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Report on the in-depth review of the second national communication of Ireland

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I. INTRODUCTION AND NATIONAL CIRCUMSTANCES

1. Ireland ratified the United Nations Framework Convention on Climate Change (UNFCCC) on 20 April 1994. Its first national communication (NC1) was submitted on 15 November 1994 and the second national communication (NC2) was submitted on 8 July 1997. Final data for 1995 and provisional inventory data for 1996 were submitted in February 1996 and are used in this report. In general, the NC2 contained much information in line with the UNFCCC reporting guidelines, but was lacking in detail.

2. The in-depth review was carried out between April and February 1998 and included a review team visit to Dublin from 5 to 8 May. The team consisted of Dr Miriam Haran (Israel), Ms Lilya Zavyalova (Uzbekistan), Mr Jan Spakman (Netherlands) and Ms Tina Dallman (UNFCCC secretariat, Coordinator). During the visit, the team met officials from government ministries and agencies, members of an environmental non-governmental organization and an industry representative.

3. Ireland is located on the north-west coast of Europe. Its climate is predominately influenced by the relatively warm waters of the Gulf Stream, making it milder than other parts of the world at the same latitude. During the coldest winter months the temperature falls to between 4^{o} and 7^{o} on average, and in the warmest summer months the temperature averages between 14^{o} and 16^{o}. Rainfall is common throughout the year, averaging from 800 to 1,200 millimetres in low-lying areas.

4. Ireland is a small open economy, which experienced cumulative gross domestic product (GDP) growth of over 60 per cent between 1985 and 1995, compared to 30 per cent, overall, for other members of the Organisation for Economic Co-operation and Development (OECD), resulting in a relatively high rate of greenhouse gas (GHG) emissions growth. This was seemingly attributable to a number of favourable underlying factors. The provision of education has improved steadily in recent years and there has been a major increase in the proportion of the population in the working age group. The economy has opened up progressively, resulting in full participation in the Single European Market. Industrial policy, involving significant financial incentives, has been successful in attracting multinational investment, resulting in a restructuring of the economy toward high technology manufacturing processes, especially electronics and pharmaceuticals. Ireland has benefited from European Community (EC) so-called ‘structural funds’, given that its income per capita has been lower than the EC average.

5. In 1990, gross national product (GNP) per capita was about 67 per cent of the EC average, but in a relatively short period the Irish standard of living has converged toward average levels as GNP per capita was expected to be 95 per cent of the EC average by 2000. GNP growth was provisionally estimated at about 8 per cent in 1997, reflecting both strong export growth and domestic demand. Growth was still expected to be very strong in 1998 at around 6.5 per cent. Officials predicted that Ireland could have one of the highest standards of living among EC countries by 2010.

6. Industry accounted for about 27 per cent of total employment and 38 per cent of GDP in 1995 and was strongly export orientated. In 1995, agriculture, mainly based on livestock rather than tillage farming, accounted for around 7 per cent of GDP and was the primary land use, accounting for 4.9 million hectares out of a total area of 6.9 million hectares. Wetlands and bogs accounted for about 14 per cent of land cover. Forest cover at 8 per cent of the land area was the lowest in the EC. The total population, in 1996, was just over 3.6 million and average population density was relatively low, creating a high dependence on car transportation although there is an increasing trend toward urbanization. Over half of the population lives along the coastline, making potential sea level rise a particular concern of climate change.

7. Although fuel consumption rapidly increased in Ireland during the early 1990s, the fuel mix did not change significantly. During this period just under one third of the energy supply was from indigenous sources, mainly gas and peat and to a lesser extent hydro, wind and biomass. The State owns and works around 88,000 hectares of peatland, which are estimated to have a remaining working life of some 30 years, based on 1995 rates of extraction. Most of the extracted peat is used in small electricity generating stations in the midlands, accounting for approximately 15 per cent of total energy use in the electricity sector in 1995. Private sector extraction of peat has expanded significantly since the early 1980s, reaching about 1.3 million tons in 1995. Peat remains a significant source of fuel for residential heating outside the main conurbations. In 1996, total primary energy requirements, a measure of all energy consumed in Ireland including that lost in transformation and transmission, amounted to about 11.5 million tons of oil equivalent (mtoe), 50 per cent of which came from oil, 20 per cent from natural gas, 19 per cent from coal, 9 per cent from peat and 2 per cent from renewable energy. The share of natural gas and renewables increased whilst the share of peat and coal declined. Nevertheless, the Irish fuel mixed remained relatively carbon-intensive. Energy consumption per capita in Ireland was lower than the International Energy Agency estimated European average in the early 1990s, but in terms of energy intensity it was on a par with the European average. Whilst in absolute terms energy consumption grew between 1990 and 1995, energy intensity, measured as energy use per unit of GDP, was on a downward trend.

8. Ireland launched its climate change abatement strategy in 1993, with the objective of limiting carbon dioxide (CO_2) emissions to no more than 37 million tons of CO_2 or 20 per cent above the 1990 level by the year 2000. This was set in the context of the EC commitment to stabilise CO_2 emissions at 1990 levels by the year 2000 for the EC as a whole. For the purposes of the EC burden sharing agreement under Article 4 of the Kyoto Protocol, in June 1998 Ireland agreed to limit the net growth of the six GHGs under the Kyoto Protocol to 13 per cent above the 1990 level over the period 2008 to 2012.

II. INVENTORIES OF ANTHROPOGENIC EMISSIONS AND REMOVALS

9. The reporting of GHG inventories improved compared to the NC1. Nevertheless, the NC2 contains very little commentary. Data were provided for emissions of the direct GHGs CO_2, methane (CH_4) and nitrous oxide (N_2O), CO_2 removals, and emissions of the indirect

greenhouse gases nitrogen oxide (NO_x), carbon monoxide (CO) and non-methane volatile organic compounds (NMVOCs) for the period 1990 to 1995 inclusive. In addition, the requested standard data tables of activity data and emission factors were submitted, for 1993, to provide further information on how the estimates of the main GHGs were derived. There were no data in the NC2 for the new gases, namely perfluorinated hydrocarbons (PFCs), hydrofluorocarbons (HFCs) and sulphur hexafluoride (SF_6). There was no information about the uncertainty associated with the various GHG estimates and only limited additional information provided during the review.

10. In 1995, total GHG emissions were about 59,400 Gg of CO_2 equivalent, on a global warming potential (GWP) basis, which is around 4 per cent higher than in 1990. Of this, CO_2 contributed approximately 58 per cent, CH_4 about 29 per cent and N_2O around 14 per cent. By source, agricultural emissions accounted for about 35 per cent of the total, energy and transformation about 23 per cent, transport approximately 11 per cent, the residential sector around 11 per cent and the remaining sectors about 20 per cent combined.

11. The Irish Environmental Protection Agency (EPA) has been responsible for compiling the emissions of all GHGs, based on activity data supplied by various government departments and detailed information on CO_2 emissions from individual electricity generating stations supplied by the State Electricity Supply Board (ESB). The national energy balance of fuels by sector is the main basis for CO_2 emission estimates, as well as for emission estimates of other gases arising from combustion. This balance sheet largely determines the degree of breakdown of the aggregated data which can be applied to the inventories. In general, the team formed the impression that activity data for major sources of the main GHGs were of good quality. However, there was insufficient information to provide a good breakdown of aggregate data by sector, especially for energy. It was noted by officials that data for oil and electricity consumption are fairly accurate, coal data are reasonably accurate, fuelwood data are of poor quality and peat data are of mixed quality. Data were available for commercially extracted peat used in power generation and for that sold to households, but there were no data for households' own extraction of peat even though this is the second most important source of solid fuel for domestic heating. Due to the historic importance of the agricultural sector and because farmers receive subsidies on the basis of animal numbers and crop acreage, detailed agricultural statistics are available on an annual basis.

12. The review team noted that many of the entries in the Intergovernmental Panel on Climate Change (IPCC) emission summary tables submitted by Ireland are zero and questioned their meaning in this context. Officials explained that zero was almost invariably equivalent to 'not estimated' because the activity did not exist, the emissions were assumed to be negligible or no data were available to estimate the emissions.

