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**UNITED KINGDOM OF GREAT BRITAIN  
AND NORTHERN IRELAND**

Report on the in-depth review of the second national communication  
of the United Kingdom

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## I. INTRODUCTION AND NATIONAL CIRCUMSTANCES

1. The secretariat received the United Kingdom's *Second Report under the Framework Convention on Climate Change*, further referred to as the NC2, on 13 February 1997. An in-depth review of the NC2 was carried out between October 1998 and October 1999, including a visit to London from 7 to 11 December 1998. The review team consisted of Ms. Patricia Ramirez (Costa Rica), Dr. Natalya Parasyuk (Ukraine), Dr. Yasuko Kawashima (Japan), Ms. Jane Ellis (Organisation for Economic Co-operation and Development)(OECD) and Dr. Katia Simeonova (UNFCCC secretariat, coordinator).
2. The territory of the United Kingdom covers 24.3 million hectares (ha) and the climate is variable, cool, moist, temperate and maritime. In 1996, the population was 58.8 million and has been growing at a rate of 0.3 per cent annually during the last decade. The United Kingdom suffered a recession in the early 1990s, when the growth in gross domestic product (GDP) fell from 5 per cent in 1990 to a negative rate of 1 per cent in 1993. The economy regained momentum thereafter, steadily growing by approximately 2 to 4.2 per cent annually to 1997. Growth is expected to continue in the short to medium term, in line with that of the country's main trading partners, such as Germany, France, the Netherlands and the United States. Historically, the United Kingdom has been a major industrialized nation. Major export goods are machinery, chemicals and petrochemicals, automobiles and food products. However, the discovery of oil and gas in the North Sea, and the resultant increase in the exchange rate led to a significant shift away from manufacturing in the 1980s and 1990s, and now services are of much greater importance. London is a major financial centre, with banking and insurance playing a significant role in the United Kingdom economy. The United Kingdom took the lead in privatization of, *inter alia*, gas, coal, electricity, nuclear energy, water, telecommunication, railways and the main bus services which resulted in that the contribution of the public sector to GDP to become less important.
3. United Kingdom energy policy has changed dramatically under the influence of liberalization and privatization. In the 1990s, gas became the fuel of choice for power generation and took an increasing share in the industrial, commercial and residential sectors. Coal mining, which had played a significant role until the 1970s, declined mainly as a result of increasing use of natural gas for electricity generation following privatization. These changes resulted in a reduction of carbon dioxide (CO<sub>2</sub>) emissions, but they made little change to the energy consumption trend. While the total primary energy supply (TPES) increased by 5.4 per cent from 213.1 million tonnes oil equivalent (Mtoe) in 1990 to 234.7 Mtoe in 1996, TPES per unit of GDP remained at the same level as in 1990. In terms of final energy consumption, the growth occurred in the residential, commercial, public and agricultural sectors, with an overall increase of 18 per cent in the 1990-1996 period, while energy consumption in industry and transport grew at a much slower pace, by 8.4 and 7.3 per cent, respectively. In terms of the contribution to TPES, in 1996, oil and oil products accounted for 36.5 per cent, followed by natural gas 32.3 per cent, coal and coke 19.4 per cent and nuclear 10.5 per cent. In the United Kingdom, hydropower generation is geographically limited, and other renewables, such as wind and biomass, only contributed 0.1 per cent of TPES in 1996.

4. United Kingdom climate policy is developed through an inter-agency consultation process with active participation of several government departments. The Department of the Environment, Transport and the Regions (DETR) is responsible for overall policy on climate change. The DETR, the Department of Trade and Industry (DTI), the Ministry of Agriculture, Fisheries and Food (MAFF), the Overseas Development Administration (Department for International Development, DFID after 1997), the Scottish Executive, the National Assembly for Wales, the Department for Environment for Northern Ireland, the Forestry Commission and Her Majesty's Treasury assumed responsibility for implementing the majority of climate change policies within their respective fields of competence. The DETR led the preparation of both the NC1 and the NC2 in close cooperation with other departments. The business and environmental non-governmental organizations (NGOs) also took part in this process, but they felt that their participation in the NC2 was less formally structured than in the case of the NC1. The United Kingdom does not feel the need for a national climate change committee, but a number of governmental, scientific and business committees serve as forums to discuss climate policy, to facilitate the consultation process and to support implementation.

5. Whilst central government coordinates United Kingdom policies consistent with international and European agreements, recently local governments have been more involved in climate change policy, *inter alia* related to waste management and transport, following the recent Integrated Transport White Paper. As climate policy evolved, more active participation of major stakeholders, such as businesses, NGOs, trade unions and the public, has been ensured through the consultation process, seminars and information campaigns. The 1998 *Marshall Report: Economic Instruments and the Business Use of Energy* was a good example of cooperation between the Government and business, with the latter taking the lead in exploring innovative options for greenhouse gas (GHG) mitigation. With respect to the European Community (EC), there are several policy areas where the United Kingdom is seeking substantial progress, examples being energy efficiency agreements, renewable energy policy, aviation fuel taxation, and a strategy to reduce hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF<sub>6</sub>) emissions.

6. To initiate the consultation process with stakeholders, the United Kingdom Government prepares consultation papers outlining the main problems and targets to be achieved, leaving open possible options to solve these problems. After the NC2 was submitted to the UNFCCC secretariat, the new Government, which took over in May 1997, published in October 1998 a consultation paper: *United Kingdom Climate Change Programme*, referred to below as the recent consultation paper, which aims to stimulate national debate on how the United Kingdom will achieve the targets of the Kyoto Protocol and move towards its domestic goal.

7. The commitment of the United Kingdom under the UNFCCC to return GHG emissions to 1990 levels by 2000 was initially presented in the NC1 and reiterated in the NC2. Additionally, in line with the EC burden-sharing agreement, the United Kingdom agreed to reduce by 12.5 per cent its emissions of all six greenhouse gases covered by the Kyoto Protocol for the 2008-2012 period. A detailed analysis of the historical GHG emissions, together with the effects of policies and measures in place and projections, clearly indicates that the United Kingdom will not only

meet its 2000 target, but go beyond it: its CO<sub>2</sub> emissions are expected to be at least 4-8 per cent lower than 1990 emissions in 2000. Furthermore, methane (CH<sub>4</sub>) emissions are expected to be 22 per cent lower and nitrous oxide (N<sub>2</sub>O) emissions 62 per cent lower. Hence, the United Kingdom ranks among the few Annex II Parties to achieve the aim of the UNFCCC. Moreover, the Government established a domestic goal to reduce emissions of CO<sub>2</sub> by 20 per cent by 2010 compared to 1990, as set out in its programme. This will be challenging to achieve, as the potential for fuel switching from coal to natural gas will be considerably reduced, the oldest nuclear units will retire and it is highly uncertain how they will be replaced. Moreover, it will be difficult to moderate the growth of energy demand and related emissions in many sectors, including transport.

8. The information presented in the NC2 is comprehensive and consistent, and reflects adequately United Kingdom climate change policy. While most of the information required by the UNFCCC guidelines is presented in the NC2, the presentation does not follow the guidelines strictly.

## II. INVENTORY OF ANTHROPOGENIC EMISSIONS AND REMOVALS

9. The United Kingdom inventory presented in the NC2 for 1990-1994 comprehensively covers emissions by source and removals by sinks. It includes emissions of the direct GHGs such as CO<sub>2</sub>, CH<sub>4</sub> and N<sub>2</sub>O, emissions of indirect GHGs, or precursors, such as nitrogen oxides (NO<sub>x</sub>), carbon monoxide (CO), non-methane volatile organic compounds (NMVOCs) and sulphur dioxide (SO<sub>2</sub>), emissions of the new gases, such as HFCs, PFCs and SF<sub>6</sub>, and carbon sinks. The team found that the results of the GHG inventory reported in the NC2 were well documented in a report, the *United Kingdom Greenhouse Gas Inventory, 1990 to 1994*. Additionally, the team was provided with the most recent GHG inventory for the period 1990-1996, which has also been submitted to the UNFCCC secretariat, referred to in this document as the recent submission. Most of the analysis is based on it. The United Kingdom GHG inventory respected the UNFCCC guidelines, being based on the Intergovernmental Panel on Climate Change (IPCC) Guidelines for National Greenhouse Gas Inventories. Moreover, while the GHG emissions inventory reported in the NC2 followed the 1995 IPCC Guidelines, the recent inventory submission conformed to the 1996 Revised IPCC Guidelines.

10. The responsibility for coordinating work on the GHG inventory lay with the DETR, while the compilation and publishing of the inventory was done by the National Environmental Technology Centre (NETCEN). NETCEN prepares the United Kingdom National Atmospheric Emissions Inventory (NAEI), which is the major source of inventory data. The emission sources not covered by the NAEI, such as land-use change and forestry and agriculture, are estimated by the Institute of Terrestrial Ecology and MAFF. Linkages between the different institutions involved in the inventory are well established, allowing the inventory to be developed, reviewed and reported on an annual basis. After reviewing the institutional arrangement, the team concluded that the United Kingdom has a good national system to produce GHG inventories of high quality.

