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Report on the in-depth review of the third national communication of Denmark

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I. INTRODUCTION AND NATIONAL CIRCUMSTANCES RELEVANT TO GREENHOUSE GAS EMISSIONS AND REMOVALS

A. Introduction

1. The secretariat of the United Nations Framework Convention on Climate Change (UNFCCC) received Denmark's third national communication (NC3) in June 2003. An in-depth review of the NC3 was carried out between August 2003 and March 2004, including a visit to Copenhagen from 6 to 10 October 2003. The members of the review team were Mr. David Lesolle (Botswana), Ms. Natalya Parasyuk (Ukraine), Mr. Remko Ybema (Netherlands), Mr. Nicolas Lefevre-Marton (International Energy Agency, IEA) and Ms. Katia Simeonova (UNFCCC secretariat, coordinator).

2. During the country visit, the review team discussed all key aspects of Danish climate policy with governmental officials, academia, business and environmental non-governmental organizations (NGOs). The review team was also provided with additional material supporting the information provided in the NC3. This allowed the review team to better understand new developments in climate change policy and policy goals in Denmark.

B. National circumstances

3. ***Geography and climate:*** The Kingdom of Denmark, which comprises Denmark, Greenland and the Faeroe Islands, is a constitutional monarchy within which Greenland and the Faeroe Islands are self-governing. Denmark's population is just over 5.3 million, and the area of the country is 43,075 km^2. Agricultural land accounts for about 62 per cent, followed by urban areas (13 per cent) and woodlands (11 per cent). The remaining 14 per cent consists of natural areas (moors, marsh, bogs, lakes and streams). A notable feature is the long coastline (7,314 km), of which about 1,800 km is protected by dykes against flooding and storm surge. Denmark has a temperate marine climate, with mild winters and cool summers, and precipitation almost evenly distributed throughout the year.

4. ***Economy:*** Between 1990 and 2001, Denmark's GDP rose by almost 27 per cent, an average of 2.2 per cent per year (table 1). By 2001, GDP was over USD 138 billion, corresponding to around USD 25,800 per capita, ranking Denmark among the top income countries in the world. The economy is open, with exports of goods and services accounting for 46 per cent of GDP in 2001 and imports for 39 per cent. The main trading partners are the European Community (EC), Norway, the United States of America and Japan. The service sector, including the provision of public services, dominates the economic structure of the country and accounted for over 70 per cent of GDP in 2001, followed by the industrial sector (including mining and utilities) with 26 per cent. Agriculture accounted for the rest.

Table 1. Main macro-economic indicators and GHG emissions

	1990	2001	Percentage change between 1990 and 2001
Population (millions)	5.138	5.357	4
Gross domestic product – GDP[a]	108.82	138.08	27
Total primary energy supply – TPES (Mtoe)	17.61	19.78	12
Electricity consumption (TWh)	30.56	35.15	15
GHG emissions (Gg CO_2 equivalent)[b]	69 217	69 410	0
GHG emissions per capita (kg CO_2 equivalent)	13 471	12 956	–4
GHG emissions per GDP unit (kg CO_2 equivalent per USD of 1995)	0.636	0.503	–21

Sources: Population and energy data are taken from the IEA database, GDP data from the Organization for Economic Co-operation and Development (OECD) database and GHG emission data from the NC3.
[a] Billions of USD of 1995 using purchasing power parities (PPPs).
[b] Without accounting for emissions and removals from land-use change and forestry (LUCF).

5. ***Total final energy consumption***: Denmark has made successful steps towards decoupling energy demand from economic growth. In 1990–2001 the total final energy consumption (TFC) grew by only approximately 9 per cent, reaching 15.2 million tonnes of oil equivalent (Mtoe) in 2001, while GDP grew by close to 27 per cent. This level of energy intensity is among the lowest in countries of the Organization for Economic Co-operation and Development (OECD) (table 1). The transport sector

accounts for over 30 per cent of TFC. With a growth of over 13 per cent, it was the fastest growing sector over the period 1990–2001. Industry accounts for a little under 20 per cent of TFC and has grown by approximately 10 per cent over the same period. Other sectors, including agriculture, commercial and public services and the residential sector, account for almost 50 per cent of TFC and grew by only 7 per cent between 1990 and 2001.

6. ***Total primary energy supply:*** In 2001, oil and oil products accounted for 44 per cent of the total primary energy supply (TPES), followed by natural gas with 23 per cent, coal with 21 per cent, and renewables with 11 per cent. There has been a steady rise in the share of natural gas and renewables in TPES over the last two decades, mainly through the replacement of oil used for heat and electricity production. Between 1990 and 2001 the share of natural gas more than doubled and the share of renewables increased by around 170 per cent. The share of coal in the TPES increased from 34 per cent in 1990 to 38 per cent in 1994 and since then has progressively reduced to 21 per cent in 2001. Denmark has drastically increased its production of oil and gas from the North Sea since 1980 and became self-sufficient in oil in 1993. At current production rates, proven reserves of oil and gas in the Danish fields are expected to cover domestic demand for around 13 and 16 years respectively. However, reserve estimates have changed recently as a result of new discoveries and technological improvements. Renewables have also become an important indigenous energy source. Altogether this led Denmark to become self-sufficient in energy, for the first time in its modern history, in 1997.

7. ***Electricity:*** Coal represented about 47 per cent of total electricity generation in 2001, followed by gas with 25 per cent, renewables with 17 per cent (with wind accounting for 12 per cent and combustible renewables and waste for the rest), and oil with around 11 per cent. The marked decline in the share of coal, from 91 per cent in 1990 to 47 per cent in 2001, was mainly a result of the policy to promote sources other than coal and of the ban on new coal-fired power plants imposed by the government in 1997. Over 50 per cent of electricity generation comes from combined heat and power (CHP) plants, which also produce over 80 per cent of district heating. Denmark is one of the leading countries in the world in terms of share of heat and electricity produced from CHP and electricity from wind. Following a 1985 decision by the Parliament, no nuclear power plants have been built in Denmark. Efficiency gains in the energy end-use sectors, together with the changes in the fuel supply mix, have led to a marked decarbonization of the economy with emissions per GDP falling by 21 per cent between 1990 and 2001.

8. Denmark has close to 50 per cent reserve power capacity, and therefore has substantial margins for electricity exports. Over the years, this has led Denmark to play a key role in the Nordic power market. It acts as a “hydro-firming” system for this strongly hydro-based market, which exports electricity in wet years, and purchases coal-based electricity from Denmark during dry years.

C. Institutional framework and recent developments in climate policies

9. ***Governmental structure, environmental and climate change issues:*** Denmark is a constitutional monarchy. Legislative power lies with the Folketing (the Danish Parliament), which is made up of 179 members of whom 2 are elected from the Faroe Islands and 2 from Greenland. Several political parties are represented in the Parliament, and since 1909 no single party has had the majority of parliamentary seats. Danish governments are most often minority party administrations, governing with the aid of one or more supporting parties, and Danish politics are characterized by inter-party compromise. Since 1993, Denmark has had three centre-left coalition governments led by social democrats, but in November 2001 a new government was elected which is a coalition of liberals and conservatives, led by the liberals.

10. One of the main elements of Denmark’s democracy is that counties and municipalities have a high degree of regional autonomy. This means, for example, that they have their own elections and regional administrations. In terms of environmental regulation, although rules and the framework for environmental administration are set at the national level, counties and municipalities plan and decide on concrete initiatives to implement and support the national legislation.

11. Until the 2001 change of government, environmental and energy matters came under the Ministry of Environment and Energy, which was responsible for coordinating the government's activities relating to climate change, including conducting international negotiations in the climate area. The new government has split this into two ministries, one for economic and business affairs, including the energy sector, and one for the environment. Under this new structure, these two ministries as well as others collaborate and share responsibility for the coordination of legislation and plans on climate change. The Danish Environmental Protection Agency (DEPA) to the Danish Ministry of the Environment assumed the responsibility for co-ordination, compilation and submission of the national communications to the UNFCCC secretariat and on information on policies, measures and projections to the EC.

12. ***The UNFCCC, the Kyoto Protocol and recent policy development:*** The Kingdom of Denmark ratified the UNFCCC on 21 December 1993. It ratified the Kyoto Protocol in May 2002, with territorial reservation for the Faroe Islands. Under the Kyoto Protocol Denmark has undertaken to reduce emissions of greenhouse gases (GHG) between 2007 and 2012 by 8 per cent (the "Kyoto target") and under the EC burden-sharing agreement[1] to reduce them by 21 per cent. Only the emissions of Denmark itself are covered by this latter agreement, as Greenland and the Faroe Islands are not members of the EC.

13. In the late 1980s Denmark was among the first countries to include climate change in its policy agenda and to link it closely to energy policy. Having energy and climate change matters under the umbrella of the same ministry contributed to this. Largely as a result of such early action, and in particular because of its success in promoting energy efficiency and renewable energy, Denmark has contributed to achieving the UNFCCC's aim to return individually or jointly GHG emissions of developed countries in 2000 to their 1990 levels, by achieving this objective itself.

14. Since 1990 Denmark's climate change policy has been target-oriented, with cost-efficiency being one of the criteria that defined policy choices. This approach changed as of 2003, as reflected in the new climate strategy adopted by the Parliament in March 2003 (hereinafter referred to as the 2003 Climate Strategy). This strategy was developed in response to the need to identify approaches and tools to meet Denmark's Kyoto target under the EC burden-sharing agreement. It sets national climate policy on a new course, with cost-efficiency becoming an underlying principle in the choice of policies. This marks a shift from relying almost exclusively on domestic action to achieving the previous targets to gradually including emission reductions abroad in order to achieve Denmark's target under the Kyoto Protocol and the EC burden-sharing agreement. The NC3 broadly reflects the content of the 2003 Climate Strategy and provides information on the progress of climate policies implemented up to 2003.

II. GREENHOUSE GAS INVENTORY INFORMATION

A. Inventory preparation

15. ***Institutional framework:*** The National Environmental Research Institute (NERI) to the Ministry of the Environment assumed the responsibility for coordination and compilation of the GHG emission inventory, and for its submission to the UNFCCC secretariat and to the EC Greenhouse gas Monitoring Mechanism. It also estimates emissions from energy, agriculture and waste. Input on carbon emissions and removals from land-use change and forestry (LUCF) was provided by the Danish Forest and Landscape Research Institute (DFLRI). A consulting company estimates emissions related to consumption of fluorinated gases under the project *Ozone-depleting Substances and the Greenhouse Gases HFCs, PFCs and* SF_6, supported by the DEPA.

16. ***Coverage:*** The information in the inventory section of the NC3 is based on the emission estimates for the period 1990–2001 contained in the 2003 inventory submission to the UNFCCC secretariat. It covers all gases and all categories of emission sources and sinks according to the Intergovernmental Panel on Climate Change (IPCC), including carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and fluorinated gases – hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and

[1] "European Council decision 2002/358/CE of 25 April 2002 concerning the approval, on behalf of the European Community, of the Kyoto Protocol to the UNFCCC and the joint fulfilment of commitments thereunder."

sulphur hexafluoride (SF_6). Emission of gases with indirect greenhouse effect, also known as precursors, namely nitrous oxide (NO_X), carbon monoxide (CO), and non-methane volatile organic compounds (NMVOC), as well as sulphur dioxide (SO_2), were not reported in the NC3. However, they are estimated on an annual basis and reported in the annual inventory submissions. Emissions from international bunkers and CO_2 emissions from biomass combustion are estimated, and according to the *Revised 1996 Intergovernmental Panel on Climate Change (IPCC) Guidelines for National Greenhouse Gas Inventories* (hereinafter referred to as the IPCC Guidelines) are reported separately and not included in the national totals.

17. ***Compliance with the guidelines***: The review team noted that the inventory section of the NC3 conforms with the "UNFCCC guidelines for the preparation of national communications by Parties included in Annex I to the Convention, Part II: UNFCCC reporting guidelines on national communications" (hereinafter referred to as the UNFCCC guidelines). It includes a summary of the reporting tables with emission estimates and emission trends. The factors and drivers underlining emission trends are clearly explained. The inventory data reported in the NC3 are consistent with the data from the 2003 inventory submission and the review team did not identify any differences between the two data sets.

18. ***Emission sources***: In terms of emission sources, the inventory includes estimates of all major sources as required by the IPCC Guidelines. Sources that are not yet encompassed: limestone and dolomite use, soda ash production and use, asphalt roofing, road paving with asphalt, production of nitric acid, pulp and paper, agricultural soils (CH_4 emissions), forest and grassland conversion, abandonment of managed lands, and CO_2 emissions and removals from soil. The review team was informed of a study to estimate emissions of CH_4 and emissions and removals of CO_2 from agricultural soils, which are planned to be included in the next inventory. The review team encouraged Denmark to include potentially missing sources in the inventory and to provide a clear explanation of why they are not included.

19. Emissions from wastewater handling systems are also not included, because all wastewater is treated aerobically; the Danish experts believe that there are no CH_4 emissions from this source. In the energy category Denmark reported the totals for the manufacturing industry and construction without distinguishing between industries, because the Danish energy statistics report energy consumption for the manufacturing industry as a whole. The review team was informed that an improvement has been initiated within the national statistics, and the data on industrial sectors will be reported by industry in future. The review team noted some inconsistencies in the use of notation keys.

20. ***Methodology***: The emission inventory estimates included in the NC3 are reported according to the IPCC and UNFCCC guidelines and prepared broadly according to the CORINAIR methodology. In a few instances, the IPCC methodology was also used for emission estimates, including estimates of CH_4 emission from storage and handling of coal, and emissions from the agriculture sector. In most cases the methods used were more detailed than the IPCC default methods: for example, the COPERT III emission model was used for emissions from road traffic, and a time-dependent first-order decay model was used for emissions from waste. In most cases, country- or plant-specific emission factors were used that are consistent with the factors from the EMEP/CORINAIR Atmospheric Emission Inventory Guidebook.

