Midwest Geological Sequestration Consortium

Inventory of Industrial Stationary CO_2 Emissions in the Illinois Basin

Summary Report

Assessment of Geological Carbon
Sequestration Options in the Illinois Basin

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The Illinois Basin is roughly 60,000 square miles and covers most of the state of Illinois, the southwestern region of Indiana, and the northwestern region of Kentucky (Figure 1). The industrial sources included in this CO_2 emission inventory are those in the entire state of Illinois, in Indiana and Kentucky within the Basin, and large point sources in Indiana and Kentucky that are located outside of, but in the vicinity of the Basin's boundaries.

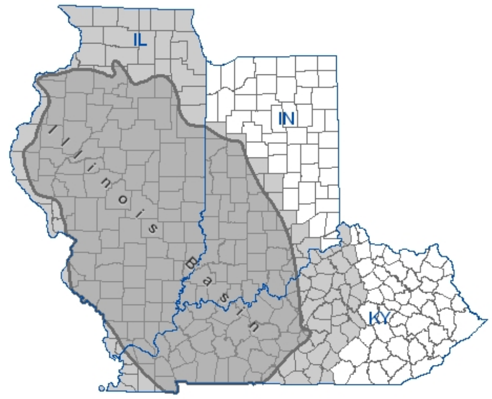

Figure1. Geographic domain of the IL Basin showing MGSC project area shaded in gray

Eleven industrial emission categories are included in this report: electricity, refineries, iron & steel, cement, ammonia, aluminum, lime, ethanol, compressor stations, autos and glass. These industrial sources are the major contributors of CO_2 emissions in the Basin. Among these, six sources, i.e., electricity, aluminum, ethanol, compressor stations, autos and glass, were either updated or added during the Phase II (interim report to DOE, June 2006). The emission data of the remaining five sources were reported in the Phase I tropical report in September 2004. The methodology for estimating the CO_2 emissions is updated in this report.

1. CO_2 Emissions from Power Generation Plants

The emissions from 126 power plants in the Basin with CO_2 emissions more than 10,000 tons (short) /year are included in the inventory. Those with emissions less than 10,000 tons/year contribute only to 0.034% of the total utility emissions.

The CO_2 emissions from 89 power plants, contributing 98% of the total utility emissions, were obtained from the EPA Acid Rain Program (APR) Emission Report for the year 2005.[1] The data for the remaining power plants, which were not included in the EPA APR report, were obtained from the EPA EGRID database for the year 2000.[2]

The types of fossil fuels used in each power plant were collected based on the DOE-EIA power plant database 767 (2004).[3] The results of the plant-level CO_2 emissions are listed in Table 1.1.

References:

1. U.S. EPA, Acid Rain Program (APR) Emission Report for the Year of 2005 Greenhouse Gas Inventory Sector Analysis, 2006.
2. U.S. EPA, EGRID data 2000, 2002.
3. U.S. DOE-EIA, Power Plant Database, EIA767, 2004.

2. CO_2 Emissions from Petroleum Refineries

The intensity of CO_2 emissions from the petroleum refinery industry, in tons CO_2 per barrel/day petroleum products produced, was estimated using the methodology provided by the Plains CO_2 Reduction Partnership (PCOR).[1]

PCOR estimated the CO_2 emission rate for each fuel within each Petroleum Administration for Defense (PAD) district by multiplying the fuel heating value (million BTU/bbl) with the fuel usage rate (bbl/yr) and the carbon coefficient (lb CO_2/million Btu). The total CO_2 emission rate for each PAD district was determined by summing the CO_2 emission rates for all fuels. An emission factor (tons CO_2/barrel per calendar day) was then calculated for each of the five PAD districts by dividing the total CO_2 emission rate for the district by the refining capacity (barrels per calendar day) for the district. As a result, the CO_2 emission factor for PAD District II was estimated as 11.44 tons CO_2/barrel per calendar day, and 11.17 tons CO_2/barrel per calendar day for PAD District IV.

Illinois, Indiana and Kentucky are represented in the PAD District II region. Therefore, an emission factor of 11.44 tons CO_2/barrel per calendar day of the major product was used to calculate the total combustion related emissions in the refinery industry:

$$CO_2 \text{ Emissions (ton/y)} = 11.44 \text{ [ton } CO_2 \text{/ (barrel/day)]} \times \text{Refinery production [barrel/day]}$$

Four refineries in Illinois and one in Indiana were identified in the Basin according to the EPA National Emission Inventory database (2002).[2] The production of the main petroleum products in the five plants for the year 2002 were obtained from the EIA refinery capacity report.[3] The results of the plant-level CO_2 emissions are listed in Table 2.1.

References:

1. Internal Communications in the CO_2 Capture Working Group, Combustion CO_2 Emission Calculations by the Plains CO_2 Reduction Partnership, October 2004.
2. U.S. EPA, National Emission Inventory Database, 2002.
3. U.S. DOE-EIA, Refinery Capacity Report Historical 2002, 2003.

3. CO_2 Emissions from Iron & Steel Manufacturing

Iron is produced through the reduction of iron oxide (ore) using metallurgical coke as the reducing agent in a blast furnace. Steel is made from iron or scrap steel in separate furnaces. The CO_2 emissions are associated with the coke oxidation during pig iron production, the re-use of scrap steel, and the consumption of graphite anodes during the production of steel in electric arc furnaces (EAFs). The assumptions used to estimate the emissions are summarized below.[1,2]

- Emissions from coke oxidation during pig iron production are based on the IPCC recommended emission factors for coal-derived coke and petroleum coke. An average emission factor of 3.3 ton CO_2/ton coke was used.
- Emissions from steel production from iron were based on the assumption that the pig iron contains about 4-4.5%wt carbon, and in the conversion to steel the carbon content is reduced to <2 %wt.
- Emissions from the re-use of scrap steel were estimated by assuming that all the associated carbon content of the scrap steel (about 0.4%wt), are released during the scrap re-use process.
- Emissions from carbon anodes, used during the production of steel in electric arc furnaces (EAFs), were calculated by multiplying the annual production of steel in EAFs by an emission factor of 4.4 kg CO_2/tonne steel produced in the EAF.

The total CO_2 emissions are the sum of the above emissions from different processes.

CO_2 emissions (ton/yr) = 3.3 [ton CO_2/ton coke] × coke usage [ton/yr] + (4%-2%)× pig iron production [ton/yr] × 44/12 + 0.4% × scrap steel production [ton/yr] × 44/12 + 0.0044 ton CO_2/ton EAF steel × EAF steel production [ton/y]

Except for steel plants using EAFs, CO_2 emissions from coke production, iron production and reuse of scrap steel were estimated at a state level due to the lack of facility-level information for these emission sources. The total coke consumption, pig iron production, and scrap steel reuse in each state were obtained from the mineral yearbook for 2002.[3] The results of the total emissions in the Basin are listed in Table 3.1.

A list of the EAF steel plants was retrieved from the EPA National Emission Inventory database.[4] There are 12 EAF plants in the Basin. The plant-specific information (address and production capacity) for 2002 was obtained via contacts with the representative from these plants. The plant-level CO_2 emissions for the EAF plants were estimated based on the method described above (Table 3.2).

References:
1. U.S. EPA, Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2004, EPA 430-R-06-002, April 2006.
2. IPCC, Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories: Vol.2 Workbook, 1997. http://www.ipcc-nggip.iges.or.jp/public/gl/invs5.htm
3. Michael D. Fenton, Minerals Yearbook: Iron and Steel Scrap, 2002. US. Geological Survey, 2003. http://minerals.usgs.gov/minerals/pubs/commodity/iron_&_steel_scrap/fescmyb02.pdf
4. U.S. EPA, National Emission Inventory Database, 2002.

4. CO_2 Emissions from Portland Cement Production

CO_2 is emitted from both the calcination of limestone and the combustion of fossil fuels during the production of Portland cement. The process-related (calcination) CO_2 emissions were estimated according to the IPCC guidelines.[1] The IPCC method suggests that the emission factor, in tons of CO_2 released per ton of clinker produced, is the product of the average lime fraction for clinker of 64.6% and the molecular weight ratio of CO_2 to CaO (44/56). This calculation leads to an emission factor of 0.507 ton CO_2 per ton clinker produced. Some of the clinker precursor materials are lost in the kiln as calcinated cement kiln dust (CKD), and are not accounted for in clinker production. The IPCC approximates these additional CKD CO_2 emissions as 2% of the CO_2 emissions calculated from clinker production. Total process-related emissions are the sum of the emissions associated with clinker production and CKD.

Process related CO_2 Emissions (ton/y) = 0.507 [ton CO_2/ton Clinker produced] × Clinker production [ton/year] × (1+ 2%)

The intensity of fuel combustion-related CO_2 emissions depends on the fuel type and the manufacturing processes employed. An accurate estimation of combustion related CO_2 emissions is difficult for a particular plant or a particular state due to the confidentiality of energy consumption data. On average, coal shared about 71% of the total energy consumption in 2001, followed by petroleum coke (12%), liquid and solid waste fuels (9%), natural gas (4%), and oil and coke (4%).[2] The replacement of wet processes with more efficient dry processes for cement production has increased significantly in the last couple of decades. In 2001, dry kilns accounted for approximately 70% of all kilns.[2] As a result, the national weighted average carbon intensity for cement production (both process and combustion related) was estimated as 0.97 ton CO_2/ton cement in 2001.[2] Therefore, the combustion related emissions were estimated based on an emission factor of 0.463 ton CO_2 per ton clinker produced.