13. Emission factors are a mixture of IPCC and CORINAIR default values, national research based estimates and values taken from literature related to other countries. In all sectors, data were available for the energy and carbon content of fuel deliveries to permit fairly accurate determination of CO_2 emission factors. Officials noted that national CH_4 and N_2O emission

factors used in the agricultural sector are similar to IPCC default values. Overall, there is no reference approach to check inventory estimates and officials noted that no quality assurance procedures are in place.

14. For 1990 emission estimates, CORINAIR methodology was followed, converted to the IPCC reporting format. For 1991 estimates onward, the revised IPCC guidelines were used. The team noted some inconsistencies between 1990 and later years in the allocation of emissions to different categories as a result of this change in procedure. Inconsistencies were also noted between the statistics supplied by the State gas company on the split between combustion and feedstock use and those taken from the national energy balance for the emissions inventory.

A. Carbon dioxide

15. It can be observed, in table 1, that between 1990 and 1996, total CO_2 emissions increased by approximately 15 per cent. Underlying this, transport emissions increased by about 42 per cent and there was a 30 per cent increase in emissions from energy and transformation.

Table 1. Emissions of carbon dioxide, by source, 1990 - 1996 (Gg)

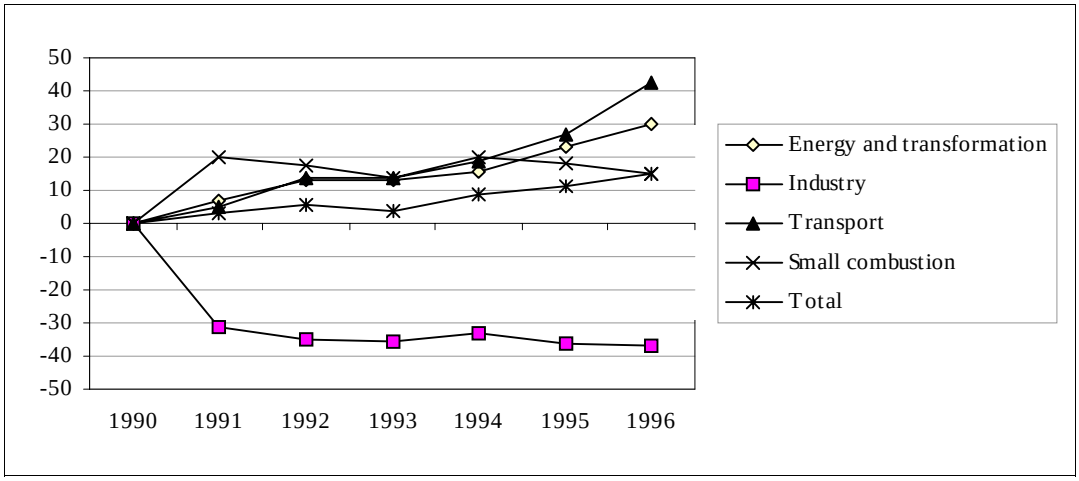
	1990	1991	1992	1993	1994	1995	1996*
Energy and transformation	10 863	11 629	12 295	12 298	12 574	13 374	14 100
Industry	5 431	3 730	3 538	3 481	3 640	3 452	3 429
Transport	4 885	5 124	3 538	5 543	5 811	6 198	6 950
Small combustion	7 859	9 446	9 238	8 935	9 418	9 266	9 033
Industrial processes	1 627	1 660	1 692	1 626	1 827	1 772	1 738
Waste	54	54	54	54	54	54	54
Total	**30 719**	**31 643**	**32 373**	**31 937**	**33 324**	**34 116**	**35 250**
Land-use change and forestry	5 160	5 390	5 580	5 760	5 970	6 230	6 497

* Provisional

16. The apparent anomaly between CO_2 emissions from industry in 1990 and in the following years is explained by the available disaggregation of total primary energy among the various fuels and sectors, as applied in the inventory for the particular year, rather than by methodological allocation when emissions are calculated. The team noted that the emission factor for coal for non-electricity generation was relatively low by international standards. It was based on a weighted average of the calorific value and carbon content of coal from different suppliers in the early 1990s and may need updating. Industrial process emissions relate to cement lime production and fertilizer production. There are only two cement and lime producers in Ireland and data were not available, owing to commercial sensitivities, although officials

obtained some information from the construction industry and via other 'informal sources'. No estimate is made of domestic wood burning for heating, as this is a small source of emissions.

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



17. It was estimated that forest covered about 570,000 hectares in 1995, of which about 390,000 hectares were owned by the State forestry company. Ireland does not have a national forest inventory covering both public and private forests, although the State company undertakes its own forest inventory. The most recent official full inventory of private forests was published in 1973, based on a survey of all forests over 40 hectares and a 9 per cent sample of those under 40 hectares. At that time the private forest estate was estimated at 82,000 hectares. There is only a small area of indigenous forest, of which approximately 5,200 hectares in national parks and nature reserves was excluded from the sinks inventory. As a result of the State-run forestry programme, officials regard data on tree coverage, type, yield class and annual planting as fairly accurate. Data for fellings were available from the issuance of forest service licences.

18. To estimate sink capacity the tree stock is split by yield class. National research showed that coniferous trees grow faster than the European average, given favourable climatic conditions in Ireland. After converting basic density to dry weight and estimating the carbon content of the dry weight, an additional 30 per cent was added for the amount of carbon assumed to be stored in roots and branches. Average yields are used; there is no dynamic model for inventory purposes. Officials noted that since 1990 a dynamic model would have resulted in a lower increment compared to that using a linear model. Using national absorption rates, it was calculated that forests absorbed about 6,200 Gg of CO_2 in 1995, an increase of 20 per cent on 1994. Officials stated that emission estimates have a 10 to 15 per cent range of uncertainty. Prior to the 1990s trees were mainly been planted on peat and during the 1990s were increasingly being planted on agricultural soil. There were no data on the effect of forestry activity on soil. The review team also noted that the inventory was not based on a three-year average as the IPCC guidelines require.

B. Methane

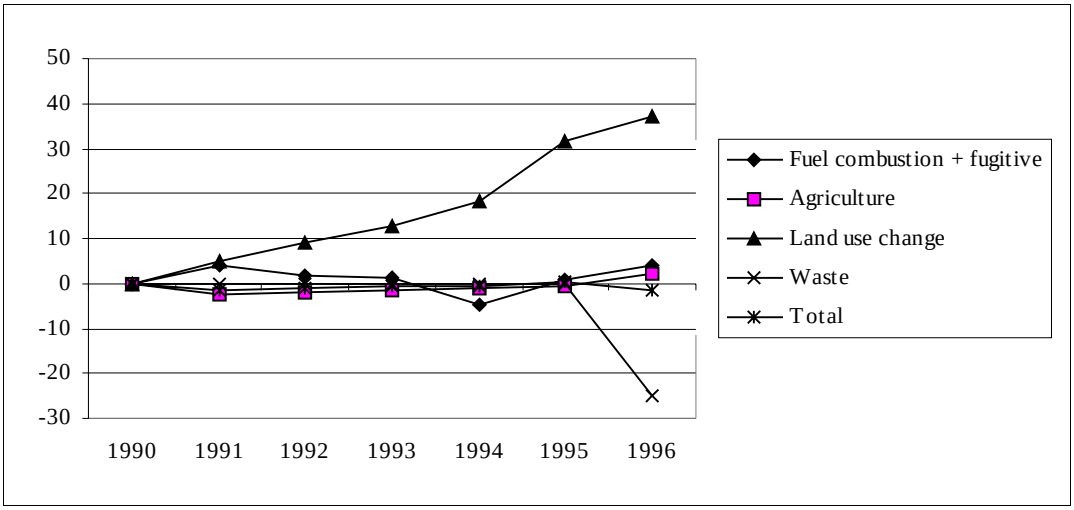
19. CH_4 emissions in Ireland are dominated by those from enteric fermentation in livestock. Emissions of CH_4 were around 1 per cent lower in 1996 than in 1990, as observed in figure 2. A number of assumptions underlie the figures. For example, there has been no estimate of CH_4 from the treatment of waste water as there is only one anaerobic digester in Ireland and this source was regarded as insignificant. Emissions from Ireland's single oil refinery and from peat conversion plants were also assumed to be negligible. It was assumed that natural gas is burnt by industry with 100 per cent efficiency, so that the only emissions from this category relate to coal use. Emissions from industrial processes are also assumed to be negligible, because coal is not used as a process feedstock.