11. The NAEI methodology used for the United Kingdom GHG inventory is broadly consistent with the IPCC bottom-up methodology. However, the NAEI fuel and source categories are slightly different from those of the IPCC. The correspondence between NAEI and IPCC is well documented and transparent. Several approaches were used to estimate the GHG emissions from different sources. The United Kingdom uses the carbon balance approach to estimate and allocate emissions from solid fuel transformation among different sources. A comprehensive model is used to estimate emissions from transport. This corresponds to the IPCC Tier 3 approach, accounts for fleet composition, and estimates emissions based on the fuel properties and a combination of performance-related emission factors and road traffic data. Emissions of CH<sub>4</sub> and N<sub>2</sub>O from agriculture are estimated according to the IPCC methodology. While most estimates are calculated by applying emission factors to activity data, some emission estimates are obtained from on-site measurements.

12. The energy-related CO<sub>2</sub> emissions are also calculated annually using the IPCC reference approach, thus offering a comparison with results from the inventory produced using a bottom-up approach, and serving as a self-verification of inventory results. The difference in the results is within the range of 1 to 4 per cent, which was explained by the use of different sets of statistics and methodology. In using the reference approach, one assumption worth mentioning is that the factor of carbon stored in lubricants was assumed to be 100 per cent, while in the inventory to be produced next year this factor will be only 40 per cent. In addition to the use of the reference approach, a project to establish an independent verification process was launched for direct ambient measurement of atmospheric fluxes and concentration at the country's borders.

13. Most of the activity data used for the GHG inventory come from official statistics. Activity data for fuel are taken from the *Digest of United Kingdom Energy Statistics*, which gives the fuel definitions and sector split used in the NAEI, and data on road traffic are taken from the DETR. Activity data for agriculture are published by MAFF annually using a census approach and data for land-use change and forestry are obtained from the forest inventory conducted every 10 years, the latest one dating from 1990, and annual data on new tree planting.

14. Emission factors used in the GHG inventory are predominantly specific to the United Kingdom, but some are from IPCC, CORINAIR and international sources. Emission factors for CO<sub>2</sub> emissions from coal and natural gas, for example, are those of British Coal and British Gas. All non-CO<sub>2</sub> emission factors for transport are calculated using experimental measurements. Emissions of N<sub>2</sub>O from nitric and adipic acid production are based on IPCC default emission factors and estimates of production and capacity provided by the Nitric Acid Association and DuPont. As for agriculture, emission factors for CH<sub>4</sub> and N<sub>2</sub>O were taken directly from the IPCC. Most of the country-specific emission factors used were published and peer-reviewed.

15. Emissions from international aviation and marine bunkers are estimated annually using the 1996 CORINAIR methodology and are not included in the national totals, in line with the IPCC guidelines. Activity data were taken from DTI statistics (inland deliveries of aviation fuel) with the assumption that domestic aviation accounts for 20 per cent of the total inland deliveries to air transport. In more recent inventories prepared after the NC2, estimates have been based on

DETR and DTI statistics, and default fuel consumption factors for aircraft. The more detailed calculation suggests that domestic aviation accounts for around 11 per cent of the total inland deliveries to the air transport.

16. A carbon accounting model was used for estimating removals by forest sink, which employs a method different from the standard IPCC one. It estimates the carbon uptake as the net change in volume of standing trees and litter, including leaves. The model considers the age structure, tree species composition and change in the wood and woody biomass products. To estimate the effect of historic land-use change on the net flux of carbon from soils in the United Kingdom, and to track loss and uptake of carbon on an annual basis, a simple exponential model of changes in soil carbon after change in use was applied.

17. Estimating uncertainties was mainly based on expert judgment and qualitative estimates suggested by the IPCC. Broadly, estimates of CO<sub>2</sub> emissions from energy and industrial processes were considered highly certain, with the exception of biomass, in contrast to the emission estimates from land-use change and forestry, and waste, which were regarded as highly uncertain. The confidence level of CH<sub>4</sub> emission estimates was medium to low, while that of N<sub>2</sub>O was low. Furthermore, in its 1998 report *Treatment of Uncertainties for National Estimates of Greenhouse Gas Emissions*, the United Kingdom provides a comprehensive review of different methods to assess uncertainties arising from its inventory methodology. This report facilitates a move to a more analytical approach and quantitative estimates<sup>1</sup>. The team was informed of several projects to reduce uncertainties, including studies on measurement and modelling of CH<sub>4</sub> emissions from landfills, on carbon from soils, on carbon losses from peat drainage, on modelling the effect of livestock diet and manure and livestock management on emissions, on N<sub>2</sub>O emissions from nitric acid production, on natural gas leakages and on emissions from offshore oil and gas systems.

18. The United Kingdom inventory included estimates of both actual and potential emissions of the new gases, including HFCs, PFCs and SF<sub>6</sub>. Estimates of potential emissions were based on the consumption data, while for the actual emissions different approaches were applied. This included use of the IPCC methodology and the country-specific emission factors for emissions of HFCs from refrigeration, use of operator data for anode effects to estimate PFC emissions from aluminium production, and use of United Kingdom methodology for the other sources.

19. The team noted the plans for future revisions and improvements of the GHG inventory, which, apart from the projects mentioned above, included new activity data for petroleum coke and updating of estimates of the new gases. Other activities included preparation of inventories for the four different parts of the country. Future improvements are also linked to the ongoing

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<sup>1</sup> The results obtained indicated that while the uncertainty of the annual emissions on a CO<sub>2</sub> equivalent basis was estimated at ±18.5 per cent, the uncertainty of the emission trend for 1990-2010 was estimated at 4 per cent with a confidence of 95 per cent. By source, the assessment of uncertainties led to the following results: ±1.5 per cent for energy and industrial sources, ±17.2 per cent for CH<sub>4</sub> sources, up to three times the estimated value for N<sub>2</sub>O sources and between ±8 and ±13 per cent for new gases sources.

elaborate research programme on methodological issues related to emissions and emission factors, with special attention given to the sectors and gases for which high quality information is still lacking, such as CO<sub>2</sub> emissions from vegetation and soils and from the national building stock, and industrial uses of the new gases.

20. The results obtained so far from this programme, new information from published literature, estimates from industry and improved statistics were used to produce the annual GHG inventories and to update the historical emissions trends. Hence, the United Kingdom has updated estimates of 1990 emissions given in the NC2, in the subsequent GHG inventories, and has produced more accurate and comprehensive inventories. Indeed, 1990 emissions, estimated at 791,000 Gg of CO<sub>2</sub> equivalent in the recent submission, are 5 per cent higher than reported in the NC2 and 11 per cent higher than in the NC1. The main factor for the revision of the 1990 inventory between the NC1 and the NC2 was the revision of estimates for land-use change and forestry and emissions from waste, while that between the NC2 and the recent submission was the revision of the N<sub>2</sub>O emissions from agricultural soils.

21. Total CO<sub>2</sub> emissions in the United Kingdom were 614,825 Gg in 1990 and declined by 3.5 per cent between 1990 and 1996. The trend was downward, although a slight increase occurred in 1996 due to the cold winter. It mirrored well a change of fuel mix, an increase in efficiency of energy supply as a result of new combined cycle gas turbines and combined heat and power (CHP) capacity commissioned in this period, and increased use of gas for heating. On a sectoral basis, emissions from small combustion and transport grew by 14 and 5 per cent, in contrast to the energy and transformation sector, where emissions dropped by 13 per cent. Energy and transformation remained the single most important source of emissions in 1996 with a share of 35 per cent, followed by small combustion and transport with almost equal shares of 23 and 22 per cent, industry 16 per cent, and other sources 4 per cent (table 1 and figure 1).

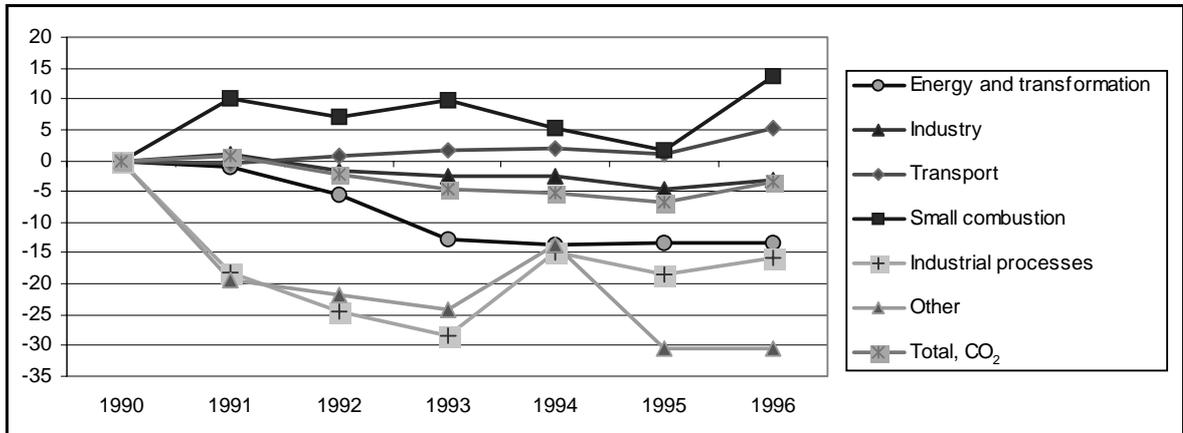
**Table 1. Carbon dioxide emissions by source, 1990 - 1996, (Gg)**

	1990	1991	1992	1993	1994	1995	1996
Energy and transformation	230 775	228 459	218 105	201 340	198 905	199 905	199 698
Industry	94 627	95 664	92 986	92 297	92 249	90 142	91 742
Transport	115 901	115 339	116 776	117 981	118 353	117 288	121 882
Small combustion	112 207	123 561	120 260	123 323	118 221	114 156	127 481
Industrial processes	13 916	11 395	10 500	9 976	11 836	11 344	11 703
Other	15 739	12 671	12 301	11 952	13 583	10 919	10 945
<b>Total CO<sub>2</sub></b>	<b>583 165</b>	<b>587 089</b>	<b>570 928</b>	<b>556 869</b>	<b>553 147</b>	<b>543 754</b>	<b>563 451</b>
LUCF emissions	31 660	31 745	31 502	30 524	30 355	30 300	29 971
LUCF removals	-11 453	-12 308	13 204	-14 169	-18 040	-18 826	-18 672

Notes: Other includes emissions from other energy combustion, fugitive emissions and waste.