Combustion related CO_2 Emissions (ton/y) = 0.463 [ton CO_2/ton Clinker produced] × Clinker production [ton/year]

Clinker production sources in Illinois, Indiana and Kentucky were found in the Mineral Yearbook 2002 - available from the U.S. Geological Survey website.[3] The above emission factors were adopted for estimating the state-level CO_2 emissions, Table 4.1. Currently, information for individual kilns and individual cement plants, and thus the corresponding facility-level CO_2 emissions are not available. However, a list of cement plants in the Basin were extracted from the U.S. EPA Aerometric Information Retrieval System databases (Table 4.2).[4]

In the United States, approximately 4-5% of the total cement production is shared by masonry cement. The addition of lime to produce masonry cement results in additional emissions. Masonry cement thus emits more CO_2 than Portland cement. However, in accordance with the IPCC Guidelines, these are accounted in the lime production, and thus are not included in this analysis.

References:
1. IPCC, Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories: Vol.2 Workbook, 1997.
http://www.ipcc-nggip.iges.or.jp/public/gl/invs5.htm
2. Lisa J. Hanle, Kamala R. Jayaraman, Joshua S. Smith, CO_2 Emissions Profile of the U.S. Cement Industry. U.S. EPA 05-03-2006, 2006.
3. Hendrik G. van Oss, Minerals Yearbook: Cement, 2002. U.S. Geological Survey, 2003.
http://minerals.usgs.gov/minerals/pubs/commodity/cement/170302.pdf
4. U.S. EPA, Enforcement & Compliance History Online (ECHO).
http://www.epa-echo.gov/echo/compliance_report_air.html

5. CO_2 Emissions from Ammonia Production

CO_2 emissions from ammonia production are produced both from natural gas reforming and combustion of fuel to supply the process heat. According to the stoichiometric conversion, CO_2 production in steam/air reforming of natural gas ranges from 1.15 to 1.30 kg CO_2/kg NH_3 produced, depending on the degree of air reforming. In partial oxidation of residual oils, the CO_2 production ranges from 2 to 2.6 kg CO_2/ kg NH_3 produced, depending on the C/H ratio of the feedstock.[1]

Assuming an efficient stand-alone plant with no energy export and no other import than feed-stock and fuel, the heat requirements range from 3.6 to 9.0 GJ/tonne NH_3 depending on the reforming or oxidation process.[1] If natural gas is used as a fuel, the corresponding CO_2 emissions range from 0.2 to 0.5 kg/kg NH_3 produced.

The total CO_2 emissions are the sum of the emissions from the reforming reaction and fuel combustion. On average, an emission factor of 1.2 tons CO_2 / ton NH_3 produced is suggested for the reforming, and a factor of 0.5 tons CO_2 / ton NH_3 produced is suggested for fuel combustion.[1] The total emissions are thus estimated as follows,

CO_2 Emissions (ton/y) = 1.2 [ton CO_2/ton NH_3 produced] + 0.5 [ton CO_2/ton NH_3 produced] × NH_3 production [ton/year]

It should be noted that the CO_2 from ammonia production may also be used for producing urea. This carbon will only be stored for a short time. Therefore, no account was consequently taken for intermediate binding of CO_2 in urea production or other downstream products.[2]

Based on the U.S. Geological Survey's Minerals Yearbook, there is only one ammonia plant in the Illinois Basin (Royster-Clark).[3] This plant produced 800 ton/day and 390 ton/day of ammonia and urea, respectively, with an operational time of 350 days/year (2002). The CO_2 emissions from this plant was estimated based on the above approach, Table 5.1.

References:
1. European Fertilizer Manufacturing Association, Production of Ammonia, June 2000.
2. IPCC, Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories: Vol.2 Workbook, 1997.
   http://www.ipcc-nggip.iges.or.jp/public/gl/invs5.htm
3. Deborah A. Kramer, Minerals Yearbook: Nitrogen, 2002. US. Geological Survey, 2003.
   http://minerals.usgs.gov/minerals/pubs/commodity/nitrogen/nitromyb02.pdf

6. CO_2 Emissions from aluminum production

Primary aluminum refers to aluminum produced directly from mined ore. The ore is refined and electrolytically reduced to elemental aluminum. Three aluminum plants in the Basin were identified from the U.S. EPA National Emission Inventory (NEI) database (2002).[1] The total annual capacity in 2004 was 347 kilo tonnes (metric) in the Basin according to the USGS survey (2004).[2]

Based on the type of aluminum reduction cell used, the aluminum production process can be classified into two categories: the pre-baked process and the Soderberg process. All three aluminum plants in the Basin employ the pre-baked process.

The emission factor for the pre-baked process was obtained from the EPA AP-42 guideline: [3]
Emission factor (EF) = 3,080 [lb CO_2/ ton Al produced]

The CO_2 emissions were then estimated as follows:
CO_2 emissions (ton/y) = 3,080 [lb CO_2/ ton Al produced] × Al production [ton/year] / [2,000 lb/ton]
The results of CO_2 emissions are listed in Table 6.1.

The short ton (ton) can be converted to metric ton (tonne) by noting 1 tonne = 1.102 ton.

References:
1. U.S. EPA, National Emission Inventory database, 2002.
2. U.S. Geological Survey, Minerals Yearbook – Aluminum, 2004.
3. U.S. EPA, AP 42 Fifth Edition, Volume I- Chapter 12: Metallurgical Industry, Table 12.1-3 for Primary Al production - Prebaked Process, 2000.

7. CO_2 Emissions from Lime Production

The intensity of CO_2 emissions depends on the type of limestone feed. The IPCC guideline recommends adopting a CO_2 emission factor of 0.79 ton CO_2/ton quicklime produced for calcite feed, and a factor of 0.91 ton CO_2/ton dolomite lime produced for dolomite feed.[1] These values are based on pure lime produced. However, the purity of lime may be as low as 85%. With an assumption of 95% purity of lime, this analysis employs an emission factor that is 5% lower than that for pure lime:

- Lime Kiln-Calcite Feed: 0.75 ton CO_2/ton quicklime produced;
- Lime Kiln-Dolomite Feed: 0.87 ton CO_2/ton dolomite lime produced.

The CO_2 emissions from lime production are estimated by applying an emission factor to the annual lime output according to the following equation.

CO_2 Emissions (ton/y) = 0.75 [ton CO_2/ton quicklime produced] × quicklime production [ton/year] + 0.87 [ton CO_2/ton dolomite lime produced] × dolomite production [ton/year]

The list of the lime production plants was obtained from the USGS's mineral industry survey (2003).[2] There are one plant in Illinois, two in Indiana, and two in Kentucky. However, only one of the plants is located within the Illinois Basin. Contact was made with a representative from this plant to obtain the lime production data for 2002.[3] The lime production and estimated CO_2 emissions of this plant are listed in Table 7.1.

References:

1. IPCC, Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories: Vol.2 Workbook, 1997.
   http://www.ipcc-nggip.iges.or.jp/public/gl/invs5.htm
2. USGS, Mineral Industry Surveys, 2003.
3. Personal Communication with Carmeuse Lime's South Chicago Plant, 2004

8. CO_2 Emissions from Ethanol Plants

There are two types of CO_2 sources in an ethanol plant: CO_2 generated from burning the fossil fuel to supply process heat, and CO_2 generated from the grain fermentation process.

(1) For CO_2 emissions from the fermentation, emission factors were acquired through communication with representatives from several ethanol plants.[1] Depending on the type of grain used, three emission factors were adopted:

- Corn as feedstock: emission factor (EF) = 6.31 lb CO_2/gal ethanol;
- Corn/wheat starch mixture as feedstock: emission factor = 6.15 lb CO_2/gal ethanol;
- Beverage waste as feedstock: emission factor = 5.05 lb CO_2/gal ethanol.

CO_2 emissions were then estimated by multiplying the emission factors with the annual ethanol production from different types of feedstock:

CO_2 emissions (ton/yr) = Σ{ethanol production by feedstock [gal/yr] × EF [lbCO_2/gal]} / 2000 [lb/ton]

(2) For CO_2 emission from fuel combustion, natural gas (NG) was assumed as the major fuel. The energy requirement for ethanol production is estimated at 39,000 Btu/gal anhydrous ethanol produced.[2] The emission factor and CO_2 emissions were estimated as follows:

Emission factor = 39,000 [Btu/gal] × [1 ft^3 NG/1000 Btu] × [1 lb-mole NG/359 ft^3] × [44.0 lb CO_2/lb-mole NG] × [1 ton/2000 lb] = 0.00239 [tons CO_2/gal anhydrous ethanol]

CO_2 (ton/yr) = ethanol production [gal /yr] × 0.00239 [tons CO_2/gal ethanol]

The annual production or production capacity of ethanol was identified for all ethanol plants in the Basin. The 2006 data were used in the CO_2 emission estimation.[3, 4] The current total capacity of ethanol production is 882 MM gallon/year from eleven plants in the Basin. In addition, two ethanol plants are under construction and two plants are under expansion, with a total new capacity of 146 MM gallon/year. Emissions from both the current ethanol facilities and those under construction and expansion were accounted for in this study, Table 8.1.