Table 2. Emissions of methane, by source, 1990 - 1996 (Gg)

	1990	1991	1992	1993	1994	1995	1996*
Fuel combustion + fugitive	15.3	16.1	15.8	15.7	14.8	15.6	16.1
Agriculture	640.3	625.2	628.8	631.7	633.3	636.9	654.7
Land-use change + forestry	19.6	20.5	21.4	22.1	23.2	25.8	26.9
Waste	136.0	136.0	136.0	136.0	136.0	136.0	102.0
Total	**811.3**	**797.9**	**801.9**	**805.5**	**807.2**	**814.2**	**799.7**

* Provisional

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



20. Activity data on livestock numbers is fairly accurate. Historically, every five years there has been a complete enumeration of all farms and in other years a one quarter sample enumeration. Emissions factors for CH_4 from enteric fermentation are based on literature review, some measurement of data from Queens University, Belfast, and on consideration of the typical

livestock energy requirements and feeding systems in Ireland. Climatic factors are not taken into account in the estimation of CH_4 emissions from manure; sheep are always outdoors and cattle are mostly kept outdoors.

21. Landfilled municipal waste is the second most important source of CH_4 emissions in Ireland. Comprehensive reporting on the production and disposal of waste in Ireland has been hampered by the relative scarcity of complete and reliable data. In 1996, the EPA began the development of a new national waste database, beginning with 1995 survey data and intending that it would be regularly updated. Information on waste quantities was mostly estimated, as only a few landfills are equipped with weighbridges. The IPCC simplified approach to estimating CH_4 emissions from landfills was used, assuming that 70 per cent of the degradable organic carbon in landfilled waste results in equal emissions of CO_2 and CH_4 over a ten-year period. Officials noted that this approach could be very inaccurate for Ireland, as few landfills are deep enough to produce CH_4; they also noted that time-dependent methodology is not relevant for Ireland.

22. The review team noted that the assumed leakage rate from gas pipes used to estimate fugitive emissions was relatively high at 1.5 per cent, which was later confirmed by gas industry representatives, as the loss rate for 1995 was around 0.2 per cent. The emission factor needs to be changed over time to reflect replacement of old cast-iron pipes with better, virtually leakproof plastic pipes. No estimate was made for fugitive emissions from Ireland's offshore exploration and exploitation of gas reserves. Officials noted that the estimate of CH_4 from soils is very uncertain. Emissions from peat soils are excluded because they are non-anthropogenic and it is not known whether to include emissions from grasslands in the inventory.

C. Nitrous oxide

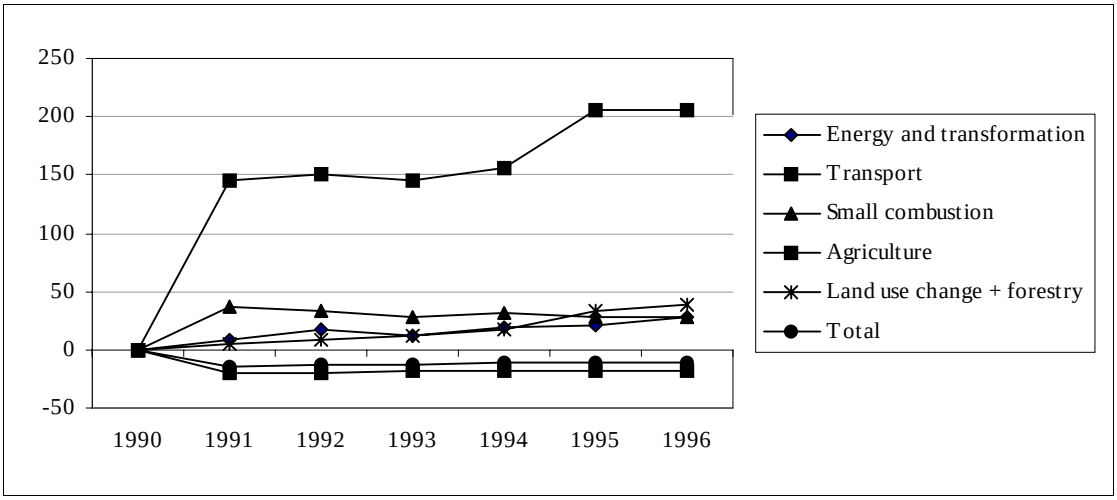
23. It can be observed in table 3 that emissions of N_2O fell slightly over the period 1990 to 1996.

Table 3. Emissions of nitrous oxide, by source, 1990 - 1996 (Gg)

	1990	1991	1992	1993	1994	1995	1996*
Energy and transformation	1.4	1.5	1.6	1.6	1.7	1.7	1.8
Industry	0.4	0.3	0.3	0.3	0.4	0.4	0.4
Transport	0.2	0.4	0.5	0.4	0.5	0.6	0.6
Small combustion	0.8	1.1	1.0	1.0	1.0	1.0	1.0
Industrial processes	2.6	2.6	2.6	2.6	2.6	2.6	2.6
Agriculture	23.3	18.7	18.7	19.0	19.1	19.1	19.0
Land-use change and forestry	0.6	0.7	0.7	0.7	0.8	0.9	0.9
Total	**29.4**	**25.3**	**25.4**	**25.7**	**26.0**	**26.2**	**26.2**

*Provisional

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



24. The team queried the change in N_2O emissions between 1990 and 1991, especially for transport, which officials attributed to methodological factors in converting from CORINAIR to the IPCC reporting format in 1990. Between the NC1 and NC2, the estimate of N_2O emissions from agriculture in 1990 fell from 39.5 Gg to 23.3 Gg. This was because previously a French default value was used, but national research resulted in an Irish emissions factor. For agricultural soils, the emissions estimate is based on measured N_2O losses for typical fertiliser application rates. Data for application are known to be reasonably accurate. Surveys have been conducted to analyse the amount of N_2O lost from fertilizer application, but given the great variation in soil type, officials noted that the margin of error could be a factor of two for emissions from this source. The team understood that emission factors for transport are not time-dependent, although the increased market penetration of cars with catalytic convertors necessitates this. There is only one nitric acid producer in Ireland, which supplies estimates of its own N_2O and NO_x emissions.

D. HFCs, PFCs, SF_6

25. There were scant activity data for the new gases, as there was no separate categorization in national statistics. All known suppliers of the gases have been contacted in order to estimate usage for 1995. Officials commented that resultant emissions estimates for the new gases have a high degree of uncertainty because of the poor quality of data on usage and leakage rates. HFCs are used in the manufacture of inhalants, but export volumes are unknown. The results of a United Kingdom study on emissions from cooling equipment have been used to inform the estimate of HFC emissions in Ireland, assuming that per capita emissions are similar. Two major electronics companies are known users of both PFC and SF_6. The ESB began auditing its usage of SF_6 in 1997, which is used, *inter alia*, in the insulation of high-voltage switchgear. At that time it had 250,000 kg in service and released about 1,140 kg. There has been no consideration of whether SF_6 is contained within imports of products and equipment.

III. POLICIES AND MEASURES

26. In general, the NC2 contains a good description of policies and measures. For several policies the estimated effect, in terms of CO_2 emissions avoided, was given, but not on a comparative basis throughout. It appeared to the review team that little attention had been given to monitoring the effects of climate change policies and measures. For those measures which have been analysed results are often non-comparable, as they are presented in terms of money saved, cumulative carbon savings or annual carbon savings. However, the team was presented with a report, dated April 1998, showing that serious consideration was being given to appraisal of GHG policy mitigation options.

27. There have been no cross-cutting taxation measures in Ireland to mitigate GHGs. Few policies and measures are specifically motivated to limit GHG emissions and it appeared to the team that climate concerns had not been integrated into agricultural policy, in particular. Nevertheless, many policies have this effect in practice.

