Updating the IEA GHG Global CO_2 Emissions Database: Developments since 2002

Technical Study

Report Number: 2006/7

Date: February 2006

INTERNATIONAL ENERGY AGENCY

The International Energy Agency (IEA) was established in 1974 within the framework of the Organisation for Economic Co-operation and Development (OECD) to implement an international energy programme. The IEA fosters co-operation amongst its 26 member countries and the European Commission, and with the other countries, in order to increase energy security by improved efficiency of energy use, development of alternative energy sources and research, development and demonstration on matters of energy supply and use. This is achieved through a series of collaborative activities, organised under more than 40 Implementing Agreements. These agreements cover more than 200 individual items of research, development and demonstration. The IEA Greenhouse Gas R&D Programme is one of these Implementing Agreements.

DISCLAIMER

COPYRIGHT

ACKNOWLEDGEMENTS AND CITATIONS

This report describes research sponsored by the IEA Greenhouse Gas R&D Programme. This report was prepared by:

Angela Manancourt, IEA Greenhouse Gas R&D Programme
John Gale, IEA Greenhouse Gas R&D Programme

The IEA GHG CO_2 Emissions Database was updated by:
Angela Manancourt, IEA Greenhouse Gas R&D Programme
Joanna Rowe, IEA Greenhouse Gas R&D Programme
Robert T. Dahowski, Battelle - Pacific Northwest Division
Stefan Bachu, Alberta Energy and Utilities Board

To ensure the quality and technical integrity of the research undertaken by the IEA Greenhouse Gas R&D Programme (IEA GHG) each study is managed by an appointed IEA GHG manager.

The IEA GHG Manager for this report: Angela Manancourt

The report should be cited in literature as follows:

IEA Greenhouse Gas R&D Programme (IEA GHG), "Updating the IEA GHG Global CO2 Emissions Database: Developments since 2002, 2006/7, February 2006".

Further information or copies of the report can be obtained by contacting the IEA GHG Programme at:

IEA Greenhouse R&D Programme, Orchard Business Centre, Stoke Orchard, Cheltenham Glos. GL52 7RZ. UK
Tel: +44 1242 680753 Fax: +44 1242 680758
E-mail: mail@ieaghg.org
www.ieagreen.org.uk

Updating the IEA GHG Global CO_2 Emissions Database: Developments since 2002

Background to the study

IEA Greenhouse Gas R&D Programme's (IEA GHG) global CO_2 emissions database was first published in July 2002 [1]. Consisting of some 14000 entries, the database was an attempt at producing a global snapshot of large stationary CO_2 emissions sources, stating their location and the size of their emissions. The database was a first step, in a series of subsequent regionally focussed studies that would match these large stationary emission sources of CO_2 with possible storage sites. Two regional studies have been completed by IEA GHG for Europe [2] and North America [3] and a third for the Indian subcontinent is now being planned.

It was acknowledged during the compilation of the database that there could be some errors in the dataset brought in with the source material. So, alongside the regional studies, IEA GHG has, since 2002, had a parallel programme to progressively improve the emissions data by updating the information contained in the database and improving its accessibility to a wider audience. This paper identifies the problems with the original database, lists the steps undertaken and the reasons behind the improvements.

Introduction

As reported by the International Panel on Climate Change (IPCC) in the Special Report on Carbon Dioxide Capture and Storage [4], there are a number of different anthropogenic sources (meaning created by human activity) of CO_2 emissions. These emissions predominately arise from the combustion of fossil fuels in power generation, industrial facilities, buildings and transportation. CO_2 capture and storage (CCS) is one of a portfolio of options identified for reducing anthropogenic emissions of CO_2. Other measures include: energy efficiency, fuel switching, nuclear power and renewable sources of energy. To assess the potential of CCS for reducing global anthropogenic emissions it is important to identify the geographical distribution and size of the large stationary sources of CO_2. The emissions of CO_2 from buildings and transportation are not currently considered suitable for CCS because they are usually small, dispersed and, in the case of transportation, mobile.

