

**KEY SOURCE CATEGORY ANALYSIS FOR THE *INVENTORY*  
OF *U.S. GREENHOUSE GAS EMISSIONS AND SINKS:*  
*1990-2000***

**ANNEX TO THE 1990-2000 U.S. INVENTORY**

U.S. Greenhouse Gas Inventory Program  
Office of Atmospheric Programs  
U.S. Environmental Protection Agency

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### **Original Reference**

All material taken from the *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990 - 2000*, U.S. Environmental Protection Agency, Office of Atmospheric Programs, EPA 430-R-02-003, April 2002. <[www.epa.gov/globalwarming/publications/emissions](http://www.epa.gov/globalwarming/publications/emissions)>

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### Introduction

In order to ensure accuracy and reliability of inventory estimates, quality assurance and quality control (QA/QC) resources and activities should be directed to the key source categories in a given country's greenhouse gas emissions inventory. The IPCC's *Good Practice Guidance* (IPCC 2000) defines a key source category as a "[source category] that is prioritized within the national inventory system because its estimate has a significant influence on a country's total inventory of direct greenhouse gases in terms of the absolute level of emissions, the trend in emissions, or both."<sup>1</sup> By definition, key source categories are sources that have the greatest contribution to the absolute overall level of national emissions. In addition, for countries that have prepared an entire time series of emission estimates, a thorough investigation of key source categories must also include accounting for the influence of trends of individual source categories. Therefore, a trend assessment is also conducted based on an attempt to identify source categories for which significant uncertainty in the estimate would have considerable effects on overall emission trends. This analysis culls out source categories that diverge from the overall trend in national emissions. Finally, a qualitative evaluation of key source categories should be performed, in order to capture any key source categories that were not identified in either of the quantitative analyses.

The purpose of this paper is to provide a brief analysis and discussion of key source categories of emissions as drafted for the *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2000* (EPA 2002). First, the paper will describe the methods by which a nation conducts a key source analysis as defined by IPCC's *Good Practice Guidance* (IPCC 2000), including:

- Tier 1 approach (including both level and trend assessments)

- Tier 2 approach (including both level and trend assessments, and incorporating uncertainty analysis)
- Qualitative criteria

Following this introduction, the paper will provide a brief statistical evaluation of IPCC's quantitative methodologies for defining key source categories. Finally, the results of the U.S. key source category analysis for the base year 2000 U.S. Inventory will be presented and analyzed.

### Tier 1 Approach

The Tier 1 method for identifying key source categories assesses the impacts of all IPCC-defined source categories on the level and, if time-series estimates are available, the trend of the national emission inventory, but works independently of any formal uncertainty analysis. However, it is important to mention that although conducting a key source category analysis can be very valuable in improving a nation's inventory, it would be ideal to undertake a full uncertainty analysis in order to accurately identify all key source categories and to be able to take into account the level of uncertainty associated with each estimate.

When using a Tier 1 approach for the *level*, a pre-determined cumulative emissions threshold is used to identify key source categories. When source categories are sorted in order of decreasing emissions, those that fall at the top of the list and cumulatively account for 95 percent of emissions are considered key source categories. The 95 percent threshold was established based on an evaluation of several inventories, and was designed to establish a general level where the key source category analysis covers 90 percent of inventory uncertainty. The Tier 1 approach for the *trend* uses a 95 percent contribution threshold of the cumulative contribution to the trend assessment metric, which was also designed to establish a general level where the key source category analysis covers 90 percent of inventory uncertainty. The Tier 1 method is completed using a simple spreadsheet analysis based on

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<sup>1</sup> See chapter 7 "Methodological Choice and Recalculation" in IPCC (2000).  
< <http://www.ipcc-nggip.iges.or.jp/public/gp/gpgaum.htm>>

equations for both level and trend assessments that are described in detail below. It is the current approach that the United States is taking to identify key source categories of greenhouse gas emissions until a rigorous uncertainty analysis is completed.

**Level Assessment**

For the 2000 U.S. Inventory, a level assessment was performed for all years in which inventory estimates were available (i.e., 1990-2000), and key source categories were identified as any source category which, when summed in descending order of magnitude for a given year, added up to 95 percent of the total level assessment for that year. Level estimates are based upon the following equation:

<p>Source Category Level Assessment = Source Category / Total Estimate</p> $L_{x,t} = (E_{x,t}) / (E_t)$
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where,

- $L_{x,t}$  = level assessment for source category  $x$  in year  $t$
- $E_t$  = total emissions estimate for year  $t$
- $E_{x,t}$  = emissions estimate for source category  $x$  in year  $t$

**Trend Assessment**

A trend assessment was then conducted to evaluate how significantly the difference between the source category’s trend and the overall inventory trend affect the overall trend. This assessment was done by multiplying the difference between the source category trend and the total inventory trend by the source category level assessment. Trend assessments were based upon the following equation:

<p>Source Category Trend Assessment = (Source Category Level Assessment) ×   (Source Category Trend – Total Trend)  </p> $T_{x,t} = L_{x,t} \times$ $\left  \left( \frac{E_{x,t} - E_{x,0}}{E_{x,t}} \right) - \left( \frac{E_t - E_0}{E_t} \right) \right $
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where,