21. ***Comparison of inventory figures***: Compared to the second national communication (NC2), emission estimates for years covered in both documents have changed as a result of recalculations as information on new data, methods, emission factors and new emission sources has became available (table 2). The estimates of total emissions in 1990 fell by 2,441 Gg CO_2 equivalent between the NC2 and the NC3. The decrease stemmed mainly from downwards revision of estimates of CO_2 emissions from energy, due to revision of the energy statistics. Emissions of CH_4 from agriculture were also revised from 329 Gg in the NC2 to 195 Gg in NC3, as a result of changes in methodology for CH_4 emissions from manure management according to the IPCC Guidelines where Denmark is defined as a region with a "cool" climate. Changes in methodology for the LUCF sector explain a more than threefold increase in the estimates of net carbon removals by LUCF in the NC3 compared to the NC2. This includes use of

lower biomass expansion factors and species-specific wood densities. Recalculations have been done for the entire period between 1990 and 2001, so the time series are consistent.

22. ***New developments***: A new development, compared to the NC2, was the inclusion of preliminary GHG inventories for Greenland and the Faroe Islands. These are reported in the NC3 for 1990–2001. The review team was informed that these inventories are still preliminary because they are not yet reported in the common reporting format (CRF). In the Faroe Islands a major project was initiated in 2002 to produce a more comprehensive inventory that conforms with the IPCC Guidelines and covers CO_2, CH_4 and N_2O. In Greenland, given that fossil fuel combustion is considered by far the most important emission source, the inventory work was initiated by providing estimates for the total CO_2 emissions from fossil fuels. The review team was informed of the plans for improvement in the statistics and inventory estimates in both Greenland and the Faroe Islands.

Table 2. Comparison of 1990–1995 emissions as given in the NC2, NC3 and 2001 inventory

	NC2		NC3		2001 inventory	
	1990	1995	1990	1995	1990	1995
CO_2 (Gg)	52 277	59 532	52 659	61 130	52 659	61 130
CH_4 (Gg)	421	430	270	284	270	284
N_2O (Gg)	34	33	35	32	35	32
LUCF (Gg)	–924	–964	–3 118	–3128	–3 118	–3 128
Total without LUCF (Gg equivalent)	**71 658**	**78 792**	**69 217**	**77 335**	**69 217**	**77 335**
Total with LUCF (Gg equivalent)	**70 734**	**77 828**	**66 099**	**74 207**	**66 099**	**74 207**

23. ***Uncertainty estimates***: For the first time, the uncertainty estimate based on the tier 1 methodology in the *IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories* has been performed for the 2003 inventory. These estimates covered stationary and mobile combustion sources, agriculture, and fugitive emissions from fuel, accounting for 93 per cent of the total Danish emissions. The overall uncertainty for total annual emissions is estimated at ±58.4 per cent, resulting from the uncertainty of annual emissions for CO_2, CH_4 and N_2O of ±2.1 per cent, ±15 per cent and ±431 per cent respectively. The uncertainty of the trend of total emissions is ±17.1 per cent, resulting from trend uncertainties of emissions for CO_2, CH_4 and N_2O of ±1.7 per cent, ±6 per cent and ±29 per cent respectively. The uncertainty for N_2O from agricultural soils is the predominant source of uncertainty for the Danish inventory. The review team commended the inventory team for comprehensive uncertainty estimates and for its plans to reduce the uncertainty in emission estimates and to include more sources in the uncertainty analysis.

24. ***Quality assurance/quality control and national system***: In the preparation of Denmark's annual emission inventory several quality control (QC) procedures have been applied, but quality assurance (QA) with independent review of the inventories is yet to be introduced. A formal QA/QC plan has not yet been developed. The review team was informed that a new project to evaluate the improvements necessary to conform with the Kyoto Protocol requirements for the national system was launched at the beginning of 2004. The main outcomes of the project encompass the development of the national inventory system and QA/QC plan, and improvements of the emission inventories especially for industry, solvents and offshore combustion.

25. In the NC3 some preliminary inventory estimates under the Kyoto Protocol and the EC burden-sharing agreement are also reported. Denmark has chosen 1995 as the base year for fluorinated gases, and has reported removals occurring in forests as a consequence of afforestation only since 1990.

B. Emission profile and trends

26. Denmark's GHG emissions totalled 69,410 Gg CO_2 equivalent in 2001 (table 3). The small growth in emissions between 1990 and 2001 resulted from two opposing tendencies: a decline of the CH_4 and N_2O emissions by 1 and 19 per cent respectively, and growth of CO_2 by 3 per cent and a huge growth (in percentage but not in absolute terms) of fluorinated gases compared to other gases. Between 1990 and 2000, overall emissions dropped by 1.5 per cent without net removals from LUCF and by

2.2 per cent with these removals. Hence, Denmark contributed to meeting the aim of the UNFCCC to return emissions to their 1990 levels by 2000.

27. Denmark's emission profile is typical for a developed country, with CO_2 being by far the most important gas and energy being by far the most important sector. In 2001, CO_2 remained the most important gas with a share of 78 per cent of total emissions, followed by N_2O with13 per cent and CH_4 with 8 per cent, fluorinated gases making up the rest. In the same year, the energy sector, including transport, accounted for 78 per cent of emissions, followed by agriculture with 17 per cent, industrial processes with 3 per cent, and other sources making up the rest.

Table 3. Total GHG emissions and emissions by gas, 1990–2000 (Gg CO_2 equivalent)

GHG emissions	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Net CO_2 emissions/removals	**49 541**	**60 264**	**54 442**	**56 805**	**60 793**	**58 002**	**71 422**	**62 067**	**56 898**	**54 118**	**49 247**	**50 824**
CO_2 emissions (without LUCF)	**52 659**	**63 383**	**57 563**	**59 928**	**63 919**	**61 130**	**74 556**	**65 209**	**60 050**	**57 279**	**52 764**	**54 355**
CH_4	5 672	5 728	5 735	5 858	5 882	5 958	6 030	5 920	5 802	5 473	5 535	5606
N_2O	10 843	10 737	10 068	10 193	9 976	9 903	9 758	9 343	9 382	9 314	9 090	8749
HFCs	0	0	4	96	141	236	371	392	489	598	705	647
PFCs	0	0	0	0	0	1	3	7	15	20	28	22
SF_6	43	62	89	135	122	107	61	73	59	65	59	30
Fluorinated gases	43	62	93	230	263	344	435	472	564	683	793	700
Total (with net CO_2 from LUCF)	**66 099**	**76 791**	**70 338**	**73 086**	**76 913**	**74 207**	**87 644**	**77 803**	**72 645**	**69 589**	**64 664**	**65 879**
Total (without CO_2 from LUCF)	**69 217**	**79 910**	**73 459**	**76 209**	**80 039**	**77 335**	**90 778**	**80 945**	**75 797**	**72 750**	**68 181**	**69 410**

Note: Discrepancies in totals in this table and in the following tables are due to rounding errors.

28. ***Carbon dioxide***: In 2001, Denmark's total CO_2 emissions amounted to 54,355 Gg (table 4, figure 1). Energy industries (public power and district heating plants) contributed 49 per cent of this. The main reason for such a high share is that the Danish heat and power sector is mainly coal-based, as coal accounts for around half of the fuel used, depending on hydrological conditions in the Nordic countries and the related levels of electricity exports. Another reason is the country's vast use of district heating, with most of the heat coming from combined heat and power (CHP) whose emissions are accounted for within the energy industries. The second largest sector is transport, accounting for 22 per cent of emissions. Energy use in the residential and commercial sectors was responsible for 14 per cent of emissions and energy use in industry for 11 per cent. The small share of emissions from industry reflects Denmark's industrial structure, which produces commodities with high added value using processes with low energy intensity.

29. The growth of emissions by 2.4 per cent between 1990 and 2001 was underpinned by growth in emissions from transport (16 per cent) and energy use in industries (5 per cent) followed by emissions from energy industries (less than 1 per cent). The main driver for the growth in transport emissions was road transportation, particularly passenger transportation, which has increased by about 40 per cent from 1990. The growth was underpinned by increased transportation activities and a constantly growing number of cars. Fugitive emissions and emissions from industrial processes increased substantially, by 264 per cent and 46 per cent respectively, but they remained a small proportion of the overall CO_2 emissions and did not influence the overall trend.

Table 4. Carbon dioxide emissions by source, 1990–2001 (Gg)

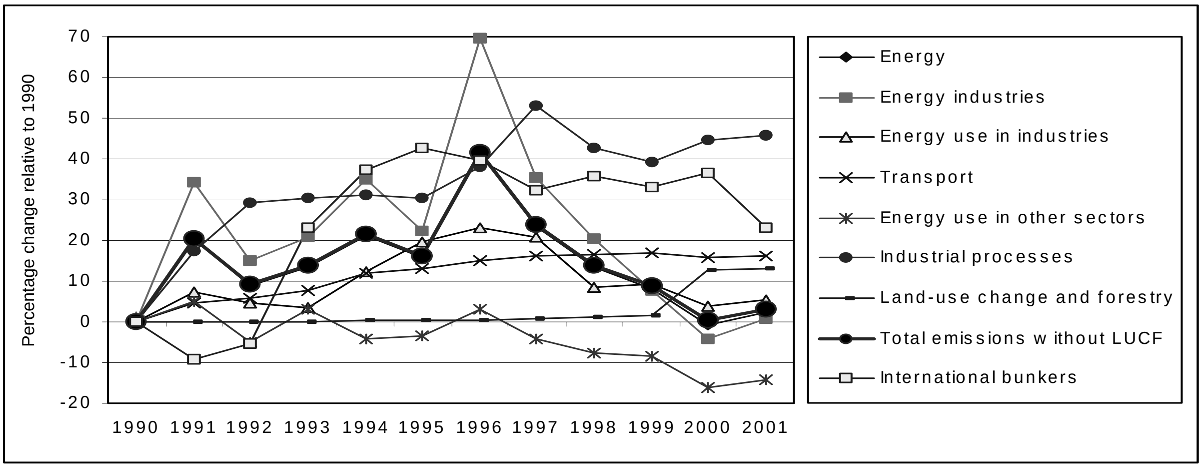
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Energy	51 530	62 082	56 142	58 492	62 482	59 701	730 51	63 555	58 500	55 764	51 199	52 779
Energy industries	*26 202*	*35 155*	*30 127*	*31 689*	*35 388*	*32 093*	*44 412*	*35 433*	*31 504*	*28 250*	*25 121*	*26 375*
Energy use in industries	*5 605*	*6 012*	*5 873*	*5 804*	*6 300*	*6 705*	*6 888*	*6 763*	*6 081*	*6 129*	*5 823*	*5 909*
Transport	*10 404*	*10 896*	*11 021*	*11 202*	*11 642*	*11 775*	*11 976*	*12 102*	*12 125*	*12 182*	*12 046*	*12 077*
Energy use in other sectors[a]	*9 078*	*9 524*	*8 610*	*9 352*	*8 684*	*8 763*	*9 374*	*8 691*	*8 367*	*8 301*	*7 616*	*7 785*
Fugitive emissions from fuels	*240*	*495*	*511*	*445*	*468*	*365*	*400*	*565*	*422*	*903*	*593*	*633*
Industrial processes	1 005	1 178	1 300	1 311	1 318	1 311	1 388	1 539	1 436	1 402	1 453	1 464
Solvent and other product use	124	122	121	125	119	118	116	115	114	113	112	112
Land-use change and forestry	–3 118	–3 119	–3 121	–3 123	–3 126	–3 128	–3 134	–3 142	–3 152	–3 161	–3 517	–3 531
Total emissions with LUCF	**49 541**	**60 264**	**54 442**	**56 805**	**60 793**	**58 002**	**71 422**	**62 067**	**56 898**	**54 118**	**49 247**	**50 824**
Total emissions without LUCF	**52 659**	**63 383**	**57 563**	**59 928**	**63 919**	**61 130**	**74 556**	**65 209**	**60 050**	**57 279**	**52 764**	**5 4355**
International bunkers	4 857	4 407	4 590	5 973	6 664	6 940	6 790	6 429	6 587	6 457	6 629	5 983

[a] "Other sectors" includes residential, commercial and service sectors.

30. Emissions from several sources declined: energy use in residential, commercial and service sectors by 17 per cent and solvent and other product use by 11 per cent. The former declined despite the increase in energy consumption because of some switching from oil to natural gas and renewables, and also because of the increased share of heat and electricity production, which means that emissions were accounted for in the energy industry sector. Emissions from international bunkers increased by 23 per cent: aviation bunker emissions by 35 per cent and marine bunker emissions by 16 per cent.

31. The relatively large fluctuation in CO_2 emissions from year to year, e.g. the high levels in 1991 and 1996, is largely driven by electricity exports. The growth of emissions between 2000 and 2001 was mainly due to an increase in the net export of electricity. Also, the annual mean temperature was lower in 2001 than in 2000 and less electricity than usual was produced by wind turbines because of poor wind conditions. From 1997 to 2000, emissions fell steadily because many power stations have switched from coal to natural gas and the share of renewable energy, mainly wind and biomass, is increasing.

Figure 1. Carbon dioxide emissions, percentage change from 1990, by source



32. The sensitivity of emissions to electricity exports made it relevant for Denmark to consider, for policy purposes, the CO_2 emission trend adjusted for electricity imports and weather variations. According to this trend, CO_2 emissions fell by 12 per cent between 1990 and 2001, while GDP increased by 27 per cent. This suggests a notable decoupling of emissions from economic growth that could be attributed to energy efficiency improvements in energy end-use sectors, increased share of CHP, and fuel switching from coal to natural gas and renewables in the energy industry.

33. ***Methane***: In 2001, CH_4 emissions amounted to 267 Gg (table 5, figure 2). With shares of 65 per cent and 21 per cent, agriculture and waste, respectively, were by far the most important sources. The rest came from the energy sector. Emissions from agriculture came mainly from enteric fermentation (76 per cent), with manure management accounting for the rest.

