UNITED
NATIONS

A

General Assembly

Distr.
GENERAL

A/AC.237/NC/6
26 October 1994

Original: ENGLISH

INTERGOVERNMENTAL NEGOTIATING COMMITTEE
FOR A FRAMEWORK CONVENTION ON CLIMATE CHANGE

EXECUTIVE SUMMARY OF THE NATIONAL COMMUNICATION OF

SWEDEN

submitted under Articles 4 and 12
of the
United Nations Framework Convention on Climate Change

In accordance with decision 9/2 of the Committee, the interim secretariat is to make available, in the official languages of the United Nations, the executive summaries of the national communications submitted by Annex I Parties.

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SWEDEN

Basic Data and National Circumstances

1. Sweden had 8.7 million inhabitants in 1993. Population growth is approximately 0.6 percent per year which is about the average for other industrialized countries. Approximately 85% of the inhabitants live in urban areas.

2. The total area of Sweden is 450,000 km^2. Compared to other OECD-countries, population density is low, on average 19 inhabitants per km^2. However, a large part of the population is concentrated in three major urban areas. Sweden has a long shoreline and a very large number of lakes. Transportation needs are high due to low population density and long travel distances.

3. Forest covers 62 % of the total land area. Forest is one of the most important natural resources in Sweden. The timber stock volume - i.e the carbon reservoir - has grown from 2100 million forest cubic meter (m^3sk) in 1920 to 2900 million m^3sk in 1990. Historically the forest industry, together with the iron and steel industry, has been the backbone of the Swedish economy.

4. Energy intensive industries are very important to the Swedish economy. As in other industrialized countries a decline in the importance of the industrial sector has taken place during the last decade. In 1992, Gross Domestic Product (GDP) per capita was SEK 165 700. Annual average real growth of the economy has been 1.8 per cent between 1975 and 1990. More recently Swedish economy has experienced a recession with low or negative growth in GDP.

5. The climate in Sweden is temperate, influenced by the Gulf Stream in the Atlantic ocean. The annual average temperature is only + 1.8 degrees Celsius(^{o}C), ranging from +7^{o}C in the south to -2^{o}C in the north. The heating requirement for homes and other premises are significant during the winter season.

6. Total final energy demand has been almost constant during the last 25 years, reaching 450 TWh/year. Hydro power has always played a major role in the total electricity production. Since the 1970's oil-crisis, the Swedish energy system has been significantly restructured. Expansion of nuclear power has reduced oil consumption. Also, different programmes for energy efficiency and oil substitution have had a considerable effect. The share of fossil fuels in total energy supply has dropped from 80% in 1970 to 50% in 1990. Nuclear and hydro today produce approximately 95% of the total electricity generated.

Inventory of Greenhouse Gases

7. An inventory of greenhouse gas emissions and removals by sinks has been performed according to Intergovernmental Panel on Climate Change (IPCC) preliminary methodology and the decision made by Intergovernmental Negotiating Committee (INC). The inventory data are presented in Table 1 for the base year 1990. Gaps in inventory data are indicated in the figure below.

ESTIMATED UNCERTAINTITIES

Carbon dioxide	10%
Carbon sinks	10-25 %
Methane	10-25 %
Nitrous Oxides	>25 %
Nitrogen Oxides	10 %
Carbon monoxide	10-25 %
NMVOC	>25 %

8. Carbon dioxide accounts for most of the greenhouse gas emissions in Sweden. More than 80 % of total greenhouse gas emissions calculated as GWP-100 is attributed to carbon dioxide. Transportation is the most important sector accounting for 40% of the total carbon dioxide emissions. Since 1970, carbon dioxide emissions has declined considerably. (Figure 1) Since 1970 emissions have decreased approximately 40 per cent. While emissions from the energy sector and from manufacturing industry have steadily declined, emissions from the transportation sector have increased.

9. Table 1 shows that carbon dioxide emissions were 61.3 million tonnes in 1990. However, if emissions are adjusted for normal climatic conditions the emissions would have been 64 million tonnes.