LUCF = land-use change and forestry.

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

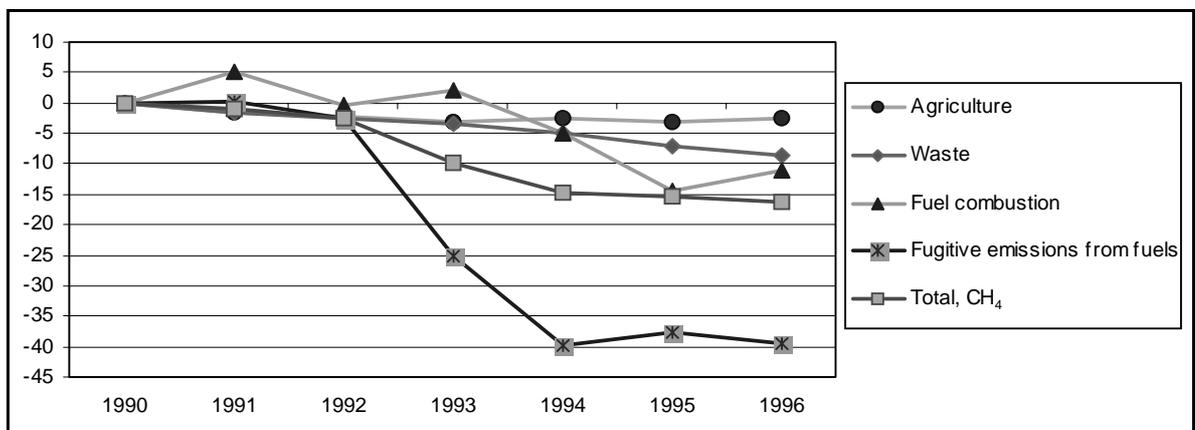


22. CH<sub>4</sub> emissions dropped by 16 per cent between 1990 and 1996, primarily because fugitive emissions slumped by 39 per cent as a result of coal mine closures. Emissions from waste dropped by 9 per cent. Emissions from agriculture fell slightly, driven by **decreases in livestock numbers**. Waste was the predominant source of CH<sub>4</sub> emissions in 1996, accounting for 47 per cent of the emissions, followed by agriculture with 29 per cent, fugitive emissions with 22 per cent and other sectors with 3 per cent (table 2 and figure 3).

Table 2. Methane emissions by source, 1990 - 1996, (Gg)

	1990	1991	1992	1993	1994	1995	1996
Agriculture	1 089.6	1 072.2	1 066	1 055.5	1 063.6	1 054	1 063.6
Waste	1 923	1 891	1 875	1 854	1 826	1 784	1 754
Fuel combustion	105.3	110.8	104.8	107.6	100.1	90	93.5
Fugitive emission from fuels	1 319.5	1 323	1 284.8	986.9	794.8	822.5	800
<b>Total CH<sub>4</sub></b>	<b>4 438</b>	<b>4 398</b>	<b>4 331</b>	<b>4 005</b>	<b>3 785</b>	<b>3 751</b>	<b>3 712</b>

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

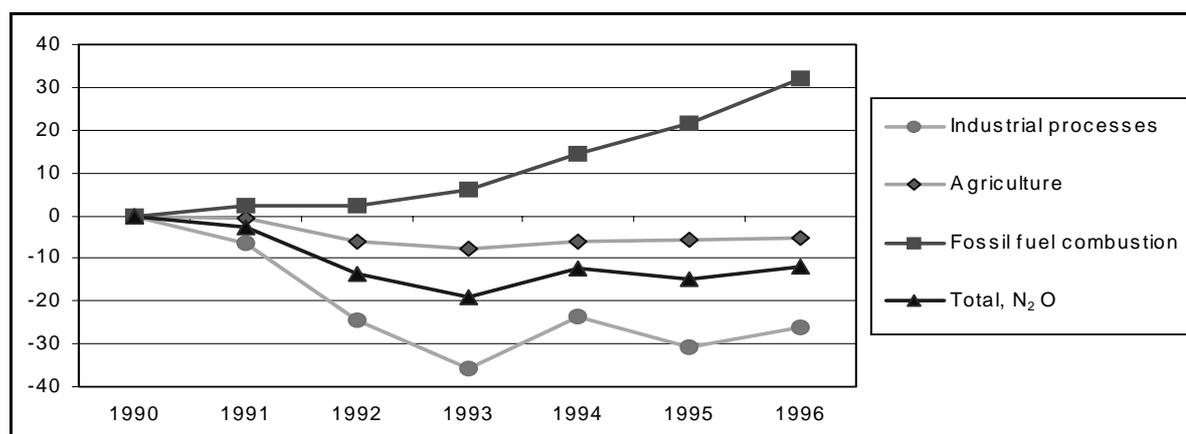


23. The 12 per cent decline in N<sub>2</sub>O emissions from 1990 to 1996 was a result of two conflicting trends, one of a decrease in emissions from industrial processes of 26 per cent and the other of an increase in emissions from fossil fuel combustion of 32 per cent due to increased use of gas. No clear trend in the emissions from agriculture was observed. As mentioned above, the major revision in the GHG emission inventory between the NC2 and the latest submission concerned the N<sub>2</sub>O estimates from agricultural soils, due to a change in methodology. This change multiplied these emissions by a factor of nearly 15: from 6.6 Gg to 98.35 Gg for 1990. This entailed also changes of the emission pattern, agriculture now being the major emission source with a share of emissions of 52 per cent, followed by industrial processes 37 per cent and fuel combustion 11 per cent (table 3 and figure 3).

**Table 3. Nitrous oxide emissions by source, 1990 - 1996, (Gg)**

	1990	1991	1992	1993	1994	1995	1996
Industrial processes	95.26	89.14	71.97	61.34	72.57	66.11	70.31
Agriculture	103.83	103.25	97.35	95.57	97.6	98.02	98.3
Fossil fuel combustion	15.52	15.87	15.89	16.46	17.76	18.88	20.49
<b>Total N<sub>2</sub>O</b>	<b>215</b>	<b>209</b>	<b>186</b>	<b>174</b>	<b>188</b>	<b>183</b>	<b>189</b>

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



24. Agriculture accounts for about 18.4 million ha and forestry for about 2.4 million ha of the total surface area of the country of 24.3 ha, and all the forest is managed. As already mentioned, the revised approach for estimating emissions and sinks in land-use change and forestry was the main reason for the change of inventory results between the NC1 and the NC2. The NC1 estimated land-use change and forestry as a net sink, while the NC2 and subsequent GHG inventories estimated it to be a net emission source over the entire 1990-1996 period. Emissions from land-use change and forestry were included in the national totals, while removals were reported separately. Between 1990 and 1996, emissions from land-use change and forestry increased slightly, while removals almost doubled.

25. Although the contribution of the new gases to overall emissions was only about 3 per cent in 1996, it was important for the United Kingdom to monitor them because of their upward trend. Emissions of HFCs doubled between 1990 and 1996 as a result of their use as a substitute for chlorofluorocarbons and hydrochlorofluorocarbons. Emissions of PFCs, on the other hand, dropped three times over the same period, driven by technological changes in the aluminium industry. Emissions of SF<sub>6</sub> originating primarily from the magnesium industry and electrical insulation in power equipment increased by about 30 per cent over the same period.

### III. POLICIES AND MEASURES

26. The NC2 presents a comprehensive overview of the wide range of policies and measures designed to meet the United Kingdom commitment under the UNFCCC. The information on each of the main policies was laid down in a clear and concise way and the tables prescribed by the guidelines were used to present this information in a systematic manner. While the quantification of the effects of individual policies and measures was better than in the NC1, even more information on this issue was made available to the team during the visit. The team noted with appreciation that the United Kingdom has in place an integrated monitoring system based on econometric analysis and surveys to assess the effect of the major policies, the results being published in a *Monitoring Note* (CO<sub>2</sub> on a quarterly basis, non-CO<sub>2</sub> on a yearly basis).

27. The United Kingdom's climate change policy as described in the NC2 showed continuity with that described in the NC1. Among all the CO<sub>2</sub> mitigation policies mentioned in both communications, the most significant was liberalization of the energy sector. The continuing shift from coal and oil to gas as a result of the liberalization of energy markets is the major factor behind the United Kingdom's likely achievement of the UNFCCC stabilization target for 2000. Both reports also highlighted the role of economic measures, such as raising the value added tax (VAT) on energy, the road fuel duty escalator, and levies on landfilled waste. Moreover, the outcome of the discussion on the recent consultation paper is expected to bring changes mainly to CO<sub>2</sub> policies and measures, while the non-CO<sub>2</sub> policies and measures may not be much affected. Finally, the team found that there has been a significant development of policies and measures since the publication of the NC2, as summarized in this report.