- $T_{x,t}$  = trend assessment for source category  $x$  in year  $t$
- $L_{x,t}$  = level assessment for source category  $x$  in year  $t$
- $E_{x,t}$  and  $E_{x,0}$  = emissions estimates for source category  $x$  in year  $t$  and year 0, respectively
- 0 = base year (e.g., 1990)

**Tier 2 Approach**

IPCC recommends that inventory agencies use the Tier 2 method for identifying key source categories if nationally derived source-level uncertainties are measured. The Tier 2 approach is a more detailed analysis that builds on the Tier 1 approach by multiplying the results of the Tier 1 analysis by the relative uncertainty of each source category. This method is likely to reduce the number of key source categories under consideration. Using the Tier 2 approach, key source categories represent 90 percent of the quantified uncertainty contribution, as opposed to those that sum to the pre-determined cumulative emissions or trend threshold. A simple spreadsheet version accounts for the uncertainty contribution by applying the source category percentage uncertainty estimates to the Tier 1 level and trend assessments.

A detailed, more complete assessment of uncertainty uses Monte Carlo uncertainty modeling. The U.S. EPA is currently working on preparing such an analysis using procedures for gathering necessary data inputs and estimating uncertainty using a Monte Carlo model developed with @Risk<sup>®</sup> software. The project, which is in the initial phase of developing the uncertainty model, has as its goal developing a simulation model to estimate uncertainty for all source categories of the U.S. Inventory, and in total. The Monte Carlo model develops estimates of uncertainty for inventory source categories based on (a) mathematical models used to estimate emissions for each source category; (b) source category specific input parameters and emission estimates; and (c) the statistical properties underlying the input parameters and estimates.

**Qualitative Approach**

In addition to conducting a quantitative assessment like the ones described above, a variety of qualitative criteria could be applied to identify additional key source categories. The following qualitative criteria for identifying key source categories have been outlined in the *Good Practice Guidance* (IPCC 2000). A source category should be identified as a key source category if:

- Mitigation techniques and technologies are being implemented to reduce emissions from the source category that are expected to be reflected in the inventory estimates
- Significant changes in emissions (i.e., growth or decline) from the source category is expected in the future
- High uncertainty is evident for the source category
- Unexpectedly low or high emissions, or other order of magnitude discrepancies, are apparent for the source category
- Major changes in estimation methodology or data have occurred

In many cases, the results of this qualitative approach to identifying key source categories will overlap with source categories already defined as key source categories through the quantitative analysis. However, the qualitative method may illuminate a few additional key source categories, which should then be included in the final list of key source categories.

However, the application of such qualitative criteria are primarily intended to identify any additional source categories that were “just under” the threshold criteria for the level assessment and not for extremely minor source categories.

The following section of this report evaluates these key source category analyses. The remainder of the paper summarizes the key source categories identified by these analyses, and quantifies their contribution to total level and trend assessments.

### **Evaluation of Key Source Category Identification Methodologies**

#### **Level Assessment**

The Tier 1 approach for level assessment defines the source category contribution as the percentage of total inventory emissions from that source category. Only emission source categories are considered.<sup>2</sup> To determine key

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<sup>2</sup> The level assessment is intended to be applied to sources and to exclude sinks. Although the assessment would still be valid if sinks were included (as unsigned values), the 95 percent threshold by which sources are deemed “key” would lose significance because it is based on an analysis

source categories, the level assessments are sorted in decreasing order, so that the source categories with the highest level assessments appear first. The level assessments are summed until the threshold of 95 percent is reached; all source categories that fall within that cumulative 95 percent are considered key source categories.

Since the Tier 1 approach does not explicitly incorporate uncertainties, the level assessment key source categories will be the largest contributors to total emissions but will not necessarily have large contributions to the total uncertainty. Focusing resources on improving the methodologies for estimating emissions from the source categories with the largest emissions is undesirable if those emissions are estimated relatively precisely using the current methodologies. Nevertheless, the analysis (reported in IPCC 2000) of several inventories that have source category uncertainties showed that about 90 percent of the total uncertainty could be covered by the source categories in the top 95 percent of emissions.

It is important to note that this key source category analysis can be very sensitive to the definitions of the source categories. If a large source category is split into many subcategories, then the subcategories may have contributions to the total inventory that are too small for those source categories to be considered key. Similarly, a collection of small, non-key source categories adding up to less than 5 percent of total emissions could become key source categories if those source categories were aggregated into a single source category. A consistent approach to addressing this issue is available in the *Good Practice Guidance*. Table 7.1 in IPCC (2000) provides guidance and a suggested list of source categories for analysis, although countries are given some discretion based upon their national circumstances.

Some important components of other source categories were not included in the list of IPCC source categories in the key source category chapter of IPCC’s *Good Practice Guidance* (IPCC 2000). These source categories include fossil fuel feedstocks, international bunkers, and

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(Flusgrud et al. 1999) of selected inventories where sinks were excluded.

emissions from territories. They are potentially large source categories that often are derived from unique data sources, have a significant impact on the uncertainty of the estimates, and therefore ought to be considered as potential key source categories.