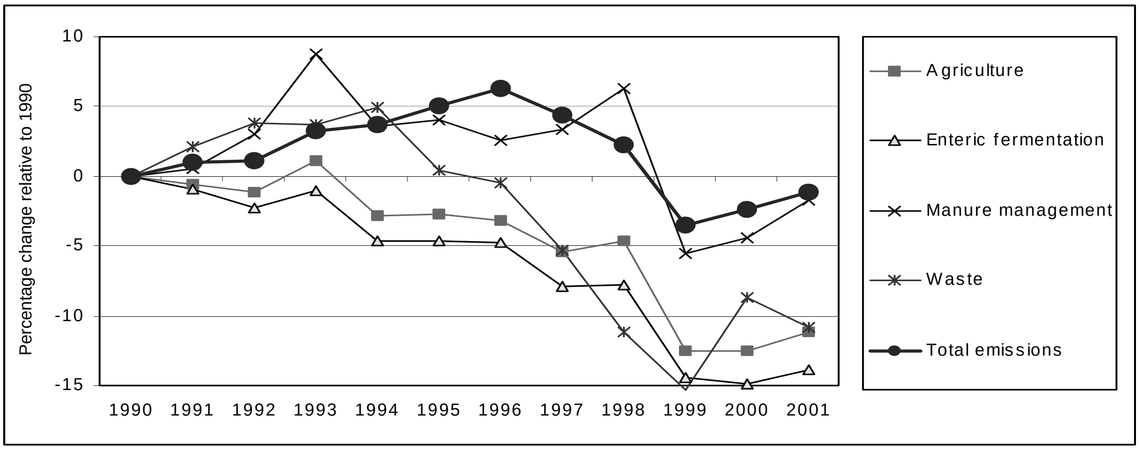
Table 5. Methane emissions by source, 1990–2001 (Gg)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Energy	13.01	15.43	15.79	17.46	25.33	31.64	36.44	38.59	35.27	37.40	36.32	38.42
Agriculture	194.70	193.63	192.49	196.79	189.25	189.37	188.59	184.20	185.59	170.38	170.25	172.95
Enteric fermentation	*151.84*	*150.52*	*148.34*	*150.20*	*144.83*	*144.76*	*144.61*	*139.90*	*140.03*	*129.89*	*129.27*	*130.83*
Manure management	*42.86*	*43.10*	*44.14*	*46.59*	*44.41*	*44.61*	*43.98*	*44.30*	*45.57*	*40.48*	*40.99*	*42.12*
Waste	62.40	63.70	64.80	64.70	65.50	62.70	62.10	59.10	55.40	52.84	57.00	55.61
Total emissions	270.11	272.76	273.07	278.96	280.07	283.71	287.13	281.90	276.26	260.62	263.57	266.98

34. Emissions of CH_4 declined by 1.2 per cent between 1990 and 2001, mainly due to a decline in emissions from agriculture and waste by 11 per cent each. The decline in emissions from agriculture was mainly due to a decrease in the number of dairy cattle as a result of the EC Common Agricultural Policy (CAP) and milk quota. This decline more than compensated for the effect on emissions of the increase in the pig population, which follows the trend of the demand for pork on the world market, as 80 per cent of pork production is exported. The decline in emissions from waste was underpinned by the steady decrease in the quantities of waste deposited in landfills since 1994. This decline stemmed from the

effects of the 1993 *Action Plan for Waste and Recycling 1993–97*, which also had objectives relating to the handling of waste up to the year 2000. Emissions from energy almost doubled because of the increased penetration of natural gas and the related increase in the number of gas engines. However, these did not influence the overall CH_4 emissions because of their small share.

Figure 2. Methane emissions, percentage change from 1990, by source



35. ***Nitrous oxide***: In 2001, the total N_2O emissions amounted to 28 Gg (table 6, figure 3). Agriculture, mainly emission from soils, and energy, including transport, were the most important sectors with shares of 91 and 9 per cent respectively. Within the energy sector, transport accounts for around half of the emissions.

36. Emissions of N_2O decreased by 19 per cent between 1990 and 2001. The main reason was the effect of the *Action Plans for Aquatic Environment I* (1987) *and II* (1998) on the improved utilization of nitrogen in manure. This resulted in less nitrogen excreted per unit of fertilizer produced, and in a reduction of fertilizer use. Another reason was the effect of the *Ammonia action plan* and the related measures to prevent loss of nitrogen in agricultural production. There was also some decrease in land use for agriculture, driven by the EC CAP, and changes in the proportion of land under cereal, driven by EC grain prices.

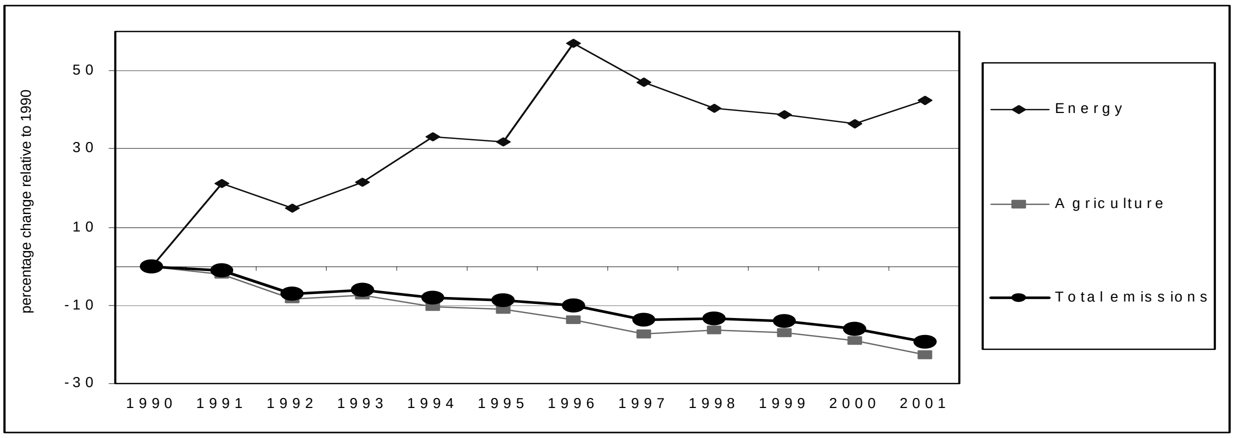
37. Emissions of N_2O from energy increased by 43 per cent between 1990 and 2001, mainly as a result of the 2.7-fold increase in N_2O emissions from transport caused by the increasing use of cars with catalytic converters. However, this did not influence the overall N_2O emissions trend because of the small share of this sector.

Table 6. Nitrous oxide emissions by source, 1990–2001 (Gg)

	1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**
Energy	1.88	2.28	2.16	2.28	2.50	2.48	2.96	2.77	2.64	2.61	2.57	2.68
Agriculture	33.09	32.35	30.32	30.60	29.68	29.46	28.52	27.37	27.62	27.44	26.75	25.54
Total	**34.98**	**34.63**	**32.48**	**32.88**	**32.18**	**31.95**	**31.48**	**30.14**	**30.26**	**30.05**	**29.32**	**28.22**

38. ***Fluorinated gases***: In 2001, emissions of fluorinated gases amounted to 700 Gg CO_2 equivalent, made up of HFCs (92.5 per cent), followed by SF_6 (4.3 per cent) and PFCs (3.2 per cent) (table 7). This part of the Danish inventory contains data on all substances and related emissions only back to 1993. Between then and 2000 there was a continuous increase in the contribution of fluorinated gases, mainly of HFCs, to the overall emissions. In 2000, the growth stopped and within one year, between 2000 and 2001, emissions dropped by 12 per cent.

Figure 3. Nitrous oxide emissions, percentage change from 1990, by source



39. Emissions of HFCs were estimated at 647 Gg CO_2 equivalent in 2001. The use of HFCs, and especially HFC-134a, increased several-fold during the 1990s. The main application of HFC-134a was as a refrigerant. However, due to a new tax and legislation on phasing out the import, production and use of fluorinated gases (new HFC-based stationary refrigeration systems will be forbidden from 2007), the tendency is towards maintaining emissions of HFCs, including HFC-134a, broadly at the same level as the servicing of existing systems and equipment is allowed by the end of their life time.

Table 7. Fluorinated gases, emissions by gas, 1990–2001 (Gg CO_2 equivalent)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
HFCs	0.00	0.00	3.64	95.66	141.01	235.83	370.80	392.15	489.42	597.90	705.02	647.32
PFCs	0.00	0.00	0.00	0.00	0.13	0.95	2.93	7.23	15.03	19.84	28.30	22.13
SF_6	43.02	62.07	89.15	134.60	122.06	107.36	60.99	73.09	59.46	65.39	59.25	30.43
Total emissions	**43.02**	**62.07**	**92.79**	**230.26**	**263.20**	**344.14**	**434.73**	**472.47**	**563.92**	**683.12**	**792.57**	**699.87**

40. Emissions of SF_6 were estimated at 30 Gg CO_2 equivalent in 2001. They contributed substantially to the overall emissions of fluorinated gases in the early 1990s, accounting for 58 per cent of the total in 1993. The new tax and regulation of fluorinated gases led to a stabilization in emissions from electrical equipment and a decline in emissions from plate glass production, and by 2001 SF_6 accounted for only around 4 per cent of fluorinated gas emissions. Emissions of PFCs were estimated at 22 Gg CO_2 equivalent. Emissions of PFCs (perfluoropropane only) are released from refrigerants in commercial refrigerators and from cleaning liquids in the electronics industry. They increased by 2300 per cent between 1995 and 2000, but stabilized thereafter.

III. POLICIES AND MEASURES

41. ***Institutional framework***: As described in section I, before 2001 the Ministry of Environment and Energy was entrusted with the coordination, development and implementation of climate change policies, as well as international negotiations on climate change on behalf of Denmark. After the new government came to power in 2001 responsibility of this ministry was split between two new ministries: the Ministry of Economic and Business Affairs and the Ministry for the Environment. The preparation of the 2003 Climate Strategy was a result of intensive inter-ministerial cooperation headed by the Ministry of Finance, and involving the Ministry of Economic and Business Affairs, the Ministry for the Environment, the Ministry of Taxation and the Ministry of Foreign Affairs.

42. In 2003, an Inter-ministerial Climate Council headed by the Ministry for the Environment was set up to monitor the implementation of policies and measures, and the cost efficiency of the policy mix implemented to meet the Kyoto target. The Council is responsible for selecting new domestic measures, if deemed necessary, that meet the cost-effectiveness threshold discussed in paragraph 50 below, and for coordinating their implementation.

43. ***Coverage***: The NC3 provides an overview of national and sectoral action plans on energy, environment and climate change enacted since the early 1990s with relevance to emission mitigation. Importantly, it provides an overview of the most recent (2003) Climate Strategy and a summary of possible new measures to be implemented, together with assessment of their mitigation potential and economic cost. The information reported in the NC3 comprehensively covers all sectors and gases.

44. ***Compliance with the guidelines***: The reporting on policies and measures in the NC3 broadly conforms with the UNFCCC reporting guidelines. However, the information on progress made in the implementation of sector-specific policies was limited. There was also little detail on the monitoring and evaluation of these policies, the mitigation effect achieved and the associated cost. For some policies and programmes only titles were provided and it was unclear whether they are still in place or not, e.g. the 1996 *Action Plan for Reduction of the Transport Sector's CO_2 Emissions*.

45. The NC3 does not contain information on policies and measures that have been discontinued, or on polices and measures with potential negative impacts on GHG emissions. For example, the review team was informed that further strengthening of the regulation of SO_2 emissions was expected to increase the CO_2 emissions from refineries by 8–12 per cent because the desulphurization process increases energy consumption. The team noted the usefulness of assessing the impact of energy market liberalization in view of its potential impact on CO_2 emission levels.

46. ***Monitoring and evaluation of effects***: During the preparation of the action plans relating to climate change mitigation adopted during the 1990s, the expected effects of different policies and measures on GHG emissions were estimated within the individual sectors by the relevant ministries and agencies, as ex-ante evaluations. The effects of existing policies and measures has been monitored mostly on an aggregate level, for example through the monitoring of emission trends at the sectoral level. It is therefore difficult to judge how the new policy development takes into account the lessons learnt from policies implemented in the 1990s.

47. The energy sector is the only sector where the impacts of individual policies have been assessed. This was the case, for example, with the grants scheme to promote energy efficiency in business, the Electricity Saving Trust, the energy labels for large and small buildings, and the 1995 green tax reform. These were all assessed between 1998 and 2002. In addition, in 2001, an inter-ministerial working group conducted a cost-benefit analysis of environmental policy including climate change, and in May 2002 the Danish Economic Council published an evaluation of Danish environmental and energy policy in the 1990s. The NC3 does not, however, provide information on these evaluations.

48. In addition, a cross-sectoral ex-ante analysis of a limited selection of potential policies, with effects both on GHG emissions and on costs, was carried out in 2002 as an input to the 2003 Climate Strategy. The review team was informed that a new ex-post evaluation of climate change policies was undertaken in 2003 to comprehensively assess emission reductions achieved so far by domestic action and to define a new baseline ("without measures") for further policy development.

49. ***Recent policy development***: The adoption of the new Climate Strategy on 13 March 2003 was an important milestone in Danish climate policy development. The 2003 Climate Strategy identified approaches and tools to attain Denmark's Kyoto target of 21 per cent GHG emission reduction in the period 2008–2012 compared to 1990 levels under the EC burden-sharing agreement. In particular, it identified ways of covering the gap between the Kyoto target and projected level of emissions between 2008 and 2012, which was recently estimated at 25,000 Gg CO_2 equivalent annually. A strategic approach for long-term emission reductions is not part of the new strategy and is yet to be developed.

50. The 2003 Climate Strategy marks a noticeable transition from the traditional approach of GHG emission reduction, articulated most recently in the climate action plan *Climate 2012* of the previous government, which focused almost exclusively on CO_2 emission reduction through domestic measures to a cross-sectoral and cross-border approach. It also marked a transition from strong government intervention towards a more market-based approach driven by cost-efficiency principles.