References:

1. Personal Communications with Ethanol Facilities in Phase I, 2004.
2. Ted Aulich, EERC, from BBI International, July 2004.
3. Fuel Ethanol Production Capacity by State and by Plant (as of May 2006). http://www.neo.state.ne.us/statshtml/122.htm
4. Renewable Fuels Association, Ethanol Industry Outlook 2006, 2006. http://www.ethanolrfa.org/objects/pdf/outlook/outlook_2006.pdf

9. CO_2 Emissions from Compressor Stations

Compressors are used to recompress and move natural gas through transmission pipelines. They are driven by natural gas fired reciprocating engines or combustion turbines. CO_2 emissions are from the combustion of natural gas.

A list of compressor stations in the Basin was identified from the U.S. EPA National Emission Inventory (NEI) Database (2002).[1] The 49 largest stations were selected in this analysis. Selection criteria were mainly based on the magnitudes of their NOx and CO emissions (also retrieved from the NEI database). The CO_2 emissions from these stations were estimated based on the heat input of natural gas burned:

CO_2 Emissions (ton/y) = Maximum NG heat input rate [MMBtu/hr] ×EF [110 lb CO_2 / MMBtu NG] × [8760 hr/year] × loading factor of 60% / [2000 lb/ton]

The name-plate heat input rates for most of the selected 49 compressor stations were acquired from the U.S. EPA air permit records.[2] The NG-fired facilities in a compressor station include 2-stroke lean burn (2-SLB) reciprocating engines, 4-stroke lean burn (4-

SLB) engines, 4-stroke rich burn (4-SRB) engines, and/or gas turbines (GT). The 2-SLB engine is still widely in operation today. The heat input rate data were collected for each engine or GT in individual stations.

The EF of 110 lb CO_2 / MMBtu NG was based on an average composition and heat value of natural gas. A loading factor of 60% was assumed in this study. The assumed loading factor was validated for most of the compressor stations by comparing the reported NOx emissions from the NEI database to the theoretical NOx emissions at the full heat-input capacity.

For several compressor stations whose name-plate heat-input rates are not available from the EPA air permit records, the NOx emissions were used to approximately estimate CO_2 emissions according to:

CO_2 Emissions (ton/y) = NOx Emissions [ton NOx/yr] / NOx emission factor [lb NOx/MMBtu] × CO_2 emission factor [110 lb CO_2/MMbtu]

The NOx emission factor (lb NOx/MMBtu) used in the above equation was a heat input rate-weighted average over different combustion facilities (engines and GT) in a station. The individual NOx emission factors for 2-SLB, 4-SLB, 4-SRB, GT and NG boilers are available from the EPA AP-42 guideline.[3]

The results of CO_2 emissions are listed in Table 9.1.

References:

1. U.S. EPA, National Emission Inventory database, 2002.
2. U.S. EPA, Title V Air Permit records, 2002-2006.
3. U.S. EPA, AP 42, Fifth Edition, Volume I- Chapter 3: Stationary Internal Combustion Sources, 2000.

10. CO_2 Emissions from Autos Manufacturing

Auto manufacturing plants in the Basin were identified according to the U.S. EPA National Emission Inventory (NEI) database (2002).[1] The fifteen largest plants were selected in this analysis, based on the magnitudes of their NOx and CO emissions (available from the NEI database). The NOx and CO emissions from the selected 15 plants contributed to about 78% and 65% of the total emissions from autos manufacturing, respectively.

The CO_2 emission sources in an auto plant include the engine test cell, internal engine, generator, gas turbine, heater, boiler and oven. Natural gas and diesel are the two main fuels to fire these facilities. Only in one manufacturing plant, coal is used to fire a boiler.

The CO_2 emissions from the selected 15 plants were estimated according to the following method:

CO_2 Emissions (ton/y) = {Maximum heat input rate by NG [MMBtu/hr] ×EF [110 lb CO_2 / MMBtu NG] + Maximum heat input rate by diesel [MMBtu/hr] × EF [146 lb CO_2 / MMBtu diesel] + Maximum heat input rate by coal [MMBtu/hr] × EF [214 lb CO_2 / MMBtu coal]} × 8760 [hr/year] x loading factor of 80% / 2000 [lb/ton]

For each auto plant, the name-plate heat input rate by fuel type for each combustion facility was obtained from the U.S. EPA air permit records.[2] The EF of 110 lb CO_2 / MMBtu NG was based on an average composition and heat value of natural gas. The EF of 146 lb CO_2 / MMBtu diesel was based on 70% carbon content in diesel.[3] The EF of 214 lb CO_2 / MMBtu coal was estimated based on a typical IL coal, which is only slightly different from that of a typical PRB coal (210 lb CO_2 / MMBtu coal).

The loading factor of 80% was assumed in this study. This factor needs to be confirmed by further contact with auto manufacturers. Table 10.1 gives the estimates of plant-level CO_2 emissions.

References:
1. U.S. EPA, National Emission Inventory database, 2002.
2. U.S. EPA, Title V Air Permit records, 2002-2006.
3. Tom Beer, et al., Study of Life-cycle Emissions Analysis of Alternative Fuels for Heavy Vehicles, Final Report (EV45A/2/F3C) to the Australian Greenhouse Office, 2006.
   http://www.greenhouse.gov.au/transport/comparison/pubs/app8.pdf.

11. CO_2 Emissions from glass manufacturing in the Illinois Basin

Ten glass manufacturing plants were identified in the Basin according to the U.S. EPA National Emission Inventory (NEI) database (2002).[1] The production capacity data in 2004 was obtained from the U.S. EPA air permit records.[2] The total annual capacity of glass products was about 1.2 million tons in the Basin.

An approximate method was adopted in this study to estimate the CO_2 emissions from glass production.[3] This method follows four steps: (1) determine typical plant size, (2) determine natural gas usage, (3) assume two-week annual down time, and (4) determine fuel factors (energy intensity factor and emission factor). For three different glass processes, CO_2 emissions were estimated as follows:

- Glass Container Manufacturer

CO_2 emissions (ton/year) = Glass production [tons/day] × (365 - 14) [days] × 7.8 [MMbtu/ton glass] × 117 [lbs CO_2/mmbtu NG] / 2000 [lbs/ton]

- Flat Glass Manufacturer

CO_2 emissions (ton/year) = Glass production [tons/day] x (365 - 14) [days] x 8.8 [MMbtu/ton glass] x 117 [lbs CO_2/mmbtu NG] / 2000 [lbs/ton]

- Pressed and Blown Glass Manufacturer

CO_2 emissions (ton/year) = Glass production [tons/day] x (365 - 14) [days] x 5.5 [MMbtu/ton glass] x 117 [lbs CO_2/mmbtu NG] / 2000 [lbs/ton]

The results of CO_2 emissions are listed in Table 11.1.

References:
1. U.S. EPA, National Emission Inventory database, 2002.
2. U.S. EPA, Title V Air Permit records, 2002-2006.
3. Glass Industry of the Future, Energy and Environmental Profile of the U.S. Glass Industry Office of Industrial Technologies, April 2002.

Summary

Table 12.1 gives a summary of CO_2 emissions from all stationary sources in the Illinois Basin.

The total annual emissions from stationary sources were estimated to be 304 million tonnes (metric). Non-utility industrial emission sources (126 plants) contributed about 32 million tonnes of CO_2 emissions, which accounted for 10.5% of total emissions in the Basin. The geographical distribution of these sources is displayed in Figure 2. Refineries, cement and ethanol production are three largest non-utility emission sources in the Basin, sharing 29%, 19%, and 16% of the non-utility emissions, respectively. The ten non-utility industries included in this inventory study are believed to be the major non-utility sources in the Basin. It should be noted that the updated emission data for aluminum, ethanol, gas compressor station, autos and glass are mostly based on the year of 2005, while the remaining sources are based on 2002. However, given that the production of major products in these industries varies very slightly from 2002 to 2005, the resulting discrepancy due to the different base years used is believed to be of little significance.