To help assess the potential for CCS, the IEA Greenhouse Gas R&D Programme (IEA GHG) has developed a global database of large stationary point sources of CO_2 emissions. The database was complied and published in July 2002 [1]. Consisting of some 14000 individual entries, the IEA GHG CO_2 emissions database was a first attempt at producing a global picture of large stationary CO_2 emission sources, stating their geographical location and size of their emissions as of the year 2000. The information that was obtained to complete the original database was available in the public domain. Where possible reported emissions were used, in other cases plant production and emissions factors were used [3].

Errors in the original dataset

It was acknowledged during the compilation of the database that there were some errors brought in with the source material. Assumptions had been made on the emissions of CO_2 from sites when specific information had not been found, and the various information sources used to complete the dataset for the each of the sectors varied in content leaving some data fields incomplete. These were all areas that would need to be addressed as part of any improvements to the dataset.

The most significant area for further attention in the original dataset was quickly identified as the gas processing sector. The exceptionally large CO_2 emissions total for gas processing drew attention to this sector from the beginning. The total emissions were 2859 Mt CO_2/yr, representing 17% of the total world's annual CO_2 emissions, second only to the power sector. The original developers of the database realised that there had been a miscalculation of emission figures and this was addressed bring the total to 66 Mt CO_2/yr. However, the gas processing sector was also dominated by Canadian entries, which represented 937 of the total 1826 entries for global gas processing plants. An additional problem was that all of the Canadian entries lacked geographical locations.

Other problems with the IEA GHG CO_2 emissions database included the lack of geographical location data for a significant number of the Asian emission sites. This problem arose because a Geographic Names Information System was used to identify co-ordinates. Where co-ordinates for a town could not be identified then those for the nearest city would be assigned. In many cases, either due to spelling errors or because a town or city could not be identified many sites were not allocated co-ordinates. This had not been rectified during the production of the original dataset but would certainly be an area for further investigation during any updates.

There are other CO_2 emissions statistics available and these could be used to check that the figures provided in the IEA GHG dataset were not wildly inaccurate and off the mark. However, comparisons have to be made carefully; it is important to compare like with like. Other emissions figures (e.g. IEA [5]) take a top down approach (an estimated CO_2 emissions total based upon known fuel consumption), rather than the bottom up (individual site emission) approach compiled in this dataset, comparisons should also be based on the same year. Although general comparisons can be made, exact matches are never going to be possible.

Improving the dataset

Since 2002, IEA GHG has had a programme to progressively improve the emissions source data by updating the information contained in the database. The first step was to remove entries with emissions smaller than 100Kt CO_2/yr, this level was set as a threshold based upon cost. It was considered that a smaller level of emissions would be cost prohibitive for CCS.

The first attempt to improve the data for the Canadian gas processing plants was to highlight entries which represented sites with acid gas injection (CO_2 is re-injected along with Hydrogen Sulphide - H_2S). Once identified these could then be removed from the database. It was still not possible to improve the geographical information of the remaining sites. However, Battelle, in co-operation with the Alberta Energy and Utilities Board (AEUB), were making improvements to the North American data as part of a larger IEA GHG study [3]. The study was able to replace the pre-existing entries with much more credible information provided by AEUB for gas processing facilities located in the Western Canadian Sedimentary Basin. This reduced the number of Canadian gas processing sources to 24 from the original 937 entries. The new data provided information on the percentage of CO_2 in the emissions stream and the geographical positions of the 24 plants. The AEUB Canadian gas processing plants data was integrated into the IEA GHG database along with the other improvements in the North America data produced by this report [3], including the addition of CO_2 emissions from oil sands and ethanol production.

