

ANALYSIS OF PER CAPITA GREENHOUSE GAS EMISSIONS IN EU-25 COUNTRIES

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Abstract. *The European Union is committed to global efforts to reduce the greenhouse gas emissions from human activities. In the first step countries accepted to reduce greenhouse gas emissions by around 5 % compared to 1990 levels, but in the longer-term, global emissions of greenhouse gases will need to be reduced by approximately 70 % and it forces the countries to update national emission inventories each year. An analysis of per capita GHG emission has been made with 25 member state of EU responsible for about 41 % of total greenhouse gas emissions. The 15 member states that made up the EU until 1 May 2004 are committed to reducing their combined emissions of greenhouse gases by 8 % from 1990 levels by the end of the Kyoto Protocol's first commitment period 2008–12. The 10 new Member States are not covered by the EU target but have their own reduction target of 6 % or 8 % under the protocol, except for Cyprus and Malta, which have no targets. Many of the EU countries have greenhouse gas emissions greater than 6 t CO₂-eq/cap. In 2004, the most important sources of greenhouse gas emissions in the EU-25 include energy industries (electricity sector and refineries) (28 %), transport (21 %), industry (without energy sector) (20 %), households and SMEs (17 %), agriculture (10 %) and other sector (4 %). Directive 2003/87/EC established a scheme for GHG emission allowance trading within the community in order to promote reductions of GHG emissions. EU scheme allows companies to use credits from Kyoto's project-based mechanisms, joint implementation (JI) and the clean development mechanism (CDM), to comply with their obligations under the scheme. This means the system not only provides a cost-effective means for EU-based industries to cut their emissions but also creates additional incentives for businesses to invest in emission-reduction projects in developing countries. The transfer of advanced, environmentally sound technologies to other member states and developing nations, gives tangible support to their efforts to achieve sustainable development, but per capita GHG emission data indicate the importance of grouping to share reduction between global regions and countries.*

Key words: Per capita greenhouse gas emission, EU-25 countries, Climate Change

INTRODUCTION

This paper presents information on per capita greenhouse gas emission in EU-25 countries. The estimates are consistent with the IPCC revised Guidelines for National Greenhouse Gas Inventories (IPCC, 1996) and Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC, 2000, 2003). Under the Kyoto Protocol the inventory covers the six direct greenhouse gases; carbon dioxide, methane, nitrous oxide, hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulphur hexafluoride (SF₆).

The Global Warming Potential (GWP) is a means of providing a simple measure of the relative radiative effects of the emissions of the various gases. Greenhouse gases have different effectiveness in radiative forcing and the direct and indirect GHGs emissions are estimated using methodologies corresponding to the guidelines of the IPCC protocol. The GWP index is expressed relative to that of CO₂ and defined as the cumulative radiative forcing between the present and a future (100 years) time horizon caused by a unit mass of gas emitted.

The greenhouse gases have different lifetimes in the atmosphere and the GWP of greenhouse gases are also changeable; methane (21), nitrous oxide (310), hydrofluorocarbons (140-11700), perfluorocarbons (6500-9200), sulphur hexafluoride (23900). This paper provides per capita emission estimates for the EU-25 countries for the year of 2004.

RESULTS AND DISCUSSIONS

The result of intensive international negotiations is only the first step in combating human-induced climate change and further action is necessary to reach the ultimate objective of the Kyoto Protocol to the United Nations Framework Convention on Climate Change (UNFCCC). The key issue is the stabilisation of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system