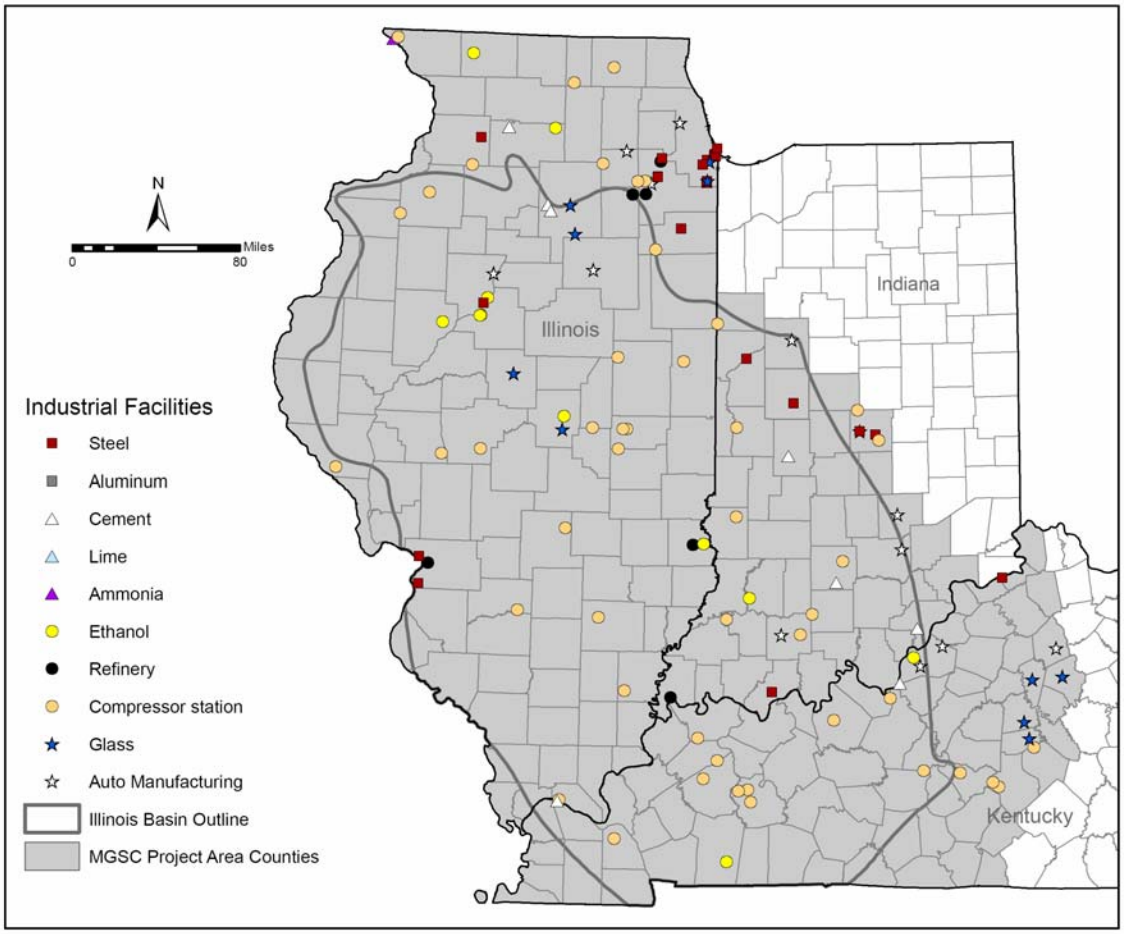

Figure 2. 126 facilities in ten non-utility industries

Coal-fired electric power plants remain the predominant stationary sources of emissions. About 272.5 million tonnes of CO_2 (90.3% of the Illinois Basin emissions) were emitted in 2005 in the Illinois Basin from 126 fossil fuel-fired power plants (only the power plants that emitted >10,000 tons of CO_2 annually were included), Figure 3. The emissions from small utility boilers (<10,000 tons CO_2) shared only about 0.03% of total utility emissions, and thus were not counted. The four largest power plants emitted about 22% of the total utility CO_2 emissions, the 12 largest power plants emitted more than 50% of the total CO_2 emissions, and the 29 largest power plants emitted over 80% of total CO_2 emissions in the Illinois Basin.

Most of the power plants in the Illinois Basin are equipped with pulverized coal boilers and use a sub-critical steam cycle. The power plants that burn natural gas tend to be small and are mostly peak-load power plants. Total CO_2 emissions from these power plants are about 6 million tonnes annually, which is 2.2% of total utility emissions in the Illinois Basin.

The GIS information related to individual non-utility and utility sources are detailed in the two electronic files. They are uploaded together with this document to the designated website.

MGSC_Phase2_IndustrialSources082007.DBF;
MGSC_Powerplants08152007.DBF.

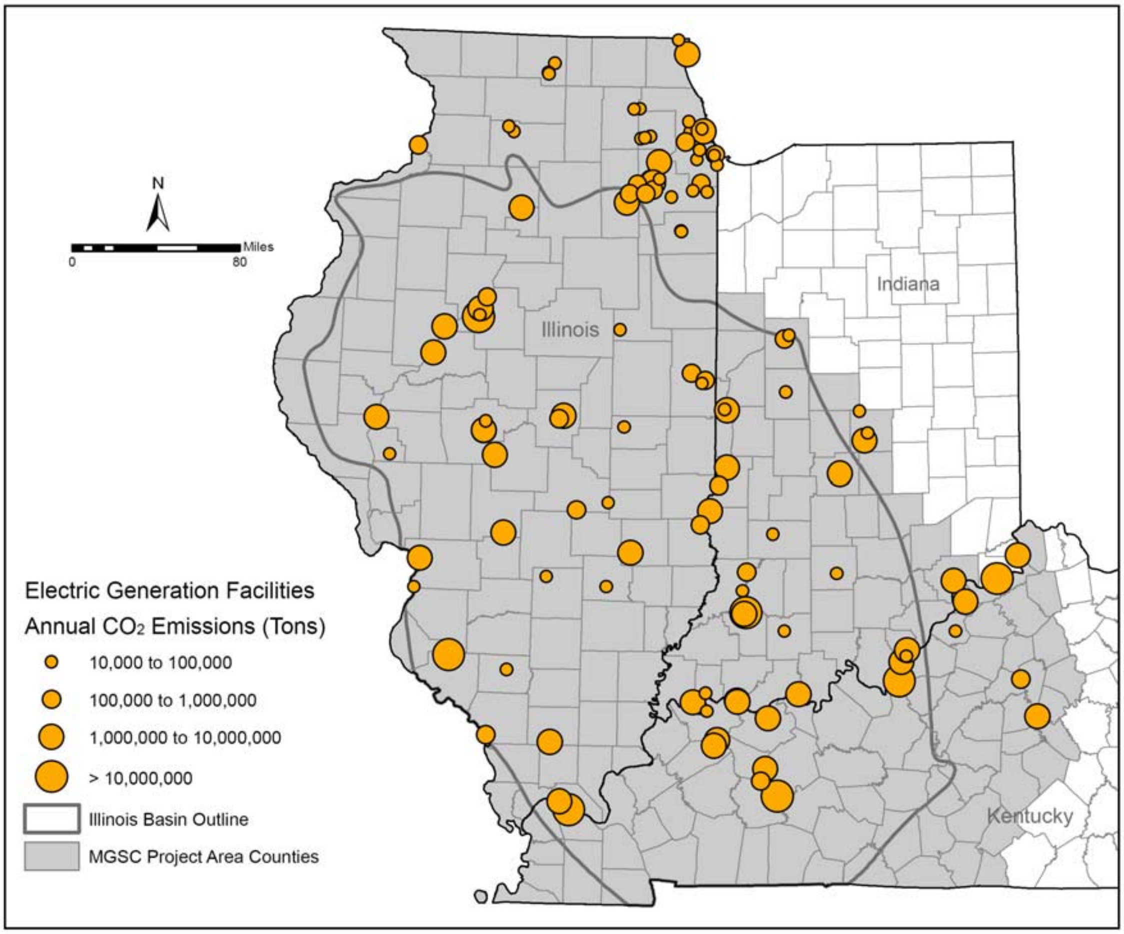

Figure 3. 126 power plants (>10,000 tons CO_2 /yr) in the Illinois Basin

Table 1.1 CO_2 emissions from power generation (data of 2005 for most sources)

	ORIS_NO	State	Plant	Longitude	Latitude	Year	Data Source	Heat Input (MMBtu)	Fuel	CO_2 Emissions (tonne)
1	6113	IN	Gibson	-87.76651	38.37267	2005	EPA ARP	332,997,519	coal	19,733,570
2	6166	IN	Rockport	-87.03541	37.92579	2005	EPA ARP	339,616,297	coal	15,809,724
3	1378	KY	TVA Paradise Fossil Plant	-86.97834	37.25989	2005	EPA ARP	142,749,521	coal	13,290,467
4	1356	KY	Ghent Generating Station	-85.03732	38.74830	2005	EPA ARP	189,622,447	coal	11,843,042
5	994	IN	AES Petersburg	-87.25224	38.52812	2005	EPA ARP	174,388,724	coal	11,778,819
6	889	IL	Baldwin Energy Complex	-89.85476	38.20495	2005	EPA ARP	126,261,505	coal	11,755,383
7	1379	KY	TVA Shawnee Fossil Plant	-88.77663	37.15195	2005	EPA ARP	203,639,610	coal	10,372,162
8	879	IL	Powerton	-89.67936	40.54073	2005	EPA ARP	203,213,699	coal	9,459,893
9	1364	KY	Mill Creek	-85.91035	38.05281	2005	EPA ARP	100,403,334	coal	9,347,891
10	983	IN	Clifty Creek	-85.41956	38.73818	2005	EPA ARP	173,592,567	coal	8,081,047
11	887	IL	Joppa Steam	-88.85857	37.20951	2005	EPA ARP	173,011,217	coal	8,052,791
12	6017	IL	Newton	-88.27645	38.93684	2005	EPA ARP	81,260,941	coal	7,565,677
13	6213	IN	Merom Generating Station	-87.57294	39.22773	2005	EPA ARP	72,646,420	coal	6,763,635
14	876	IL	Kincaid Generation LLC	-89.49673	39.59094	2005	EPA ARP	137,801,748	coal	6,414,907
15	6705	IN	Warrick	-87.32900	37.91933	2005	EPA ARP	101,115,471	coal	5,969,720
16	1001	IN	Cayuga	-87.42720	39.92398	2005	EPA ARP	63,158,778	coal	5,869,237
17	384	IL	Joliet 29	-88.12391	41.49446	2005	EPA ARP	123,975,440	coal	5,771,223
18	1010	IN	Wabash River	-87.42335	39.52926	2005	EPA ARP	104,365,957	coal	5,495,621
19	884	IL	Will County	-88.06181	41.63360	2005	EPA ARP	58,053,829	coal	5,405,014
20	861	IL	Coffeen	-89.40256	39.05946	2005	EPA ARP	102,978,863	coal	4,793,792
21	883	IL	Waukegan Station (Midwest Generation EME LLC)	-87.81394	42.38326	2005	EPA ARP	51,215,605	coal	4,768,345
22	856	IL	E D Edwards	-89.66288	40.59561	2005	EPA ARP	71,905,354	coal	4,315,418
23	6823	KY	D B Wilson Station	-87.08007	37.44825	2005	EPA ARP	40,766,898	coal	3,795,538
24	6639	KY	R D Green Station	-87.50017	37.64603	2005	EPA ARP	39,789,549	coal	3,704,541
25	1363	KY	Cane Run	-85.88996	38.18283	2005	EPA ARP	38,674,328	coal	3,600,711
26	1355	KY	E W Brown Generating Station	-84.71290	37.78834	2005	EPA ARP	67,154,485	coal	3,488,418
27	990	IN	Harding Street (formerly EW Stout)	-86.19670	39.71183	2005	EPA ARP	37,494,974	coal	3,448,363
28	6071	KY	Trimble County	-85.31776	38.59256	2005	EPA ARP	38,347,521	coal	3,433,073
29	6018	KY	East Bend Generating Station	-84.85139	38.90463	2005	EPA ARP	35,725,528	coal	3,326,168
30	6137	IN	A B Brown	-87.71569	37.90572	2005	EPA ARP	35,937,762	coal	3,321,466
31	891	IL	Havana	-90.07813	40.28138	2005	EPA ARP	35,192,718	coal	3,259,306
32	867	IL	Crawford Station	-87.72292	41.82886	2005	EPA ARP	32,914,863	coal	3,064,488
33	1381	KY	Kenneth C. Coleman Station	-86.79166	37.96274	2005	EPA ARP	32,539,714	coal	3,029,559

