Geothermal | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | | |
| Combust. renew.& waste | 0.02 | 0.03 | 0.05 | 0.05 | 0.05 | 273.5 | 10.6 % |
| **Average Thermal Efficiency [%]** | **32.3 %** | **32.2 %** | **33.9 %** | **34.3 %** | **39.0 %** | **105.2** | **0.5 %** |
| **Non energy use [Mtoe]** | **0.14** | **0.14** | **0.15** | **0.15** | **0.15** | **101.5** | **0.2 %** |
| **Total final energy demand [Mtoe]** | **4.38** | **4.90** | **5.17** | **5.30** | **5.39** | **118.2** | **1.7%** |
| Solids | 0.06 | 0.06 | 0.06 | 0.06 | 0.05 | 98.5 | -0.1 % |
| Oil | 2.28 | 2.51 | 2.66 | 2.73 | 2.76 | 116.8 | 1.6 % |
| Gas | 0.60 | 0.70 | 0.77 | 0.80 | 0.83 | 127.9 | 2.5 % |
| Electricity | 0.92 | 1.06 | 1.11 | 1.15 | 1.19 | 120.9 | 1.9 % |
| Heat | 0.17 | 0.20 | 0.21 | 0.21 | 0.21 | 119.6 | 1.8 % |
| Renewable energy sources | 0.34 | 0.37 | 0.36 | 0.35 | 0.34 | 106.1 | 0.6 % |
| **Indicators** | | | | | | | |
| Population [million] | 1.99 | 1.99 | 1.98 | 1.98 | 1.96 | 99.5 | -0.1 % |
| GDP [billionSIT 2000][4] | 4081 | 4814 | 5759 | 6452 | 7157 | 141.1 | 3.5 % |
| Gross inl. Cons./GDP [toe/2000 MSIT] | 1.55 | 1.50 | 1.28 | 1.16 | 1.04 | 82.3 | -1.9 % |
| toe/1995 MEUR] | 506 | 488 | 416 | 379 | 338 | 82.3 | -1.9 % |
| Gross inl. Cons./Capita [kgoe/cap.] | 3181 | 3626 | 3714 | 3796 | 3773 | 116.8 | 1.6 % |
| Electricity generated/Capita [kWh/cap.] | 6837 | 7904 | 8085 | 8441 | 8696 | 118.3 | 1.7 % |
| Import dependency [%] | 52.0 % | 51.4 % | 56.9 % | 58.3 % | 59.4 % | 109.4 | 0.9 % |
| % oil in final demand [%] | 52.1 % | 51.3 % | 51.5 % | 51.6 % | 51.3 % | 98.8 | -0.1 % |

[1] Base year data source: Statistical bulletin of energy sector, publ. MOPE
[2] Includes nuclear, hydro, wind, net imports of electricity (imp.-exp.), and other energy source
[3] Gross production (net production for smaller units)
[4] In model old data on GDP were used. Since later it was corrected so it differs from the data in the chapter Economy profile.

Table D. 2: Energy balance and indicators for projection ‘with additional measures’