Unfortunately, it has not been possible to obtain information on reported CO_2 emissions from gas processing plants for all other countries. Having now identified that Canadian gas processing plants had been included from the original source material without being able to confirm CO_2 emissions, and seeing the vast reduction once more reliable data was available, it raised the question of the reliability of the remaining information presented for the gas processing sector. This resulted in a key decision being made to improve the quality of the data held in the database. This decision was that rather than assume

that every gas processing plant listed emits CO_2, it should be assumed there are no CO_2 emissions unless it has been reported as such. In response, all other entries were removed. The exception to this has been the improvement of the UK data using the published UK Environment Agency Pollution Inventory (www.environment-agency.gov.uk); this included adding the offshore operations in the North Sea. So as a whole, the gas processing sector reduced from 1826 to 106 entries. The only information that remains for gas processing plants sector in the database is reported information for Canada and the UK. Efforts to source gas processing data in other countries and regions are continuing.

The UK Environment Agency Pollution Inventory also provided an opportunity to improve the UK dataset for all other sectors. This resulted in the removal of plants no longer operating and the addition of newer plants that had been built since the cut-off date of the original source material. The UK data has been updated so that England and Wales have entries from 2003, and Scotland and Ireland from 2002.

The European part of the power sector section of the database has been compared with a very similar data set developed by Chalmers University in co-operation with the European power generators. No significant discrepancies in the number of plants were identified. There is also a possibility for comparison with the IEA Clean Coal Centre's database of coal-fired power plants. Again, this could be used to identify any major inconsistency within a specific area of the power plant sector dataset.

In addition, through the IPCC Special Report on CO_2 Capture and Storage [4], IEA GHG has received new entries for Swedish paper mills and Brazilian biomass and ethanol plants.

IEA GHG has also co-operated with CO2CRC who have undertaken a study on the prospects for CCS in the Asia Pacific Region funded by the Asia-Pacific Economic Cooperation (www.apec.org). As a result of the CO2CRC study, the number of emissions sources without geographic location data, which had been a problem in the original dataset, has been significantly reduced.

There have been several requests for specific parts of the database (i.e. specific country data or sector) for use in external pieces of work. If this work has lead to improvements in the original dataset, these have been supplied back to IEA GHG and have replaced the existing information.

General housekeeping improvements have include re-ordering of columns, merging data fields, and the removal of unnecessary fields, all to improve the accessibility of the database to the general audience. The developments to the database are indicated using different coloured fonts and a key explains when the changes were made.

Current Structure of the Database

The latest version of the database contains around 8000 entries, reduced from the original 14000 entries. There are 13 sectors included in the database; these are listed in Table 1.

• Ammonia (215)	• Biomass Production (189)
• Cement (1174)	• Oil and Gas Processing (106)
• Ethanol (70)	• Power (5010)
• Ethylene (234)	• Refineries (638)
• Ethylene Oxide (16)	• Oil Sands (9)
• Hydrogen (106)	• Other sources (106)
• Iron & Steel (265)	**(Total = 8138)**

Table 1 CO_2 emissions database sectors, the number of entries is shown in brackets.

A standard set of data fields were established and used for all the emissions sources; these are shown in Table 2.

• Sector	• Information source
• Name of company	• Information Source Other
• Plant name	• Concentration of CO2 in fluegas (%)
• Zip code	• Product mix
• City	• Production
• State/Province	• Unit of production
• Country (NIMA)	• Full load hours (h)
• Region (EDGAR)	• Capacity
• Latitude	• Unit of capacity
• Longitude	• Emission factor (kg CO2/kg product)
• Status	• Technology
• CO2 (Kt)	• Fuel class
• Year	• Main fuel
• Estimated =E, Reported=R	• Other fuels

Table 2 CO_2 Emissions database sectors.