51. The approach is based on three groups of instruments. The first is the EU emission trading scheme (ETS).[2] According to preliminary estimates the EU ETS may cover slightly less than half of the emissions for the first commitment period. However, this is linked to the assigned amount that is yet to be fixed by 2006 together with the size of the quota for this period. The second is based on an indicative cost threshold for emission reductions of DKK 120 (approximately EUR 16) per tonne of CO_2. This figure was chosen given the estimates in 2003 of the likely international price of emission quotas/credits adjusted for a net domestic tax factor and may change in the future. The third group of instruments comprises joint implementation (JI) and the clean development mechanism (CDM). Under the new strategy, only domestic emission reductions that could be achieved under the cost threshold would be implemented. Further emission reductions would be achieved through the purchase of credits and quotas on the international market or through the development of JI and CDM projects abroad.

52. The strategy implicitly acknowledges that the target set by the Danish Parliament in 1990 and included in the landmark *Energy 2000* plan from the same year, of reducing CO_2 emissions by 20 per cent in 2005 compared to the 1988 emission levels, is no longer relevant as a policy objective in energy and environmental policy.

A. Cross-cutting issues

53. Since the early 1980s, taxes have played an increasingly important role in addressing environmental issues in Denmark. In 1991, energy taxes were restructured into an energy and carbon tax reflecting Denmark's ambition to reduce GHG emissions. This approach received renewed momentum in 1994, when Denmark embarked on a green tax reform aimed at shifting the taxation from labour and income to the use of natural resources and pollution, while maintaining the overall tax burden broadly unchanged. This led to the introduction of a number of environmental taxes such as on water, wastewater, and paper and plastic bags. Later, the 1995 green tax package, effective since 1996, introduced higher carbon and energy taxes for trade and industry aimed at emission mitigation.

54. Since 1996, the standard carbon tax rate has been EUR 13.4 (DKK 100) per tonne of CO_2. As the carbon tax is fuel dependent, the tax rate varies from EUR 1.3 per GJ for brown coal, to EUR 0.8 per GJ for natural gas and to zero for combustible renewables. The tax rate for electricity was set at EUR 3.7 per GJ with no differentiation made for source. The carbon tax applies to all energy users, although fuel used for electricity generation is exempt. The tax package differentiates between heavy and light industrial processes, in order to protect the competitiveness of energy-intensive industries. The carbon tax was gradually phased in between 1996 and 2000, in order to allow companies to adjust to the new tax scheme. For industrial space heating the standard carbon tax rate was applied from 1996 onwards.

55. The carbon tax scheme is linked to a tax rebate system for industries that introduce voluntary measures to reduce GHG emissions. Table 8 shows the resulting taxes per tonne of CO_2 with and without tax rebates for voluntary agreements. The difference between the tax rate with and without voluntary agreement grew considerably between 1996 and 2001.

56. In line with the principles of the green tax reform, much of the revenue from the 1995 tax package has been transferred back to industry by a number of initiatives in order to entail no net cost to the economy. The largest portion of tax revenue transfers occurred through reduced employers' labour market contributions.[3] A share of the tax revenue was also redirected to the services and industry sector in the form of subsidies for energy efficiency projects. In 1996–2000 EUR 242 million (DKK 1.8 billion)

[2] "Directive 2003/87/EC of the European Parliament and of the Council of 13 October 2003 establishing a scheme for greenhouse gas emission allowance trading within the Community and amending Council Directive 96/61/EC."

[3] In 1997, when the transfer for labour market contributions was put in place, it amounted to 0.11 per cent of companies' total contributions. By 2000 it had reached a maximum level of 0.53 per cent of those contributions, representing approximately EUR 270 million (DKK 2 billion). Another EUR 27 million (DKK 200 million) was transferred back in 2000 through reduced payment of supplementary labour market pensions.

was set aside for such subsidies. The Danish Energy Authority has established a list of 40 standard solutions for energy efficiency improvements, and determines which projects qualify. Eligible projects have to meet one of three criteria: to lead to increased energy efficiency, to reduce CO_2 (or SO_2) emissions, or to be of a developmental character.

Table 8. Effective carbon tax rates per tonne of CO_2

	1996	1997	1998	1999	2000	2001	2002	2003	2004
Light industrial processes Basic rate	EUR 6.7 (DKK 50)	EUR 8.1 (DKK 60)	EUR 9.4 (DKK 70)	EUR 10.8 (DKK 80)	EUR 12.1 (DKK 90)	EUR 12.1 (DKK 90)	EUR 12.1 (DKK 90)	EUR 12.1 (DKK 90)	EUR 12.1 (DKK 90)
Light industrial processes With voluntary agreement	EUR 6.7 (DKK 50)	EUR 6.7 (DKK 50)	EUR 6.7 (DKK 50)	EUR 7.8 (DKK 58)	EUR 9.1 (DKK 68)	EUR 9.1 (DKK 68)	EUR 9.1 (DKK 68)	EUR 9.1 (DKK 68)	EUR 9.1 (DKK 68)
Heavy industrial processes Basic rate	EUR 0.7 (DKK 5)	EUR 1.3 (DKK 10)	EUR 2.0 (DKK 15)	EUR 2.7 (DKK 20)	EUR 3.4 (DKK 25)	EUR 3.4 (DKK 25)	EUR 3.4 (DKK 25)	EUR 3.4 (DKK 25)	EUR 3.4 (DKK 25)
Heavy industrial processes With voluntary agreement	EUR 0.4 (DKK 3)	EUR 0.4 (DKK 3)	EUR 0.4 (DKK 3)	EUR 0.4 (DKK 3)	EUR 0.4 (DKK 3)	EUR 0.4 (DKK 3)	EUR 0.4 (DKK 3)	EUR 0.4 (DKK 3)	EUR 0.4 (DKK 3)

57. The tax, subsidy and voluntary agreements scheme was evaluated in 1999. The evaluation suggested that in 2005 the expected CO_2 emissions reductions would amount to 3.8 per cent of the projected emission levels, corresponding to 2.3 million tonnes. Half of this reduction was expected to come from the tax itself, with the other half expected to come from the subsidies and voluntary agreements (table 9).

58. The evaluation concluded that the package had delivered the expected emission reductions. Importantly, the administrative cost of the voluntary agreement scheme was considered too high, which led to a reorganization of the scheme to improve cost-efficiency. In 2002, the new government introduced a general freeze on all taxes. This freeze is in nominal terms and will therefore lead to reductions in carbon and energy taxes in real terms.

Table 9. Estimated reductions of CO_2 emissions in 2005 from carbon tax and related instruments

	Per cent	Emission reductions (million tonnes)
Taxes	2.0	1.2
Subsidies	1.2	0.7
Voluntary agreements	0.6	0.4
Total	**3.8**	**2.3**

59. In March 2004, Denmark submitted to the EC the ***Initial Allocation Plan for the EU ETS*** for 2005–2007. It covers around half of the emissions under the “with measures” scenario for 2005-2007 and envisages a 15 per cent emission reduction from sources covered by the quota system under this scenario, which is equal to 6,000 Gg CO_2 equivalent. Some uncertainty remained on the coverage of the EU ETS for 2008–2012, as this issue is to be decided by 2006.

60. The EU ETS is expected to help reduce some uncertainties related to the impact on national emissions from Danish electricity exports in the first commitment period. Historically, Denmark’s coal-powered plants have played an important role in ensuring a reliable source of power for the Nordic electricity market in years with poor hydrological conditions. Decisions taken in other Nordic countries relating to future electricity production infrastructure will inevitably affect the role of Danish coal-powered plants and the existing excess capacity on this market. According to the 2003 Climate Strategy this will require Danish electricity producers of electricity to off-set the impact on emissions from possible increases in electricity exports and associated increase in emission levels estimated at 10,000 Gg CO_2 equivalent by buying CO_2 quotas and/or credits.

61. The review team was informed that the government has been preparing a proposal for phasing out the carbon tax on fuels for installations to be covered by the EU ETS, to avoid covering the same emission sources by two instruments. The losses in tax revenue were expected to amount to DKK 30 million annually. The tax on electricity would remain until the implementation of the EU ETS unfolds and its impact on electricity prices becomes clear.

B. Energy

62. Within the energy sector, energy supply accounted for around half of the CO_2 emissions, with transport and energy use in residential, commercial and industry accounting for the rest. As discussed in paragraph 28 above, the large share of emissions from energy supply is mainly due to a heavy, but diminishing, dependence on coal for electricity generation, electricity exports, and extensive use of CHP and district heating for electricity and heat production.

63. ***Energy market liberalization***: An amendment to the former Electricity Supply Act in 1996 set the electricity market on the course of liberalization. The process began in April 2000, when the market was opened for consumers with annual consumption levels of over 100 GWh, and gradually expanded thereafter. In January 2003, competition was extended to all consumers. In 2000, around 30 per cent of the gas market was opened up to competition. In 2002 the new government announced plans to introduce full retail competition in the gas market in 2004, and to privatize the state-owned transmission company.

64. ***Energy efficiency***: Energy efficiency has played a central role in reducing energy consumption in Denmark. In 2001 the total energy consumption (excluding consumption for transport and non-energy purposes) was estimated to be 50 per cent lower than it would have been without the improvements that occurred between 1975 and 2001 in energy efficiency in end-use consumption and energy supply. In the political agreement of 29 May 2001 between the government and industry on natural gas supply and energy savings, further specific targets for energy savings by 2005 were set by sector (table 10), based on the latest projections of expected consumption in individual sectors. A summary of the key policies in the energy sector is provided in table 11.

Table 10. Energy efficiency targets laid down for 2005

Sector	2001	2005	Energy-savings targets 2005		
	Current consumption (PJ)	Projections without new initiatives (PJ)	Savings (PJ)	Estimated CO_2 reduction (Gg)	Savings in % compared with projections in 2005
Household	187	187	8	940	4
Public services	24	24	2	330	8
Private trade and services	56	60	3	490	5
Agriculture and industry	169	177	2	380	1
Total (excluding transport)	436	448	15	2 140	3

Table 11. Summary of the key policies and measures in the energy sector

Policy or measure	Policy instrument used	CO_2 emission reductions
Green tax package: carbon and energy taxes	Tax	Total of 1.2 million tonnes in 2005
CO_2 tradable allowances	Domestic emissions trading scheme	In 2003 emission quota equal to 66% of 1994–1998 emission levels.
Support for wind power	Production subsidies, priority access to the grid, demonstration plants	NA
Support for biomass	Mandatory production use	NA
Support for combined heat and power	Production subsidies	NA
Green tax package agreements	Voluntary agreements/tax rebates	Total of 0.4 million tonnes in 2005
Energy labelling of large and small buildings	Energy conservation advice, consumption labelling	–
Electricity saving trust	Subsidy/financial incentives, demonstration/information dissemination	Between 1997 and 1998: 46.8 Gg/year

1. Energy supply

65. Several policies and measures in the power sector constitute the main thrust of Denmark's climate policy, along with carbon and energy taxes. These include policies to promote CHP, district heating, renewable energy and fuel switching. Also relevant to climate change and national emissions is the existing reserve capacity for excess electricity generation, which is expected to play an increasingly important role in the Nordic electricity market, as both Norway and Sweden are faced with constraints on the building of new capacity.

66. Current policies almost exclusively address CO_2 emissions from energy, but rapid penetration of natural gas in the TPES, notably for gas-fired CHP plants, gave rise to a concern over CH_4 emissions. To

regulate these, a statutory order was introduced to limit emissions from new gas plants, which sets a cap for these emissions of 3 per cent of the natural gas used.

67. ***CO_2 tradable allowances****:* As part of the electricity market reform launched in March 1999, Denmark introduced a system of tradable CO_2 allowances or quotas for 2000–2003. This approach, aimed at regulating CO_2 emissions from electricity production, was considered to entail the least impact on competition within the market. The CO_2 Quotas Act was adopted by Parliament in June 1999 and came into force in January 2001, after approval by the EC.

68. According to the existing quota scheme, CO_2 allowances are allocated per company and not per plant or plant unit. A minimum emission threshold level of 100 Gg CO_2 per year per company was used to determine the companies to be included in the scheme. Just eight companies account for more than 90 per cent of total CO_2 emissions from electricity production. The allocation of quotas was based on historic emission trends (“grandfathering”). Special consideration was given to CHP operators, given their contribution to reducing the CO_2 emissions as a result of government policy. The total allocated quotas covered around 66 per cent of emissions from the electricity sector for 1994–1998. It was progressively reduced from 22,000 Gg CO_2 in 2001 to 20,000 Gg CO_2 in 2003 and was set to remain unchanged between 2003 and 2005. The penalty for exceeding the allocated quota was set at a relatively low level of EUR 5.4 (DKK 40) per tonne of CO_2. The effect of the quota system was limited as, with the existing high electricity prices, in many cases it appeared to be cost-effective for power producers to pay this penalty rather than reduce emissions.

69. During its visit to Denmark, the review team was informed that a political agreement had been reached to extend the existing quota system until 2005, when the EU ETS is expected to be launched.

70. ***Renewables:*** Denmark’s policies to promote renewable energy have been central to the national strategy to mitigate GHG emissions. The increase in the share of renewables in power generation from 3.2 per cent in 1990 to around 20 per cent in 2002 is indicative of the policy’s success. This far exceeded the goal set by the former government for 1 per cent annual growth in renewable energy, and Denmark seems to be on track to achieve the EC target for electricity from renewables.

71. Production subsidies, priority access to the grid, state orders to build offshore wind farms, a biomass agreement, and support for research and development have been the main instruments in reaching this goal. Carbon and energy taxes and tradable CO_2 quotas also contributed. Planning the sites of wind turbines has been important and is expected to become even more important in future.