10. The largest sources of methane emissions in Sweden are the agricultural sector and refuse disposal.

11. Nitrous oxide emissions are poorly monitored. Burning of fuels and releases from arable land are the most important sources.

12. The Swedish forest today constitutes a sink for carbon dioxide. The increment or annual growth of the forest is larger than the harvest. That leads to accumulation of carbon dioxide in the biomass. The net carbon dioxide accumulation in Swedish forests has been estimated to nearly 35 million tonnes per year. This is more than half of the annual emissions of fossil carbon dioxide emissions.

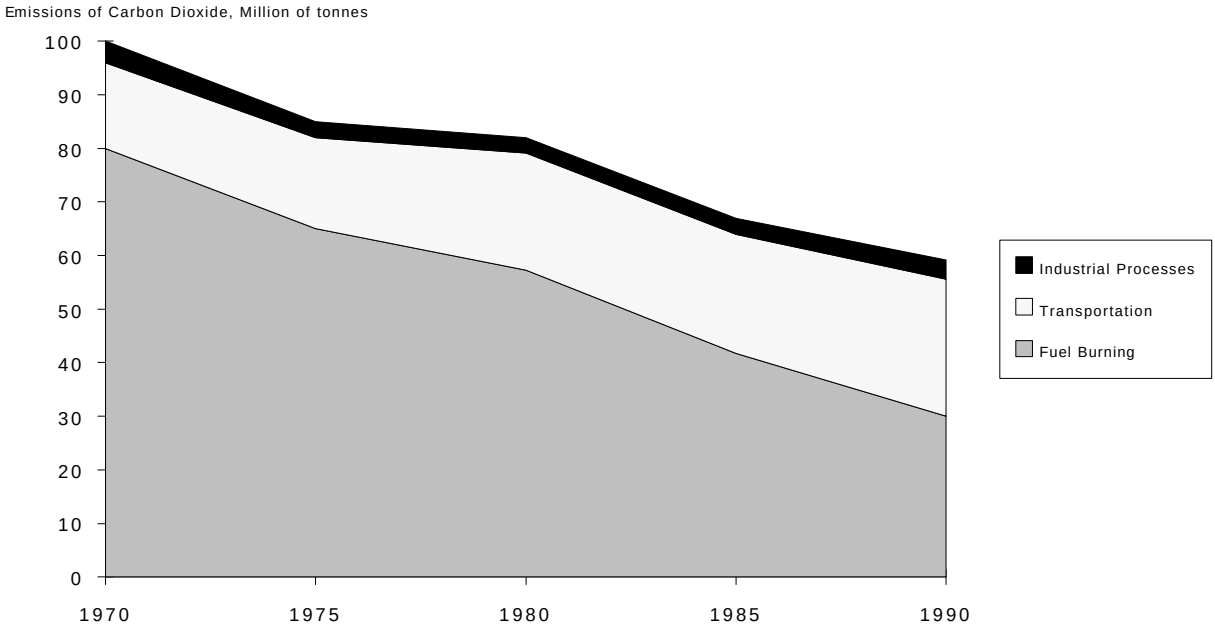
13. However, most of the increment are anthropogenic, due to forest management which raises the forest timber stock above the level of non-managed forest.

Vulnerability

14. Average temperatures in Sweden increased from the middle of 18th century through the 1930's. From 1940 to 1960 the average temperature decreased followed by a new period with raising temperature. Even if most winters in the beginning of the 1990's were unusually mild it is difficult to draw any definite conclusions from current trends.

15. Sub-arctic ecosystems' like those in Sweden are sensitive owing to long generation times, slow growth and irregular reproduction. Initially climate change is expected to affect higher mountain areas. The adaptability of these ecosystems is limited.