34	898	IL	Wood River	-90.13401	38.86370	2005	EPA ARP	31,423,948	coal	2,919,072
35	1012	IN	F B Culley	-87.32534	37.91000	2005	EPA ARP	59,068,248	coal	2,876,521
36	1008	IN	R Gallagher	-85.83836	38.26371	2005	EPA ARP	61,034,118	coal	2,841,293
37	963	IL	Dallman	-89.60191	39.75489	2005	EPA ARP	42,150,350	coal	2,662,837
38	976	IL	Marion	-88.95280	37.61972	2005	EPA ARP	27,442,927	coal	2,623,354
39	1374	KY	Elmer Smith Station	-87.06023	37.79478	2005	EPA ARP	53,625,295	coal	2,497,273
40	1382	KY	Reid Green HMP&L Station 2 Henderson	-87.50217	37.64646	2005	EPA ARP	24,604,967	coal	2,290,823
41	892	IL	Hennepin Power Station	-89.31443	41.30320	2005	EPA ARP	44,358,404	coal	2,064,924
42	874	IL	Joliet 9	-88.11554	41.49325	2005	EPA ARP	20,662,055	coal	1,923,708
43	6025	IL	Collins	-88.35139	41.35233	2000	EPA EGRID	29,858,553	gas	1,672,863
44	6016	IL	Duck Creek	-89.98481	40.46601	2005	EPA ARP	17,143,969	coal	1,596,364
45	886	IL	Fisk Street	-87.65325	41.85064	2005	EPA ARP	16,791,112	coal	1,563,306
46	864	IL	Meredosia	-90.56671	39.82360	2005	EPA ARP	19,528,666	coal	1,491,195
47	991	IN	Eagle Valley	-86.41814	39.48530	2005	EPA ARP	31,898,868	coal	1,485,956
48	1043	IN	Frank E Ratts	-87.26660	38.52003	2005	EPA ARP	11,350,765	coal	1,056,796
49	10865	IL	Archer Daniels Midland Decatur	-88.89029	39.86994	2000	EPA EGRID	11,134,582	coal	1,005,205
50	863	IL	Hutsonville	-87.65967	39.13375	2005	EPA ARP	9,333,119	coal	868,943
51	1357	KY	Green River	-87.12172	37.36343	2005	EPA ARP	7,776,926	coal	724,059
52	897	IL	Vermilion	-87.74851	40.17813	2005	EPA ARP	15,234,544	coal	708,804
53	10867	IL	A E Staley Decatur Plant Cogen	-88.93096	39.84934	2000	EPA EGRID	6,573,453	coal	614,843
54	55131	IL	Kendall County Generation Facility	-88.25647	41.48079	2005	EPA ARP	9,973,090	gas	537,825
55	1361	KY	Tyrone Generating Station	-84.84822	38.04814	2005	EPA ARP	4,561,801	coal	424,715
56	1383	KY	Robert A Reid Station	-87.50027	37.64613	2005	EPA ARP	4,278,593	coal	398,352
57	1004	IN	Edwardsport	-87.24710	38.80680	2005	EPA ARP	4,248,146	coal	395,516
58	55188	IL	Cordova Energy	-90.27961	41.71259	2005	EPA ARP	6,631,885	gas	357,643
59	55334	IL	Holland Energy Facility	-88.75884	39.22454	2005	EPA ARP	6,549,206	gas	353,189
60	55199	IL	Elwood Energy LLC	-88.11517	41.44159	2005	EPA ARP	5,476,554	gas	295,337
61	55216	IL	Morris Power Plant (Morris Cogeneration LLC)	-88.32939	41.41362	2000	EPA EGRID	5,141,037	gas	270,112
62	964	IL	Lakeside	-89.60028	39.75724	2005	EPA ARP	5,147,099	coal	239,604
63	54556	IL	Corn Products Illinois	-87.82128	41.77598	2000	EPA EGRID	2,817,365	coal	223,559
64	55364	IN	Mirant Sugar Creek Power Plant	-87.49417	39.40407	2005	EPA ARP	3,712,624	gas	188,067
65	55279	IL	Aurora	-88.22662	41.81513	2005	EPA ARP	3,252,844	gas	175,420
66	10866	IL	Archer Daniels Midland Peoria	-89.60444	40.67722	2000	EPA EGRID	2,560,663	gas	164,635
67	6238	IL	Pearl Station	-90.61356	39.44897	2000	EPA EGRID	1,688,607	coal	156,920
68	862	IL	Grand Tower	-89.51130	37.65769	2005	EPA ARP	2,637,571	gas	142,238
69	10399	IL	LTV Steel South Chicago Works	-87.54805	41.69083	2000	EPA EGRID	2,653,460	coal	139,414

70	50240	IN	Purdue University Wade Utility Plant	-86.91250	40.41728	2000	EPA EGRID	1,489,294	coal	137,654
71	55640	IL	PPL University Park Power Project	-87.67445	41.49144	2005	EPA ARP	2,522,352	gas	136,026
72	51000	IL	Bunge Milling Cogen	-87.62363	40.12680	2000	EPA EGRID	1,108,958	coal	104,897
73	50627	IL	ExxonMobil Oil Joliet Refinery	-88.18204	41.41521	2000	EPA EGRID	1,729,088	gas	90,847
74	55250	IL	University Park Energy LLC	-87.75291	41.44052	2005	EPA ARP	1,560,544	gas	83,552
75	55202	IL	Pinckneyville	-89.34642	38.11292	2005	EPA ARP	1,447,347	gas	78,013
76	1372	KY	Henderson I	-87.59106	37.84513	2005	EPA ARP	772,725	coal	71,941
77	55111	IN	Vermillion Energy Facility	-87.44976	39.92855	2005	EPA ARP	1,291,565	gas	69,653
78	1366	KY	Paddys Run	-85.84611	38.22138	2005	EPA ARP	1,312,103	gas	69,340
79	55308	KY	Calvert City (Air Products & Chemicals Inc. cogen)	-88.34527	37.05500	2000	EPA EGRID	1,312,903	gas	68,980
80	7948	IN	Hoosier Energy Bedford	-86.45269	38.79881	2005	EPA ARP	1,278,573	gas	68,952
81	7760	IL	Tilton	-87.65381	40.10605	2005	EPA ARP	1,273,938	gas	68,703
82	54780	IL	University of Illinois Abbott Power Plant	-88.24201	40.10477	2000	EPA EGRID	904,409	gas	68,552
83	992	IN	Perry K	-86.16675	39.76225	2005	EPA ARP	1,245,541	coal	67,232
84	55236	IL	Lee Energy Facility	-89.40501	41.82884	2005	EPA ARP	1,171,257	gas	63,163
85	7759	IN	Georgetown	-86.23901	39.91623	2005	EPA ARP	1,138,450	gas	61,396
86	6225	IN	Jasper 2	-86.91501	38.40037	2000	EPA EGRID	558,131	coal	52,204
87	7818	IL	Alsey	-90.43570	39.57040	2000	EPA EGRID	916,559	oil	48,419
88	55245	IL	Tuscola Station Equistar Chemicals	-88.34944	39.79844	2000	EPA EGRID	498,216	coal	44,283
89	55417	IL	Raccoon Creek Energy Center, MEP Flora Power	-88.48565	38.69982	2005	EPA ARP	796,195	gas	42,935
90	55237	IL	Energy Shelby County	-88.47701	39.27956	2005	EPA ARP	800,442	gas	42,862
91	913	IL	Venice	-90.17787	38.66438	2005	EPA ARP	789,810	gas	42,616
92	55148	IN	Worthington Generation LLC	-87.01307	39.07190	2005	EPA ARP	788,268	gas	42,510
93	866	IL	Calumet	-87.52944	41.61563	2000	EPA EGRID	776,220	gas	40,783
94	55496	IL	Goose Creek Energy Center	-88.59940	40.10696	2005	EPA ARP	736,198	gas	39,701
95	55222	IL	Lincoln Energy Center	-87.94345	41.39384	2005	EPA ARP	725,030	gas	39,099
96	55201	IL	Gibson City	-88.39799	40.47130	2005	EPA ARP	673,828	gas	36,378
97	10406	IL	Alsip Paper Condominium Association	-87.71585	41.65338	2000	EPA EGRID	664,450	gas	34,910
98	54044	IL	University of Illinois Cogen Facility East Campus	-87.66967	41.86865	2000	EPA EGRID	643,438	gas	34,214
99	1011	IN	Broadway Ohio River	-87.60525	37.96944	2000	EPA EGRID	635,171	gas	33,543
100	50722	IL	BP Naperville Cogeneration Facility	-88.14856	41.81051	2000	EPA EGRID	617,487	gas	32,443
101	55164	KY	Bluegrass Generation LLC	-85.41423	38.39002	2005	EPA ARP	570,748	gas	30,778
102	50903	IN	Sagamore Plant Cogeneration	-86.86900	40.44300	2000	EPA EGRID	389,335	coal	29,629
103	55204	IL	Kinmundy	-89.01266	38.76109	2005	EPA ARP	534,313	gas	28,814
104	7384	IL	Indian Trails Cogen 1 at MGP Ingredients, Inc.	-89.67096	40.55333	2000	EPA EGRID	543,210	gas	28,685
105	1024	IN	Crawfordsville	-86.89925	40.04928	2000	EPA EGRID	292,821	coal	27,278