72. From near zero installed capacity in the early 1980s to over 2,500 MW in 2001 (representing over 12 per cent of electricity consumption), wind power has grown in importance as a result of government support. The new government, however, has phased out priority access to the grid for electricity from wind and reduced the production subsidy for existing wind turbines from DKK 0.6/kWh to DKK 0.25/kWh. It remained unclear to the review team whether priority access for wind power was going to be replaced by another support scheme. For new wind turbines, the current support scheme includes a subsidy of DKK 0.1/kWh paid up to a maximum electricity price of DKK 0.26/kWh, as well as assistance for the replacement of old and poorly located onshore windmills. The changes in the support measures were expected to reduce incentives to build new wind power, given that the number of remaining locations for potential new onshore wind turbines is now limited.

73. In 1998 the government set a target of 750 MW to be supplied by offshore wind farms by 2008, and planned the construction of five large wind farms of approximately 150 MW capacity each. The first two, at Horns Rev and Nysted, were completed in 2002 and 2003 with a total capacity of 320 MW. However, in relation to the liberalization of the electricity market, the government cancelled the obligation for power suppliers to reach the 750-MW target and decided to employ a tendering process for further offshore wind farms. The financial framework of the tenders was not finalized by the time of the review team’s visit, and it is uncertain if offshore wind production will expand in the near future.

74. Biomass also played an important role in Denmark's renewable energy strategy. The utilization of biomass in CHP grew rapidly when electricity utility companies were ordered through an agreement with the government in 1993 to gradually increase the use of biomass, mainly straw and to a lesser extent wood, to 1.4 million tonnes per year in centralized CHP plants in 2000. This target proved difficult to reach, and in 2000 a new agreement deferred the target to 2004.

75. ***Green certificates and renewables obligation:*** The Electricity Reform Act 1999 established the role of renewable energy sources within the liberalized electricity market. It foresaw the introduction of market-based mechanisms to support renewables, including the setting up of a market for green certificates. However, the change of government has stalled further development of a green certificates scheme, although it is expected that this will be reconsidered in the broad context of electricity reform. The market for green electricity was scheduled to start in 2003, but will probably not start until 2005.

76. ***CHP:*** District heating and CHP have an important share of the energy market. Denmark ranks high in district heating use worldwide, with around 58 per cent of demand for household space heating being met in this way. In 2000, approximately 35 per cent of district heat production was from renewables, 30 per cent from coal, 28 per cent from gas and 7 per cent from oil. The share of CHP in district heating has increased steadily from 29 per cent in 1972 to 59 per cent in 1990 and over 81 per cent in 2000. The share of electricity produced from CHP has grown from approximately 30 per cent in 1990 to 53 per cent in 2000.

77. This remarkable market transformation has been achieved through strong political support since the late 1970s and early 1980s. District heating companies were encouraged to convert heat-only boilers to CHP, and provided with production subsidies, obligations to purchase power and guaranteed premium buy-back rates (equal to the price of electricity from a new coal-fired power plant). Small-scale CHP plants and industrial CHP were also given preferential treatment, and encouraged to switch from coal to natural gas. The 1990s saw rapid growth of small-scale CHP, starting from practically zero. It was expected to cover at least 90 per cent of the local heat demand, and the electricity generated was to be sold to the public grid. Since 1996, mostly small-scale CHP plants have been built, running on natural gas, straw, wood and municipal waste. The market for both district heating and CHP is now considered to have reached saturation and there is little scope for further cost-effective increases in capacity.

78. As in the case of wind power, in 2003 the government had proposed that priority access to the grid for electricity produced by CHP should be discontinued and be replaced by investment grants. At the time of the review, the government was still discussing this replacement. The magnitude of the impact of this change on building of new CHP plants and on the productivity of existing ones remained uncertain. In any case, the CHP growth that has occurred in past years is not expected to continue.

2. Energy use in industry

79. The energy saving target for the industry sector was set at 1 per cent in 2005 compared to projections (see table 10). The carbon and energy tax introduced in 1996 as part of the green tax reform (see paragraphs 52–56) constituted the core instrument to reduce energy consumption in this sector and associated emissions. The taxes were phased in gradually to allow businesses sufficient time to improve efficiency, to switch to fuels with lower carbon content and to define voluntary agreements. The overall effect of the taxes on competitiveness was modest, in fact much less than some other factors, such as fluctuation of wages, interest rates and inflation. The recycling of tax revenue back to industry through voluntary agreement schemes contributed to this effect.

80. ***Voluntary agreements and tax redistribution:*** Voluntary agreements for energy-intensive industry were introduced as part of the 1995 green tax package. A company entering into a voluntary agreement scheme obtains a rebate on its carbon tax. The purpose of the scheme was to reduce CO_2 emissions by promoting energy efficiency measures in energy-intensive companies, and to ensure that the competitiveness of energy-intensive companies was not impaired by taxation. By 2001, approximately 330 Danish companies had entered an agreement with the Danish Energy Authority, representing more than 50 per cent of the total energy consumption in industry. These voluntary

agreements were based on the submission of an energy audit and a formal project proposal that must be verified and approved by the Danish Energy Agency for the rebate to be granted.

81. Table 12 summarizes revenues from the carbon and SO_2 taxes under the green tax package and revenue recycling. The recycling of revenue to industry was planned to fully compensate for the tax increase. The 1999 evaluation of the green tax showed that industry was under-compensated and a set of adjustments have been made. In addition, the energy labelling of large buildings described below also applies to industrial buildings.

Table 12. Revenues from carbon and SO_2 taxes and their redistribution
(millions of euros)

	1996	**1997**	**1998**	**1999**	**2000old[a]**	**2000new[b]**
Tax revenue						
Additional carbon tax	69	140	224	263	283	277
SO_2 tax	25	27	28	40	42	42
Total	**94**	**167**	**252**	**303**	**325**	**319**
Revenue recycling:						
Tax on labour	–25	–74	–153	–184	–297	–261
Self-employment funds	–24	–28	–34	–34	–40	–40
Investment subsidies	–27	–46	–60	–77	–31	–62
Administration costs	–4	–4	–4	–4	–4	–4
Total	**–80**	**152**	**251**	**299**	**372**	**–367**
Total tax increase	**14**	**15**	**1**	**4**	**–47**	**–48**

[a] This column shows the expected tax increase if no corrective actions had been implemented.
[b] This column shows the actual tax increase after a number of adjustments in favour of industry had been made.

3. Residential and commercial sector

82. An array of measures has been introduced to enhance energy efficiency in the residential and commercial sector. These include, among others, carbon and energy taxes, subsidy schemes and labelling of buildings and appliances. The target set for this sector was 4 per cent reduction in energy consumption compared to projections for 2005. Over the past decades, the government provided subsidies through a number of programmes to support energy efficiency in the residential and commercial sector. In 2003, these were phased out and regulatory policies, many EC driven, together with the carbon and energy taxes, became the core of the policy in this sector.

83. ***Energy labelling of large buildings:*** The Energy Management Scheme (ELO scheme) targets energy savings in large buildings (1,500 m^2 or more) and aims to make energy-saving initiatives more transparent, easier and cheaper for property owners. The scheme involves registration of the consumption of heat, electricity and water for all buildings, except industrial ones, and preparation of an annual audit, an energy plan (with potential measures to reduce energy and water consumption), rating of buildings and attribution of an energy label. The evaluation of the scheme in 2000–2001 demonstrated that considerable savings were achieved, although it was not always considered financially attractive. Some adjustments to the scheme followed to improve its efficiency.

84. ***Energy labelling of small buildings:*** Under the programme for small buildings, house owners have to have an audit of their buildings, containing information on energy consumption and possible energy-saving measures, with ensuing rating of the building, which is required when a building is sold. This scheme was also evaluated in 2001. Although energy savings amounting to almost DKK 1 billion annually were identified, many opportunities for savings identified during audits remained untapped. The government has intensified the efforts to improve public awareness of the scheme, and to make the relationship between savings and costs clearer.

85. ***Electricity Saving Trust:*** The Danish Electricity Saving Trust was set up in 1997 to ensure electricity savings in the household and the public sector. The Trust's resources could also be offered to industry and business if there were "spin off" effects of initiatives aimed at the housing sector and the public sector. The Trust seeks to develop, test, and implement cost-effective measures that make it simple, safe and cheap for consumers to acquire and use energy-efficient appliances and systems (such as lighting, white goods, IT equipment and ventilation) or to convert from electric heating to district heating

or natural gas. The performance of the Trust was evaluated in its early stages (1997–1998). This revealed worthwhile emission reductions achieved per Danish Krone through the Trust subsidies, resulting in overall CO_2 emission reductions of 46.8 Gg annually. It also revealed potential improvements in the efficiency of the scheme through improved and better targeted marketing.

86. ***Energy labelling of appliances:*** Labelling of appliances is covered by a number of international and domestic schemes. Examples of international labelling schemes include the compulsory EC energy labelling scheme, principally covering white goods, the Energy Star labelling scheme for office equipment (based on a EC–US agreement), and the Energy Arrow scheme for office equipment and consumer electronics. These were supplemented by voluntary national labelling schemes for windows and boilers, and for electric motors and ventilation equipment used by industry.

C. Transport

87. The foundation of climate policy in the transport sector was set out in three documents: the 1990 *Transport Action Plan*, the 1994 *Transport 2005* and the 1996 *Energy 2000* programme. A specific target was set for the transport sector to stabilize its emissions by 2005 at the 1988 level and reduce them by 25 per cent in 2030, thus contributing to the overall national target of reducing CO_2 emissions in 2005 by 20 per cent compared to 1988.

88. Notwithstanding the ambitious targets set for the transport sector, emissions from this sector rose by 19 per cent between 1990 and 2001, suggesting that the measures in place were not sufficient to arrest the increase. The growth mainly came from road transport, as its share in energy consumption compared to overall transport has risen from 70 per cent in 1980 to 76 per cent in 2001.

89. In 2000, the Danish Ministry of Transport published a new report *Measures to Reduce CO_2 Emissions in the Transport Sector*, followed in 2001 by an *Action Plan for Reducing CO_2 Emissions in the Danish Transport Sector*. In this latest action plan, faced with continuously growing emissions, the government revised its targets substantially downwards. The plan aimed to reduce CO_2 emissions by 7 per cent in 2010 compared to "business as usual" trends (representing an actual increase in emissions of 19 per cent over 1990 levels). The 2003 Climate Strategy recognizes the high costs associated with emission reductions in transport and implicitly phased out previous targets in this sector.

90. ***Tax-related measures*** remained the core of the government's effort to reduce emissions from transport. In July 1997 the annual car ownership tax was changed from a vehicle weight basis to a fuel consumption basis. This provided a considerable and effective disincentive to the use of inefficient cars. The registration tax for passenger cars in Denmark is also high, leading to a low car ownership compared to countries with a similar GDP per capita. However, as a result, the existing cars are driven a relatively long distance annually and the car stock is relatively old. From January 2000, a reduction in the registration tax of passenger cars was introduced, based on fuel efficiency. This reduction was planned to be gradually phased out as fuel-efficient cars become more common and less expensive. A recent study by an inter-ministerial working group on the effect of introducing additional changes in registration tax to further promote energy-efficient cars suggested that this would not be a cost-effective way of reducing environmental externalities from cars. Finally, the energy tax may have also influenced emissions from the transport sector in that it creates incentives to buy more efficient cars. However, this effect could be partly off-set by the tendency to drive more, leading to an increase in mileage.

91. A number of additional measures were also in place to promote energy efficiency in transport, supplementing the effect of the tax. These include, for example, an information campaign on vehicle fuel consumption, and the promotion of low-energy driving techniques. Overall, efforts to encourage people to buy more fuel-efficient cars were reflected in sales, as more than 30 per cent of new cars sold in 2002 were of higher efficiency classes, compared to 27 per cent in 2001.

92. ***Promoting alternative transport modes*** is another important aspect of Denmark's climate policy in the transport sector. Examples include the 2003 Metro extension in Copenhagen and the development

of intermodal facilities for both freight and personal transport such as “park and ride” areas, the notable improvement of rail infrastructure, and increased urban planning aimed at the promotion of bicycle use.

93. The Danish experts expected the emissions from transport to continue to rise. Given the high costs of additional emission reductions in this sector, the 2003 Climate Strategy is not likely to lead to new transport-related measures. Nevertheless, coordination and integration of existing mitigation measures, as well as monitoring the impact in terms of emissions and costs, could be further emphasized.

D. Industrial processes

94. Denmark is at the forefront in developing policies to limit emission of fluorinated gases. These policies have been implemented chiefly through a tax on the use of substances and products containing these gases and a phasing out of many of their uses. No measures have been considered to limit emissions from other processes, such as CO_2 emissions from cement production.

95. A ***tax on the use of fluorinated gases*** was introduced in March 2001. It is based on the Danish carbon tax, corrected for the global warming potential (GWP) of the GHGs. For example, given a carbon tax of DKK 0.1/kg CO_2, the tax for HFC134a, which has a GWP of 1300, was set at DKK 130/tonne. The tax has a major effect on the price of substances containing these gases; for most of them it more than doubled the price. The tax cap is set at DKK 400/tonne, and the tax is paid when the gases or products containing them are imported and refunded if they are exported.

96. In July 2002, the phasing out by January 2006 of new equipment and many of the current applications using fluorinated gases was introduced by statutory order. Exceptions comprise: (i) general exemption for servicing of existing equipment until the end of its useful life; (ii) phasing-out of applications in larger refrigeration systems by January 2007 and; (iii) other exemptions, such as for medical dose inhalers for asthma patients.

97. A large reduction in estimates of fluorinated gases occurred from 2000 to 2001 as a result of large stocks that had been accumulated in anticipation of the tax and related reduction in imports. The tax revenue amounted to around DKK 66 million annually. The tax and the phasing out together are expected to stabilize the use and emissions of these gases between 2008 and 2012 at their 2003 level. The tax alone was expected to result in a 5 per cent annual reduction.

98. The EC has been preparing a regulation to control the use and emissions of fluorinated gases. When this regulation enters into force the Danish Government may have to replace its own policy by the potentially less stringent EC policy. The resulting effect on future emissions of fluorinated gases is expected to be much less than under the current national regulation.