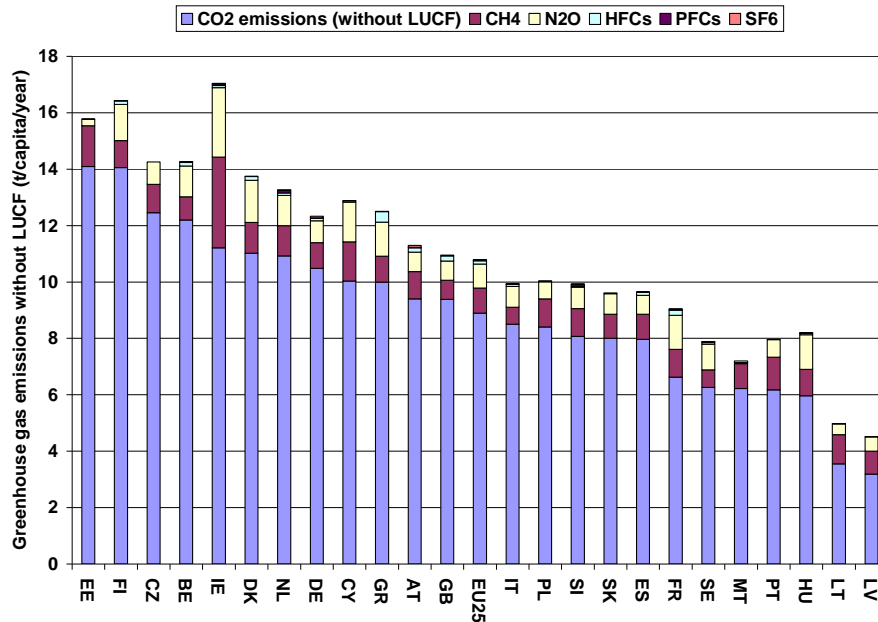


Figure 1. Greenhouse gas emissions without LUCF (CO₂ equivalent t/capita/year)

BE=Belgium, CZ=Czech Republic, DK=Denmark, DE=Germany (including ex-GDR from 1991), EE=Estonia, GR=Greece, ES=Spain, FR=France, IE=Ireland, IT=Italy, CY=Cyprus, LV=Latvia, LT=Lithuania, HU=Hungary, MT=Malta, NL=Netherlands, AT=Austria, PL=Poland, PT=Portugal, SI=Slovenia, SK=Slovakia, FI=Finland, SE=Sweden, UK=United Kingdom

Except for Latvia and Lithuania, EU-25 countries had greenhouse gas emissions greater than 6 t CO₂-eq/capita/year (Figure 1). Per capita emission was lowest in Latvia (4.5 t/capita/year) and highest in Luxemburg (23.850 t/capita/year, not included in Figure 1) Estonia (15.8 t/capita/year) and Finland (16.4 t/capita/year).

The largest contributor to global warming in EU-25 countries was carbon dioxide (72.5 %). Methane contributes 8.3 % and nitrous oxide 7.9 % of the weighted emission. In spite of their high GWPs the contribution of halocarbons is small, less than 1.5 % of the total, as their mass emissions are very small. Difference between nations is small. Highest proportion of methane (18.9 %) and dinitrogen oxide (14.4 %) are in Ireland, where the total CO₂ emission is only 65.8 % of total GHG emission. Except for Estonia and Czech Republic, East-European countries have lower GHG emission compared to industrialized, EU-15 countries.

Land use change and forestry (LUCF) contains both sources and sinks of carbon dioxide.

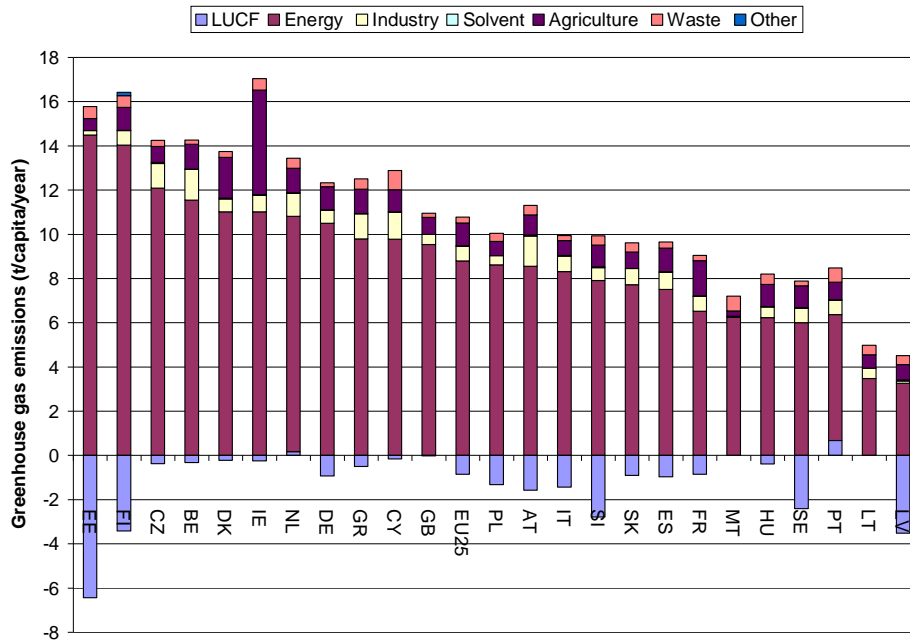


Figure 2. Greenhouse gas emissions by sectors (CO₂ equivalent t/capita/year)

The sinks, (or removals), are presented as negative quantities in Figure 2. Net emissions from land use change and forestry were approximately -8.7 % of the EU-25 countries, which is higher than the total GHG emission of agriculture (6.7 %). The highest amount of sink was reported in Estonia (6.4 t/capita/year), Latvia (3.5 t/capita/year) and Finland (3.4 t/capita/year).