A. Energy and transformation

28. Energy consumption in Ireland has grown in absolute terms and on a per capita basis during the 1990s. As in other developed countries, electricity continues to take a greater share of final energy consumption as the economy grows. Based on the provisional energy balance for 1996, electricity accounted for 17 per cent of total final energy requirements. Electricity has been predominantly generated from fossil fuels as the Government opposes nuclear energy. There is no scope for further large-scale hydroelectric plant and there is also limited scope for district heating owing to the low population density. The State operates several energy companies, including a vertically integrated, monopoly electricity supply company, the ESB, although there are a small number of private renewable and auto-generators. In 1998 the ESB portfolio of installed capacity was made up of a 915 MW coal plant, 860 MW from 2 oil plants which were both over 25 years old and being used more heavily as demand increased, 1,068 MW from 4 gas plants, a combined oil/gas plant with 510 MW capacity, 430 MW from 6 peat plants, 517 MW from 6 hydro plants and 60 MW from 3 wind stations. The shares in electricity generation, in 1997, were coal 34 per cent; gas 33 per cent; oil 18 per cent; peat 10 per cent; and renewables 5 per cent.

29. By 2001, competition should be introduced into the Irish electricity market as a result of the EC Directive on liberalization, initially providing large users with a choice of supplier, and the ESB will be restructured to operate in the liberalized market. Given the growing demand for electricity, there are difficulties with the early retirement of old fossil fuel plant, including peat plants with an average conversion efficiency of only about 25 per cent.

30. For reasons of security of supply and to maintain employment in rural areas, peat is likely to retain an important role in the Irish fuel mix. There was a decision to refurbish Ferbane peat power station, which should extend its life well into the twenty-first century, and there are plans to build a new 120 MW peat-fired power station in the Midlands with a conversion efficiency of

around 37 per cent, using EC funds, which should be ready early next century. A gas fired combined cycle gas turbine (CCGT) station is under construction and should provide an additional 470 MW of capacity by late 1999. All additional plant to meet expanding demand is likely to be either CCGT or renewables. It is unlikely, in the opinion of the review team, that independent renewables projects would exist outside of the government-supported schemes.

31. The electricity distribution network is being upgraded over the period 1998 to 2003, which should result in a reduction in losses and a saving, in terms of CO_2 emissions, of about 60 Gg per annum. However, increased loading on the high-voltage transmission network is likely to result in a corresponding growth in losses. The upgrading of boiler burners at the Moneypoint power station reduced NO_x emissions by 50 per cent from this source, and sulphur emissions were also within the EC target level in 1996 thanks to the availability of additional supplies of natural gas.

32. As of 1998, it was estimated that the Irish natural gas field had about five years of reserves remaining. Approximately 50 per cent of gas demand will be imported through the single interconnector to the United Kingdom in 1998 and this will increase on a yearly basis as the Kinsale Head Field depletes. As the State gas company has been required to operate on a commercial basis, this has limited the extent of the gas network. Of over 1.1 million households in Ireland, about 280,000 are gas customers. This number could increase to 460,000 by 2010, especially as most new houses include gas central heating. Studies were also underway to determine the gas supply infrastructure requirements to the year 2025, including options for a second inter-connector or to boost the capacity of the existing inter-connector to the United Kingdom to meet future demand.

33. Ireland actively participates in EC energy efficiency programmes. The JOULE-THERMIE programme promotes the research, development and demonstration of energy technologies. Within Ireland, emphasis was placed upon adapting technologies to local circumstances. Demonstration projects have included projects to improve hydroelectricity efficiency and complex wind turbine applications. The SAVE programme aims to reduce energy consumption through the development of energy-saving policies at both the national and the EC level. A number of directives related to this programme have been transposed into Irish law, including those on new gas-fired hot water boiler efficiency, insulation, energy audits, and energy labelling of domestic appliances such as fridges and washing machines. Funding was provided under the programme to assist in the establishment of seven local energy agencies.

34. There have been no obligations on the ESB to run energy efficiency projects. It voluntarily operated a demand-side management strategy from 1991 to 1997, involving expenditure of £Ir 7 million per annum (approximately £Ir 50 million over this period). Programmes were designed to encourage more efficient use of electricity, and technical and financial support was given to combined heat and power (CHP) projects. It was estimated that CO_2 emissions were, cumulatively, about 700 Gg lower than they would have been otherwise, but this number is uncertain as, in part, the strategy targeted the same companies as the Irish

Energy Centre (IEC) schemes. An evaluation of 69 initiatives conducted in 1995 showed that, although most had been cost-effective, in that the user's fuel bill was reduced by more than the cost of the investment, only one had been profitable for the company such that network costs saved exceeded the loss of sales revenue. Consequently, the revised strategy of the ESB as of December 1997, became to 'engage in the promotion of energy efficiency through actively marketing electricity as an efficient form of energy.' In this circumstance, it appeared to the team that promoting the sale of electricity more than 90 per cent generated by fossil fuel could be detrimental to the mitigation of GHG emissions.

35. The IEC, which is funded partly by the Government and partly by the EC, was established in 1994 to coordinate and implement the national energy conservation programme. It promoted a steam boiler evaluation scheme involving surveys designed to identify energy savings. Reports on 30 of the approximately 1,000 steam boilers in operation had been completed at the time of the review. A national boiler award scheme, established in 1996, is intended to further promote energy efficiency awareness. The Energy Audit Grant Scheme incorporated a more detailed study of energy use in companies and was up to 40 per cent subsidized. It was not designed to be a major saver of energy in its own right, as the IEC estimated that only 5 per cent of the savings identified would be spontaneously realised without government support. The IEC also offered a grant, under the Energy Efficiency Investment Support Scheme, to subsidize up to 40 per cent of the implementation costs for proven energy conservation technologies or measures, with an upper limit of £Ir 100,000 per site. This was thought to have been the most significant contributor to CO_2 reduction of ICE activities. These schemes all ended in 1997 with 477 audits having been supported and funds of £Ir 7.3 million committed to 236 projects. At the time of the review no comprehensive measures were in place or planned to address industry's energy use. Voluntary measures to limit industry's use of energy were under consideration by government officials, but industry representatives, in particular, were concerned about the lack of data on which to base such agreements in future.

36. Renewable energy accounted for about 2 per cent of primary energy supply or 6 per cent of electricity generating capacity in 1996, of which a significant proportion was large-scale hydropower, but owing to the interruptible nature of renewable energy sources, this represented less than 5 per cent of actual electricity generation. According to the Renewable Energy Strategy, published in 1996, installed electricity generating capacity from renewables should reach 10 per cent of total installed capacity by the end of 1999, or 450 MW, and increase to 14 per cent or 770 MW by 2010. The targets should mainly be achieved through the construction of wind farms although for technical reasons wind cannot provide more than 7 per cent of electricity supply. Small scale hydro, landfill gas and biomass plants should also benefit from funding. The Renewable Energy Strategy is based on a series of Alternative Energy requirement competitions offering funding, combined with agreements for the guaranteed purchase of electricity over a 15 year period. Awards are offered in excess of the required capacity, given that some projects will not achieve planning permission. The scheme was given £Ir 7.5 million in support from EC structural funds, in addition to government funding.

37. Tax relief for corporate equity investment in renewable energy sources was provided as of January 1998. Up to 50 per cent of the total costs, excluding land costs, of projects approved by the Minister for Public Enterprise can be financed under the scheme, subject to an overall cap of £Ir 7.5 million per project. In 1996, four Irish projects received funding totalling £Ir 285,900 under the EC ALTERNER programme which promotes the development of renewable energy within the EC. These projects mainly involved training and awareness-raising.

38. There is no flaring of natural gas in Ireland. Old cast-iron gas pipes in Dublin and Cork are being replaced at the rate of 3 to 4 per cent per annum with plastic alternatives, which has already resulted in a substantial reduction in leakages. By 2020 all iron pipes should have been replaced.

B. Transport

39. Transport-related CO_2 emissions grew by about 27 per cent between 1990 and 1996 to account for about one fifth of the national total. There has been a significant growth in road transport and little change in the use of the railways as, over this period, both the number of passenger-kilometres travelled by rail and the total rail freight tonnage were, broadly, unchanged. In contrast, based on survey data, total vehicle-kilometres travelled increased by between 5 and 8 per cent per annum over the period 1990 to 1996, vehicle-kilometres travelled per capita grew from 7,163 in 1991 to 8,836 in 1995 and the number of private cars grew from about three quarters of a million to over one million. Car ownership was still relatively low, compared to the rest of the EC, on a per capita basis. The number of goods vehicles was also on an upward trend for many years and exceeded 158,000, in total, by 1997. About 96 per cent of passenger traffic and about 89 per cent of freight traffic was carried by roads in 1995. The growth in freight transport demand has, in part, been attributed to increased dispersal of industrial activities away from traditional urban locations and increased use of 'just in time' delivery for inputs to manufacturing. Growth in tourism has also contributed to overall transport growth.