E. Agriculture

99. In Denmark agriculture accounts for a relatively high share of GHG emissions: 20 per cent in 2001. The NC3 details several measures, the most prominent being the *Action Plans for Aquatic Environment I and II*, the *Ammonia Action Plan* and the *Biomass Agreement* on the use of straw as fuel. More detailed studies in the agricultural sector were undertaken after the adoption of the 2003 Climate Strategy in response to the requirement to identify potential cost-effective measures in this sector.

100. The *Action Plans for Aquatic Environment I* and *II* and the *Action Plan for Sustainable Agriculture* contained, among other things, measures that directly affected the level of N_2O emissions, including norms on the rate of fertilizer use and support for organic farming, restrictions on livestock density and increased utilization of nitrogen from manure. They also contained a ban on straw burning, its use for energy, and some measures with a small impact on the CO_2 emissions, including support for conversion of cropland to permanent wetland and for afforestation of agricultural land.

101. The effect of these plans was estimated as a difference between emission levels based on fertilizer utilization efficiency without the plans, and the actual sales of fertilizer. The effect was estimated at around 2,300 Gg CO_2 equivalent annually, coming mainly from reduced use of fertilizers

and nitrogen leaching. Additional emission reductions came from a reduction of area under agriculture and changes in the crop mix. The plan was expected to remain in place until the end of 2003, but its extension was uncertain.

102. Eight additional measures were identified in the sector in 2003, after the publication of the NC3. The most promising of these are a change in cattle feed, and use of biogas from animal manure. A change of cattle feed, with an increase in fat, has a potential to reduce emissions by 433 Gg CO_2 equivalent annually between 2008 and 2012. The cost estimates of DKK 790 per tonne CO_2 equivalent were well above the threshold value of DKK 120 per tonne CO_2.

103. The potential for emission reduction of the use of biogas for energy was estimated at 500 Gg CO_2 equivalent annually between 2008 and 2012. The cost estimates of DKK 589 per tonne CO_2 without considering side effects[4] were comparable with the previous measure. With these effects in place, cost estimates were DKK 43 per tonne CO_2 only. Part of the effect of this measure was included in the recent projections from agriculture, produced after publication of the NC3. If implemented, this measure will contribute to the target of 8 PJ from biogas in 2008–2012, which is supported by a subsidy scheme.

F. Land-use change and forestry

104. In 2000 forest occupied 486,000 ha, around 11 per cent of the national territory. Recreation is among the important forest functions in Denmark, along with nature conservation and biological diversity, but forest is also a source of timber production. The land-use change component of the LUCF is minimal, as 85 per cent of the forest area constitutes forest reserve and could only be converted to other uses following very strict rules. The Danish Forest and Nature Agency assumed responsibilities for coordinating the activities related to forest management, including providing information on afforestation on forest land and providing subsidies for afforestation on private land. The Forest and Landscape Institute conducts forestry censuses every 10 years, the most recent one being the 2000 census with data published in 2002, and on the basis of these it provides activity data for inventories and projections estimates for LUCF.

105. The slight increase in annual carbon uptake in the Danish forests from 3,118 Gg in 1990 to 3,531 Gg in 2001 was caused by relatively low harvest intensity and by uneven class distribution within the existing forest which is characterized by relatively many young stands. A small portion of this growth was caused by the afforestation programme launched in response to the decision taken by the government in 1989 to double the forested area in around 80–100 years. The annual carbon sequestration was expected to grow faster in the first decade of the present century when the newly afforested area would give maximum increment. Estimates suggested that in 2008–2012 the afforestation of former arable land carried out between 1990 and 2012 could reach 49,100 ha. This could result in carbon sequestration from this land of around 1,480 Gg CO_2 compared to the 2001 level of 73 Gg CO_2.

106. An afforestation rate of around 4,000–5,000 ha per year was considered sufficient to attain the target of doubling the area under forest, but the actual afforestation levels were lower than that.

107. In 2002, the *Danish national forest programme* was launched. It reaffirmed the target of doubling the forest area within 100 years and marked a transition to a new “near to nature” forest management principle, which includes planting of more indigenous species, promoting natural regeneration, and avoiding use of pesticides and fertilizers. The effect, at least in the longer term, would be positive in terms of enhanced accumulation of biomass. Several instruments were put in place to support the implementation of the programme, including subsidies for private afforestation and forest protection.

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[4] Side effects encompass using a fraction of the organic waste for biogas instead of being incinerated, avoiding storage and manure management and improved fertilizer utilization. Minor side effects encompass reduced odour problems and reduced nitrogen-leakage into the soil and waters.

108. In terms of the contribution of the LUCF sector to meeting the Kyoto target, afforestation under Article 3.3 of the Kyoto Protocol could bring carbon sequestration of between 280 and 1,270 Gg CO_2 annually. The small cap set for Denmark on activities under Article 3.4 does not provide incentives for them.

G. Waste

109. Emissions of CH_4 from waste dropped by 11 per cent between 1990 and 2001. This resulted mainly from a target-oriented waste management policy launched in the early 1990s, which led to a decoupling of the waste quantity from economic growth until 1999. As of 1999 the quantity of waste grew in proportion to economic growth. Before the development of the relevant EC policies, this policy was country-driven. It centres on reducing landfilling of organic waste, utilizing landfill gas and using waste for energy. It has been implemented chiefly through fiscal instruments and supported by a series of plans and strategies.

110. In implementing this policy, the *Action Plan for Waste and Recycling 1993–1997* set the target of reducing waste disposal in 2000 to 21 per cent of the total amount of waste. The most important initiative in this plan was the introduction of a regulation to stop the landfilling of combustible waste. This initiative was supported by a tax on waste disposal at landfills and on incineration, introduced in 1987. This tax has been most successful in increasing the recycling of construction and demolition waste, but less successful in increasing recycling of municipal waste. The next plan, *Waste 21*, covers the period between 1998 and 2004 and set targets for 2004. The main targets include stabilization of total waste quantities by 2004, a further reduction of landfilling of waste to 12 per cent and the augmenting of incineration capacity. An array of weight-based taxes aimed at waste minimization supported the effect from these plans, including taxes on specific packaging, paper and plastic bags and PVC film.

111. A new *Waste strategy 2005–2008* was submitted to Parliament in 2003. This set a new target to maintain the proportion of landfilled waste at 9 per cent of total waste. It did not introduce any new instruments to reduce landfilling of waste, but relied on instruments of the European Landfill Directive. These include regulations and new requirements for existing landfills that have been incorporated into Danish legislation, and the waste acceptance criteria and procedures to be introduced next year.

IV. PROJECTIONS AND THE TOTAL EFFECT OF POLICIES AND MEASURES

A. Preparation of projections

112. ***Institutional framework***: A new "with measures" set of emission projections for Denmark reported in the NC3 was prepared in 2002 as an integral part of the 2003 Climate Strategy. The Risø National Laboratory was in charge of the overall emission projections based on activity data and emission factors used in inventories, and the Danish Energy Authority prepared the projection of energy use and supply. Other institutions involved included the Ministry of Transport on data for energy use in the transport sector; the Ministry of Finance on economic growth figures needed for energy demand projections; the Danish Institute of Agricultural Sciences on emissions from agriculture; the DFLRI on CO_2 sequestrated by LUCF; the COWI consultancy on emissions of fluorinated gases; and the NERI on emissions from agriculture other than CO_2, waste, the NMVOC emissions and projections of emission factors from transport. A similar set of projections was prepared in 2001 by the same institutions and was used for the preparation of the climate action plan *Climate 2012* by the previous government. New projections of emissions from agriculture were prepared in 2003, after the publication of the NC3. Also after the publication of NC3, the NERI assumed responsibilities for emission projections.

113. ***Coverage***: The NC3 projections cover the period from 2001 to 2017, with 2001 being the base year for projections. Information is reported on a gas-by-gas basis for all sectors according to the IPCC categorization. Reported figures encompass emissions for 2005, and average emissions for the periods 2008–2012 and 2013–2017. Projections of precursors (CO, NO_X, NMVOCs) and SO_2 are not reported. Projections between 2013 and 2017 are described as "somewhat less certain" than the projections up to

2013, as the uncertainty associated with policies and measures and their expected effect increases over time. No projections were prepared for Greenland or the Faroe Islands.

114. ***Compliance with the guidelines***: The reporting of projections broadly conforms with the UNFCCC guidelines and comprehensively covers all emissions and sources. Projection figures and inventory figures for 2001 (the last year for which inventory data were available) were consistent. Projections of emissions from bunker fuels and removals from LUCF were also reported. Aggregated national emissions expressed in CO_2 equivalent using the GWP were presented by gas and by sector.

115. The review team noted that some sensitivity analysis was performed but results were not discussed in the NC3. The emission figures in tables were complete but graphical representation of emissions trends was missing. No quantitative estimates were provided on the aggregated effect of policies and measures, although some elements of information on such estimates are available (paragraphs 46 and 47). This resulted in reporting of only a “with measures” scenario, whereas the UNFCCC guidelines provide that Parties may report also a “without measures” and a “with additional measures” scenario. Also, it was not clear from the NC3 how policies and measures were considered in the scenario and how overlaps and synergies in policies were handled. The review team encouraged Denmark to adhere more strictly to the UNFCCC guidelines when reporting on projections.

B. Scenarios, models and assumptions underlying future emission trends

116. ***Scenarios:*** The scenario reported in the NC3 encompasses the effect of all implemented policies and measures. The review team noted that a “without measures” scenario would have been useful in outlining the relative contribution of policies in mitigating emissions. It also noted that in most cases little information was reported on the expected effect of individual policies and measures on emission trends. The review team was informed that such information would be available soon after a new scenario “without policy measures implemented since 1990” is finalized by the end of 2003. The review team further noted that a “with additional measures” scenario was not reported, as the Danish government was yet to decide how the emission deficit between the Kyoto target and the current “with measures” scenario will be split between domestic measures, and emissions trading and JI/CDM.

117. ***Methodology:*** Several sectoral energy models were used to prepare emission projections from energy use. This included bottom-up models for the residential sector based on drivers such as numbers of households, and numbers of appliances and their energy intensity. It included also a macroeconomic model, EMMA, to project energy demand in industry, commercial and public sectors, and agriculture. Along with the economic activities, this model considers technological improvements and energy prices. The Ministry of Transport VD model has been used to prepare projections of energy demand in transport. It is based, inter alia, on historic annual registration of cars, private consumption and vehicle cost. All models are also used to analyse domestic energy policies.

118. Forecasts of the electricity production and district heat production were prepared with the RAMSES model, which optimizes the operation of all electricity and district heating plants in Denmark. Although the current version of the model is not designed to consider the effects of electricity market liberalization, work has been undertaken by the Danish Energy Authority to remove this limitation. In contrast to EMMA, RAMSES allows for an explicit representation of existing and new technologies. The set of models used for the NC3 is different from the set used for the NC2, except that RAMSES was used for both. The other models used for the NC2 have been replaced by models which are believed to produce more robust projections.

119. The models for non-CO_2 GHGs from agriculture and waste were based on projections of activity data and relevant emission factors. The approach to projections of emissions from agriculture, waste and fluorinated gases and removals from LUCF is more advanced than in the NC2.

120. ***Assumptions underlying the future emission trends:*** A summary of the key project preparation assumptions from the NC2 and NC3 and comparison with actual developments is presented in table 13. In the NC3, GDP growth rate is projected to be 1.8 per cent annually on average between 2002 and 2017.

The expected growth is highest in the service sector and lowest in agriculture. The expected GDP growth is much lower than the average historical growth of 2.7 per cent between 1990 and 2000. This highly conservative expectation is underpinned in part by the current lower unemployment rates and ageing population, which leave small potential for labour growth as a factor of production.

Table 13. Comparison of actual growth or values of some key parameters for 1995–2000 and assumptions for these parameters for 2000–2010 in the NC2 and NC3[a]

	Actual development 1995–2000	NC3 assumptions	NC2 assumptions
Economic growth (GDP) (%/year)	2.7	1.8	1.8
Population (millions)	5.36	5.45	5.42
Final energy consumption (%/year)	1.6	1.1	–0.4
Primary energy consumption (%/year)	2	1.7	–0.8
World oil price (USD/barrel)	18	21	28
Exchange rate (USD/DKK)	6.6	7.5	6.5

[a] Both the NC2 and NC3 scenarios are "with measures" scenarios. However, the NC2 scenario is a "plan" scenario as it includes many policies that have been planned but not yet implemented.

121. The future fuel prices were mainly based on a recent IEA assumption that the oil price would drop to USD 21/bbl by 2005. For the Nordic electricity market, it was assumed that while the market structure and the number of participating countries would remain unchanged, market competition would lead to small margins for producers. The assumed Nordic market price of DKK 0.25/kWh for electricity was based on the long-term marginal cost of electricity from a gas-fired combined cycle plant.

122. As already noted, Denmark has large electricity import and export flows that rely heavily on hydro power and vary with fluctuations in precipitation in Norway and Sweden. It is assumed that Denmark will continue to be a net exporter of electricity between 2004 and 2017 (12 TWh per year) due to its excess power capacity, increasing demand for electricity in Norway and Sweden and the likelihood that little or no new power capacity can be installed in these countries (see paragraph 60 above).

123. At present, Denmark has an eastern and a western electricity grid. In October 2003 the Minister of Economy and Business Affairs announced that these grids will be connected. The effect from this connection is believed to be small and is likely to be considered in the next energy projections.

124. Electricity from renewables and CHP used to have priority access to the grid, but this policy was abolished in 2003. This change was not envisaged to affect the annual utilization rate of CHP or coal-fired power plants. The CO_2 quota system was expected to continue until the end of 2003, with little impact on emission levels (see paragraphs 62 and 63 above).

125. The NC3 did not elaborate on how technological progress is considered in the projections, except for some specific cases. For offshore wind energy, for example, technological progress was not considered to be fast enough to make investments in offshore wind energy cost-effective. A maximum equivalent subsidy of DKK 120/tonne CO_2 for electricity production from new wind turbines was assumed.