16. Another vulnerable area is the Baltic Sea. The Baltic Sea could be affected in three different ways; through sea level rise, through warmer temperature in the water body and finally through reduced salinity. Sea-level rise would cause serious erosion on the southern coasts of



the Baltic. Flooded areas in coastal zones may increase the leakage of nitrogen to the sea. An increasing water temperature would generate certain physiological changes in marine organisms leading to modification in the fish population. The most probable development would be that catchments of cod, salmon and whitefish would decline, thus affecting fishery. The water exchange in the Baltic is mostly controlled by runoff of surface water from land areas and water exchange with the North Sea through the Belts and the Sound (Öresund). Climate models predict more precipitation in the winter, leading to an increase in runoff of surface water to the Baltic. In such a case the salinity in the Baltic sea could fall. If the interflow of oxygen-rich and saline water coming from the Atlantic into the Baltic would be affected, serious consequences could emerge.

17. Increasing air temperature and precipitation would result in more rapid growth of forests. However some species are adapted to cold winters and increasing temperature may enhance damage by insects and pests. Spruce forests are expected to be the most vulnerable to rapid changes in the climate. Obviously forestry must adapt its management practises to any changing situations.

18. Global warming could also have other adverse effects on the environment. Transport patterns for air pollutants from Europe to Scandinavia could be changed. Conditions for ground-level ozone formation would become more favourable. If the frequencies of mild and wet winters could increase, the amount if nitrogen reaching the sea would grow, other circumstances being unchanged. Thus, if the environmental goals for acidification, eutrophication and air quality may be met, more stringent measures will be required due to global warming.

Policies and Measures

Overall Policy Context

19. Sweden has applied policies and measures for climate change since 1988, when the issue was discussed in the Riksdag (Parliament) for the first time. A more comprehensive programme was adopted by the Riksdag in May 1993 the Government Bill on action to limit climate change was adopted. The goal established by the Riksdag is that emissions of carbon dioxide from fossil fuels in the year 2000 shall, pursuant to the UN Framework Convention on Climate Change, be stabilised at the 1990 level and shall decline after that.

20. Furthermore emissions of methane from disposal of wastes shall be reduced by 30 percent between 1990 and 2000.

21. The main strategy for achieving the carbon dioxide goal is to limit the demand for fossil fuels, replacing them with renewable energy resources, along with improved energy management and more efficient use of energy. Measures to improve energy efficiency includes technology procurement and demonstration of electricity efficient products, processes and systems in homes, non-housing premises and industry. In contrast to other countries the possibility of reduction of greenhouse gases by changes in the electricity sector is very limited in Sweden. Today only five per cent of the electricity is based on fossil fuels.

22. In the climate debate one could argue that policies and measures should be concentrated to increase carbon storage in the forest. However, whereas an increment of carbon storage is just temporary, reductions in the use of fossil fuels gives permanent effects. If biomass is grown in a sustainable way its production and use cause no net build-up of carbon dioxide in the atmosphere. Carbon dioxide released in combustion is offset by reabsorption of carbon dioxide by the biomass culture during photosynthesis. This imply that one efficient way to reduce the atmospheric burden of fossil carbon dioxide in Sweden is to expand the use of biomass and use it to replace fossil fuels in the energy system.

23. In Sweden, economic instruments were introduced in environmental policy in the mid-1970's and their use has since increased and successively developed. In the field of climate change the government places great attention on carbon and other forms of energy taxes as means for limiting carbon dioxide emissions.

24. In Sweden marginal cost for further reduction of carbon dioxide emissions is high, compared to most OECD countries. As part of our national programme we have taken initiatives in the Baltic countries and Eastern Europe in order to finance measures in the field of renewable energy, energy management and certain supportive measures. The possibilities for joint implementation or similar policy measures are of great importance for Sweden.

Actions Taken in the Energy and Transportation Sectors

25. As from January 1991 a carbon dioxide tax is levied on fossil fuels. The introduction of the carbon dioxide tax coincided with a major tax reform with the aim to reduce taxes on

SUMMARY OF THE ENERGY POLICY PROGRAMMES (million SEK)

	M SEK	time period
INVESTMENT PROGRAMMES		
CHP's biofuel	1000	1991-1996
Windpower	250	1991-1996
Solar-heating	57,5	1991-1996
District heating	50	1993-1994
DEMONSTRATION PROGRAMMES		
New technology	187	yearly
Biofuel technology	625	1991-1996
Transport technology	500	1991-1996
More efficient use of energy	1000	1991-1998

income and capital and to increase environmental taxes. Value Added Tax (VAT) was from that date applied to all forms of energy (fuels, heat, electricity). The carbon dioxide tax was initially set at the level of SEK 250 per tonne carbon dioxide released. The existing rates of energy taxes were at the same time reduced by 50 per cent.