40. In 1996, almost 40 per cent of households lived in rural areas, defined as outside settlements exceeding 50 dwellings, which resulted in a high dependence on road transport, especially private motor vehicles. In the early 1990s, almost half of all road freight traffic involved journeys of less than 15 miles, which also suggests limited scope for a modal switch away from road to rail. In 1998, Ireland had the highest road density, measured in terms of kilometres per capita, in the EC, dating back to when the Irish population exceeded 8 million, more than double the 1998 level. Population dispersal makes bus routing difficult and limits the scope for cost-effective public transport. Rural bus services have received only a small part of public transport subsidies in the 1990s.

41. Environmental concerns feature in overall transport policy, but there have been no major cross-cutting policies to limit emissions, such as a fuel duty strategy. Some measures were intended to reduce the age profile and improve fuel efficiency of private vehicles and several measures have been targeted at limiting transport growth in cities, in part, owing to concerns

about congestion and local air quality. The Government's operational programme for transport was allocated a total of £Ir 2,611m between 1994 and 1999, of which 63 per cent should be spent on roads and 11 per cent on rail. The primary objective is to assist in the development of the economy and create employment, in part by reducing transport costs and improving reliability. The road programme focuses on bypasses, relief road schemes and linking cities. Whilst it is argued by officials that improved journey times and reduced congestion lower emissions, offsetting this is the possibility that improved roads increase the number of journeys made. As in previous years, about 90 per cent of the annual support for financially unviable public transport services went toward rail in 1997. The rail network in Ireland consists almost entirely of trunk lines connecting towns with populations in excess of 5,000 as the least profitable rural lines have been closed over the course of many decades. Almost all of the allocated funds are going on rail refurbishment and rolling stock to provide a faster and more efficient service; there were no plans to extend the network in 1998. Particular emphasis was given to improving the Dublin to Belfast service and Dublin radial routes.

42. In 1995, a special incentive was introduced to encourage scrapping of the most dangerous and worst polluting cars. A £Ir 1,000 refund of vehicle registration tax was available to owners of private cars over 10 years old buying a new car and scrapping their old one. During the period July 1995 to March 1997 over 29,000 cars were scrapped under the scheme, which ended in 1998. New vehicle registration tax differs by engine size. Adjustments were made in 1998 so that those over 2,000 cc pay 30 per cent, those between 1,401 cc and 2,000 cc pay 25 per cent, whilst those under this capacity pay 22.5 per cent of the purchase price. There is also a graduated annual road tax which applies to vehicles according to engine size. At the time of the review, the tax ranged from £Ir 92 for cars up to 1,000 cc to £Ir 800 per annum for all cars in excess of 3,000 cc.

43. Given Dublin's size of population, at around 1 million, the efforts of the Dublin Transport Initiative are of particular importance. The strategy included the establishment of a light railway system (LRS), improved bus services, improved rail services, park-and-ride facilities, improved enforcement of existing traffic measures and improved cycle access. For the period 1994 to 1999, about half of the £Ir 626 million budgeted was to be spent on roads and £Ir 200 m on the LRS. Although in absolute terms car travel will increase, by 2006 it has been predicted that more passengers will travel by public transport than by car. In May 1998, the Government decided that an expanded LRS should be built with an underground section in the city centre. A public enquiry was held in November 1998 into the first stage of the expanded system which somewhat delayed the original timetable for construction. The LRS network is being designed more to improve mobility for those without cars than to achieve a modal switch. There has been trial use of one natural gas fired bus in Dublin and while there is infrastructure for liquefied petroleum gas refuelling by private vehicles in Dublin and elsewhere, there was no gas fuel infrastructure for public transport and no long-term plans for alternative fuelled vehicles, as of May 1998.

44. In 1995, transport was the largest source of NO_x emissions accounting for over 41 per cent of the national total. The growth in transport has, thus far, counterbalanced technological improvements in vehicle standards.

C. Agriculture

45. The agricultural sector has a greater prominence in Ireland than in many other EC countries, accounting for about 7 per cent of Irish GDP, around 11 per cent of employment and about 40 per cent of net foreign exchange earnings in 1995. Livestock and livestock products accounted for nearly 87 per cent of the value of gross agricultural output in 1995. Approximately 78 per cent of CH_4 emissions in 1995 were attributed to the agricultural sector, with CH_4 releases from animals about three times the total natural gas consumption in the residential sector, and 73 per cent of N_2O emissions. A number of agricultural reforms and measures to address environmental problems such as water quality may, in effect, also limit GHG emissions.

46. The level of emissions from agriculture is highly dependent on animal numbers which, in turn, are strongly influenced by policy at both the national and the EC level. From 1990 to 1996 cattle numbers rose from around 6.9 million to 7.4 million, sheep numbers fell from 8.5 million to 7.9 million, whilst pig numbers rose from 1.2 million to 1.6 million and the number of poultry increased from 11.3 million to around 13.1 million. Policy changes in the 1990s could slow or reverse upward trends. The 1992 EC Common Agricultural Policy (CAP) reform package included the imposition of ceilings on the number of animals eligible for premium payments and an additional 'extensification' premium for producers whose stocking densities were less than 1.4 livestock units per hectare. Officials noted the effect is likely to be minor. An agri-environment programme accompanied the CAP reform, including the provision of aid to farmers who reduce applications of fertilizers and pesticides, adopt organic farming, set aside farmland for 20 years for environmental purposes and manage land for public access and leisure activities. By the end of February 1997, approximately 23,200 out of around 140,000 farmers had been approved under the related Rural Environment Protection Scheme (REPS), resulting in around 772,000 hectares or 16 per cent of total agricultural land being farmed in a so-called 'environmentally friendly' manner. Officials envisaged that 43,000 farms could participate in the REPS by 1999. A voluntary EC agreement related to protection of land with a high natural value, agreed in May 1998, is expected to reduce the stocking intensity of sheep.

47. The consumption of nitrogen fertilizers exhibited an upward trend for two decades. The 1996 Code of Good Agricultural Practice to Protect Waters from Pollution by Nitrates, prepared in response to obligations under EC law, includes recommended nitrogen application rates. It should be promoted by local authorities and farmer representative associations. As part of the Code of Good Agricultural Practice, farmers collect and store animal waste which they are encouraged to spread in the spring when the soil is dry; this maximizes the uptake of nutrients by crops as opposed to the traditional practice of autumn spreading when the land is wet and the

conditions are anaerobic; hence the new practices could reduce N_2O emissions. The sole disposal route for slurries in Ireland is land spreading.

48. National research has shown it is technically feasible to improve milk productivity by improving the genetic make-up of herds and switching from silage feeding to pasture grazing, and that it may also be possible to improve the feed-to-meat conversion rates in beef and sheep by similar strategies. It could be possible to reduce CH_4 emissions from agriculture, related to dry matter up-take, by up to 25 per cent with no loss in agricultural output. However, this would entail an increase in costs and no plans were in place to implement such changes at the time of the review.

D. Forestry

49. In 1995 the forest, predominantly Sitka spruce, covered about 8 per cent of the total land area, the lowest proportion in the EC. The balance of ownership may change as afforestation by the private sector, especially by farmers, has increased in recent years and has exceeded that of the public sector and because the State has very limited land available for afforestation. Annual timber production was about 2.2 million m^3 in 1996. The Department of Agriculture, Food and Forestry has a long-term strategic forest expansion plan to increase this figure to 10 to 15 million m^3 in order to compete in international timber product markets. The aim is to achieve afforestation levels of 25,000 hectares per annum by 2000 and 20,000 hectares per annum by 2030, resulting in 17 per cent of land with forest cover. The annual target reported in the NC1 was 30,000 hectares per annum, but this was found to be overly ambitious. Annual afforestation between 1990 and 1995 averaged around 19,000 hectares per annum. In 1996, planting fell to 14,000 hectares, but this low level was attributed to an expectation by farmers of higher payments in following years. Afforestation is driven by the availability of attractive grant and premium supports and virtually no afforestation is undertaken without such assistance. The grant covers costs of afforestation whilst the premium is broadly equivalent to earnings from alternate land use.