126. The effects of the implementation of the EU ETS, which constitutes an important element of the Danish strategy to limit emissions, were not considered as it had not yet entered into force in 2002 when projections were prepared and the details on allocation were not available. New policies to meet the EC target for national emission ceilings for air pollutants in 2010, including SO_2, mentioned in paragraph 45 above and their possible effect on energy use, in particular higher energy use in refineries, and GHG emissions have not been considered explicitly.

127. In agriculture it was assumed that, in line with the historical trend, the cattle population would decrease further, pig production would increase by 1.5 per cent annually and agricultural area would decrease by 0.3 per cent annually. A 46 per cent growth in anaerobic fermentation of animal manure was expected between 2000 and 2010.

C. Results of projections

128. ***Results:*** Denmark's total annual emissions have been estimated to grow from 69,300 Gg CO_2 equivalent in 2001 to 80,100 Gg CO_2 equivalent in 2008–2012 and fall slightly thereafter to 78,300 Gg CO_2 equivalent in 2013–2017 (table 14). Emissions of CO_2 were expected to grow from 54,300 Gg in 2001 to 65,600 Gg in 2012, a 21 per cent increase. In the same period CH_4 emissions were expected to fall from 5,600 to 5,000 Gg, while emissions of N_2O and fluorinated gases were expected to remain constant at 8,700 and 700 Gg CO_2 equivalent respectively (under the assumption that the existing Danish legislation on fluorinated gases is not replaced by EC-wide legislation in the future).

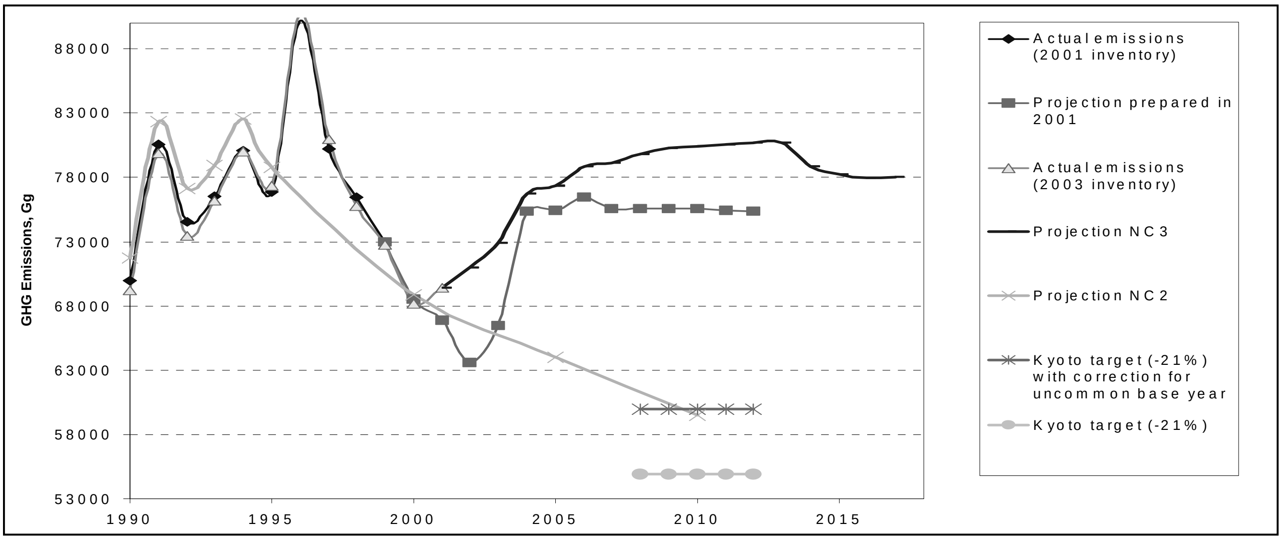
Table 14. Projections of emissions for 2010 in the NC3, NC2 and the Climate 2012 action plan (Gg CO_2 equivalent)

	NC3	NC2	Climate 2012
Emissions in 2010 for "with measures" scenario, including:	80 134	60 942[a]	63 600
Emissions of CO_2	*65 672*	*44 660*	*48 400*
Emissions of non-CO_2 gases	*14 462*	*16 282*[a]	*15 200*
Kyoto target of 21 per cent emission reduction	54 900	NA[b]	55 200
Deficit	25 234	NA	8 400
Kyoto target corrected for electricity imports 1990[c]	60 000	NA	
Deficit corrected for electricity imports 1990	20 134	1 800	3 400

[a] Emissions excluding fluorinated gases.
[b] NA in this table and in the other tables in this document stands for not available.
[c] The Danish Government has suggested to the EC that its Kyoto target should be corrected for a special situation in the base year 1990 when electricity imports were high, as in most years Denmark is an exporter of electricity.

129. According to table 14 and figure 4, the Danish deficit is estimated at 25,000 Gg CO_2 equivalent. This is much larger than the deficit of 1,800 Gg estimated in the NC2. The increase in the deficit shown in this report comprised 5,000 Gg CO_2 equivalent from not adjusting the base year 1990 emissions and 9,900 Gg from emissions associated from projected electricity export in 2008–2012. The rest came from recalculation of the base year emissions (2,400 Gg) and from higher levels of energy-related CO_2 emissions projected from the transport, industry and service sectors.

Figure 4. Projections of total GHG emissions and Denmark's Kyoto target in the NC3



130. The Danish government intends to fill the emission deficit by a mix of additional domestic measures, the EU ETS, and JI/CDM. In 2003, the relative contributions of these policy options was yet to be decided. Within the EC the Danish government has requested the emission target to be corrected by 5,000 Gg to account for the high net import of electricity in 1990, but as of 2003 a clear decision on this issue was yet to be made.

131. The main reason for the differences between the projections in the NC2 and NC3 is the philosophy behind them. The NC2 was a "plan" projection, including many policies and measures not

yet implemented, whereas the NC3 projection is "business as usual" with existing measures. This is one reason why electricity and heat demand in 2010 are projected to be higher in the NC3 than in the NC2, by around 30 and 25 per cent respectively. Together with the 10,000 Gg CO_2 coming from electricity exports in 2010 in the NC3 projections, this explains the differences in CO_2 from energy.

132. When the NC2 was released, liberalization of the electricity market had not yet begun. The NC2 gave the impression that the Danish government expected to direct development in the energy sector in a manner that would drastically reduce CO_2 emissions. However, in the liberalized electricity market it has become difficult to influence the fuel mix and energy demand through governmental interventions.

133. The clear message from the NC3 is that emissions from the energy sector will grow. This was reflected in the projected 20 per cent increase in CO_2 emissions over the next decade, although these emissions had remained broadly constant over the last decade despite the significant growth in energy consumption and electricity exports. The largest increase is expected to occur in the energy production sector: it is projected that electricity produced from carbon-intensive fuels will grow substantially, while electricity production from renewables and CHP will remain broadly constant. Part of the increase in CO_2 emissions was expected to come from increased energy use in industry, transport and production of natural gas and oil discussed in section D below. The trend in CH_4 emissions was about the same as in the NC2, defined largely by the slight decrease in CH_4 emissions from agriculture.

134. ***Consistency between projections 1995–2000 and actual developments:*** According to the NC2, CO_2 projections were expected to decrease between 1995 and 2000 and reach a level of 53,000 Gg CO_2. The actual emissions level in 2000 (52,800 Gg CO_2) was well in line. This is remarkable, since actual GDP growth of 2.7 per cent annually was well above the 2.2 per cent projected in the NC2. Apparently, most GDP growth did not occur in energy-intensive sectors. The electricity exports did not influence the CO_2 emission level for 2000, as the balance of electricity imports and exports in 2000 was almost zero.

135. ***Uncertainty levels of projections and sensitivity to key variables:*** The sensitivity analysis of the assumptions on key variables suggests the following changes in CO_2 projections (excluding effects on the transport sector): (a) 1 per cent higher economic growth leads to +1.5 Mt CO_2 and 1 per cent lower economic growth leads to –1.4 Mt CO_2; (b) higher oil price (USD 30 per barrel) and dollar exchange rate (8.0) lead to –2.5 Mt CO_2, and lower oil price (USD 15 per barrel) and dollar exchange rate (6.5) lead to +2.5 Mt CO_2; (c) lower electricity price on the Nordic market (DKK 0.171/kWh) leads to –1.9 Mt CO_2. The review team noted a fairly narrow uncertainty range of only a few per cent, some limitations of the sensitivity analysis and the possibility for the uncertainty range to be wider than estimated.

136. The review team noted that the assumptions on economic growth could be "conservative", given that the historical growth figures were much higher. In addition, the projected growth of CO_2 emissions from passenger cars could be relatively low, because it is assumed that the EC agreement with car manufacturers covenant for CO_2 reduction in 2005 compared to 1995 (ACEA agreement) would result in an average CO_2 emission of 140 g/km for newly sold vehicles. The agreement requires the automobile industry to supply fuel-efficient vehicles but consumers need incentives to buy these. It is not clear at present whether the existing transport policies, e.g. taxes on car ownership and registration, and energy tax will provide sufficient incentives for their purchase.

137. The overall uncertainty of the projection of emissions from energy use and its impact on Denmark's ability to reach its Kyoto target is reduced by the choice of implementing quotas on energy-intensive industries and the energy industry. No further changes in policies were planned in 2003, but an interim review in the light of the actual development was envisaged in 2006. Notwithstanding all these uncertainties, the review team considers the overall emission projections to be plausible at the time they were prepared.

D. Projections by sector and estimated effect of policies and measures

138. Emissions from the ***energy sector*** were expected to grow from 26,375 Gg in 2001 to 35,400 Gg in 2010 and then slightly decline to 32,986 Gg in 2015. The TPES was expected to grow by 1.7 per cent

annually. The emissions growth until 2010 was strongly dominated by emissions from electricity production with power plants fired by coal and waste. As noted earlier this growth is possible because there is excess capacity in coal-based electricity and the possibility for export. Also, this growth is partly driven by the increase in domestic electricity demand, which is projected to grow by 11 per cent between 2002 and 2010. At the same time, production of electricity and heat from CHP is expected to remain constant between 2002 and 2010. Emissions of CO_2 from oil and gas production were expected to increase by around 30 per cent between 2002 and 2010 due to higher production of natural gas.

139. Denmark is a leading country in terms of electricity produced from ***wind power*** (11 per cent of the mix). In the projections wind-based electricity production was expected to grow slightly until 2004 and decrease slightly thereafter. New concessions for offshore wind energy would be put out to tender, but the maximum price that the government considered paying (DKK 0.36/kWh) seemed to be too low to stimulate new offshore wind energy. After 2004, some existing onshore wind projects would be taken out of operation at the end of their lifetime. New wind turbines were expected to be commissioned only at sites with the best wind conditions. Renewable electricity production from biomass and waste was expected to increase. Denmark was expected to achieve its indicative EC target for the minimum share of electricity from renewables. The electricity mix in 2010 was expected to be approximately 44 per cent coal, 23 per cent gas, 14 per cent wind power, 10 per cent wood/straw/waste and 10 per cent oil products.

140. GHG emissions from ***transport*** were projected to grow from 12,540 Gg CO_2 equivalent in 2001 to 14,446 Gg CO_2 equivalent in 2010 and 14,851 Gg in 2015. This amounts to 1.5 per cent annual growth between 2002 and 2010 and is driven by the growth of transport activity leading to growth in the number of vehicles and the average distance travelled per vehicle. Around 95 per cent of emissions were expected to come from road transport. The effect of policies and measures to increase efficiency has not been estimated explicitly, but the objective of the ACEA agreement (see paragraph 133 above) was expected to be met. The further market penetration of catalysts will lead to an increase in N_2O emissions from transport from 393 Gg CO_2 equivalent in 2001 to 652 Gg in 2010. The projected emissions for transport in 2010 are 4 per cent higher than the projected levels in *Climate 2012* and significantly higher than the levels in the NC2, where planned measures were considered along with implemented ones.

141. Compared with the projection of *Climate 2012*, energy consumption in the ***manufacturing and commercial sectors*** has been revised upward. It was projected to grow by 2.0 and 2.2 per cent annually, respectively, between 2002 and 2010. Despite assumed economic growth being lower than the actual growth before 2000, energy consumption was expected to grow faster than before. This could be a result of the discontinuation of incentives for energy saving in industry, and lower energy and carbon taxes in real terms.

142. In contrast, energy consumption in the ***household sector*** was estimated to remain constant. This may be due to more stringent tax levels and efficiency standards than in other sectors. It may also be due to the different modelling approach that was applied for the analysis of energy use in the household sector, which explicitly takes concrete energy efficiency measures into account.

143. Between 2001 and 2010, emissions of N_2O and CH_4 from ***agriculture*** were expected to drop slightly, from 7,918 to 7,553 Gg CO_2 and from 3,632 to 3,199 Gg CO_2 equivalent respectively, and stabilize thereafter. The continued decline in the number of cattle was the main driver for the expected trend of CH_4 emissions. The expected drop in N_2O emissions was, in part, an extension into the future of the impact from the *Action Plans for Aquatic Environment I* and *II*. These were assumed to be fully implemented in 2003, with resulting constant levels in fertilizer and manure use thereafter. Since publication of the NC3, new projections for agriculture have been prepared. They suggest significantly lower N_2O emission levels than in the NC3, amounting to 6,120 Gg CO_2 equivalent in 2010, while the projected CH_4 emissions in 2010 (3,720 Gg CO_2 equivalent) are higher than in the NC3. The differences in projections stemmed, in part, from improved methodologies for estimating emissions and from revised estimates on organic farming, from 220,000 ha in the NC3 to 130,000 ha recently.

144. The growth of ***fluorinated gases*** was expected to slow down and the emission trend to be reversed as a result of the tax thereon and their phasing out. Between 2008 and 2012 emissions would decline to the 2003 level. Without measures, emissions were expected to more than double for the same period. The effect was estimated to be more than 700 Gg CO_2 equivalent annually in 2010. The socio-economic cost of the tax and phasing out were estimated at DKK 250/tonne CO_2 equivalent. Emissions from ***waste*** were expected to continue to decrease, reflecting the effect of the ban on landfilling of combustible waste and the ageing of landfills.