26. The carbon dioxide tax and the energy taxes work as excise duties levied on fossil fuels (oil, coal, natural gas and liquified petroleum gas) except fuels for electricity generation. The tax in SEK per unit of energy is calculated on the basis of the average carbon content of the fuels.

27. In 1993 the energy and the carbon dioxide taxation was changed in order to adjust the Swedish tax rates on sectors subject to international competition to those applied in other similar countries. The general carbon tax rate increased from SEK 250 to 320 per tonne of carbon dioxide. A lower tax rate of 80 SEK/tonne was introduced for manufacturing industry. At the same time energy taxes were abolished for manufacturing industry.

28. Up to 1993 an exemption system existed for mainly energy intensive industry providing possibilities for single enterprises to apply for tax reductions. This regulation implied that companies energy taxes were limited to a certain per cent of the value of the goods produced. A similar system, which is applied to a minor number of enterprises, is still in force until the end of 1995. From January 1996 all branches of the manufacturing industry will be subject to uniform carbon dioxide taxation.

29. The first of January 1994, energy and carbon taxes were increased by 4 per cent (adjusted for inflation).

30. In order to promote and stimulate the introduction of renewable energy sources and energy efficiency the Riksdag has decided on several programmes. These programmes include the programme for energy management and promotion of bio-fuels, wind power and solar energy. The National Board for Industrial and Technical Development (NUTEK) has the responsibilities for these programmes. The programmes started in 1991.

31. In order to limit emissions from the transport sector we have up till now introduced mainly two measures, higher taxation on fuels and research and development. During the last four years two broad R&D-programmes have been initiated, concerning the use of alternative fuels and hybrid and electrical vehicles.

Action Taken in the Forestry and Agriculture Sectors

32. Many actions that have been taken in the forestry sector since 1990 affect the carbon balance. Various measures are taken to reduce carbon releases from the soils, e.g. through restrictions on forest site preparation operations and drainage.

33. A new agricultural policy was adopted by the Riksdag in 1990. Some of the policies indirectly affect climate change. In general, these measures will lead to reduced emissions of greenhouse gases. These include reduced and better nitrogen application practices, replacements from arable land to grazing grounds or forests, and increased use of winter overgrown land. However, methane emissions are expected to increase due to changes in land use patterns.

Projections and Effects of Measures

Projection of Greenhouse Gas Emissions until 2005

34. The projections of the carbon dioxide emissions are based on assumption of Swedish future energy demand and supply. Basic economic forecast is given in Appendix 2. The figure shows the key assumptions.

FORECAST KEY DATA ASSUMPTIONS

	1993	2005
World Oil Price	USD 17/bbl	USD 28/bbl
GDP Level	1.8% increase	
Population Level	0.4% increase	
Electricity Price House-holds	850 SEK/MWh	970 SEK/MWh
Electricity Price Heavy Industries	230 SEK/MWh	339 SEK/MWh
Specific Energy Use Industry	0.217 kWh/SEK	0.188 kWh-/SEK
Industry Production billion 1985 SEK	658	859
Number of Dwellings	4 144 000	4 506 000

35. The total energy demand is expected to grow by 0,9 per cent per year during the years 1993-2005 compared to the expected GDP-growth of 1,8 per cent per year. There is consequently a considerable improvement in energy efficiency during the period. The analyses show that there are rather large uncertainties in the fuel demand for electricity production, the assessment of energy efficiency and fuel used in the transport sector. Increasing demand for electricity can raise emission of carbon dioxide up to four million tonnes per year depending on fuel used and amount of electricity imported from neighbouring countries. We have assumed that further power demand comes from natural gas combi cycles.