The largest contribution to greenhouse gas emissions in EU-25 arises from the energy sector. In 2004, this contributed 88.6 % to the total GHG emissions. The second largest source of greenhouse gases is the agricultural sector (10.3 %). Emissions from this sector arise for both CH₄ and N₂O. Per capita emission from agriculture is lowest in Malta (0.2 t/capita/year) and highest in Ireland (4.7 t/capita/year). Industrial processes make up the third largest source of greenhouse gases in EU-25, contributing 6.7 % to the total GHG emission in 2004. Emissions of all six direct greenhouse gases occur from this sector. Non-industrial applications include aerosols, decorative paints and consumer products. In 2004, waste contributed 0.3 t/capita/year to the total GHG emissions (2.8 %) which arise for CO₂, CH₄ and N₂O. These emissions are occurring from waste incineration, solid waste disposal on land and wastewater handling.

The energy sector is the largest emitter of greenhouse gases in the EU-25 and 82.5 % of direct CO₂ gas emissions came from this sector. Total CO₂ emission of energy sector is 8473.6 kg/capita/year. Major sources include power stations, road transport, combustion from industrial sources and provision of building services. Fugitive emissions are also accounted for in this sector. These are emissions that arise from the production, extraction of coal, oil and natural gas, and their storage, processing and distribution. GHG emission from electricity generation, the use of fossil fuels for petroleum refining, and the production of coke and solid smokeless fuels are also calculated in the energy industry. Total CO₂ emission of energy

industries is 3285.4 kg/capita/year. Manufacturing and construction category covers the use of fossil fuels by industrial processes. The inventory separately reports emissions from autogenerators, cement clinker manufacture, lime manufacture, and iron and steel processes.

An estimate of CO₂ emissions from manufacture of soda ash is also reported in this category. Emissions from aviation, railways, road transport, and shipping are covered by transport category. Total CO₂ emission of transport is 2017.9 kg/capita/year. Road transport is by far the largest contributor to CO₂ emissions and estimations are available for a wide variety of vehicle using both petrol and diesel fuel. The emissions that are included in the other source category in EU-25 countries (1617.6 kg/capita/year) arise from the emissions from fuel combustion in commercial and institutional buildings, emissions from fuel combustion in households and emissions from fuel combustion in agriculture, forestry and fishing. Fugitive emissions from fuels are also reported in this category. Differences between countries are very characteristics.

Table 1:

Carbon dioxide emission in the energy sector (kg/capita/year)

	1.	2.	3.	4.	5.	6.
EU25	3285.4	1489.2	2017.9	1617.6	63.4	8473.6
LV	1036.4	407.0	1110.7	473.3	0	3027.3
LT	1547.9	333.6	1025.3	329.5	0	3236.3
PT	1922.6	1030.2	1881.7	633.7	72.5	5540.6
HU	2021.4	1041.6	945.4	1670.0	0	5678.4
SE	1428.2	1244.7	2243.3	689.6	120.8	5726.5
MT	4866.6	150.4	1086.5	122.9	0	6226.4
FR	1035.5	1260.0	2294.6	1630.3	62.7	6283.1
ES	2528.2	1613.7	2292.1	859.6	47.7	7341.3
SK	2486.2	2712.0	956.1	1056.4	212.1	7422.8
SI	3087.7	1111.0	1975.1	1376.0	35	7584.8
IT	2806.7	1483.5	2198.4	1468.3	55.1	8012.0
PL	4790.1	1188.8	882.9	1267.0	6.4	8135.2
AT	1978.5	1748.1	2800.8	1814.6	33.3	8375.2
CY	4495.1	1227.6	2535.3	610.1	0	8868.1
GB	3579.0	1475.8	2119.4	1867.8	136.8	9178.9
GR	5097.0	908.6	1928.9	1298.7	0	9233.2
DE	4393.0	1563.6	2062.2	2154.1	24.9	10197.8
NL	4159.1	1670.9	2109.4	2479.6	80.7	10499.7
IE	3905.5	1207.1	2874.2	2589.2	14.9	10591.0
DK	5833.0	1003.8	2374.9	1374.9	119.2	10705.8
BE	2814.0	2931.8	2442.8	3016.6	36.9	11242.0
CZ	5775.0	2700.7	1316.3	1423.7	175.5	11391.2
FI	6923.8	2655.3	2509.9	1158.4	395.1	13642.5
EE	11692.3	309.7	1583.0	301.5	0	13886.4
LU	593.7	5133.3	13426.2	3052.5	0	22205.7