Comparison of CO_2 emission data

A comparison of emissions from the two versions of the IEA GHG CO_2 emissions database (versions 2006 and 2002 [1], see Table 3), shows that the latest version is more in line with the emission figures published in the recent IPCC Special Report on CO_2 Capture and Storage [4]. The major overhaul of the Oil and Gas Processing Sector brings the figures to a more realistic level but still reflects the fact that they only represent emissions from Canada and UK, given the total is lower than that in the IPCC report [4]. The development of the Biomass Sector to include entries other than from Brazil is also highlighted in the table. These are both areas suitable for future improvements.

The IEA CO_2 Emissions from Fuel Combustion Report [5] gives a comparative world emissions total for CO_2 emissions as 16867 Mt CO_2/yr for 2003. This can not be directly matched to the new IEA GHG CO_2 emissions database figure of 13806 Mt CO_2/yr because of the way the sectors are defined in both. In addition, the IEA report [5] contains data for 2003, and whilst some updates in the IEA GHG CO_2 emissions database are from 2003, the general date is 2000 so it would be expected to be different. Finally the IEA GHG CO_2 emissions database only includes large point sources, those suitable to be considered for CCS.

Sector	2006 version CO_2 Emissions Mt/Yr	2002 version CO_2 Emissions Mt/Yr [1]	IPCC Report on Carbon Dioxide Capture and Storage [4] CO_2 Emissions Mt/Yr
Ammonia	130	132	-
Cement	932	938	932
Ethanol*	22	-	-
Ethylene	254	258	-
Ethylene Oxide	2	5	-
Hydrogen	25	32	-
Iron & Steel	671	691	646
Biomass Production*	69	-	91
Oil and Gas Processing	29	2859	50
Power	10871	11107	10439
Refineries	801	804	798
Oil Sands*	26	-	-
Other	51	41	-
Petrochemical industry	-	-	379
Total	**13806**	**16867**	**13466**

* New fields in version 2006 IEA GHG Emissions database

Table 3 Emissions from each sector in the new 2006 version of the IEA GHG CO_2 emissions database. Comparison with 2002 version [1], and the IPPC report [4].

Dissemination activities

The most recent activity is the dissemination of the data to a wider audience. A snapshot of the database has been made available on the IEA GHG website www.co2captureandstorage.info. This includes a description of the contents of the database and the sources of information. To show the potential of the emissions database, a geographical map of emissions sources in the newly improved UK dataset has been produced (Figure 1). The map has been created to show the type of emissions source and indicate the size of emissions within a set of emission ranges.