36. Other projections about emissions from the transport sector predict a higher penetration of new technologies that lead to less fuel consumption. The sensitivity analysis show that influence of world oil price on carbon dioxide emissions is small. The most important factor with the respect of carbon dioxide emissions is the growth of the economy.

37. It is important to stress that emission levels for 1990 are based on actual emissions, not adjusted for temperature variation. This is however the case for the projected years 1995 -

2005. If this would be done for a climatic normal year, emissions in 1990 would have been at the same level as for the year 2000 - i.e 64 million tonnes. The projections show that carbon dioxide emissions will grow somewhat until the year 2005 (Table 3). The decline from 1990 adjusted level in 1995, could mainly be attributed to industry production level.

38. Methane and nitrous oxides emissions are expected to decrease 10% until the year 2000 from 1990 levels, while HFC's emissions are expected to increase. Forest growth is expected to increase in forthcoming years. Timber lodging is the greatest factor determining total net removal by sinks. Thus, industry demand is crucial for the forecast but also difficult to predict. Estimations done show an increasing demand of timber for the industry. The increase in forest growth cannot compensate the increase in timber consumption. Net removals of carbon dioxide by sinks will therefore decrease from 1990 levels. However, forest carbon reservoir is expected to increase.

Effects of the Measures Taken

39. The effects of the action taken to combat climate change is difficult to estimate. This is specially true for the programmes for research and development and the programmes for energy efficiency. Effects of these programmes can only be fully evaluated in the long term.

REDUCTION OF CARBON DIOXIDE IN THE YEAR 2000 [million tonnes]

Carbon taxes - energy sector	5.3
Gasoline tax and carbon tax - transport sector	2.2
Efficiency Programme	2.1
Investment Programme - Biofuel	0.6
Others	0.2
Summary	10.4
Projected emission in 2000: 64 million tonnes	

40. Estimations have been made using different methods. Analysis of the effects of taxation on fossil fuels, the investment-programmes and the programme for more efficient use of energy were made separately.

41. In addition, an energy-model called MARKAL was used to estimate the overall effects of the climate change programme on the energy supply-side. The model optimizes the energy supply - given different available technologies - at lowest possible cost. However, the model cannot predict the relationship between energy-demand and energy-prices.

42. Higher prices on gasoline will lead to less traffic and a shift to more efficient cars i.e limited fuel demand. The study shows that emissions from the transport sector would have been two million tonnes higher without changes in tax rates. The programme for energy efficiency will decrease electricity consumption. Electricity savings due to the efficiency programme are estimated to 8 TWh, compared to the present consumption of 145 TWh up to year 2000.

43. The MARKAL-model compared the energy taxation at the beginning of 1990 with present energy taxes and subsidies for bio-fuels, windpower and solar heating. The result shows

that the 1994 measures reduce emissions of carbon dioxide at the year 2000 with about five

million tonnes. In the future increased demand for electricity will make the differences larger.

44. In total we estimate that the effects of the measures taken decrease the carbon dioxide in the year 2000 with about 10 million tonnes i.e 16% reduction from projected levels.

Finance and Technology

SWEDISH CONTRIBUTION TO FINANCIAL ISSUES (million SEK)

GEF, TOTAL	646	1991-1997
Energy systems in the Baltic countries and eastern europe	227	1993-1995
Transportation systems in the Baltic countries	15	1992-1993
Climate and Africa	8	1993-1994

45. The Swedish government contributed SEK 196.07 million to the pilot phase programme of the GEF for the three years up to July 1994. For the first period of the permanent phase ending in June 1997, Sweden will contribute SEK 450.04 million. The contribution to the core fund can not be directed to a specific focal area but will cover projects in all four windows.

46. The Swedish Government has so far allocated SEK 227 million to be used for activities aiming at an environmentally adapted energy-system in the Baltic states and Eastern Europe in particular measures to reduce carbon dioxide emissions.

47. The overall goal is to promote cost-effective activities that have a sustainable influence on the emissions of carbon dioxide. Such activities may also simultaneously reduce acidifying substances. The programme will primarily target the Baltic rim area and areas where there exists established Swedish contacts in the energy sector have been established earlier.