28. Many policies described in the NC2 do not have climate change mitigation as their main goal, for example energy market liberalization and promotion of cost-effective CHP in industry. For instance, energy market liberalization was driven mainly by economic reasons, while many policies in agriculture were launched to resolve general environmental problems. For other policies associated primarily with climate change, the costs tend to be borne directly by consumers: e.g. the road fuel duty escalator, the levy in favour of renewable electricity known as the non-fossil fuel obligation (NFFO) and the renewables order in Scotland. It seems that the Government is now considering a wider range of policies and acknowledges that not all of them are of a 'no regrets' nature.

## A. Carbon dioxide

### 1. Energy supply and transformation

29. As energy supply and transformation has been the single most important source of CO<sub>2</sub> emissions, the single most important measure, which is expected to deliver almost half of the CO<sub>2</sub> emission savings in the period 1990 to 2000, has been energy market liberalization and privatization. The competitive market in turn has been regarded as the most important tool in attaining the objectives of the United Kingdom energy sector development, including security of supply, diversity and sustainability. The process of energy market deregulation, in general, had a large positive impact on the economy and the environment, as it created pressure for increased efficiency, encouraged innovation, accelerated capital turnover, created conditions for faster penetration of CHP and renewables, and stimulated a fall in energy prices. Along with the privatization two regulators were established, one for electricity and one for natural gas.

30. The post-deregulation so-called "dash for gas" is well documented and has resulted in gas-fired electricity generation growing from almost zero in 1990 to 28 per cent of the total in 1997 and a reduction in coal-fired electricity generation from 65.3 per cent to 38.4 per cent. The lower carbon content of gas compared to coal, combined with the higher efficiency of the new gas-fired power stations, has resulted in a significant drop in CO<sub>2</sub> emissions per kWh of electricity generated, and reduced emissions by an estimated 40,000 Gg CO<sub>2</sub> in 1997. The rapid fuel shift in electricity generation has led the Government to raise concerns about supply security and diversity, and about the functioning of the United Kingdom's electricity market. The Government concluded, as reflected in the 1998 White Paper *Review of Energy Sources for Power Generation*, that there were distortions in the market. These concerns led the Government to impose a stricter consent policy for proposed new gas-fired power stations, while a programme of reform aimed at removing the identified distortions in the market is under way. In the short term, this will slow the rate of decline in coal-fired generation. Nonetheless, gas-fired capacity will continue to increase, as 9 GW of CHP capacity has already gained planning consent. Therefore, fuel switching seems to be on track to achieve in 2000 the effect anticipated in the NC2 (table 4).

31. Other developments in the electricity supply industry have also reduced CO<sub>2</sub> emissions. For example, in anticipation of privatization of the most modern nuclear power plants in 1996, generation efficiency improved, which led to an increase of nuclear in the electricity mix from 20 to 28 per cent between 1990 and 1997. The efficiency gains exceeded expectations. Hence, CO<sub>2</sub> mitigation by the nuclear industry was also higher than anticipated and amounted to 12,800 Gg of CO<sub>2</sub> saved in 1997. Construction of new nuclear power stations was not envisaged in the United Kingdom, although no formal ban on building of new plants was adopted. Despite obtaining planning consent, the Sizewell C station was not constructed, and further planning permissions are unlikely to be sought in the liberalized electricity market, given the current overcapacity, the high cost of nuclear power stations, and the problems of nuclear waste and of decommissioning.

32. Deregulation of the electricity supply industry led to government support for renewable electricity sources via the NFFO, which imposes an obligation on the public electricity suppliers to contract for a certain amount of non-fossil fuel generated electricity. This policy was initially put in place in the 1989 Electricity Act to support nuclear power, but was subsequently extended to renewables, while the support for nuclear power under this scheme has been phased out. The NFFO supports selected renewable energy projects, mainly for independent power producers, by guaranteeing to pay premium prices for electricity generated over a period. The projects are selected according to a competitive bidding procedure and are chosen on a price basis according to a technology band, which ensures that, as like technologies compete with like, a variety of technologies are supported under the scheme. Competition has been successful in driving prices down to almost a commercially viable level, as the average price for all renewables was 2.71 p/kWh in the recent NFFO, compared to the reference pool price of about 2.5 p/kWh. Utilities have been compensated for the difference between the premium prices and market prices via the fossil fuel levy, which was initially set at 10 per cent of electricity sales, and then gradually reduced to the level of 0.9 per cent in 1998. The fossil fuel levy in England and Wales is set at a rate of 0.3 per cent and the revenue from the levy is expected to rise by £40 million annually.

33. The NC2 reiterated the target, first set in 1993, of 1,500 MW of new renewable capacity by 2000. By mid-1999, some 700 MW had been installed, which means that the 1,500 MW will probably not be reached until after 2000. Consequently, as of 1997, the CO<sub>2</sub> mitigation effect of renewable energy was estimated at 2,200 Gg of CO<sub>2</sub>. Successful bids for more capacity were submitted under the previous rounds of the NFFO, but delays or failure of the bidders to obtain planning permission meant that only some of the bids were commissioned. The Government has undertaken a review of policy to promote renewable energy and, despite the delays encountered in meeting the initial capacity target, in 1999 set a new target for renewable electricity to account for 5 per cent of total generation by 2003, with a view to achieving 10 per cent by 2010. With these targets in mind, the Government will raise the rate of the fossil fuel levy to around 1 per cent in 2003.

34. Policy to promote CHP, as described in the NC1 and reiterated in the NC2, has also been target oriented. The current target calls for 5,000 MW of installed CHP capacity by 2000. By the end of 1998, nearly 4,000 MW had been installed (and permissions granted for a further 500 MW), compared to about 3,000 MW in 1994, so a somewhat faster rate of installation will be needed to reach the 2000 target. However, good quality gas-fired CHP is likely to be consistent with the stricter consent policy on new gas-fired power plants and CHP is being promoted by policies, including the Energy Efficiency Best Practice Programme (EEBPP) and the high-level ministerial campaign, and interministerial cooperation to remove implementation barriers. The Government is considering an increased target of at least 10,000 MW of CHP by 2010, and is planning to announce the strategy to achieve this next year. The industrial sector is likely to have the largest potential for CHP, given the widespread availability of gas for heating in existing domestic and commercial buildings. As of 1997, the savings of CO<sub>2</sub> emissions attributable to CHP were estimated at 8,000 Gg.

35. Average electricity prices have dropped since electricity market liberalization. By 1997, in real terms, prices for industrial users averaged 20 per cent below their 1990 levels, while prices for households were approximately 10 per cent below their 1990 levels. Natural gas prices decreased by 15 per cent on average in the same period. This has been attributed to competition, to the possibility for large industrial users to generate their own electricity and to the increase in the supply of natural gas from the North Sea. Full liberalization of the electricity market, with choice for all levels of consumers, was due to be complete by 1998. Due to some delay, the process will in fact be completed by mid-1999. Despite the drop in electricity prices, and the slight rebound effect, electricity demand growth has remained at a level of 1 per cent per annum, without accelerating.

36. Policy reform was expected to continue in the energy sector: in 1998 the Government also carried out a review of regulations governing the privatized utilities, including gas and electricity markets. A paper, *A Fair Deal for Consumers*, published as part of the review process, contains a number of proposed reforms. Accordingly, the role of the electricity and gas regulators is expected to change, as well as the institutional structure, which would include merging of the two regulators. Further reforms may facilitate the introduction of new renewable electricity capacity and CHP, if the appropriate price signals are sent for distributed (decentralized) generation. Such signals could be sent via changes in the structure of transmission pricing to reflect the actual transmission cost. Proposals for transmission loss charging were outlined in the NC2, but have been stalled due to objections from electricity generators.

## 2. Industrial, residential, commercial and public sectors

37. The industrial, residential, commercial and public sectors together accounted for 38 per cent of energy-related CO<sub>2</sub> emissions in 1990, and 40 per cent in 1996. The increased percentage was due to a fast rise in emissions from the buildings sector (residential, commercial and public), which completely offset a slight drop in emissions from industry. Mitigation measures in these sectors focused mainly on measures to promote energy efficiency.

38. The NC2 outlined several energy-efficiency measures in the commercial, industrial and residential sectors. To the extent that these measures reduce electricity supply, they are reducing emissions, but to a lesser extent as the electricity supply industry is increasingly decarbonized. This, combined with the fact that the United Kingdom was on track to exceed its target under the UNFCCC, might have contributed to the relatively low emphasis placed on energy efficiency measures in the NC2. Furthermore, it was expected that companies would be established in the liberalized market to provide energy efficiency services, in particular to industry. Since 1998, the Government has stressed the importance of energy efficiency, and policies in this area have been strengthened. In this context, the EC Integrated Pollution Prevention and Control (IPPC) has to be phased in over the period 1999 to 2007. The IPPC requires that energy is used efficiently by those installations, which are subject to regulation under the regime. These tend to be the most energy-intensive installations and it is estimated that the regime will cover about 40 per cent of industry's CO<sub>2</sub> emissions in the United Kingdom. While the IPPC should help to improve the energy efficiency of some industrial sectors, it will not be the primary instrument for such

improvement. Following the Lord Marshal report, the Chancellor announced in his March 1999 budget that a levy on the business use of energy will be introduced from April 2001. The levy is to be based on energy, rather than carbon content of fuels, and fuels used for heat and power generation are not covered. The levy will not increase the overall tax burden on businesses, as the revenue will be fully recycled via cuts in labour costs and schemes to promote energy efficiency. In this context, the Government intends to set a significantly lower rate for energy-intensive industries.