| | 2000 | 2005 | 2010 | 2015 | 2020 | 2010/00 Index | 2010/00 Annual growth |
|---|---|---|---|---|---|---|---|
| **Primary production [Mtoe]** | **3.04** | **3.54** | **3.18** | **3.04** | **3.07** | **104.66** | **0.5 %** |
| Solids | 1.42 | 1.60 | 1.26 | 1.10 | 1.11 | 88.8 | -1.2 % |
| Oil | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.0 | -86.6 % |
| Natural gas | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 104.6 | 0.4 % |
| Nuclear | 1.24 | 1.51 | 1.42 | 1.40 | 1.40 | 114.5 | 1.4 % |
| Hydro | 0.33 | 0.34 | 0.37 | 0.41 | 0.42 | 113.0 | 1.2 % |
| Geothermal | 0.03 | 0.04 | 0.04 | 0.05 | 0.05 | 124.9 | 2.2 % |
| Other renewable sources | 0.01 | 0.04 | 0.08 | 0.09 | 0.09 | 1384.3 | 30.1 % |
| **Net imports [Mtoe]** | **3.29** | **3.61** | **4.00** | **4.12** | **4.11** | **121.7** | **2.0 %** |
| Solids | 0.25 | 0.33 | 0.40 | 0.35 | 0.19 | 157.3 | 4.6 % |
| Oil | 2.31 | 2.47 | 2.54 | 2.53 | 2.51 | 109.5 | 0.9 % |
| Crude oil | 0.15 | 0.00 | 0.00 | 0.00 | 0.00 | 0.0 | -86.6 % |
| Oil products | 2.17 | 2.47 | 2.54 | 2.53 | 2.51 | 116.9 | 1.6 % |
| Natural gas | 0.83 | 0.96 | 1.18 | 1.39 | 1.63 | 142.1 | 3.6 % |
| Electricity | -0.11 | -0.14 | -0.12 | -0.14 | -0.22 | 102.4 | 0.2 % |
| **Gross Inland Consumption (TPES) [Mtoe]** | **6.33** | **7.14** | **7.19** | **7.17** | **7.18** | **113.5** | **1.3 %** |
| Solids | 1.68 | 1.96 | 1.72 | 1.51 | 1.36 | 102.4 | 0.2 % |
| Oil | 2.32 | 2.47 | 2.54 | 2.53 | 2.51 | 109.5 | 0.9 % |
| Gas | 0.84 | 0.96 | 1.19 | 1.40 | 1.64 | 141.8 | 3.6 % |
| Other | 1.49 | 1.75 | 1.74 | 1.73 | 1.67 | 116.4 | 1.5 % |
| **Electricity generation [TWh]** | **13.61** | **15.84** | **16.16** | **17.05** | **18.59** | **118.7** | **1.7 %** |
| Nuclear | 4.76 | 5.81 | 5.45 | 5.36 | 5.36 | 114.5 | 1.4 % |
| Hydro & wind | 3.83 | 3.94 | 4.51 | 4.95 | 5.16 | 117.6 | 1.6 % |
| Thermal | 5.01 | 6.09 | 6.20 | 6.74 | 8.06 | 123.7 | 2.1 % |
| **Generation capacity i[$GW_e$]** | **2.82** | **2.96** | **3.17** | **3.40** | **3.58** | 112.6 | 1.2 % |
| Nuclear | 0.68 | 0.68 | 0.68 | 0.68 | 0.68 | 100.0 | 0.0 % |
| Hydro&Wind | 0.82 | 0.92 | 1.07 | 1.20 | 1.25 | 130.0 | 2.7 % |