48. Financial resources will be used for capacity building and direct investments in conversion to renewable fuels and in equipment for improvement of energy efficiency. Now, about 30 projects have been initiated.

49. The Swedish Government does also support programmes in developing countries trying to meet their commitments under the Convention One example is the project Climate and Africa. The Stockholm Environment Institute (SEI) has got the assignment to support participation of countries in Africa in the global climate debate. African experts will carry out the major part of the work. The budget for the project is SEK million.

Research, Education and Public Awareness

50. The Swedish Government has set up a special committee to promote and coordinate research in the field of climate change (The Swedish Committee on Climate Change). Sweden has supported the IPCC assessments through the chairmanship of professor Bert Bolin. Sweden

also supports contribution by other scientists in the different IPCC working groups. Swedish research on global change is coordinated in the international programmes - International Geosphere-biosphere Programme (IGBP) and World Climate Research Programme (WCRP).

RESEARCH IN SWEDEN RELATED TO CLIMATE CHANGE 1993/94 (million SEK)

Scientific issues	43
Energy supply and use	180
Transportation	52

51. The Swedish Environmental Protection Agency is financing research on the impacts of climate change on Nordic ecosystems. The programme is mainly focusing on the following areas;
- Emissions and removals of greenhouse gases
- Effects of global climate change on Nordic ecosystems

52. Technical research in climate change is mostly dealing with different measures. The Energy Research Programme and the Transportation research Programme concentrate on renewable energy sources. A large part of the programme concerns different measures to enhance energy efficiency. The transportation programme also involves demonstration a programme on alternative fuels and electric vehicles.

53. Information activities are conducted in connection with the different R&D programmes addressing public awareness. The National Environment Protection Agency has the responsibility for a special information campaign.

Future Work

54. The long term climate policy must, according to the decision by the Riksdag in 1993, be based on a firm scientific basis, be comprehensive and cover all sectors in the society. Through the complexity of the climate change problem and the near association to central economic and political questions, international cooperation in this field is essential.

55. The Riksdag has requested the Government to propose new targets for carbon dioxide and other greenhouse gases after the year 2000. The Riksdag has also asked the Government to review the energy tax-system. The purpose is to establish energy taxes that in the long term and clearly promote an efficient and environmental friendly energy use and production.

56. Several committees have been established to elaborate new measures to combat climate change.

57. A shift in taxation from private enterprises, labour and savings to a taxation of limited resources could be beneficial to the environment. A parliamentary committee will be looking into these issues.

58. Another parliamentary committee is focusing on the energy sector. The energy policy is based upon a parliamentary agreement from 1991. The aim of the measures decided upon is to secure the long and short term energy supply on economically competitive terms and on environmentally sustainable conditions. The committee shall review ongoing energy programmes and estimate the demand for changes. The committee will also follow the work with reformation

of the electricity market. The committee shall after its analyze is completed, propose measures to secure an efficient electricity supply. The commission shall also propose a scheduled programme on how to transform the energy system. The deliberation within the committee shall be done against, among other things, the need to limit climate change at a level that can be sustainable for the society and for ecosystems. The measures proposed should be cost effective.

59. A third committee is concerned with the transportation system. It will analyze economic instruments in order to promote more fuel efficient cars and alternatives to petroleum based fuels. It will also propose measures to promote public transport systems and consider the importance of physical planning.

60. Another important area is individual and private sector work in the context of climate change. How to strengthen these sectors will be addressed in conjunction with local follow-up of Agenda 21 and the decisions made during UNCED.

Table 1. Summary Report for 1990 National Greenhouse Gas Inventories (1000 tonnes).