39. Energy efficiency is promoted through a number of policy instruments. These include information, new technology development and promotion, building regulations, statutory duties on local authorities relating to energy conservation, VAT reduction for some uses of energy efficiency equipment, and some limited financial support to install such equipment.

40. The EEBPP, launched in 1989, remains the main programme to stimulate take-up of more efficient technology. It targets industrial, commercial, domestic and public sectors, and also contains a small component related to transport. The NC2 indicated that the EEBPP had a target of 18,300 Gg CO<sub>2</sub> reduction by 2000 compared to 1990. This included 5,500 Gg CO<sub>2</sub> savings from increased use of industrial CHP (revised upwards from 3,700 Gg CO<sub>2</sub> in the NC1). Emission mitigation from the EEBPP was estimated at 6,000 Gg CO<sub>2</sub> in 1995 and 12,100 Gg CO<sub>2</sub> in 1997, so the target for 2000 should be met if the current rate of improvement in annual abatement is sustained.

41. The EEBPP works by providing information and advice, emphasizing the financial savings obtainable by installing energy efficient technologies. Its budget was £ 15 million in fiscal year 1997, and was expected to rise to £ 20 million annually in 1999-2002, thanks to the increased funding allocated as part of the 1998 Comprehensive Spending Review (CSR). The EEBPP provides industry and households with good practice guides and case studies, and energy consumption leaflets. These activities were extended in December 1998 to running an Energy and Environment Helpline and providing on-site technical advice for small and medium enterprises (SMEs). SMEs accounted for 60 per cent of industrial energy use and had been identified as a particularly difficult audience to reach because energy costs for them are less significant than for heavy industry and there is a lack of in-house expertise on energy and environment issues. The EEBPP is a good example of cooperation between the Government and green NGOs and, recently, also business NGOs, and the team felt that the approach employed in this programme is potentially replicable.

42. Voluntary agreements with the industrial sector were also used to reduce CO<sub>2</sub> emissions. The 1998 Marshall Report indicated that there was significant room for energy efficiency improvement in industry. The first voluntary agreement with the chemical industries association was signed in November 1997 and aims to improve energy efficiency (per unit output) by 20 per cent by 2005 compared to 1995 levels. This agreement covers 80 per cent of the industry's CO<sub>2</sub> emissions and allows for independent verification. However, the role of such agreements with industry in the United Kingdom is limited because of the country's institutional structure: not all industries have a central association. Nonetheless, the Government and some industrial groups

have planned to sign a few more agreements. In addition to voluntary agreements, there is a voluntary "Making a Corporate Commitment" campaign that aims to raise environmental awareness at board level. This campaign was described in both the NC1 and the NC2, but has not been as effective as expected, and is winding down.

43. Building regulations for England and building standards for Scotland, which set energy efficiency and thermal insulation standards, were revised for new and refurbished buildings in July 1995. The thermal insulation standards were broadly similar to those of neighbouring countries, but less demanding than those typical of northern European countries with a colder climate. The team felt that strengthening of building codes for old buildings would bring additional emission reductions as the United Kingdom has a large old building stock, although the potential to insulate these buildings is lessened by the fact that most do not have cavity walls, and local climatic conditions, including driving rain, can make filling cavities unwise. The Government announced in January 1998 a further review of building regulations to see what maximum contribution they could make to achieving the United Kingdom's CO<sub>2</sub> targets, including possibilities for bringing more maintenance and refurbishment work within the scope of the regulations, as well as improving the overall effectiveness of energy use. Other initiatives announced in 1998 could also help, among other objectives, to improve the overall energy efficiency of the building stock. The 1998 CSR made an additional £3.6 billion available to local authorities in England and Wales for public housing repairs, approximately £1.44 billion of which is likely to have a positive impact on energy efficiency. The Home Energy Efficiency Scheme (HEES), initiated in 1991, provided financial incentives to low-income households to install energy efficiency equipment. This was done by providing a 100 per cent grant, capped at about £315. Funding has been increased since the NC2: it was at £75 million in 1997 and this trend is expected to continue in the near term as HEES has been allocated a further £150 million between 2000 and 2002 as part of the 1998 CSR. However, the rebound effect in some households, following the provision of insulation, was up to 80 per cent.

44. VAT was first levied on domestic fuel in 1994 at a rate of 8 per cent, energy having been previously exempted from VAT. Initial plans to raise it to 17.5 per cent, as it was set for other goods, were abandoned, and the Government cut the rate to 5 per cent, which has reduced the price signal that had previously been given and hence has reduced the effectiveness of this policy.

45. In 1998, the Government changed the VAT rate on energy efficiency equipment from 17.5 per cent to 5 per cent under government-funded grant schemes. This partially corrected the situation whereby energy-saving equipment was charged VAT at the full rate while domestic energy consumption was only charged at a partial rate. The Government is pressing the EC to allow energy efficiency equipment to qualify for a reduced VAT rate for the private sector as well.

46. The Energy Saving Trust (EST) was set up in 1992 to promote energy efficiency in the domestic sector and in SMEs. The Trust works by providing consumers with advice, information and grants to partially offset capital outlays for energy-efficient equipment or insulation. Funding for the EST was reduced significantly in the early 1990s following the decision of the gas

regulator not to introduce standards of performance for the gas industry. Consequently, emissions savings expected from the EST in 2000 fell by 80 per cent between the NC1 and the NC2. The Government subsequently took powers to fund the Trust directly. By 1997 it was estimated that about a quarter of the projected 2000 emissions savings had been achieved.

47. The EST operates two main programmes, one funded by the DETR and the other funded by the electricity regulator from revenue collected at a rate of £1 per customer per year. The DETR-funded programme comprised a number of elements, including establishing energy efficiency advice centres (43 of which were in operation in 1998), which have saved over 664,000 customers to the end of 1998 an average of £ 57 per customer annually. Under the second programme, entitled Standards of Performance, each public electricity supplier was assigned an energy-saving target, which could be met if its customers installed energy-efficient equipment. The programme was designed for the period 1994-1998, but has been extended to 2000 at the same funding level. In 1999, the Government was considering the regulatory situation beyond 2000 and announced that the proposed Utility Reform Bill would include powers for ministers to set energy efficiency standards of performance.

48. There are also a number of programmes under way that aim to improve the energy efficiency of the public sector (both central government and local authorities). The NC2 stated that the target to improve the energy efficiency of central-government buildings by 15 per cent between 1990 and 1995 was to be extended to an improvement of 20 per cent by 1999 relative to the same baseline. According to the NC2, the 1995 target was met and the figures available for 1997 indicate that the Government is on course to meet the 2000 target.

### 3. Transport

49. Transport is an important and growing source of CO<sub>2</sub> emissions in the United Kingdom and road transport is by far the most important component, contributing 94 per cent of total transport CO<sub>2</sub> emissions in 1996. Mitigation policies in this sector are, therefore, aimed at road transport. The NC2 outlines two approaches to tackle emissions from road transport: improving the efficiency of road vehicles and reducing vehicle use by switching to less fuel-intensive forms of transport. The most important measure and the only one whose effect is quantified in the NC2, has been that of increasing the road fuel duty, introduced in 1993, when the then government pledged to raise it by at least initially 3 and then 5 per cent per year in real terms. Actual rises have been at a higher rate, and in 1997 the current Government raised the commitment to a minimum 6 per cent real price rises annually. Public transport systems underwent a disruption after privatization, which limited the impact of the road fuel escalator, as people continued to use their cars for lack of a convenient alternative. Nevertheless, the Government estimated that the road fuel escalator is on track to deliver the expected 11,000 Gg CO<sub>2</sub> saved by 2000, although the impact of this measure is difficult to quantify due to the complex interactions between fuel cost and car use. Initiatives to raise public awareness of transport issues are contained in the EEBPP.

50. Other transport measures outlined in the NC2 included encouraging freight traffic to go by rail rather than road, and passengers to use public transport rather than private one, as well as

measures taken by local authorities. For example, grants were available to secure the increased use of rail freight. There were two grants: a capital grant to help offset the capital cost of providing rail freight handling facilities, and a revenue grant paid to goods service operators to offset their rail network access charges. Following increased publicity of the availability of these grants, the funds used doubled to £30 million in both 1997 and 1998 compared to 1996. This, however, did not arrest the energy consumption growth and number of tonne-kilometres of freight transport.

51. Some transport policies described in the NC2 have been substantially strengthened under the new government, which issued a transport White Paper: *A New Deal for Transport - Better for Everyone* in 1998. In this context, the 1998 CSR put an extra £1.8 billion into improving local and public transport and road maintenance between 1999 and 2002. The White Paper gave future directions for transport policy, and emphasized the need to make transport more sustainable by increasing the importance of non-car transport modes and by improving integration between different transport types, and between transport policies and land-use planning. It also outlined future transport-related targets, such as targets for public transport, and estimated a potential to reduce CO<sub>2</sub> emissions from road traffic by 22-27 per cent by 2020 compared with their 1995 level.