| Thermal | 1.32 | 1.37 | 1.42 | 1.52 | 1.66 | 108.2 | 0.8 % |
| **Average Load Factor [%]** | **55.2 %** | **61.1 %** | **58.2 %** | **57.3 %** | **59.3 %** | **105.4** | **0.5 %** |
| **Fuel inputs for Thermal Power Generation [Mtoe]** | **1.34** | **1.62** | **1.53** | **1.54** | **1.64** | **114.8** | **1.4 %** |
| Solids | 1.23 | 1.43 | 1.13 | 0.94 | 0.79 | 91.9 | -0.8 % |
| Petrol. products | 0.02 | 0.03 | 0.02 | 0.02 | 0.03 | 107.3 | 0.7 % |
| Gas | 0.07 | 0.12 | 0.31 | 0.51 | 0.74 | 452.0 | 16.3 % |
| Geothermal | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | | |
| Combust. renew.& waste | 0.02 | 0.05 | 0.07 | 0.08 | 0.08 | 450.2 | 16.2 % |
| **Average Thermal Efficiency [%]** | **32.3 %** | **32.2 %** | **34.8 %** | **37.6 %** | **42.3 %** | **107.7** | **0.7 %** |
| **Non energy use [Mtoe]** | **0.14** | **0.14** | **0.15** | **0.15** | **0.15** | **101.5** | **0.2 %** |
| **Total final energy demand [Mtoe]** | **4.38** | **4.83** | **5.03** | **5.10** | **5.13** | **115.0** | **1.4 %** |
| Solids | 0.06 | 0.06 | 0.06 | 0.05 | 0.05 | 96.6 | -0.3 % |
| Oil | 2.28 | 2.44 | 2.51 | 2.51 | 2.47 | 110.3 | 1.0 % |
| Gas | 0.60 | 0.69 | 0.74 | 0.76 | 0.77 | 122.4 | 2.0 % |
| Electricity | 0.92 | 1.06 | 1.11 | 1.15 | 1.20 | 121.0 | 1.9 % |
| Heat | 0.17 | 0.20 | 0.21 | 0.22 | 0.23 | 122.7 | 2.1 % |
| Renewable energy sources | 0.34 | 0.38 | 0.40 | 0.40 | 0.41 | 116.4 | 1.5 % |
| **Indicators** | | | | | | | |
| Population [million] | 1.99 | 1.99 | 1.98 | 1.98 | 1.96 | 99.5 | -0.1 % |
| GDP [billionSIT 2000] | 4081 | 4814 | 5759 | 6452 | 7157 | 141.1 | 3.5 % |
| Gross inl. Cons./GDP [toe/2000 MSIT] | 1.55 | 1.48 | 1.25 | 1.11 | 1.00 | 80.4 | -2.2 % |
| toe/1995 MEUR] | 506 | 484 | 407 | 362 | 327 | 80.4 | -2.2 % |
| Gross inl. Cons./Capita [kgoe/cap.] | 3181 | 3599 | 3629 | 3628 | 3654 | 114.1 | 1.3 % |
| Electricity generated/Capita [kWh/cap.] | 6837 | 7978 | 8161 | 8635 | 9463 | 119.4 | 1.8 % |
| Import dependency [%] | 52.0 % | 50.5 % | 55.7 % | 57.6 % | 57.2 % | 107.2 | 0.7 % |
| % oil in final demand [%] | 52.1 % | 50.5 % | 50.0 % | 49.2 % | 48.2 % | 95.9 | -0.4 % |