1 = Energy industries, 2 = Manufacturing and construction, 3 = Transport, 4 = Other,
5 =Fugitive emissions from fuels, 6 = Total, energy sector

Methane is produced in many sectors, but agriculture, waste management and energy sector are the most important in European countries. Enteric fermentation is a digestive process where carbohydrates are broken down by micro organisms and methane is a by-product of this fermentation. Both ruminant animals (cattle and sheep), and non ruminant animals (pigs and poultry) produce CH₄, although ruminants are the largest source per unit of feed intake. Methane emission of EU-25 countries was 42.4 kg/capita/year.

Emission was highest in Ireland 153.2 kg /capita /year and lowest in Italy 28.8 kg/capita/year as emissions from enteric fermentation are usually calculated from animal population data. Agriculture also reports emissions of methane from animal manure management. When manure is stored or treated as a liquid in a lagoon, pond or tank it tends to decompose anaerobically and produce a significant quantity of methane.

When manure is handled as a solid or when it is deposited on pastures, it tends to decompose aerobically and little or no methane is produced. Emissions of methane from animal manures are also calculated from animal population data, but the system of manure management used greatly affects emission rates. Methane is also emitted during the anaerobic decomposition of organic waste in disposal sites (SWDS). Organic waste decomposes at a diminishing rate, but takes many years to decompose completely.

Nitrous oxide emission of EU-25 countries was 2.7 kg/capita/year. Emission was highest in Ireland 7.9 kg /capita /year and lowest in Malta 0.1 kg/capita/year. Per capita emission values are low, but the global warming potential of nitrous oxide is 310 indicating the relative importance this green house gas. Similarly to methane, agriculture is also responsible for the larger part of this emission. Animals are assumed not to give rise to nitrous oxide emissions directly, but emissions from their manures during storage are calculated for a number of animal waste management systems defined by IPCC.

Direct emissions of nitrous oxide from agricultural soils are also estimated using the IPCC recommended methodology (IPCC, 1997), which involves contributions from: (i) the use of inorganic fertilizer, (ii) biological fixation of nitrogen by crops, (iii) ploughing in crop residues, (iv) cultivation of organic soils, (v) spreading animal manures on land (vi) manures dropped by animals grazing in the field, (vii) emission from atmospheric deposition, (viii) emission from leaching of agricultural nitrate and runoff.

CONCLUSIONS

The Sixth Community Environment Action Programme established by Decision No 1600/2002/EC of the European Parliament and of the Council identifies climate change as a priority for action and establish a Community-wide emissions trading scheme. The Community is committed to achieving an 8 % reduction in emissions of greenhouse gases by 2008 to 2012 compared to 1990 levels. In longer-term, the global emissions of greenhouse gases will need to be reduced by approximately 70 % compared to 1990 levels.

The Community and its Member States have agreed to fulfil their commitments to reduce anthropogenic greenhouse gas emissions under the Kyoto Protocol jointly, in accordance with Decision 2002/358/EC. This Directive aims to contribute to fulfilling the commitments of the European Community and its Member States more effectively, through an efficient European market in greenhouse gas emission allowances, with the least possible diminution of economic development and employment.

Per capita GHG emission data, on the other hand, indicate the importance of grouping. Large emitting countries above 9 t CO₂-eq/capita/year include countries such as South Korea, Taiwan, Singapore, Kazakhstan, and South Africa. Middle emitting countries that have emission rates between 5-9 t CO₂-eq/capita/year include countries such as Mexico and Iran, China, India and Indonesia have respectively 3.9, 1.8, and 2.4 t CO₂-eq/capita/year emission

and grouped to the low emitting countries of the EU. Directive 2003/87/EC is a cost-effective and economically efficient scheme for GHG emission allowance trading within the community in order to promote reduction of GHG emissions, but per capita GHG emission data indicate the importance of grouping to share reduction between global regions and countries. Regarding future protocols, a large variety of approaches have to be taken into consideration to provide methods for differentiate between countries in respect of reduction in GHG emission.

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