52. As of 1999, some of the initiatives of this White Paper were beginning to be implemented. For example, local authorities in England will have to draw up five-year transport plans for their area, and will also have to respond to the Road Traffic Reduction Act of 1997 (subsequent to the NC2) that requires them to consider targets for reducing road traffic or its rate of growth. Moreover, the 1998 EC agreement with manufacturers to improve the fuel efficiency of new cars and reducing emissions from new cars to 120 g CO<sub>2</sub>/km by 2010, was emphasized in the White Paper as a measure that could have a notable impact on the emissions trend. The Government has also set up the Commission for Integrated Transport, an independent body which will advise the Government on the implementation of its transport policies.

53. Some initiatives, including those in the White Paper, require new legislation: for example, the Government announced in November 1993 that it would introduce tolls on motorways, but they were never implemented as the required legislation was not put in place. A differentiated vehicle excise duty, whereby cleaner vehicles pay less, has recently been introduced. In the longer term, measures such as research and development are also being pursued, e.g. via the Foresight Vehicle programme.

#### 4. Land-use change and forestry

54. The share of the land area covered by forest in the United Kingdom is about 10 per cent. The NC2 described few incentive schemes to encourage new forest planting and a financial commitment of £90 million was made for 1995-1997 to maintain the current rate of tree cover increase of about 20,000 hectares per year. The recent consultation paper mentioned that the country is committed to a steady expansion of the woodland area and is considering how forestry policy could be developed to meet climate change goals, within the broader environmental

objectives of this sector development. It set an ambitious target for an increase of sinks uptake from 1.7 per cent of the CO<sub>2</sub> emissions in 1990 to 2.6 per cent in 2010. Nonetheless, the measures targeting sinks will have a limited impact on the emissions.

## **B. Methane**

55. Mitigation of CH<sub>4</sub> emissions in the United Kingdom is achieved chiefly by pursuing an active policy for waste management and also as a consequence of coal mine closure. The 1995 White Paper, *Making Waste Work*, laid the foundations of the United Kingdom strategy for sustainable waste management, based on a waste management system, use of waste and landfill gas for energy, and a landfill tax. The 1998 consultation paper, *Less Waste More Value*, emphasized waste minimization and sustainable use of resources. New targets for waste were published in June 1999 as part of the Government's draft waste strategy for England and Wales: *A Way With Waste*. In particular, the Government set goals to reduce the amount of commercial and industrial waste sent to landfills to 85 per cent of 1998 levels by 2005; recover 45 per cent of municipal waste by 2010, and recycle or compost 30 per cent of household waste by 2010. Commensurate targets have been proposed in the equivalent waste strategies for Scotland and for Northern Ireland. The landfill tax was introduced in 1996. Current rates are £10 per tonne for active waste and £2 per tonne for inactive waste. The landfill tax credits scheme channeled up to 20 per cent of the revenue for environmental objectives, such as support for research and education to promote more sustainable waste management practices. The 1999 budget introduced a standard rate escalator of £1 per tonne from April 2000, which is to be applied for at least five years. Gas collection from landfill sites has also been promoted; in 1994, about two thirds of landfilled waste was sent to sites with gas collection systems, thus saving 162 Gg of CH<sub>4</sub> emissions. In 1999, an EC directive on landfills was agreed. It seeks to prevent or reduce the possible negative environmental effects of landfilling waste by introducing uniform standards throughout the EC.

56. CH<sub>4</sub> emissions from coal mining have decreased, mainly because of a fall in coal production and the closure of coal mines, which in turn was triggered by a decrease in coal consumption from 108 Mt in 1990 to 63 Mt in 1997. A further drop to 50 Mt is expected by 2010. For the remaining coal mines CH<sub>4</sub> emission reduction is envisaged by gas collection. Fugitive emissions from offshore oil and gas extraction have been reduced as a result of industry measures in response to environmental guidelines published by the United Kingdom OOA. Fugitive emissions from natural gas distribution have also been reduced by pursuing a strategy of controlling leakages (BG Transko). This action was driven partly by the need to comply with pollution control regulations and partly by economic efficiency concerns.

57. There have been no specific GHG mitigation measures in the agricultural sector. The long-term reduction of CH<sub>4</sub> emissions from this sector is expected to come from a reduction in the number of cattle due to improvement of animal diet and productivity, which in turn was partly caused by the Common Agricultural Policy (CAP) and the response measures taken to tackle bovine spongiform encephalopathy. The ongoing research seeks further options for CH<sub>4</sub>

mitigation from agriculture, although these are not expected to be sufficiently developed for widespread use in the near term.

### **C. Nitrous oxide**

58. Most of the N<sub>2</sub>O emission reduction was expected to come from the chemical industry, in particular from DuPont, which operates the only adipic acid plant in the United Kingdom. DuPont installed in 1998 a common gas abatement unit that will reduce N<sub>2</sub>O emissions at least by 95 per cent. Concerning N<sub>2</sub>O emissions from agriculture, the largest contribution to the slight downward trend was made by reducing fertilizer consumption, as a consequence of policies aimed at improving water quality management and economic efficiency. Emissions of N<sub>2</sub>O from transport have been rising rapidly: 2.4 times in 1996 compared to 1990, due to increased use of catalytic converters in cars.

### **D. New gases**

59. Emission trends of HFCs, PFCs and SF<sub>6</sub> in the United Kingdom have been diverse. Emissions were expected to be controlled mainly by pollution abatement regulations, but also through voluntary agreements. After the NC2 was published, one of the only two manufacturers of HFCs in the United Kingdom announced plans to install emission abatement technology by 1999, which is expected to reduce HFC-23 losses by over 95 per cent. The team noted that emission abatement measures for the new gases are one of the areas where industry and government need to work together closely to find effective solutions.

## **IV. PROJECTIONS AND ESTIMATES OF THE EFFECTS OF MEASURES**

60. The United Kingdom provided in the NC2 projections of CO<sub>2</sub>, CH<sub>4</sub> and N<sub>2</sub>O emissions for reference and “with measures” scenarios, and the new gases (HFCs, PFCs and SF<sub>6</sub>) for a “with measures” scenario. Information on projections is presented by gas and by sector, and the effect of the main policies and measures is estimated. The team noted that although the NC2 did not contain projections of bunker fuel emissions and the information on the methodology used for projections was limited, in general, the United Kingdom respected the guidelines. The review team was impressed by the quality of analytical work and efforts to produce robust estimates of the future emission trends.

61. In the NC2, two sets of projections of the main GHGs were given: a reference or “without measures” scenario and a “with measures” scenario, with data on emissions given to 2020, using 1990 as a base year. The same approach to emission scenarios was employed in both the NC1 and the NC2, namely, to establish a “with measures” scenario, estimate the effect of individual policies and measures and their overall effect, and finally subtract this from the “with measures” scenario to obtain the baseline scenario. The “with measures” scenario, which included only implemented policies and measures, provided a view of the possible future level and composition of energy demand and supply. Underlying the analysis, six scenarios were considered, covering

high, medium and low GDP growth and high and low energy prices. The NC2 only presented the average of the two mid-range scenarios.

62. Two institutions took the lead in preparing projections of CO<sub>2</sub> emissions: DTI and DETR, and advisory groups were set up with the participation of academic institutions and NGOs to ensure methodological guidance, including that on the new methods for transport projections. CO<sub>2</sub> projections presented in the NC2, based on the DTI model (1995 Energy Paper 65), indicated that emissions in 2000 will be 4 to 8 per cent lower than in 1990, given existing policies. In contrast, projections in the NC1, based on the earlier DTI model (1992 Energy Paper 59), indicated that with the then implemented policies, CO<sub>2</sub> emissions might only return to their 1990 levels by 2000. The main reason for the revision of the emissions trend was the success of energy market liberalization and the subsequent fuel switching, and improved nuclear productivity, which altogether is expected to contribute about 60 per cent of the overall emissions saving in 2000. In the recent consultation paper, the same projections given in the NC2 were used to facilitate policy making, supplemented by new projections for the transport sector, using a new bottom-up traffic forecast model, documented in the 1997 *National Road Traffic Forecasts*. The new projections indicated a less steep increase in transport emissions, mainly as a result of policy to promote fuel efficiency, including the real increase in fuel duty of 6 per cent annually till 2002 and the inclusion of some saturation effect of transport demand, given GDP growth. Finally, as of 1998, the DTI has been in the process of updating the projection model and new projections were due in 1999.

63. The DTI energy projection model combines demand-side econometric sub-models for energy end-use sectors and a supply-side optimization model for the electricity industry. The demand-side econometric links in the model were fitted to historical data of, *inter alia*, fuel demand, fuel price and economic activity by sector for the period 1950-1995. The model has been used for many years and is continuously updated. The current model is more detailed than its earlier versions, the industrial sector being divided into eight subsectors, for example, compared to two previously. This allows for realistic handling of structural changes in industry, and more detailed accounting of technology take-up and saturation effects in the service and domestic sectors. The model has some limitations, because behavioural relationships are based on historic data mainly before 1990, when the energy markets had not yet been liberalized. To compensate for this effect, expert judgment is used. Assumptions are made with respect to progress in energy efficiency and supply standards, and the model does not identify energy demand at technology or process specific level.