# Appendix E

# GHG Emissions According to “with measures” and “with additional measures” Projections

Table E. 1: GHG emissions according to 'with measures' projection for 1986, 2002 and 2005–2020 by sectors

| Gg $CO_{2\ eq.}$ | 1986 | 2002 | 2005 | 2008 | 2010 | 2012 | 2015 | 2020 | Average 2008-2012 |
|---|---|---|---|---|---|---|---|---|---|
| **1. Energy** | **15,603** | **16,080** | **16,916** | **16,712** | **16,997** | **17,090** | **17,248** | **16,299** | **16,939** |
| **A. Fuel Combustion** | **15,218** | **15,745** | **16,530** | **16,344** | **16,647** | **16,758** | **16,938** | **15,999** | **16,589** |
| **1. Energy Industries** | **6,729** | **6,430** | **6,647** | **6,088** | **6,128** | **6,144** | **6,175** | **5,098** | **6,121** |
| - Thermal Power Plants | | | 5,593 | 5,046 | 5,091 | 5,079 | 5,109 | 4,164 | 5,074 |
| - TE-TO (CHP Ljubljana) | | | 844 | 830 | 825 | 855 | 860 | 744 | 836 |
| - Heating Plants | | | 204 | 206 | 206 | 205 | 201 | 186 | 206 |
| - Mining and Oil Industry | | | 6 | 6 | 6 | 5 | 5 | 4 | 6 |
| **2. Manufacturing Industries and Construction** | **4,171** | **2,412** | **2,284** | **2,348** | **2,413** | **2,370** | **2,328** | **2,318** | **2,381** |
| - Manufacturing Industries | 3,899 | 2,281 | 2,153 | 2,209 | 2,269 | 2,224 | 2,180 | 2,164 | 2,238 |
| - Construction | 272 | 131 | 131 | 139 | 144 | 146 | 148 | 155 | 143 |
| **3. Transport** | **2,008** | **3,965** | **4,340** | **4,569** | **4,712** | **4,818** | **4,957** | **5,064** | **4,701** |
| **4. Other Sectors** | **2,311** | **2,938** | **3,260** | **3,339** | **3,394** | **3,426** | **3,477** | **3,519** | **3,387** |
| -Households | 1,201 | 1,812 | 1,575 | 1,641 | 1,688 | 1,711 | 1,748 | 1,767 | 1,681 |
| - Commercial / Institutional | 632 | 867 | 1,427 | 1,440 | 1,448 | 1,459 | 1,474 | 1,499 | 1,449 |
| - Agriculture | 478 | 258 | 258 | 258 | 257 | 256 | 255 | 253 | 257 |
| **B. Fugitive Emissions from Fuels** | **384** | **335** | **386** | **368** | **350** | **332** | **310** | **300** | **350** |
| **2. Industrial Processes** | **1,309** | **1,051** | **1,201** | **1,339** | **1,431** | **1,469** | **1,495** | **1,640** | **1,415** |
| 1. Mineral Production | 762 | 548 | 535 | 538 | 541 | 543 | 547 | 553 | 541 |
| 2. Aluminium production | 366 | 303 | 334 | 291 | 310 | 329 | 358 | 407 | 310 |
| 3. Use of HFC and $SF_6$ | 7 | 90 | 189 | 319 | 406 | 392 | 384 | 443 | 376 |
| 4. Other Industries | 174 | 109 | 143 | 191 | 175 | 204 | 206 | 237 | 188 |
| **3. Solvent and Other Product Use** | **128** | **73** | **39** | **37** | **35** | **35** | **35** | **35** | **35** |
| **4. Agriculture** | **2,564** | **2,070** | **2,141** | **2,176** | **2,199** | **2,190** | **2,183** | **2,181** | **2,189** |
| **5. Land Use Change and Forestry** | -2,950 | -5,561 | -840 | -840 | -840 | -840 | -840 | -840 | -840 |
| **6. Waste** | **997** | **1,110** | **1,026** | **959** | **914** | **837** | **733** | **591** | **905** |
| | | | | | | | | | |
| **Total emissions without removals (LUCF)** | **20,601** | **20,383** | **21,322** | **21,222** | **21,576** | **21,620** | **21,694** | **20,745** | **21,483** |
| **Total emissions with removals (LUCF)** | **17,650** | **14,821** | **20,482** | **20,382** | **20,736** | **20,780** | **20,854** | **19,905** | **20,643** |

Table E. 2: GHG emissions according to 'with measures' projection for 1986, 2002 and 2005–2020 by gases

| Gg $CO_{2\ eq,}$ | 1986 | 2002 | 2005 | 2008 | 2010 | 2012 | 2015 | 2020 | Average 2008-2012 |
|---|---|---|---|---|---|---|---|---|---|
| $CO_2$ | 15,998 | 16,349 | 17,181 | 17,027 | 17,352 | 17,510 | 17,716 | 16,866 | 17,302 |
| $CH_4$ | 2,531 | 2,281 | 2,359 | 2,291 | 2,240 | 2,137 | 2,004 | 1,849 | 2,224 |
| $N_2O$ | 1,790 | 1,546 | 1,478 | 1,511 | 1,534 | 1,537 | 1,545 | 1,543 | 1,528 |
| HFCs | 0 | 69 | 152 | 232 | 286 | 327 | 355 | 412 | 282 |
| PFCs | 276 | 116 | 116 | 73 | 44 | 44 | 44 | 44 | 53 |
| $SF_6$ | 7 | 21 | 37 | 87 | 120 | 65 | 29 | 31 | 93 |
| **Total emissions without removals (LUCF)** | **20,601** | **20,383** | **21,322** | **21,222** | **21,576** | **21,620** | **21,694** | **20,745** | **21,483** |