106	870	IL	Electric Junction Combustion Turbine	-88.23185	41.79534	2000	EPA EGRID	493,260	gas	26,029
107	54855	IL	M&M Mars Chicago	-87.79340	41.91720	2000	EPA EGRID	484,433	gas	25,495
108		IL	Nrg Rockford II Energy Center	-89.10265	42.24025	2001	EPA EGRID		gas	23,688
109	54790	IL	Aventis Behring LLC	-87.85551	41.16080	2000	EPA EGRID	442,413	gas	23,245
110	55392	IL	Zion Energy Center	-87.89532	42.47759	2005	EPA ARP	420,760	gas	22,789
111	54933	IL	Pfizer Adams or Warner Lambert	-89.04607	42.30709	2000	EPA EGRID	432,878	gas	22,744
112	55438	IL	Elgin Energy Center	-88.24397	42.00044	2005	EPA ARP	404,302	gas	21,804
113	54516	IL	Cemex (Dixon Marquette Cement Inc.)	-89.45480	41.86100	2000	EPA EGRID	337,119	gas	17,712
114	7858	IL	MEPI GT Facility	-88.86564	37.21806	2005	EPA ARP	322,859	gas	17,412
115	7425	IL	Interstate	-89.58879	39.82336	2005	EPA ARP	298,108	gas	17,017
116	55238	IL	NRG Rockford II	-89.10265	42.24025	2005	EPA ARP	300,340	gas	16,197
117	52034	IL	Bunge Foods	-87.85300	41.15512	2000	EPA EGRID	290,397	gas	15,258
118	55296	IL	Calumet Energy Team LLC	-87.55655	41.68372	2005	EPA ARP	260,062	gas	14,025
119	54523	IL	Hoffer Plastics	-88.30166	41.99870	2000	EPA EGRID	223,600	gas	11,748
120	882	IL	Sabrooke Combustion Turbine	-89.09573	42.23203	2000	EPA EGRID	216,420	gas	11,598
121	50326	IL	ONDEO Nalco	-88.19710	41.80100	2000	EPA EGRID	216,395	gas	11,369
122		IL	Freedom Power Project	-88.85830	39.10270	2001	EPA EGRID		gas	10,433
123	55224	IN	Wheatland Generating Facility	-87.28572	38.67912	2005	EPA ARP	191,191	gas	10,311
124	52032	IL	IVEX Packaging	-88.05440	41.51810	2000	EPA EGRID	195,031	gas	10,247
125	10400	IL	Little Company of Mary Hospital	-87.69291	41.72252	2000	EPA EGRID	178,688	gas	9,388
126	55253	IL	Crete Energy Park	-87.61805	41.43184	2005	EPA ARP	173,888	gas	9,376
Total								4,215,229,663		272,488,563

Table 2.1 CO_2 emissions from petroleum refineries (2002)

ORISPL	Company	State	City	Long.	Lat.	Production of Main Products		CO_2 Emissions (tonne/yr)
						bbl/day	bbl/yr	
50627	ExxonMobile	IL	Joliet	-88.18204	41.41521	238,000	86,870,000	2,470,708
52191	Marathon Ashland	IL	Robinson	-87.72459	38.99895	192,000	70,080,000	1,993,176
880076	PDV Midwest LLC	IL	Lemont	-88.05250	41.64400	160,000	58,400,000	1,660,980
880067	ConcoPhillips	IL	Woodriver	-90.06416	38.83744	288,300	105,229,500	2,992,878
	Countrymark Coop	IN	Mt. Vernon	-87.90935	37.94226	23,000	8,395,000	238,766
Subtotal						901,300	328,974,500	9,356,508

Table 3.1 State-level CO_2 emissions from iron & steel manufacturing (2002)

	Illinois		Indiana		Kentucky		Total emissions (tonne/yr)
	Production (ton/yr)	Emissions (tonne/yr)	Production (ton/yr)	Emissions (tonne/yr)	Production (ton/yr)	Emissions (tonne/yr)	
Coke	1,061,194	3,210,776	39,303	118,918	-	0	3,329,694
Pig Iron	2,975,400	197,856	110,200	7,328	-	0	205,184
Scrap Steel	4,628,400	61,555	-	0	1,763,200	23,450	85,005
EAF	4,235,000	16,909	2,097,000	8,373	1,500,000	5,989	31,271
Subtotal		3,487,097		134,618		29,439	3,651,154

Table 3.2 Emissions from steel plants using electric arc furnaces (EAF's) (2002)

Company	State	City	Lat.	Long.	Commence Year	Furnace No.	Type of Steel	Steel Capacity (ton/y)	CO_2 emissions (tonne/y)
Northwestern Steel & Wire Co.	IL	Sterling	42.8	89.69	2000	2	Carbon	1,400,000	5,590
Keystone Steel & Wire Co.	IL	Peoria	40.75	89.60	1998	1	Carbon	1,000,000	3,993
Nucor Steel	IL	Kankakee	41.11	87.86	1990	1	Carbon	800,000	3,194
Northwestern Steel & Wire Co.	IL	Sterling	42.8	89.69	1971	1	Carbon	670,000	2,675
Austeel Lemont Co. Inc.	IL	Lemont	41.67	88.00	1959	1	Carbom, alloy	200,000	799
Calumet Steel Co.	IL	Chicago Heights	41.51	87.64	1967	1	Carbon, Alloy	75,000	299
Finkl, A., & Sons	IL	Chcago	41.92	87.65	1953	1	Carbon, Alloy	45,000	180
Finkl, A., & Sons	IL	Chcago	41.92	87.65	1953	2	Carbon, Alloy	45,000	180
Nucor Corp.	IN	Crawfordsville	40.04	86.9	1989	1	Carbon, stainless	2,000,000	7,985
Harrison Steel Castings Co.	IN	Attica	40.29	87.25	1974	2	Carbon, low alloy	40,000	160
Harrison Steel Castings Co.	IN	Attica	40.29	87.25	1992	3	Carbon, low alloy	40,000	160
Harrison Steel Castings Co.	IN	Attica	40.29	87.25	1951	1	Carbon, low alloy	17,000	68
Gallatin Steel Co.	KY	Ghent	38.74	38.06	1995	1	Carbon	1,500,000	5,989

Table 4.1 State-level CO_2 emissions from cement production (2002)

	Illinois		Indiana		Kentucky		Total emissions (tonne/yr)
	Production (ton/yr)	Emissions (tonne/yr)	Production (ton/yr)	Emissions (tonne/yr)	Production (ton/yr)	Emissions (tonne/yr)	
Clinker	2,810,100	1,292,850	2,923,140	1,344,857	1,276,116	587,106	3,224,813
Fuel use	-	1,180,650	-	1,228,143	-	536,154	2,944,947
Subtotal		2,473,500		2,573,000		1,123,260	6,169,760

Table 4.2 Cement plants in the Illinois Basin (2002)