64. The NC2 provided a detailed description of the key assumptions made in the projection exercise, including that of annual GDP growth (high 2.85 per cent, central 2.35 and low 1.75 per cent) and the assumption that no major changes of economic structure were expected other than an increase in the share of services by 3 per cent by 2020 accompanied by a decline in manufacturing. Two sets of energy prices were considered, a low and a high; coal and gas prices were expected to increase in both scenarios, but crude oil prices were expected to drop according to the low scenario and increase in the high. The 1998 energy prices were very low compared to the central assumptions, but the effect was not expected to be significant because of the low price

elasticity of energy demand. In the transport sector, an important assumption was that the share of diesel vehicles would be 20 per cent of car sales and 90 per cent of large goods vehicle sales.

65. According to the projections contained in the NC2, total final energy demand is expected to grow by 10 per cent by 2000 and by 30 per cent in 2020, mainly because of increased demand in the service and transport sectors. Compared to 1990, electricity demand is expected to grow by between 15 and 23 per cent by 2000 and between 42 and 66 per cent by 2020; gas demand is projected to grow by 20-25 per cent by 2000 and 41-57 per cent by 2020; demand for oil products is expected to grow by 1-13 per cent by 2000 and 21-64 per cent by 2020; and the demand for solid fuel is to decline by 20-26 per cent by 2000, and 52 per cent by 2020. Nuclear fuel input is expected to decline gradually in line with the retirement of units in the post-2000 period, and in 2020 it will account for a very small share of the energy demand (about 3-4 per cent). Renewable energy capacity will increase steadily, to about 3 GW in 2000, and 3.5 to 5 GW in 2020.

66. Although CO<sub>2</sub> emissions in 2000 are expected to fall well below their 1990 level, in the longer term an upward tendency is anticipated, as fuel switching (into gas) becomes less economic, more difficult or simply restrained for energy security considerations, and energy demand continues to grow. Another important reason for the long-term trend is the steady decline in nuclear power output as nuclear capacity is phased out, and the continued dominance of fossil fuels in the energy market. Hence, the energy and transformation, and transport sectors are those that will contribute most to emissions growth in the long term.

67. The key policies and measures were considered in the projections given in the NC2 and their effects are set out in table 4. The total effect of these measures in terms of CO<sub>2</sub> saved was estimated at 129,000 Gg in 2000. The United Kingdom uses a set of four high-level indicators to monitor and assess the effect on the emission trend of different factors. The analysis, conducted under the monitoring procedures set up in the United Kingdom, suggests that in 1998 compared to 1990, energy efficiency measures, structural changes and the road fuel escalator together saved 62,300 Gg CO<sub>2</sub>, and changes in the fuel mix accounted for 80,700 Gg CO<sub>2</sub> saved, while the GDP growth brought an increase in emissions of 106,300 Gg CO<sub>2</sub> and the impact of outside temperature has generally been to increase emissions, but the effect in 1997 was neutral.

68. In addition to the highly aggregated indicators listed above, the United Kingdom estimated the effects of individual policies and measures on the current and future emissions trend. The DTI model was used to estimate the effect of the road fuel escalator and VAT on domestic fuel. The effects of achieving national targets for renewable energy, CHP and public sector energy efficiency were based on the associated energy savings and the assumption about the underlying fuel mix. Assessing the effects of energy efficiency measures and energy market liberalization other than fuel switching appeared as the most difficult task from the point of view of methodology. Bottom-up models were used as a part of this analysis along with different assumptions about technology change, discount rates, etc. Such models tend to overstate the effect of measures as they neglect many barriers to technology uptake. The analysis also encompassed market research and monitoring of the actual energy efficiency investment

decisions. Results summarized in table 4 clearly indicate that, as of 1997, with a few exceptions, such as renewable energy and EST, policies are on track to deliver the effect expected.

**Table 4. Effect of policies and measures on the current and future emissions trend (per annum)**

	Estimates of mitigation impact in 2000 (Gg CO <sub>2</sub> )	Revised estimates, of impact in 2000, if applicable, (Gg CO <sub>2</sub> )	Estimate of impact in 1997 (Gg CO <sub>2</sub> )	Savings in 1997 compared to estimates for 2000, or effect in 2000, in case of revised estimates (percentage)
Fuel switching	62 300		40 300	65
Nuclear productivity	10 600		12 800	120
Renewable energy	7 300		2 200	30
Combined heat and power	12 800		8 000	62
Road fuel escalator	11 000	8,000 to 13,200	-	67-110
Domestic fuel prices (VAT) <sup>(a)</sup>	1 500	1 100	-	75
Energy efficiency programme	12 800	8 500	-	66
Energy Saving Trust	440	106	-	24
Other <sup>(b)</sup>	8 800	-	-	-

(a) Estimates of the impact of VAT on domestic fuel prices in the NC2 were based on a rate of 8 per cent rate, while the new Government reduced it to 5 per cent.

(b) Other includes saving target for the public sector and impact on energy efficiency of regulations, advice, grants and labelling.

69. Projections of non-CO<sub>2</sub> emissions were compiled by the DETR in close consultation with industry and other government departments, using a number of sector-specific research projects. This kind of institutional arrangement and regular contact with business has become increasingly important to produce robust projections, to quantify the effect of measures and to monitor progress. Efforts were geared to ensuring consistency with the GHG inventory and with other published government projections, including the DTI energy projections. Projections of non-CO<sub>2</sub> emissions have been revised as new information becomes available. A full revision has been carried out every two years, the 1997 revision being included in the NC2.

70. Emissions of CH<sub>4</sub> and N<sub>2</sub>O from fuel combustion, and fugitive CH<sub>4</sub> emissions from coal mines were projected by the DETR using the demand data from the DTI model. The DETR also prepared projections of CH<sub>4</sub> emissions from waste, employing a first-order decay model calibrated to United Kingdom data. Two different approaches, namely, an installation-based (bottom-up) and a production-based (top-down) method, were agreed with the United Kingdom OOA to estimate the future trend of fugitive CH<sub>4</sub> emissions from offshore oil and gas operations. MAFF prepared projections of N<sub>2</sub>O emissions from agriculture and CH<sub>4</sub> emissions from livestock, using a spreadsheet model.

71. According to the NC2, emissions of CH<sub>4</sub> are expected to decrease by 22 per cent in 2000 and by 35 per cent in 2010 compared to 1990, with the effect of measures estimated at 940 Gg CH<sub>4</sub> saved in 2000 and 1,590 Gg in 2010. The projected trend for N<sub>2</sub>O is similar to that of CH<sub>4</sub> at the beginning of the period under study, when emissions are projected to decrease by 62 per cent in 2000 compared to 1990, followed by a slight increase to the level of 54 per cent of 1990

emissions. The main drivers behind the CH<sub>4</sub> emissions trend are the closure of coal mines and the increase of landfill gas collection for energy recovery. The projected decline in N<sub>2</sub>O emissions is explained by a drop in emissions from industrial processes as a result of technological changes and installation of gas abatement unit by 1998. Future trends of CH<sub>4</sub> and N<sub>2</sub>O emissions given in the NC2 were somewhat lower compared to the trends given in the NC1, due to changes in GHG inventory methodology with implications on projections. The difference between projections included in the recent consultation paper and the NC2 are marginal, with the exception of N<sub>2</sub>O emissions. A revised methodology applied to N<sub>2</sub>O emissions from agricultural soils (based on the IPCC 1996 Guidelines) resulted in an increase in such emissions of approximately an order of magnitude, but the trend remained broadly the same.

72. HFC, PFC and SF<sub>6</sub> projections given in the NC2 were based on a 1996 DETR-funded study, which used a spreadsheet model to estimate the emissions trend. In 1998, the results of this study were updated and the approach employed was extended to consider cost-effective measures for further emissions reduction. The study incorporated the results of HFC projections from the only two HFC manufacturers in the United Kingdom.

73. Estimates of future emissions from land-use change and uptake by sinks were produced by the Institute of Terrestrial Ecology, and included in both the NC2 and the recent consultation paper. To project emissions, land-use change matrices were derived from aerial surveys made in 1947 and 1980 and from an inventory of land-use change in 1984 and 1990, and carbon flux simulation was applied by exponential decay and accumulation models. Estimates of the forest sink were obtained using the recent forest inventory, and annual tree planting and harvesting data coupled with a dynamic model of tree growth. The total uptake by sinks from land-use change and forestry was projected to increase from about 10,400 Gg in 1990 to 16,900 Gg in 2000 and 11,200 Gg in 2020.

## V. VULNERABILITY ASSESSMENT AND ADAPTATION MEASURES

74. The United Kingdom made noteworthy progress between the NC1 and the NC2 on the reporting of climate change impacts and adaptation, and has been continuously developing activities in this field since submission of the NC2. While the NC1 did not contain a chapter on this item, in the NC2 the output of the United Kingdom Climate Change Impact Review Group, established in 1996 and consisting of about twenty experts of different sectors, was used. The climate change scenario assumed in the Group's report was based on Hadley Centre modelling studies and was consistent with scenarios from the IPCC Second Assessment Report.