50. Since 1981 a variety of forestry development programmes have been supported by the EC, of which the most recent CAP Forestry Accompanying Measure, introduced in 1994, was designed to encourage the alternative use of agricultural land through a range of grant aid for afforestation and premium payments. As of March 1996, the afforestation grant varied from a total of £Ir 1,500/hectare for non-diverse conifers to £Ir 3,000/hectare for mostly oak and beech species. An annual 'forest premium' to farmers ranged from £Ir 155/hectare to £Ir 300/hectare according to the type of tree species and quality of the land, whilst non-farmers received a maximum of £Ir 120/hectare. At these grant and premium levels, the total cost of supporting afforestation in the period 1996 to 2030 inclusive was estimated at £Ir 3.1 billion, at 1996 prices. A total of 1,300 farmers undertook afforestation projects in 1995 and afforestation grants totalling £Ir 79 million plus forest premiums amounting to over £Ir 4 million were paid in that year. At the time of the review, 75 per cent of afforestation grants and premium payments were funded by the EC. The future completion of the strategic expansion plan may be dependent on a continued high level of EC support.

51. The forest area is maintained through the control of felling, including thinning, under the Forestry Act, 1946. For most felling licences issued by the State Forest Service, replanting is a standard condition. The annual reforestation rate in 1995 was of the order of 5,000 hectares.

E. Waste

52. In Ireland, landfill has been the primary method for the disposal of household, commercial and industrial wastes. Landfill waste accounted for about 17 per cent of CH_4 emissions in 1995. A number of measures, which parallel initiatives at the EC level, are designed to prevent waste, reduce quantities of non-recoverable waste, and recycle and dispose safely of non-recoverable wastes. The Government adopted a target of diverting 20 per cent of combined household and commercial waste away from landfill through recycling by 1999, compared to a diversion rate of about 7 per cent in 1995. Efforts will be directed at packaging waste, the combustible fraction of household and commercial waste and waste newsprint. These measures may have some impact in reducing energy use and also on CH_4 emissions from landfills. In 1995, recovery rates were well below those necessary to meet targets. Ireland's low population density, which makes collection costs relatively high, along with a small domestic market for recycled products could limit the scope of future recycling activity.

53. The 1996 Waste Management Act should contribute toward limiting CH_4 emissions. It requires all landfills to be licensed by 1999 as, to date, most local authority landfills have not been subject to environmental control, in breach of EC legislation. In issuing licences the EPA will require, as far as is practicable, all landfills to introduce gas flaring or collection and recovery systems. In 1995, of 118 active landfill sites surveyed, only 2 had gas collection and flaring. Landfill manuals have been produced which set out good practice guidelines for landfill management including the use of gas recovery systems. Although they are voluntary, many landfills were expected to follow the guidelines. There is a strong emphasis in the Waste Management Act on waste planning with local authorities required to prepare waste management plans with, *inter alia*, objectives to minimize waste arisings.

F. Buildings

54. The housing stock is unusually new by European standards, making the need for replacement relatively low, but there is demand for additional dwellings to accommodate both a growing population and an increasing number of single person households. Revised Building Regulations, introduced in 1992, provided higher standards of thermal insulation for new buildings. By 1996, about 12 per cent of the housing stock had been constructed under these regulations. Since the introduction of the regulations insulation levels were estimated to have increased by up to 50 per cent and overall energy use in new buildings was estimated to have been reduced by up to 20 per cent. Further amendments are to be made, following a recent review of the regulations, and should yield additional savings in the order of 5 per cent of energy use for space heating. The accompanying revised Technical Guidance Document will contain an optional energy rating system for new houses to inform customers of relative energy

requirements. The IEC has developed a software package and a set of guidance notes to support architects in the application of building regulations. The review team noted that, as there are no measures to improve the insulation of the existing building stock and house numbers are increasing, emissions from this sector are likely to rise.

55. Under the EC THERMIE programme, with funding of just over £Ir 500,000, 58 houses had been built in Ireland by 1997 to demonstrate the practicability of cost-effective high energy efficiency houses. A second project involving 500 houses was under way with additional funding from the IEC. In the public sector there is a plan to reduce energy consumption in buildings by 10 per cent over the period 1995 to 2000.

G. New gases

56. As of 1998, work was under way to identify sources of HFCs, PFCs and SF_6, but there were no mitigation measures in place, apart from a recent initiative by the ESB to develop a SF_6 detection programme, including the purchase of leak detection equipment, with a view to significantly reducing SF_6 emissions.

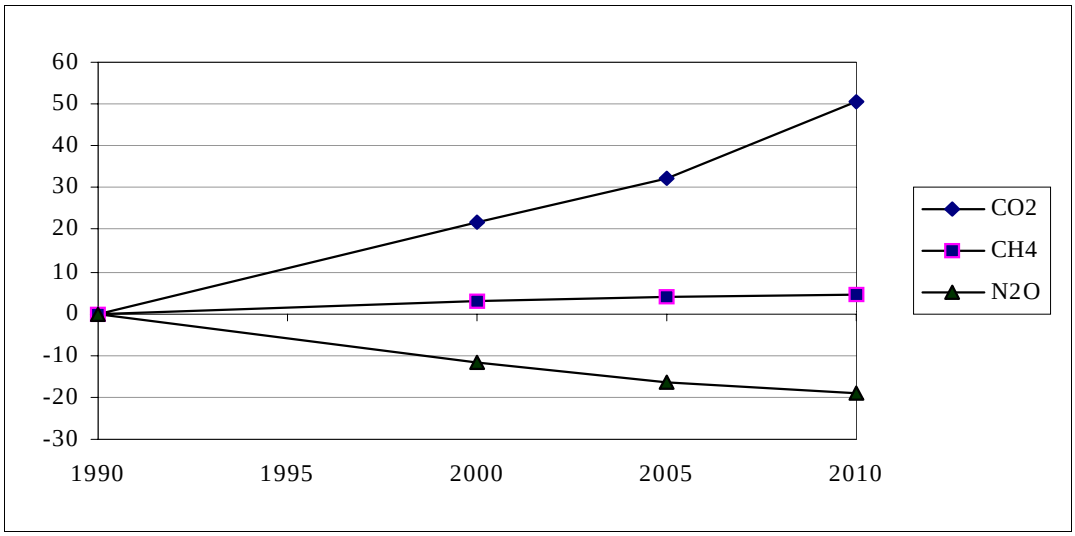
H. Measures that conflict with GHG mitigation

57. The EC Rural Environment Protection Scheme is a competing attraction to forestry for some categories of farmers, especially cattle and sheep farmers, owing to the relative returns. Forestry payments need to be at least equal to what farmers would otherwise earn from the sale of agricultural produce, plus EC agricultural support payments and over time the payments will become more expensive as increasingly profitable agricultural land is converted. For reasons of security of supply, existing inefficient peat power plants are being maintained and new plant constructed. The roads programme, supported by EC funding, is intended to support economic growth, but could also lead to an increase in emissions.

IV. PROJECTIONS

58. The NC2 contains information about projections of the three main direct greenhouse gases, CO_2, CH_4 and N_2O up to 2010. Officials were reluctant to provide projections beyond 2010 because of the high level of associated uncertainty. There has been no analysis of emissions without existing policies and no analysis of different scenarios with alternative economic growth or fuel price assumptions, for example. Revised projections were provided during the review, as shown in figure 4. There has only been a small increase in the expected emissions of CH_4 and the figures for N_2O have only been slightly modified to take account of a forecast decrease in the use of nitrogen fertilizer. The CO_2 figures have been substantially revised upwards, reflecting a change in modelling procedures along with updated assumptions about economic growth, in particular.