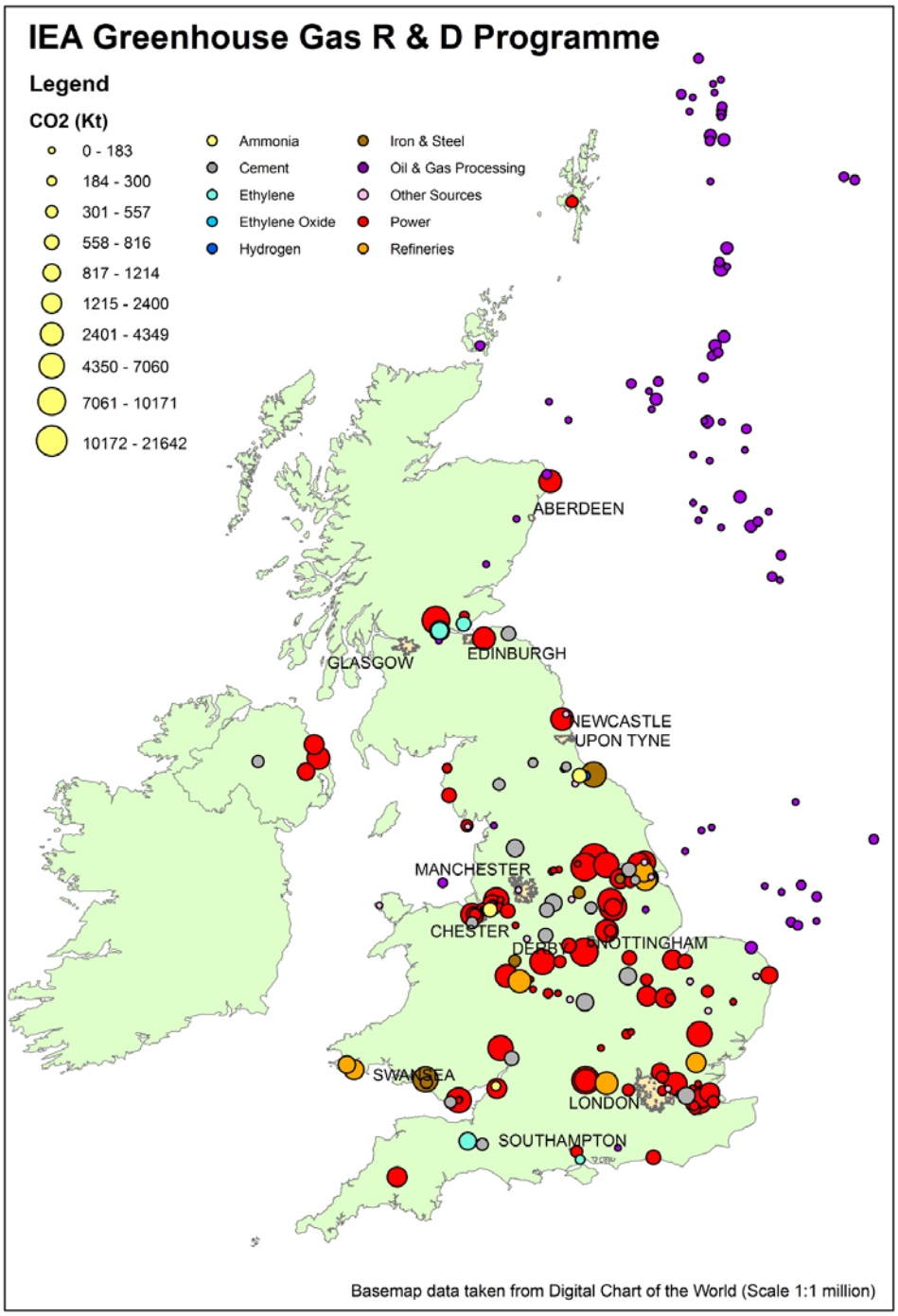

Figure1 Map of UK CO_2 emissions dataset. Kindly produced by British Geological Society using the IEA GHG database.

Conclusions

Overall, the dataset has been refined considerably since it was first developed. One of the key future developments IEA GHG sees for the database is the dissemination of the data to a wider audience. In preparation for this, the database has been overhauled to make it easier to find information and unnecessary fields removed. In the continued collaboration described above, there is an ongoing improvement of the original data. IEA GHG is keen to co-operate with organisations that want to use the database. The use of the database by any external organisation will, however, require that any updates are reported back.

List of References

[1] IEA Greenhouse Gas R&D Programme (IEA GHG), Building the Cost Curves for CO_2 Storage: Part 1: Sources of CO_2, PH4/9, July 2002
[2] IEA Greenhouse Gas R&D Programme (IEA GHG), Building the Cost Curves for CO_2 Storage: European Sector, 2005/02, February 2005
[3] IEA Greenhouse Gas R&D Programme (IEA GHG), Building the Cost Curves for CO_2 Storage: North America, 2005/03, February 2005
[4] IPCC Special Report on Carbon Dioxide Capture and Storage. Prepared by Working Group III of the International Panel on Climate Change [Metz, B., Davidson, O., de Coninck, H.C., Loos, M., and Meyer, L.A.]. Cambridge University Press, Cambridge, United Kingdom and New York, USA, 442pp.; 2005.
[5] IEA CO_2 Emissions from Fuel Combustion 2005 edition; OECD/IEA, 2005.