Plant Name	State	City	Address	Zip	Longitude	Latitude
Cemex	IL	Dixon	1914 White Oak Lane	61021	-89.45480	41.86100
Illinois Cement Co	IL	LaSalle	1601 Rockwell Rd, Box 442	61301	-89.08119	41.32977
Buzzi Unicem-Lone Star Industries	IL	Oglesby	490 Portland Avenue, PO Box 130	61348	-89.05114	41.28858
Lafarge	IL	Grand Chain	2500 Portland Road	62941	-88.88100	37.21657
Essroc	IN	Speed	301 Highway 31	47172	-85.74790	38.41773
Lehigh	IN	Mitchel	PO Box 97 121 N. First Street	47446	-86.45716	38.73880
Buzzi Unicem	IN	Greencastle	3301 S. County Rd. 150 W, PO Box 482	46135	-86.87884	39.61100
Kosmos Cement	KY	Louisville	15301 Dixie Highway	40272	-85.90581	38.03607

Table 5.1 CO_2 emissions from ammonia production (2002)

Company	State	City	Longitude	Latitude	Production		CO_2 Emissions (tonne/yr)
					Ammonia (ton/y)	Urea (ton/yr)	
Royster-Clark, Inc.	IL	East Dubuque	-90.55739	42.44275	280,000	136,500	431,942

Table 6.1 CO_2 emissions from aluminum production (2004)

	EPA_FRS	State	Plant	Longitude	Latitude	Fuel	Process	Emission Factor (lb CO_2/ton Al product)	Al Production 2004 (tonne/y)	CO_2 Emissions (tonne/y)
1	110000602045	IN	Alcoa Inc. - Warrick Operations	-87.32771	37.92186	coal	Prebaked	3080	309,000	475,860
2	110000380917	KY	Century Aluminum Company	-86.78684	37.94360	coal	Prebaked	3080	244,000	375,760
3	110000714326	KY	ALCAN Primary Metal Group	-87.50114	37.65808	coal	Prebaked	3080	196,000	301,840
Total									347,167	1,153,460

Table 7.1 CO_2 Emissions from lime production (2002)

Company Name	Plant Name	State	City	Address	Long.	Lat.	Quicklime		Dolomite lime		Total CO_2 emissions (tonne/yr)
							Lime (ton/yr)	CO_2 (tonne/yr)	Lime (ton/yr)	CO_2 (tonne/yr)	
Carmeuse Lime	South Chicago	IL	Chicago	3245 E. 103rd	-87.54400	41.70561	35,000	23,820	315,000	248,684	272,505

Table 8.1 CO_2 Emissions from ethanol plants (2006)

No.	Company	City	State	Long.	Lat.	Feedstock	Capacity (Mm gallon/year)		Data date	CO_2 emissions (tonne/y)	
							Current	Under construct.		Fermentation	Fuel burning
1	Adkins Energy, LLC*	Lena	IL	-89.80457	42.36285	Corn	40.00		2/1/2006	114,525	86,751
2	Archer Daniels Midland	Peoria	IL	-89.60444	40.67722	Corn	273.00		2/1/2006	781,632	592,078
3	Archer Daniels Midland (FRS: ADM East plant)	Decatur	IL	-88.89029	39.86994	Corn	274.00		2/1/2006	784,495	594,247
4	Aventine Renewable Energy, LLC	Pekin	IL	-89.66301	40.55506	Corn	100.00	57.00	2/1/2006	449,510	340,499
5	Central Illinois Energy Cooperative	Canton	IL	-90.00557	40.50151	Corn		30.00	5/1/2006	85,894	65,064
6	Illinois River Energy, LLC	Rochelle	IL	-89.02484	41.86201	Corn		50.00	2/1/2006	143,156	108,439
7	Lincolnland Agri-Energy, LLC*	Palestine	IL	-87.63168	39.00401	Corn	48.00		2/1/2006	137,430	104,102
8	MGP Ingredients, Inc.	Pekin	IL	-89.67136	40.55346	Corn/wheat starch	78.00		2/1/2006	217,740	169,165
9	Grain Processor Corporation	Washington	IN	-87.22500	38.63230	Corn	40.00			114,525	86,751
10	Commonwealth Agri-Energy, LLC*	Hopkinsville	KY	-87.41650	36.80800	Corn	24.00	9.00	2/1/2006	94,483	71,570
11	Parallel Products	Louisville	KY	-85.78567	38.21622	Beverage waste	5.40		2/1/2006	12,369	11,711
Total							882.40	146.00		2,935,759	2,230,377

Table 9.1 CO_2 Emissions from compressor stations (2005)

No.	State	Plant	Long.	Lat.	Pollutant Emissions		Equipment Capacity (Mmbtu/hr)						CO_2 Emissions (tonne /y)
					NOx	CO	2SLB	4SLB	4SRB	GT	NG Boiler	Total	
1	IL	Panhandle Eastern Pipeline Co. cmp station	-88.35806	39.79063	2229.89	237.51	234.84	0	0	0	0	234.84	61,604
2	IL	Natural Gas Pipeline Co Of America cmp station 201 NGT	-88.08905	41.03344	2107.74	278.70	238.17	0	0	188.89	45.5	472.55	123,962
3	IL	Natural Gas Pipeline Co. of America cmp station 311 NGT	-88.63545	39.79434	1709.34	213.43	267.90	0	0	0	16.74	284.64	74,668
4	KY	Texas Eastern Transmission Corp.	-84.74990	37.57890	1679.88	207.20	151.44	0	0	279.73	0	431.17	113,106
5	IL	Natural Gas Pipeline Co. of America cmp station 110 NGT	-90.16795	41.39214	1677.17	298.36	209.88	0	0	77.10	0	286.98	75,280
6	IN	Panhandle Eastern Pipeline Co. cmp station	-86.25691	39.92356	1559.53	165.51	203.30	0	3.76	0	0	207.06	54,317
7	IL	Trunkline Gas Co. cmp station NG	-88.86486	37.22354	1503.11	140.22	188.47	0	0	68.00	0	256.47	67,277
8	IN	Panhandle Eastern Pipeline Co. Montezuma cmp station	-87.34067	39.80563	1500.36	76.18	59.60	82.80	72.54	79.50	0	294.44	77,238
9	IL	Panhandle Eastern Pipeline Co. cmp station	-89.63154	39.63286	1289.83	229.76	135.50	57.96	0	0	0	193.46	50,748
10	IL	Panhandle Eastern Pipeline Co. cmp station	-90.91379	39.47236	1181.20	141.30	166.22	0	0	102.92	0	269.14	70,603
11	KY	Columbia Gulf Trans Co *	-85.06140	37.31080	1175.95	50.45	na	na	na	na	na	na	37,029
12	KY	ANR Pipeline Co. *	-87.61905	37.38160	1144.21	90.93	na	na	na	na	na	na	36,030
13	IL	Trunkline Gas Co. cmp station NG	-88.32400	39.79072	1129.28	122.01	89.83	0	0	0	0	89.83	23,564
14	IL	ANR Pipeline Co. cmp station	-90.42921	41.23979	923.46	297.49	121.23	0	0	0	5.5	126.73	33,244
15	IL	Texas Eastern Transmission Corp. cmp station NG	-88.31363	37.98378	735.36	254.17	0	0	72.45	0	0	72.45	19,005
16	IL	Natural Gas Pipeline Co. of America cmp station 310 NGT	-89.26609	38.53104	692.63	182.65	256.89	0	0	0	16.7	273.59	71,768
17	KY	Tennessee Gas Pipeline Co. *	85.34394	37.22523	631.33	78.33	na	na	na	na	na	na	19,880
18	KY	Texas Gas Trans Corp *	-87.50120	37.50845	616.35	164.01	na	na	na	na	na	na	19,408
19	IN	ANR Pipeline Co. Celestine cmp station NG	-86.77633	38.37849	579.25	34.20	242.90	0	0	0	0	242.90	63,718
20	IN	Texas Eastern Transmission Co. French Lick cmp station NG	-86.66960	38.52114	576.41	43.23	58.77	0	0	0	0	58.77	15,415
21	IL	ANR Pipeline Co. cmp station	-88.58015	41.62314	477.97	62.06	135.92	55.49	0	0	5.5	196.91	51,653
22	IL	Panhandle Eastern Pipeline Co. cmp station / underground storage	-89.97913	39.59194	405.52	44.73	12.11	27.37	10.76	0	5	55.24	14,491
23	IL	Trunkline Gas Co. cmp station 512 NG	-88.55282	38.48883	362.92	107.99	228.32	0	0	0	0	228.32	59,894