Table E. 3: GHG emissions according to 'with additional measures' projection for 1986, 2002 and 2005–2020 by sectors

| Gg $CO_2$ eq, | 1986 | 2002 | 2005 | 2008 | 2010 | 2012 | 2015 | 2020 | Average 2008-2012 |
|---|---|---|---|---|---|---|---|---|---|
| **1, Energy** | **15,603** | **16,080** | **16,476** | **15,651** | **15,898** | **15,445** | **15,293** | **15,061** | **15,689** |
| **A. Fuel Combustion** | **15,218** | **15,745** | **16,090** | **15,287** | **15,549** | **15,110** | **14,993** | **14,762** | **15,339** |
| **1. Energy Industries** | **6,729** | **6,430** | **6,624** | **5,608** | **5,729** | **5,288** | **5,178** | **5,039** | **5,560** |
| - Thermal Power Plants | | | 5,570 | 4,646 | 4,763 | 4,291 | 4,171 | 4,024 | 4,586 |
| - TE-TO (CHP Ljubljana) | | | 836 | 736 | 736 | 780 | 780 | 780 | 749 |
| - Heating Plants | | | 212 | 220 | 223 | 212 | 222 | 231 | 219 |
| - Mining and Oil Industry | | | 6 | 6 | 6 | 5 | 5 | 4 | 6 |
| **2. Manufacturing Industries and Construction** | **4,171** | **2,412** | **2,262** | **2,313** | **2,366** | **2,322** | **2,274** | **2,256** | **2,337** |
| - Manufacturing Industries | 3,899 | 2,281 | 2,131 | 2,174 | 2,222 | 2,176 | 2,126 | 2,102 | 2,194 |
| - Construction | 272 | 131 | 131 | 139 | 144 | 146 | 148 | 155 | 143 |
| **3. Transport** | **2,008** | **3,965** | **4,063** | **4,227** | **4,315** | **4,382** | **4,456** | **4,471** | **4,309** |
| **4. Other Sectors** | **2,311** | **2,938** | **3,140** | **3,140** | **3,139** | **3,117** | **3,085** | **2,995** | **3,133** |
| -Households | 1,201 | 1,812 | 1,367 | 1,344 | 1,327 | 1,313 | 1,290 | 1,252 | 1,328 |
| - Commercial / Institutional | 632 | 867 | 1,515 | 1,538 | 1,554 | 1,548 | 1,540 | 1,490 | 1,548 |
| - Agriculture | 478 | 258 | 258 | 258 | 257 | 256 | 255 | 253 | 257 |
| **B. Fugitive Emissions from Fuels** | **384** | **335** | **386** | **364** | **350** | **336** | **300** | **300** | **350** |
| **2. Industrial Processes** | **1,309** | **1,051** | **1,109** | **1,138** | **1,157** | **1,198** | **1,225** | **1,299** | **1,164** |
| 1. Mineral Production | 762 | 548 | 535 | 538 | 541 | 543 | 547 | 553 | 541 |
| 2. Aluminium production | 366 | 303 | 334 | 291 | 310 | 329 | 358 | 407 | 310 |
| 3. Use of HFC and $SF_6$ | 7 | 90 | 98 | 118 | 132 | 121 | 114 | 102 | 124 |
| 4. Other Industries | 174 | 109 | 143 | 191 | 175 | 204 | 206 | 237 | 188 |
| **3. Solvent and Other Product Use** | **128** | **73** | **41** | **37** | **35** | **35** | **35** | **35** | **36** |
| **4. Agriculture** | **2,564** | **2,070** | **2,141** | **2,146** | **2,149** | **2,140** | **2,133** | **2,131** | **2,145** |
| **5. Land Use Change and Forestry** | -2,950 | -5,561 | **-840** | **-840** | **-840** | **-840** | -840 | **-840** | -840 |
| **6. Waste** | **997** | **1,110** | **1,026** | **904** | **822** | **716** | **581** | **395** | **815** |
| | | | | | | | | | |
| **Total emissions without removals (LUCF)** | **20,601** | **20,383** | **20,793** | **19,875** | **20,061** | **19,534** | **19,267** | **18,921** | **19,847** |
| **Total emissions with removals (LUCF)** | **17,650** | **14,821** | **19,953** | **19,035** | **19,221** | **18,694** | **18,427** | **18,081** | **19,007** |