Figure 4. Projected emissions, percentage change from 1990



59. The NC2 contains a very brief description about projections which were made on the basis of a simple correlation between total primary energy requirements and GDP. The review concentrated on how the revised projections were made. The Economic and Social Research Institute's (ESRI) "Medium Term Review 1997 - 2003" (April 1997) provided the basic economic assumptions for all official projections. Its economic growth forecasts formed the basis of ESB International (ESBI) energy projections, on behalf of the Government, and resultant CO_2 projections. The in-depth review report focuses on the ESRI economic growth forecasts and the resultant ESBI emission projections, including the underlying assumptions.

60. Underlying the ESRI projections, population is forecast to grow to about 3.9 million in 2011. The supply of labour is of great importance to the likely future course of the Irish economy and is likely to continue growing at about 1 per cent per annum to 2010, owing to natural increase, migration and increased participation of women. Here one of the greatest causes of uncertainty lies in the volatile nature of migration, which is sensitive to conditions in both the domestic labour market and abroad. The bulk of new workforce entrants will have a higher level of educational attainment than the labour force as a whole. The effect of increasing numbers of young, well-educated adults on housing demand is also factored into the projections. As Ireland is a small open economy, assumptions are made about export markets and hence the economic state of major trading partners. For example, it has been assumed that the European Monetary Union goes ahead on 1 January 1999 with Ireland amongst the first members, thereby maintaining European inflation at around 2 per cent for the forecast period. It has also been assumed that a major reform of the EC CAP takes place around the end of the decade such that trade restrictions are removed and EC agricultural prices fall to world levels. As Irish economic progress continues, it is assumed that structural funds from the EC are halved as a share of GNP from 2000 to 2005 and halved again in the following five years. It is also assumed that Irish labour costs remain lower than those of other European countries, thanks to moderate wage

inflation, at least until 2003. The combined effects of educational improvement, demographic changes expanding the labour force, continued development of the physical infrastructure and stable macroeconomic circumstance are expected to result in annual output growth of around 5 per cent up to 2010, nearly double that forecast for overall GDP growth in the EC, although the precise timing of the growth is uncertain. This compares to 4 per cent GDP growth assumed for the projections in the NC2.

61. There is a considerable margin of error around the central forecast of GDP, with the size of error on the up side seemingly smaller than the potential for the economy to underperform. The economy could do better than expected if female labour force participation is greater than assumed or because of substantial net immigration. Perhaps the most likely way in which the economic boom could slow down would be due to capacity constraints and higher wage inflation than anticipated raising the costs of production. The upper and lower bounds are about 6 per cent and 3.5 per cent per annum.

62. On the basis of the central GDP forecast, final demand for each energy type is assessed. This is calculated principally using the historic elasticity of fuel and electricity demand with respect to GDP, i.e. the percentage increase in energy consumption given a one per cent increase in GDP. It is assumed all marginal electricity production is generated using CCGTs which burn gas with an efficiency of 55 per cent. According to the ESRI, final energy consumption in 2010 could be around 15.3 mtoe, more than double the 1990 consumption level. Demand for oil and gas is expected to increase most significantly whilst final consumption of peat and coal fall substantially. CO_2 emissions from energy use may then be 175 per cent to 185 per cent of the 1990 level.

63. The ESB International energy projections, on behalf of the Government, are founded on the ESRI economic growth estimates. They are based on historic econometric relationships, without the use of an energy sector model. Emission estimates are then made by multiplication of emission factors by fuel consumption estimates. Current energy policy, as of 1997, is assumed to be implemented, including the achievement of renewable energy goals. Although the electricity market is due to be liberalised, it is assumed that real prices will not fall, in part because they are already low by European standards. Data deficiencies made subdivision of fuels by sectors difficult. For example, industrial, commercial, residential and agricultural energy use are treated together. As a result, the review team noted that it is difficult to use these projections for domestic policy-making purposes. There are separate statistics for the transport sector where data are collected for taxation purposes and also separate information about electricity consumption, which appears to have had a 1:1 relationship with GNP growth since 1985. Whilst saturation effects begin to occur in the ownership of electrical goods, this is offset by increasing numbers of households. Having forecast useful energy demand, assumed efficiency improvements and assumptions about the electricity generating mix were used to estimate the likely future fuel demand. It was assumed that the least efficient peat-fired electricity generation plants are closed and that installed capacity doubles over the forecast period with the construction of modern efficient CCGT plant. Coal plant is maintained for reasons of security of supply, but gas is expected to account for 65 per cent of generation in 2010

and renewables 8 per cent. Officials noted that the wind-power capacity is likely to be greater than in the projections and generation efficiencies may improve still further. Overall, CO_2 emissions were expected to be about 51 per cent higher than the 1990 level by 2010. At the time of the review, there were proposals to build two or three additional cement plants in Ireland. Their construction could increase predicted CO_2 emissions by an additional 5 per cent by 2010.

64. Separate consideration was given to emissions from transport. It was noted during the review that the projections reported in the NC2 include aviation bunker emissions. No policies are incorporated into the projections. Again the projections were based on historic elasticities which suggest a 1:1 relationship between GNP growth and transport fuel demand. This is complicated by the changing pattern of fuel consumption as tax differentials between the UK and Ireland have affected purchases. There are more people moving into the labour force than leaving it, which is likely to increase demand for cars, but it is not yet necessary to model saturation effects because car numbers per capita are below the EC average. Car ownership in 1995 was 27 per 100 people, compared to 43 per 100 in the EC. Car numbers are expected to be in the range 1.6 million to 1.8 million by 2010, compared to about 1.1 million in 1996. Any likely improvement in fuel efficiency is assumed to be negated by increased congestion, so this is not taken into account. Little growth in export freight traffic is assumed as growth is most likely to be in the services sector. The revised ESBI transport emissions projection showed an increase of 40 per cent relative to 1990 levels by 2010, compared to a forecast increase of 77 per cent in the NC2 and 15 per cent according to ESRI projections.

65. Since the NC2, projections of the new gases have been made, although these are based on provisional data for 1990 and 1995, as shown in table 4.

Table 4. Emissions of HFCs, PFCs and SF_6, 1990 - 1995 and projections for 2000 - 2010 (tons of CO_2 equivalent)

	1990	1995	2000	2010
HFCs	1	111	254	656
PFCs	0	103	597	912
SF_6	45	84	120	72
Total	**46**	**298**	**971**	**1,640**

66. The NC2 includes an estimate of future removal of CO_2 by sinks. This could reach 7,580 Gg by 2000 and 9,690 Gg by 2010, compared to 5,160 Gg in 1990. Given the strategy to increase the total forested area, no deforestation is assumed. Sink absorption was calculated using planned planting rates. It was assumed that Sitka spruce represents 70 per cent of the conifer forest and that oak is the main component of broadleaves. It was also assumed that these trees grow faster in Ireland than in average conditions. The forecast assumes a simple growth pattern, whereas growth rates actually follow an S curve such that CO_2 absorption rates are lower in early years and at maturity. Officials noted that the projections may be over-optimistic as the

planned tree planting rate may not be sustained over time. There is potential to afforest peatland, which means that carbon will be released during initial drainage.

67. Not only is the estimate of CH_4 from waste constant in the inventory from 1990 to 1995, the same figure is used for projections up to 2010. It appeared to the review team that no change in the volume or composition of waste has been assumed in the projections although it could be argued that increases in waste arising associated with population growth could be offset by increased recycling and gas capture. Similarly, in estimating non-CO_2 transport emissions over time, the emission factor did not change, despite the likelihood of increased market penetration by cars with catalytic converters. Furthermore, projected CH_4 and N_2O emissions from agriculture also remained unchanged over the forecast period.

68. The CH_4 projections in the NC2 assume no change in cattle or poultry numbers over time, a fall in the number of sheep to 7.4 million in 2005 and an increase in the number of pigs to 2.2 million in 2005, but no changes thereafter to 2010. Revised agricultural emission projections have been produced since the publication of the NC2, as part of work by independent consultants on behalf of Government. They are mainly based on projections of animal numbers and land using a policy background of 1992 CAP reform, changes resulting from the 1995 GATT Uruguay round trade negotiations and further EC proposals for reform in 1997. From 1996, a decrease in the number of dairy cattle from around 1.3 million to about 0.8 million in 2010 is projected and other cattle numbers could increase from approximately 0.6 million to 0.7 million in 2010 whilst there could be 8.8 million sheep in 2010 compared to about 7.9 million in 1990. In contrast to these estimates, the national agricultural expert informed the review team that cattle numbers are unlikely to change up to 2005, although some farms are above the stocking requirement for a revised EC funding scheme and productivity improvements in diary farming could result in some reductions. The expert also predicted that sheep numbers could fall by about 7 per cent by 2005 due to changes in EC agricultural policy and pressure to reduce overgrazing, soil erosion and water contamination. The study's predicted increase in pig numbers was confirmed by the expert, due to an expected increase in demand for pork. The projections of the study for CH_4 are as shown in table 5.