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2[1]	CH_4	N_2O	NO_X	CO	NMVOC
TOTAL National Anthropogenic Emission	61256	329	15.2	373	1612	540
1 All Energy (Fuel Combustion + Fugitive)	55175	32.9	4.6	362	1606	375
A Fuel Combustion	55122	32.9	4.6	362	1606	357
Energy and Transformation Industries	7041	1.25	1.42	19.58	7.83	3.54
Transport[2]	23092	17	0.4	285	1503	201
Industries (ISIC)	13446	4.2	2.1	38.9	25.7	10.8
Commercial/Institutional	11543	10.4	0.7	19.0	69.3	141.2
Residential						
Agricultural/Forestry						
Other						
Biomass Burned for Energy	21737[3]	14.6[4]	1.3[4]	19[4]	84[4]	153[4]
B Fugitive Fuel Emission	53	0	0	0	-	17.8
Oil and Natural Gas Systems	53	0	0	0	0	17.8
Coal Mining	NO	NO	NO	NO	NO	NO
2 Industrial Processes	4972	NE	2.7	11	5.9	67
A Iron and Steel	1561	NE	0	1	2.2	2.2
B Non-Ferrous Metals	720	NE	0	1.3	0	NE
C Inorganic Chemicals	NE	NE	2.6	1.6	NE	0
D Organic Chemicals	16	0	NE	NE	NE	5.3
E Non-Metallic Minerals Products	2493	NE	0	7.2	0.16	0
F Other	182	NE	0.1	0	3.5	59
3 Solvent and Other Product Use	294	-	-	-	-	98
A Paint Application	120	-	-	-	-	40
B Degreasing and Dry Cleaning	45	-	-	-	-	15
C Chemical Products Manufacture/Processing	21	-	-	-	-	7
D Other	108	-	-	-	-	36

[1]Total CO_2 according to IPCC methodology. Includes emitted CO_2 and oxidized carbon.

[2]Emissions from international aviation and marine bunker fuels not included.

[3]Not included in Total National Anthropogenic Emissions.

[4]Included in the Total National Anthropogenic Emissions, but also under the different sub-categories under Fuel Combustion.

GREENHOUSE GAS SOURCE AND SINK CATEGORIES (continued)	CO_2	CH_4	N_2O	NO_X	CO	NMVOC
4 Agriculture	540	196	7.9	-	-	-
A Enteric Fermentation	518	188	-	-	-	-
B Agricultural Wastes	22	8	-	-	-	-
C Agriculture Soils	-	-	7.9	-	-	-
D Rice Cultivation	-	NO	-	-	-	-
E Agriculture Waste Burning	NO	NO	NO	NO	NO	NO
F Savannah Burning	NO	NO	NO	NO	NO	NO
5 Land Use Change & Forestry	- 34368	-	-	-	-	-
A Forest clearing and On Site Burning of Cleared Forests	NO	NO	NO	NO	NO	NO
B Grassland Conversion	NO	-	-	-	-	-
C Abandonment of Managed Lands	NO	-	-	-	-	-
D Managed Forests	- 34638	-	-	-	-	-
6 Waste	275	100	-	-	-	-
A Landfills	275	100	-	-	-	-
B Wastewater	NE	NE	-	-	-	-
C Other	NO	NO	NO	NO	NO	NO
TOTAL NET National Emission (sum 1 through 6)	26888	329	15.2	373	1612	540
Emissions from international aviation and marine bunker fuels	*4190*	*1.3*	*0.04*	*60*	*44*	*15*

NE=not estimated NO=not occurring -not applicable

Table 2. Carbon Dioxide Emissions and Removals 1990 - 2005 (million tonnes)

Source	1990	1995	2000	2005
Energy and Transformation Industries	7,0	9,2	10,9	13,7
Transportation	23,1	24,0	25,3	26,7
Industry	13,5	12,6	13,1	13,7
Residential, Commercial	11,5	9,5	8,4	7,7
Industrial processes and others	5	5	5	5
Other sources	1,2	1,2	1,1	1,1
TOTAL	**61,3 (64)[5]**	**61,5**	**63,8**	**67,9**
Net removal of carbon dioxide by sinks	**-34**	**-31**	**-29**	**-28**
Forerst carbon reservoir	**2679**	**2846**	**2996**	**3139**

[5]Adjusted for normal precipitation and temperature