Table E. 4: GHG emissions according to 'with additional measures' projection for 1986, 2002 and 2005–2020 by gases

| Gg $CO_{2\ eq.}$ | 1986 | 2002 | 2005 | 2008 | 2010 | 2012 | 2015 | 2020 | Average 2008-2012 |
|---|---|---|---|---|---|---|---|---|---|
| $CO_2$ | 15,998 | 16,349 | 16,748 | 15,979 | 16,263 | 15,872 | 15,784 | 15,644 | 16,061 |
| $CH_4$ | 2,531 | 2,281 | 2,362 | 2,228 | 2,139 | 2,019 | 1,847 | 1,666 | 2,130 |
| $N_2O$ | 1,790 | 1,546 | 1,466 | 1,476 | 1,482 | 1,478 | 1,478 | 1,466 | 1,479 |
| HFCs | 0 | 69 | 75 | 95 | 108 | 99 | 92 | 83 | 101 |
| PFCs | 276 | 116 | 116 | 73 | 44 | 44 | 44 | 44 | 53 |
| $SF_6$ | 7 | 21 | 23 | 23 | 24 | 22 | 22 | 19 | 23 |
| **Total emissions without removals (LUCF)** | **20,601** | **20,383** | **20,791** | **19,875** | **20,061** | **19,534** | **19,267** | **18,921** | **19,847** |

# Appendix F

# Report on Slovenian Activities in Relation to Systematic Climate Observation and Global Climate Observing System

## According to Decisions 4/CP.5 in 5/CP.5 of the Conference of the Parties to the United Nations Framework Convention on Climate Change

## 1. General Approach to Systematic Observation

Meteorological observations in Slovenia began more than 150 years ago. The first meteorological observation station started functioning in 1850 in Ljubljana, and in 1871 also other stations were established in Celje, Novo mesto, Maribor, Ptuj, Kranj and Kamnik. There is a problem of non-homogeneity with the long term series of measures. This is the consequence of moving the metering points, changing the instruments and observation protocols, and the changes in the surroundings of metering points. The homogeneity of data is assured by a reanalysis method based on a repeated weather analysis from the past. Long-term and homogenous data series enable pointing out the weather changes. The most unchanged data is noticed at the Ratece station in the north west of Slovenia [ **1**]. Since 1955 there has been a highland meteorological observation station Kredarica at 2514 m above the sea level [ **2**]. Hydrological observation has a long tradition as well as the first water monitoring stations were founded as early as 1850, while the quality measures have been carried out since 1893 [ **7**]. Regular observation of the Triglav glacier has been performed since 1946 and of the Skuta glacier since 1948 [ **5**]

Until 2001 Hydrometeorological Institute of Slovenia was in charge of meteorological, agrometeorological and hydrological observations and air quality measuring, then ARSO was founded which took over all these activities. The Agency is organized within the Ministry of the Environment, Spatial Planning and Energy (MOPE). The observation of the glaciers is performed by the Anton Melik Geografical Institute, which is a part of the Scientific Research Centre of the Slovenian Academy of Science and Arts, while oceanographic observations take place at the Marine Biology Station within the National Institute of Biology.