75. In April 1997, after preparation of the NC2, the United Kingdom Climate Impacts Programme (UKCIP), was launched at Oxford University with the objective of co-ordinating research on climate change impacts in the United Kingdom, and helping organizations assess their vulnerability to climate change and plan appropriate adaptation measures. The UKCIP uses a new climate change scenario to examine scientific aspects of expected global warming. It considers two options of annual concentration of CO<sub>2</sub> increase in the atmosphere (1 per cent and 0.5 per cent), and incorporates these options into high and low case temperature-rise scenarios to

estimate plausible global temperature rise in the next century. The UKCIP has also published a study on the climate change observed over the last 100 years in the United Kingdom, which indicated an overall increase in total precipitation but a decrease in summer precipitation (by up to 20 per cent) over large parts of England. Finally, the UKCIP has started to develop a network with different institutions to involve various stakeholders in the United Kingdom in climate impact studies, and to obtain a better view of impacts at regional level. Regional workshops, for example on the impacts on Scotland and Wales, and a scoping study on biodiversity, are among the most recent activities of the UKCIP.

76. Adaptation measures have not yet been developed in the United Kingdom, mainly due to the uncertainty of the impacts of climate change on the country. Impacts, which have been considered so far the most serious for the country relate to sea-level rise and water resources, as described below. In 1998, the Environment Agency prepared a study on potential impacts on water resources, including water quality, navigation, recreation, fisheries and floods. In 1996, the Department of the Environment/Welsh Office published *Water Resources and Supply: Agenda for Action* to set out policy for effective water supply in the long term. MAFF has issued operating authorities with guidelines on the rates of sea level rise that should be considered when planning. Guidelines related to construction, such as those on flood defence, are periodically reviewed from the point of view of climate change.

## VI. FINANCIAL ASSISTANCE AND TECHNOLOGY TRANSFER

77. In the NC2, the United Kingdom reported activities for both bilateral and multilateral technology transfer and financial assistance, and the presentation of information followed the guidelines. Out of £2.3 billion provided annually for financial assistance, £1.1 billion was a contribution to multilateral entities and the remaining £1.2 billion was used to support bilateral projects. The DFID coordinated the work of other agencies on financial assistance and the DTI was responsible for the policy framework to facilitate technology transfer.

78. The United Kingdom reported its contribution to the World Bank, IPCC, UNFCCC and GEF, as well as a series of climate change related projects and programmes implemented with the support of these institutions. Among these institutions, GEF was considered the main mechanism to provide financial resources to developing countries for climate change projects; the total commitment to the GEF was £215 million, of which £7.38 million was provided in 1995, £6.63 million in 1996, £11.88 million in 1997 and £10 million in 1998.

79. The main focus of United Kingdom development assistance was on the least developing countries. Some of the assistance was spent on energy and infrastructure projects, helping the countries to meet the increasing energy demand in a most cost-efficient way, by implementing new technologies, transferring management practices and setting up production of energy efficient equipment. In 1998, the Private-Public Infrastructure Advisory Facility was created in cooperation with the World Bank and Japan to encourage private sector investment in infrastructure projects in the developing countries, and possibly in the future, to provide access for the developing countries to the clean development mechanism.

80. In the United Kingdom, as in many other developed countries, the private sector is the main vehicle for technology transfer, but no clear picture emerged during the discussion on the priority areas for such transfer. In this context, it is worth mentioning the United Kingdom Technology Partnership Initiative, launched in 1993 and relaunched in 1996, to encourage the transfer of environmental technologies via the private sector by providing information. So far, the United Kingdom has no AIJ projects, but in 1998, a discussion was initiated on the incentives which the Government needs to create to stimulate interest in joint implementation.

## VII. RESEARCH AND SYSTEMATIC OBSERVATION

81. The team noted with appreciation that the support for climate-related research continued to be a priority in the United Kingdom. Moreover, in 1998, £40 million was provided for climate research by the National Environment Research Council, and the DETR has allocated £11.8 million for the period 1998-1999 for research on climate change, climate prediction, earth observation, trace gases, radiative forces, climate change impacts and response strategies. Other ministries, such as MAFF, the Scottish Office and DTI, have also funded climate-related research in areas of their specific interest. The team also noted the excellent coordination of climate related research at the national level done by the Inter-Agency Committee for Global Environmental Research, and the involvement of wide range of stakeholders in such activities. In the international context, the United Kingdom is an active participant in coordination of climate change research in Europe, especially research on impact assessment. It also participates in international programmes of IPCC and the World Meteorological Organization, and in several atmospheric monitoring and observing activities, such as the Global Climate Observing System, the Global Ocean Observing System and the Global Terrestrial Observing System.

82. The main part of climate research, aimed at obtaining a better understanding of climate change science, continued to be carried out at the Hadley Centre. In the last few years, a major improvement of the global model resolution from 50 to 25 km was made and data were collected to validate the global circulation models. Results from the regional models have been used for the national impact assessment. The United Kingdom monitors the climate via its Meteorological Office and, as of 1987, manages a monitoring station for background pollution and tropospheric ozone on the Irish coast, as part of a global network. Data and model results on climate change have been made available to the international scientific community through the LINK programme in the University of East Anglia. Research on mitigation technologies was done mainly by the private sector. Governmental technology research is funded by the DTI and research on basic science is funded by the Engineering and Physical Sciences Research Council.

## VIII. EDUCATION , TRAINING AND PUBLIC AWARENESS

83. The United Kingdom recognizes the increased awareness of climate change as an important part of its climate policy. While information dissemination has been a part of the energy efficiency schemes, the United Kingdom also has campaigns aimed specifically to raise awareness of energy use and its links to climate change. The campaign *Are you doing your bit?* in the national media is a new initiative, that features simple adverts and detailed article-type “advertising features” actions by celebrities. The campaign was launched in 1997 with a yearly

budget of £1.5 million, which was to increase to £7 million in 1998. More details are available on the Internet at address [www.doingyourbit.org.uk](http://www.doingyourbit.org.uk). It was well thought out as it promoted general awareness of energy use and global warming, reinforced the connection between the two, and set out individual actions to combat global warming. Interim evaluation has indicated increased awareness of energy and global warming. The United Kingdom has also undertaken pilot information projects, such as the *Greener Vehicles Campaign*, in which the information measure was linked to the local authority campaign aimed at improving car tuning that gave the police powers to stop cars, to test emissions, and to fine the owners if necessary. A great deal of information was available electronically, including the DETR *Climate Change Newsletter*. Information exchange was also a part of the work of the United Kingdom group concerned with climate impacts, but it was limited to responses to requests. Local authorities were also involved in awareness-raising activities, including through Local Agenda 21 activities.

84. More targeted education measures were also in place. For example, architecture students are taught about the links between building design and energy use (particularly for lighting and heating). The new Government has been also considering how the Sustainable Development Education Panel might feed into the national curriculum.

## IX. CONCLUSIONS

85. The team formed the impression that the estimates provided in the NC2, according to which the United Kingdom will have by 2000 a level of GHG emissions approximately 4-8 per cent below that of 1990 with the current policies in place, are realistic. In the longer term, notwithstanding a number of new policies put in place after the NC2, efficient new policies appear necessary together with strengthening of some of the existing policies, to achieve the national aim and the binding targets under the Kyoto Protocol. This conclusion is supported by the projections presented in the recent consultation paper, which suggest that emissions will start to rise again after 2000, unless new policies are implemented.

86. The team also acknowledged the tendency after the NC2 to change the balance of the policy instruments: while the climate change policy presented in the NC2 relied heavily on a single policy, namely, energy market liberalization, and gave strong emphasis to voluntary measures and raising public awareness, with limited scope for economic instruments, the new approach is intended to broaden the range and improve the balance of policy instruments, especially by increasing the role of economic instruments. On a sectoral basis, the progress in mitigating GHG emissions from energy supply is remarkable, while in public transport, energy efficiency, CHP and renewable energy, the progress still seems to be slow compared to the goals set. As these are the areas in which public policies might be effective for emission reduction in the longer term, more attention to these sectors will help to strengthen the climate policy. The recent consultation paper has generated significant debate on the approaches to GHG mitigation. In this context, steps have already been taken, including the decision to impose the energy levy on business energy use. The outcome of this debate is likely to be a comprehensive strategy to achieve the targets set. This strategy will be followed by an integrated climate change strategy, in which both mitigation and adaptation policies will be taken into account. The ongoing process of devolution of power to Northern Ireland, Scotland and Wales on the issues related to energy,

energy efficiency, renewable energy, waste and integrated transport will also contribute to achieving the climate policy objectives, if the necessary regulations and legislation are put in place.

87. The team noted the very high quality of the United Kingdom GHG inventory and the comprehensive coverage of sources and sinks. Moreover, it noted the constant efforts to improve methodologies and the use of the best available scientific information to obtain accurate emission estimates. The team also noted the long list of ongoing projects aimed at improving further the quality of inventory estimates, *inter alia*, studies aimed at reducing uncertainties and a project to establish an independent verification. Finally, the team noted the commendable work of the United Kingdom experts on methodology related to GHG inventories, in particular in the IPCC.

88. Projections presented in the NC1 and the NC2 provided a robust estimate of the possible future emissions trends and effect of policies and measures, thanks to plausible assumptions, adequate models, an adequate institutional arrangement and coordinated efforts of, *inter alia*, the DTI and the DETR. Projections were analysed and compared with those of the Cambridge Econometrics in order to have a reliable outside reference and were always well linked to the historical emission estimates. Estimates of both actual emissions and emissions corrected for fluctuations, the business cycle and outside temperature, have been within the range of 2 to 3 per cent of the projected level, and as of 1998 were very close to the NC2 projections.

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