24	KY	Texas Gas Transmission *	-86.48560	37.78696	361.83	24.95	na	na	na	na	na	na	11,393
25	IL	Natural Gas Pipeline Co. of America cmp station 206 NGE	-88.85935	39.10254	247.01	58.66	50.37	21.72	0	0	76.28	148.37	38,920
26	IL	Peoples Gas Light & Coke Co. cmp station / Manlove Storage	-88.41471	40.28384	156.48	71.96	104.20	46.60	0	0	422.63	573.43	150,424
27	KY	Louisville Gas & Electric	-85.70820	37.43110	137.70	49.33	31.20	0	31.68	0	0	62.88	16,495
28	KY	Tennessee Gas Pipeline Co. *	-85.39330	37.41280	136.28	8.99	na	na	na	na	na	na	4,291
29	IL	ANR Pipeline Co. cmp station NG	-88.49465	42.28864	95.64	32.54	102.42	0	0	46.17	0	148.59	38,979
30	KY	Tennessee Gas Pipeline Co. *	-85.11170	37.34500	93.08	48.27	na	na	na	na	na	na	2,931
31	IL	Natural Gas Pipeline Co. of America cmp station 116 NGT	-88.86431	42.17745	85.29	14.31	0	0	0	50.20	0	50.20	13,169
32	IN	Texas Gas Transmission Petersburg cmp station	-87.42426	38.48395	76.22	3.36	0	15.24	15.96	0	0	31.20	8,184
33	IL	Northern Natural Gas Co	-90.51430	42.45430	73.94	10.22	0	0	0	98.68	0	98.68	25,886
34	KY	Texas Gas Transmission *	-87.31368	37.29638	71.34	11.39	na	na	na	na	na	na	2,246
35	KY	Texas Gas Transmission *	-88.38399	36.96230	66.25	7.43	na	na	na	na	na	na	2,086
36	IL	Natural Gas Pipeline Co. of America cmp station 203 NGT	-88.39812	39.65283	65.53	4.57	27.28	0	0	0	0	27.28	7,157
37	KY	Texas Gas Trans Corp	-87.20758	37.21980	62.70	1.71	na	na	na	na	na	na	1,974
38	IL	Alliance Pipeline L.P., Tampico 29-A Cmp Station	-89.78356	41.59269	49.71	60.26	0	0	0	228.60	0	228.60	59,967
39	IL	Natural Gas Pipeline Co. of America station 115 *	-88.25958	41.50320	44.02	62.89	na	na	na	na	na	na	1,386
40	IN	Trunkline Gas Co. Ambia cmp station	-87.51832	40.52264	43.09	4.31	75.56	0	0	0	0	75.56	19,820
41	KY	Texas Gas Trans Corp *	-87.67000	37.66080	40.59	8.28	na	na	na	na	na	na	1,278
42	IN	Citizens Gas & Coke Utility - LNG South	-86.06902	39.71560	28.84	3.98	33.36	0	0	0	174	207.36	54,395
43	IN	Texas Gas Transmission Wilfred cmp station *	-87.34279	39.19360	23.80	5.73	6.18	0	0	0	0	6.18	1,621
44	IN	Texas Gas Transmission Leesville cmp station	-86.39805	38.88460	20.58	7.14	0	46.50	0	0	7.18	53.68	14,082
45	KY	Texas Gas Trans Corp *	-87.23580	37.30550	19.32	2.58	na	na	na	na	na	na	608
46	KY	Louisville Gas & Electric	-85.99100	37.93660	15.98	4.01	67.50	0	0	28.40	12.6	108.50	28,462
47	IL	Midwestern Gas Transmission cmp station 2118	-87.82205	40.26204	13.42	3.27	45.00	0	0	37.17	0	82.17	21,555
48	IL	Natural Gas Pipeline Co. of America cmp station 113 NGT *	-88.19117	41.50665	11.59	20.68	0	0	0	223.45	0	223.45	58,616
49	IL	Aux Sable Liquid Products L.P.	-88.30423	41.41272	na	na	0	0	0	457.20	402.1	859.30	225,414
Total													2,045,241

Table 10.1 CO_2 Emissions from autos manufacturing (2005)

No.	State	City	Facility	Long.	Lat.	Pollutant Emissions (short ton/y)		Heat input (MMBtu/hr)			CO_2 emissions (tonne/y)			
						NO_X	CO	NG	Diesel	Coal	NG	Diesel	Coal	Total
1	IN	Columbus	Cummins, Inc. (columbus Engine Plant)	-85.90956	39.20333	231.54	55.55	143.00	86.32	0	50,016	39,961	0	89,977
2	IN	Lafayette	Caterpillar Inc.	-86.84750	40.41350	185.70	55.93	249.90	371.58	0	87,406	172,025	0	259,431
3	IN	Seymour	Cummins Engine Co	-85.87854	38.96201	184.64	38.22	41.80	80.73	0	14,620	37,375	0	51,995
4	IL	Melrose Park	International Truck And Engine Corp	-87.87940	41.91158	137.41	85.23	386.98	10.43	0	135,351	4,827	0	140,179
5	IL	Mossville	Caterpillar Inc	-89.55702	40.84450	100.77	45.12	19.47	23.60	0	14,751	10,926	0	25,677
6	IN	Jasper	Jasper Engine Exchange, Inc.	-86.94375	38.37641	54.92	8.21	26.86	28.00	0	9,393	12,963	0	22,356
7	IL	Pontiac	Caterpillar Inc.	-88.65196	40.88673	54.60	6.95	103.51	56.42	0	36,202	26,118	0	62,321
8	IL	East Moline	John Deere Harvester Works	-90.43455	41.52752	165.64	75.57	0	0	414.00	0	0	281,706	281,706
9	IL	Mossville	Caterpillar Tractor-Mossville Tech Ctr	-89.55757	40.84450	356.77	78.30	0	100.98		0	46,750	0	46,750
10	IL	Aurora	Caterpillar Tractor	-88.36310	41.71390	173.93	81.78	723.82	0	0	253,166	0	0	253,166
11	IL	Joliet	Caterpillar Inc.	-88.13569	41.48834	60.01	37.51	569.52	0	0	199,197	0	0	199,197
12	KY	Georgetown	Toyota Motor Mfg Usa Inc	-84.53602	38.26078	166.13	50.58	1,516.00	0	0	530,242	0	0	530,242
13	KY	Louisville	Ford Motor Co, Ky Truck Plt	-85.53070	38.29240	75.93	75.82	715.04	0	0	250,095	0	0	250,095
14	KY	Louisville	Ford Motor Co, Lou Assy Plt	-85.72616	38.15434	53.01	44.44	499.20	0	0	174,602	0	0	174,602
15	IN	Indianapolis	Allison Transmission General Motors Corp	-86.23860	39.77808	198.33	177.65	96.97	854.17	0	33,917	395,448	0	429,365
Total						2,199	917	5,092	1,612	414	1,788,960	746,394	281,706	2,817,060

Table 11.1 CO_2 Emissions from glass manufacturing (2005)

No.	State	City	Company	Long.	Lat.	Glass Product	Production (ton/y)	Energy Factor (Mmbtu/ton glass)	Total_heat input (mmbtu)	Emission factor ($lbCO_2$/mmbtu)	CO_2 emissions (tonne/y)
1	IL	Mt. Zion	PPG Industries Inc. Works14	-88.90109	39.77936	flat glass	na	8.8	6,182,374	117	328,193
2	IL	Ottawa	Pilkington North America Inc.	-88.87485	41.32968	flat glass	167,273	8.8	1,472,000	117	78,142
3	IL	Dolton	Saint Gobain Containers	-87.60006	41.64243	containers	313,871	7.8	2,448,194	117	129,963
4	IL	Streator	Owens Illinois Inc.	-88.82516	41.13178	containers	192,915	7.8	1,504,737	117	79,879
5	IL	Lincoln	Saint Gobain Containers	-89.35345	40.15776	containers	130,815	7.8	1,020,357	117	54,166
6	IL	Chicago Heights	Kimble Glass Inc.	-87.61925	41.51034	containers	na	7.8	na	117	na
7	KY	Versailles	Osram Sylvania Inc.	-84.75074	38.04666	pressed or blown	140,850	5.5	774,675	117	41,124
8	KY	Harrodsburg	Corning Inc.	-84.82970	37.75530	pressed or blown	na	5.5	764,141	117	40,565
9	KY	Lexington	GE Lighting Lexington	-84.48667	38.06138	pressed or blown	135,828	5.5	747,054	117	39,658
10	KY	Danville	Philips Lighting Co.	-84.78770	37.64090	pressed or blown	128,887	5.5	708,880	117	37,631
Total									17,617,576		829,320

Table 12.1 Annual industrial CO_2 emissions in the Illinois Basin

Sources	**Illinois**		**Indiana**		**Kentucky**		**Total in basin**	
	CO_2 (tonne/yr)	**Plants (no.)**	**CO_2 (tonne/yr)**	**Plants (no.)**	**CO_2 (tonne/yr)**	**Plants (no.)**	**CO_2 (tonne/yr)**	**Plants (no.)**
Power generation								
Coal	95,577,470	30	95,241,278	20	75,638,733	17	266,457,481	67
Natural gas	5,339,133	48	474,432	7	169,098	3	5,982,663	58
Oil	48,419	1	0	0	0	0	48,419	1
Subtotal	100,965,022	79	95,715,710	27	75,807,831	20	272,488,563	126
Industries								
Refinery	9,117,742	4	238,766	1	0	0	9,356,508	5
Iron and steel	3,487,097	17	134,618	5	29,439	1	3,651,154	23
Cement	2,473,500	4	2,573,000	3	1,123,260	1	6,169,760	8
Ammonia	431,942	1	0	0	0	0	431,942	1
Aluminum	0	0	475,860	1	677,600	2	1,153,460	3
Lime	272,505	1	0	0	0	0	272,505	1
Ethanol		8		1		2		11
Fermentation	2,714,382		114,525		106,852		2,935,759	
Combustion	2,060,345		86,751		83,281		2,230,377	
Compressor station	1,439,233	25	308,791	9	297,217	15	2,045,241	49
Auto manufacturing	1,008,996	7	853,124	5	954,940	3	2,817,060	15
Glass products	670,343	6	0	0	158,977	4	829,320	10
Subtotal	23,676,085	73	4,785,435	25	3,431,566	28	31,893,085	126
Total	**124,641,107**	**152**	**100,501,145**	**52**	**79,239,397**	**48**	**304,381,648**	**252**