## 2. Meteorological and Atmospheric Observation

Slovenia is characterized by diverse local climatic conditions, which is a consequence of mixture of three climatic types, alpine in the Northwest, submediterranean in the Southwest and continental in the Northeast, and its diverse relief. This is the reason why extensive monitoring network is needed for good quality monitoring of climatic conditions in Slovenia. At the moment the network consists of 39 climatological stations, 13 of them being synoptical, 180 precipitation stations, a radiosounding station, sodar and a meteorological radar station. Most of the 30 automatic meteorological stations operate at climatological meteorological stations. The problem of measuring sequence in Slovenia is its non-homogeneity because of moving of measuring spots, change of observation protocol, instruments, and the surroundings of the measuring spots. Correction of the non-homogeneity of the data is done with a reanalysis method, based on a repeated weather analysis in the past: that helps us get a longer and more homogenous set than it would be if it was presented by measured data only. The drawback of this method is that it is useful only for the data after 1957 due to the lack of quality satellite, ground and height surveys. ARSO (Environmental Agency of the Republic of Slovenia) archive has to use more detailed methods of measured data homogenization in order to define trends and climate change in Slovenia. Since there are no measuring stations in Slovenia with the same measuring method on a long-term in unchanged surroundings 5 to 6 reference meteorological stations are planned for climate change monitoring in the future.

International participation of Slovenia in terms of exchanging meteorological data takes place mainly within the projects under the sponsorship of the World Meteorological Organisation. The most extensive data exchange takes place within the World Weather Watch (WWW), for which data from 13 synoptical stations are sent. Within the GCOS (Global Climate Observing System) project, Kredarica station and Ljubljana station take part with meteorological data and data form meta base. GPCC which is a part of World Climate Research Programme regularly receives data from synoptical stations, and if requested monthly data of the precipitation network are sent. Besides these data also the selected meta base data are assured: geographical coordinates, altitude, ombrometer type and presence of the against-wind shield.

Within the GAW project (Global Atmosphere Watch) data on ozone measures in Krvavec and Iskrba are sent. The data from both stations are also sent to the EMEP coordination centre (for the CLRTAB programme).

Table F. 1: Participation in the Global Atmospheric Observation System

| | GAW | GCOS | WWW | WCRP | CLRTAB |
|---|---|---|---|---|---|
| How many stations are the responsibility of the Party? | 2 | 2 | 19 | 19 | 2 |
| How many are providing data to international data centres now? | 2 | 2 | 19 | 19 | 2 |
| How many are expected to be operating in 2005? | 2 | 2 | 19 | 19 | 2 |

Air quality measurements for Slovenia are being done in several networks. The national network, which is under ARSO competence, comprises an automatic network and a 24–hour network. Additional networks of automatic stations operate around thermal power plants Šoštanj, Trbovlje and Brestanica and in town municipalities of Ljubljana, Maribor and Celje. $SO_2$ concentration measuring instrument is part of Nuclear Power Plant Ecological-information system in Krško [ 6].

Regarding the quality of data, all the procedures collected in 2003 from this area, were regulated through the Rule on ensuring the quality of the data from the ARSO metering networks, while in 2004 ISO9001 standard acquisition is in its final stages [ 15].

## 3. Terrestrial Observations

The observation of glaciers is performed on the glacier under Skuta and Triglav glacier, which are the most South-eastern positioned Alpine glaciers on relatively low sea levels. Therefore they are particularly sensitive to climate conditions [ **10**]. Regular observations, performed by the Anton Melik Geographical Institute take place at the end of the melting period [ **5**]. Until the middle 90's Triglav glacier was measured by a classical method by which data on changes in the thickness and length of the glacier on individual spots were gained, while in 1995 and 1999 geodetic measurements of the glacier were performed [ **10**]. Due to the lack of financial means needed for the data adjustment, the Institute is not included into international data exchange within GCOS. In 2004 it is planned to gain membership of the World Glacier Monitoring Service programme (WGMS), which is a part of the Global terrestrial network–glaciers (GTN–G) [ **5**].