Table 5. Projected methane emissions, 2000 - 2010 (Gg)

	2000	2005	2010
Enteric fermentation and manure management	619	643	659
Agricultural soils	28	27	26
Total	**646**	**670**	**686**

69. The new study also provided alternative figures for N_2O, assuming total crops remain broadly constant. The area of grassland with fertilizer may fall from about 3.3 million hectares in 1996 to around 2.9 million hectares in 2010. N_2O from soils is projected to fall from 23 Gg in 1990 to 18 Gg in 2000, 18 Gg in 2005 and 17 Gg in 2010. Underlying the projections in the NC2, it was assumed that nitrogen fertilizer use will decline by 10 per cent by 2005 and

15 per cent by 2010, compared to 1995, as a result of new codes of good farming practice and that there is a 1:1 relationship between application rates and emissions. It was further assumed that more farmers join the environment scheme to limit nitrogen fertilizer use. However, this does not seem to be reflected in the figures in the NC2 which show agricultural N_2O emissions lower in 2000 than 1990, but then unchanged over the period 2000 to 2010.

Table 6. New agricultural emission projections compared to NC2; percentage change in 2010 compared to 1990

	New study	NC2
Enteric fermentation (CH_4)	7.4%	2.9%
Manure management (CH_4)	28.7%	12.1%
Agricultural soils (CH_4)	-24.8%	-16.5%
Agricultural soils (N_2O)	-25.6%	-18.7%
All agriculture (GWP basis)	-4.4%	-5.1%
Total CH_4	**7.3%**	**3.4%**
Total N_2O	**-16.8%**	**-11.2%**

V. EXPECTED IMPACTS AND ADAPTATION

70. A study was conducted in 1991 on the possible impacts of climate change in Ireland up to 2030, based on information contained in the IPCC first assessment report; it considered different scenarios for changes in average temperature and sea level rise. At the time of the review, it still represented the best available understanding. Potential positive impacts include improvements in agricultural and forestry production. Negative impacts include greater risks of flooding along with increased severity and duration of rainfall in winter, regular water shortages in summer affecting population and ecosystems and more storm events on both the east and west coasts. Peatlands could suffer serious damage if summer soil has less water. As peatlands gradually shift toward drier shrub or grass-dominated heath CO_2 would be released. A draft coastal zone management policy was published in 1997 which should lead to public consultation about, *inter alia*, marine environmental protection, land use, coastal protection and conservation of habitats. Consideration of climate change impacts has not yet led to specific adaptation measures.

VI. EDUCATION AND PUBLIC AWARENESS

71. The IEC has been the main provider of education material related to energy efficiency. It allocated approximately half its budget or £Ir 10 million to awareness raising activities over the period 1994 to 1999. Energy Watch Day is the culmination of a week's energy efficiency related activity in primary schools for the 7 to 11 year old age group. About 10,000 students took part in 1997, compared with 5,000 in 1996. Pamphlets about energy efficiency have also been produced

for this age group, for distribution to schools on request. At secondary level the energy link project aims to foster relationships between schools and local businesses and to raise awareness of energy efficiency. An 'Energy Conservation and the Environment' resource pack has been distributed to schools as an additional source of information. The IEC developed a series of leaflets covering the main aspects of energy use in the home and guides to saving energy, which are issued on request or at exhibitions. It has also been associated with the 'Our House' television series which, in part, has promoted energy-saving ideas. The Energy Awareness Week further promoted such ideas to householders by the inclusion of energy efficiency pamphlets with The Irish Times. A public information service called Enfo was established in 1990 to provide easy public access to wide-ranging information on the environment, including climate change. *Inter alia*, it collects and maintains up-to-date information in a variety of media, operates an information centre and presents exhibitions on environmental themes.

VII. FINANCIAL ASSISTANCE

72. Ireland is making steady progress in official development assistance toward achieving the United Nations recommended target of 0.7 per cent of GNP. In 1997, £Ir 124m or 0.31 per cent of GNP was allocated to overseas aid compared to £Ir 40m or 0.16 per cent of GNP in 1992. Ireland is a party to the Global Environment Facility and made its first contribution of £Ir 425,000 in 1996. Ireland's bilateral aid programme does not contain any projects specifically related to climate change mitigation or adaptation, but some of the initiatives will have benefits in this respect.

VIII. RESEARCH AND SYSTEMATIC OBSERVATION

73. Irish research has focussed on energy efficiency, renewable energy sources and the effects of climate change. Most effort has been put into EC related programmes. The IEC has participated in the JOULE and THERMIE research and technological development and demonstration programmes. As part of the EC environment programme, under the Fourth Framework Programme, work has been carried out in Ireland investigating the basic process of climate change, atmospheric physics and chemistry and hydrological risks associated with climate change. Ireland is also involved in the International Geosphere-Biosphere Programme. There were 14 synoptic observing stations in Ireland in 1997, distributed principally around the coast. There were a further 80 climatological observing stations distributed throughout the country.

IX. CONCLUSIONS

74. Ireland has an objective to limit the increase in CO_2 emissions to no more than 20 per cent over the 1990 level by 2000. Between 1990 and 1996 total CO_2 emissions increased by about 13 per cent. Overall CH_4 emissions fell by around 1 per cent over this period and N_2O emissions also fell slightly. On the basis of the projections presented during the in-depth review, compared to the 1990 level, CO_2 emissions may be 22 per cent higher by 2000 and 51 per cent higher by 2010. CH_4 emissions may increase only modestly to be about 3 per cent above the

1990 level in 2000 and around 5 per cent higher in 2010 whilst N_2O emissions may fall by around 12 per cent by 2000 and approximately 19 per cent by 2010.

75. In general, the review team formed the impression that basic activity data for compilation of the inventories were adequate, but disaggregation was difficult and data were absent for several of the minor emission sources. Some inconsistencies were noted between the reporting of data for 1990 and subsequent years, given that methodology was changed, but the 1990 base year was not recalculated.

76. Ireland has witnessed a significant improvement in economic growth and standards of living in recent years, leading to increased energy use and rising GHG emissions. At the time of the review, Ireland had few policies and measures that were specifically designed to mitigate GHG emissions. Nevertheless, some policies with other goals had this effect in practice. For example, plans to create an internationally competitive timber products industry will also significantly enhance Ireland's CO_2 absorption capacity. Concerns about air quality have driven measures in the transport sector although there were no significant cross-cutting measures to tackle the continued growth in demand for car transportation.

77. As natural gas is increasingly used as the fuel of choice for electricity generation and for central heating in homes this will lower CO_2 emissions compared to the use of fossil fuels with a higher carbon content. The renewables programme, with support of EC funding, should increase electricity generation from this source, especially wind. In contrast, for reasons of security of supply and to maintain employment in rural Ireland, peat continues to have an important role in the energy balance.

78. Agriculture is an important component of Ireland's economy and hence a major source of CH_4 and N_2O emissions. Reforms to the CAP may reduce livestock numbers and hence emissions, although the effect is unlikely to be significant. Recent legislation relating to stricter environmental controls at landfills should result in more gas flaring and hence reduce CH_4. Aside from the provision of advice about energy efficiency, little was being done to promote emissions mitigation in either industry or households at the time of the review as several schemes had been discontinued. However, new buildings were being constructed with a higher standard of insulation than in the early 1990s. Various schemes have been targeted at schools and households to encourage energy-saving behaviour. There has been less activity to raise public awareness about the climate change issue.

79. Although monitoring the mitigation effects of existing policies has been limited, prior to the in-depth review Ireland undertook a comprehensive appraisal of potential policies and measures to mitigation emissions across all sectors. This will form the basis of policies to achieve targets agreed under the Kyoto Protocol.

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