145. ***Afforestation*** was expected to continue at the same pace as in the 1990s, i.e. around 2,500 ha per year, subject to budget availability for purchase of land to be afforested.

V. VULNERABILITY ASSESSMENT, CLIMATE CHANGE IMPACTS AND ADAPTATION MEASURES

146. ***Institutional framework and compliance with the guidelines:*** Assessment of impacts, vulnerability and possibilities for adaptation were undertaken by a number of institutions including the Climate Centre of the Danish Meteorological Institute (DMI), the NERI, the Risø National Laboratory, the DFLRI and the Danish Institute of Agricultural Sciences.

147. ***Overall assessment:*** Denmark has carried out a qualitative assessment of the socio-economic impacts of climate change, in parallel with a scenario approach described in the NC2. The DMI's Climate Centre has completed its work on global climate scenarios and scenarios for Europe and the Arctic region. The NERI and Risø National Laboratory coordinated studies on impacts and adaptation options. A prominent activity included assessment of the impact on fragile ecosystems (from precipitation changes, CO_2 fertilization and species invasion) and changes in the thermocline and its impact on forests, degradation of the coastline and coastal management.

148. ***Impact assessment:*** The NC3 provides new information on climate scenarios compared to the NC2. The projected increase in temperature was expected to be 3–5 ºC. The overall impact from climate change was expected to be modest. However, hotter and drier summers were expected to lead to an increased demand for water for domestic resources and irrigation, and also for natural ecosystems and the maintenance of wetlands. A small increase in storm activities was also expected and a 5–10 per cent increase in the maximum storm surge level. Within the agriculture sector there could be further decline in the productivity of dairy cattle, pigs and grain. High temperatures could also increase the risk of pests and plant diseases. Some decline in Norway spruce was expected, but higher temperatures would favour the regeneration of the indigenous, better adapted tree species. A warmer climate could also lead to invasions of vector-borne diseases, and increased risk of photochemical air pollution.

149. Studies confirmed that climate change would have an impact on the fragile ecosystems of Greenland and the Faroe Islands. There would be an increased risk to the reproductive capacity of some endangered species, including polar bears and Arctic birds, and more plant growth on areas previously under permafrost. However, increased melting of the ice cap would provide more water and the cost of heating in winter would be reduced. Quantitative assessment of the impacts of climate change on water resources using climate models were also undertaken.

150. ***Adaptation***: Specific adaptation measures considered at the time of the NC2 included coastal protection (dyke maintenance), agriculture crop development and afforestation using mixed forest (replacing Norway spruce by oak and beech). The forestry sector has already included some elements of adaptation in its new strategy. Since December 1999, new planting of species other than Norway spruce has become more widespread. No other adaptation measures have been developed since then.

VI. FINANCIAL RESOURCES AND TRANSFER OF TECHNOLOGY

151. ***Institutional framework and compliance with the guidelines:*** The Ministry for Foreign Affairs coordinates activities related to financial assistance and technology transfer. The review team was

informed of the ongoing reorganization that would involve decentralization of these activities. It noted the transparent reporting in the NC3 on financial resources and transfer of technology.

152. ***"New and additional" funding:*** Denmark reported new and additional funding through bilateral channels, e.g. the Environment, Peace and Stability Facility (MIFRESTA) and multilateral channels, e.g. through the EC, the United Nations and the Least Developed Countries Fund. In 2001, Danish bilateral and regional assistance on climate-related activities stood at DKK 415 million.

153. Denmark's contribution to the ***official development assistance (ODA)*** amounted to almost 1 per cent of GNP in 2002. The focus of the ODA is on poverty alleviation. Around 16 per cent of the ODA, DKK 1.7 billion in 2002, was allocated for projects on the environment, climate change and mitigating the effects of natural disasters. The ODA is expected to decline to about 0.9 per cent of GNP between 2004 and 2008. Denmark would still remain among the few developed countries to attain the indicative ODA target of 0.7 per cent of GNP.

154. ***Assistance to vulnerable developing countries:*** Denmark provides assistance to small island developing States (SIDS), which are particularly vulnerable to climate changes, and support for capacity-building through the United Nations Environment Programme (UNEP) on renewable energy projects.

155. ***Technology transfer:*** For 2004–2008 the government has allocated DKK 1 billion for JI/CDM projects, to be managed by the Ministry of Foreign Affairs and the Ministry of Environment respectively. The intention is for the government to play only a catalytic role and involve the private sector in these projects. The government also supported technology transfer activities, e.g. in Egypt and Malaysia.

156. In addition to the Government's assistance programme, the ***private sector*** in Denmark uses a number of assistance instruments and measures, such as mixed credits, totalling DKK 3.6 billion during 1997–2001, and through the Private Sector Programme with more than DKK 137 million in 2001. Around 20 per cent of these mixed credits were used to support renewable energy projects and another 40 per cent for energy efficiency and coal projects.

157. ***Assistance to economies in transition:*** From 1991 to 2003, support for 11 countries with economies in transition was provided through the environmental assistance programme. The support amounted to DKK 500 million and centred on energy projects, including geothermal district heating and biogas for energy. The overall effect was estimated at about 750 Gg CO_2 saved annually. In 2003–2004, DKK 700 million was provided for environmental projects, including DKK 130 million for activities implemented jointly (AIJ).

VII. RESEARCH AND SYSTEMATIC OBSERVATION

158. ***Institutional framework:*** Information on research reported in the NC3 is underpinned by the results of a mapping exercise conducted by the DEPA in 2002 as a follow-up to *Climate 2012*, aiming at identifying all relevant activities and possibilities for improved coordination among institutions. Several institutions are involved in research and systematic observation, including the DMI, the NERI, the Risø National Laboratory and several universities. In 2001 alone, DKK 379 million was provided for energy-related research, including mitigation, and DKK 114 million for basic climate and climate-related research, including impacts and adaptation.

159. ***Research:*** The DMI is the main institution in Denmark in the field of climate change research. Its activities range from studies on climate processes to climate modelling and studies of future climate. For many of these studies the DMI uses its global model (*The Danish Climate Model*) and a regional climate model. Three large European research projects with participation of the DMI were expected to bring together expertise from across Europe in the field of climate modelling: Prediction of Regional Scenarios and Uncertainties for Defining European Climate Change Risks and Effects (PRUDENCE, coordinated by DMI), Statistical and Regional dynamical Downscaling of Extremes for European Regions (STARDEX), and Modelling the Impact of Climate Change (MICE) aimed at exploring future

changes in extreme events (floods, droughts, heat waves) in response to global warming. The Ministry of Agriculture used climate scenarios from the climate assessment as an input to its research. Finally, an initial consideration of climate change has been made for water resource management.

160. Denmark contributes to a large number of international research projects such as the Arctic Climate System Study (ACSYS), Climate Variability and Predictability (CLIVAR) and Stratospheric Processes and their Role in Climate (SPARC). A special area of expertise of the DMI is the use of a nested climate modelling approach that enabled Denmark to improve model resolution from 250 km to 25 km or even finer resolution to better assess possible impacts from climate change. Other research activities focus on economic research, including evaluation of climate change and possibilities for mitigation, and on mitigation and adaptation technologies.

161. ***Systematic observation:*** Denmark has a well-maintained network of stations for systematic observations, mainly within the programmes of the World Meteorological Organization, including in situ and space-based observations. They cover atmospheric (including stratospheric) and oceanic observations carried out by the DMI, the NERI and the Royal Danish Administration for Navigation and Hydrography. This network provides a solid basis for supporting technical research and socio-economic analyses. It is automated and adequate, but one station may have to be closed due to resource constrains.

162. ***Implementation of Article 5 of the UNFCCC:*** Denmark, in particular the DMI, supported capacity-building in developing countries in areas of climate change, including on establishing of the observational networks, on adaptation and on development and implementation of mitigation options for forestry, energy, agriculture and industry. Between 1997 and 2001 capacity-building for adaptation assessment was a major area of support. In 2001 alone, about DKK 114 million was set aside for such support for developing countries.

VIII. EDUCATION, TRAINING AND PUBLIC AWARENESS

163. ***Institutional framework:*** The DEPA played a major role in activities relating to education, training and public awareness. Other players include ministries, universities, private sector and research institutes; in particular the DMI, which communicates the latest climate change news to the general public. The review team noted with appreciation the book *Climate Change Research: Danish Contribution*, published by the DMI and the Ministry of Transport and comprising scientific and policy-related information on climate change, aimed at Danish society as a whole.

164. ***Education and training:*** Educational materials on climate change have been developed by governmental agencies and NGOs for specific age groups, and made available on the Internet for use by trainers and teachers. A curriculum on climate change for schools has yet to be prepared by the Ministry of Education. The review team acknowledged the Copenhagen Global Change Initiative, which provides for cooperation in training at doctoral level between the University of Copenhagen, DMI, GEUS and NERI. Also, a number of experts from developing countries, such as South Africa and Malaysia, have participated in training programmes offered by the Risø National Laboratory.

165. ***Public awareness and participation:*** Denmark has a long tradition of involving the general public in political decisions, and there has been a high demand for climate and environment information. The Ministry of Environment and the Ministry of Health have been involved in informing the public and in the development of a series of public awareness programmes and campaigns. Campaigns such as *We Cycle to Work* and *Environmental Traffic Week* enjoyed vast public participation. The *Climate Days* initiative organized by the DMI draws public attention to climate change issues and helps to stimulate collaboration on research. The industrial NGOs launched a day on climate change and provided information on the initiative in the business sector on JI, CDM and emissions trading. In 2003, the DEPA conducted a survey on public perceptions of climate change. The outcome of the survey was indicative of the Danish public's high awareness of the danger of climate change and willingness to support actions at the national and international level, which sets a solid foundation for climate policies.

IX. CONCLUSIONS

166. The review team did not identify any major gaps in the NC3 and concluded that Denmark conformed with the UNFCCC reporting guidelines. Compared to the previous national communications, the NC3 contained more detailed information on Greenland and the Faroe Islands. The recent changes in Denmark's climate strategy, giving more prominence to economic efficiency while meeting climate change objectives, have been transparently reflected in the NC3. However, there was some lack of information on the progress to date of the policies implemented before 2003, and on monitoring and evaluation of policy performance. Also, the NC3 did not contain information on policies and measures that have been discontinued or have a potential negative effect on emissions. Information on GHG inventories, projections and other issues required by the UNFCCC guidelines was presented in a comprehensive way. Some suggestions for improving reporting on projections are contained in the relevant section of this report.

167. Over the past decade, Denmark has been at the forefront of climate change mitigation efforts and has made an ambitious effort to arrest emission growth. Achieving stabilization of GHG emissions in 2000 at their 1990 levels, one of the aims of the UNFCCC, was a clear result of this effort. This achievement was underpinned by successful integration of climate change considerations in sectoral policies, notably energy policies. It was also underpinned by considerable efficiency improvements all along the energy supply chain and changes within the fuel supply mix away from coal towards natural gas and renewables, being driven to a large extent by high energy prices in the early 1980s and dependency on energy imports. These improvements were particularly visible in energy end-use sectors, but also in energy supply, e.g. CHP. A diverse portfolio of policies and measures with an emphasis on economic instruments has been implemented that covers all emissions and sources. Denmark was among the first countries to introduce new and innovative policies such as carbon and energy taxes, taxes and bans on fluorinated gases, as well as tradable CO_2 allowances.

168. Ambitious targets for energy efficiency, and rigorous monitoring and evaluation of the support schemes and programmes to ensure that targets are met, were essential for the continuing decoupling of energy demand from economic growth initiated in the 1980s. Support for CHP has also been an essential element of the Danish strategy to reduce emissions. Similarly, support for promoting renewable energy, wind in particular, with a large increase of the share of renewables from 3.2 per cent in 1990 to 20 per cent in 2002, has been another integral element of this strategy. Altogether this has led to decarbonization of the economy, while Denmark continued to enjoy one of the highest economic growth rates among the EC countries.

169. Since 2001, the strategic energy and climate change policy approach has changed radically, from strong government intervention towards a more market-based approach driven by cost-efficiency principles. This was reflected in the 2003 Climate Strategy, which introduced a stringent cost-efficiency criterion in selecting domestic policies. This change of approach is likely to increasingly shift from achieving emission reductions through domestic policies to purchasing and acquiring emission reduction credits abroad, through the EU ETS, JI and CDM. Within the domestic policy context this approach is likely to increasingly shift from government-led decision-making on all GHG reducing measures to decentralized decision-making in companies covered by the EU ETS. In addition to the EU ETS, domestic policy will aim at cost-effective emission reductions of both CO_2 and non-CO_2 gases.

170. This policy change and the move to a more market-based regime has brought some uncertainty in regard to the future development of technologies which benefited from strong governmental support before 2001, such as CHP and renewable energy, notwithstanding the fact that support for research and development for some of them, e.g. windpower and biomass, has been maintained. On the other hand, the impact from the Danish electricity exports in the Nordic electricity market on emission levels might become less uncertain with the provisions of the EU ETS covering the electricity sector between 2008 and 2012, including electricity exports. Altogether, monitoring of emission levels appears critical, especially on the part of sources not covered by the EU ETS, with a view to taking corrective actions if necessary.

171. The review team noted that the 2003 Climate Strategy focuses only on the first commitment period of the Kyoto Protocol. The review team encouraged Denmark to elaborate further details of its climate strategy in the broader context of the significant long-term emission reductions that may appear necessary for effective climate mitigation.

172. The review team acknowledged with appreciation the contribution of Denmark to international cooperation on climate change by providing developing countries with extensive technical and financial support as well as support for capacity-building to address all relevant areas of climate change. It also acknowledged the contribution of Danish scientists to advancing the scientific understanding of climate change through research and systematic observations, and endeavouring to disseminate the results from this research. The review team noted that public awareness of climate change and its effects is high in Denmark, which ensures a solid foundation and support for climate change policies.

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