Slovenia is a country rich in waters. The observation of surface water is carried out with a network of 185 stations of hydrological watercourse monitoring, while observation of lakes takes place at four stations. All those stations, perform water level measures, on a third of them performs water temperatures measures as well. Hydrological monitoring of subterranean water takes place at 132 stations[5]. Observations are performed by the Monitoring Office of the ARSO, of the Ministry of Environment, Spatial Planning and Energy [ **12**].

Phenological observations are carried out under professional surveillance of Meteorology Office of the ARSO. In 1950/51 observation began at a network of special phenological observation stations. At the moment there are 61 stations distributed by the regional climate key [ 4].

Table F. 2: Participation in the global terrestrial observation system

| | GTN–G |
|---|---|
| How many sites are the responsibility of the Party ? | 2 |
| How many are providing data to international data centres now? | 0 |
| How many are expected to be operating in 2005? | 2 |

## 4. Oceanographic Observations

Oceanographic observations in Slovenia started at the Marine Biology Station of National Institute of Biology approximately 15 years ago. Twelve years ago measures of vertical profiles of temperature, salinity, oxygen and chlorophyll with a probe attached to the boat. In 2000 an oceanographic buoy started working experimentally in the Trieste Gulf and has been operative since 2002. It performs the measures of the speed and direction of the wind, air temperature, air humidity, temperature and salinity at the depth of 2 m, temperature at the depth of 23 m and sea currents speed at the depth from 2 to 33 m with the interval of 1 m. The Marine Biology Station is a National Oceanographic Data Centre (NODC). It also takes part in the multilateral ADRICOSM project (ADRIatic sea integrated COastal areaS and river basin Management system pilot project), in the EU project called MFSTEP (Mediterranean Forecasting System Toward Environmental Predictions) and in the MAMA project (Mediterranean network to Assess and upgrade Monitoring and forecasting Activity in the region) which represents an important component of the Mediterranean Global Ocean Observing System (MedGOOS) [ **8**], [ **11**].

Sea observation is the responsibility of Monitoring Office of the ARSO. In 2004 two stations carried out measures of the sea level and sea temperature. Assuming the possible identification of climate change as the consequence of increased anthropogenic GHG emissions, the analyses of sea levels on a monthly, annual and multiyear basis take place. Data on monthly and annual sea levels including the current meta data are sent to the PSMSL centre in England, which is one of the two largest collection

[5] Data valid for 2003

centres for the sea level data. International participation takes place also within the international long-lasting project of the Intergovernmental oceanographic commission of the Permanent Office for monthly sea level (IOC/PSMSL) and within the project Infrastructure development of the European Sea level Office (EU FP5 ESEAS RI) [ **14**].

Table F. 3: Participation in the global oceanographic observation systems

| | Moored buoys | Tide gauges |
|---|---|---|
| For how many platforms is the Party responsible? | 1 | 2 |
| How many are providing data to international data centres? | 1 | 2 |
| How many are expected to be operating in 2005? | 1 | 2 |

## Abbreviations and Symbols

| | |
|---|---|
| ADRICOSM | »ADRIatic sea integrated COastal areaS and river basin Management system pilot project« |
| EARS | Environmental Agency of the Republic of Slovenia |
| CLRTAP | Convention on Long-range Transboundary Air Pollution |
| GCOS | »Global climate observing system« |
| GTN–G | »Global terrestrial network–glaciers« |
| MAMA | »Mediterranean network to Assess and upgrade Monitoring and forecasting Activity in the region« |
| MBP | Marine Biology Station |
| MedGOOS | »Mediterranean Global Ocean Observing System« |
| MFSTEP | »Mediterranean Forecasting System Toward Environmental Predictions« |
| MOPE | Ministry of Environment, Spatial Planning and Energy |
| NIB | National Institute of Biology |
| NODC | »National Oceanographic Data Centre« |
| WGMS | »World Glacier Monitoring Service« |

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