### Trend Assessment

The Tier 1 approach for trend assessment is defined as the product of the source category level assessment (i.e., source category emissions as a fraction, or percentage, of total emissions) and the absolute difference between the source category trend and the total trend. In turn, the source category trend is defined as the change in source category emissions from the base year to the current year, as a percentage of current year emissions from that source category. The total trend is the percentage change in total inventory emissions from the base year to the current year. Thus, the *source category trend assessment* will be large if the source category represents a large percentage of emissions and/or has a trend that is quite different from the overall inventory trend. Only emissions source categories are considered.<sup>3</sup> To determine key source categories, the trend assessments are sorted in decreasing order, so that the source categories with the highest trend assessments appear first. The trend assessments are summed until the threshold of 95 percent is reached; all source categories that fall within that cumulative 95 percent are considered key source categories.

It is important to note that the trend assessment calculation assumes that the base and current year source category emission uncertainties are the same. Therefore, the trend assessment is a useful measure in cases where the percentage uncertainties of the base and current year source category emission levels are thought to be the same. However, its usefulness diminishes when individual source category uncertainties are different between the base year and the current

year. Such time series inconsistencies could result from changes in data quality or availability over time. As more rigorous methods to determine uncertainties in emission estimates are applied, it may be necessary to revisit the results of the trend assessments.

Another important caveat to the identification of key source categories through the trend assessment is that, while each individual source category's trend assessment provides a measure of how sensitive the overall trend in the inventory is to the trend of a particular source category, the sum of a number of trend assessments does not yield the total sensitivity of the overall trend to changes in all of those source categories. In other words, the cumulative percentages should not be considered a measure of the percentage contributions to the trend from those source categories.

The trend assessment key source categories are also sensitive to the level of aggregation of the source categories; and the IPCC list of source categories may exclude some important, potentially key source category components.

### Key Source Categories

Table 1 presents the key source categories for the United States using emissions data as reported in the 1990-2000 greenhouse gas inventory report, and ranked according to their global warming potential weighted emissions in 2000. The table also identifies the criteria used in identifying these source categories (i.e., level, trend, and/or qualitative assessments).

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<sup>3</sup> The trend assessment is intended to be applied to sources and to exclude sinks. Although the assessment would still be valid if sinks were included (as unsigned values), the 95 percent threshold by which sources are deemed "key" would lose significance because it is based on an analysis (Flusgrud et al. 1999) of selected inventories where sinks were excluded.

## Key Source Category Analysis

**Table 1: Key Source Categories for the United States (1990-2000) Based on Tier 1 Approach**

Key Source Categories	Gas	Level	Trend	Qual.*	2000 Emissions (Tg CO <sub>2</sub> Eq.)
CO <sub>2</sub> Emissions from Stationary Combustion – Coal	CO <sub>2</sub>	✓	✓		2,030.1
Mobile Combustion: Road & Other	CO <sub>2</sub>	✓	✓		1,503.2
CO <sub>2</sub> Emissions from Stationary Combustion – Gas	CO <sub>2</sub>	✓	✓		1,162.9
CO <sub>2</sub> Emissions from Stationary Combustion – Oil	CO <sub>2</sub>	✓	✓		640.7
Direct N <sub>2</sub> O Emissions from Agricultural Soils	N <sub>2</sub> O	✓			217.8
CH <sub>4</sub> Emissions from Solid Waste Disposal Sites	CH <sub>4</sub>	✓	✓		203.5
Mobile Combustion: Aviation	CO <sub>2</sub>	✓			196.5
Fugitive Emissions from Oil & Gas Operations	CH <sub>4</sub>	✓	✓		138.2
CH <sub>4</sub> Emissions from Enteric Fermentation in Domestic Livestock	CH <sub>4</sub>	✓	✓		123.9
CO <sub>2</sub> Emissions from Other Industrial Processes	CO <sub>2</sub>	✓	✓		107.6
Mobile Combustion: Marine	CO <sub>2</sub>	✓	✓		89.9
Indirect N <sub>2</sub> O Emissions from Nitrogen Used in Agriculture	N <sub>2</sub> O	✓			79.8
Fugitive Emissions from Coal Mining & Handling	CH <sub>4</sub>	✓	✓		61.0
Emissions from Substitutes for Ozone Depleting Substances	HFC & PFC	✓	✓		57.8
Mobile Combustion: Road & Other	N <sub>2</sub> O	✓			55.7
CO <sub>2</sub> Emissions from Cement Production	CO <sub>2</sub>	✓			41.1
CH <sub>4</sub> Emissions from Manure Management	CH <sub>4</sub>	✓		✓	37.5
HFC-23 Emissions from HCFC-22 Manufacture	HFCs	✓	✓		29.8
Indirect CO <sub>2</sub> Emissions from CH <sub>4</sub> Oxidation	CO <sub>2</sub>		✓		26.3
CO <sub>2</sub> Emissions from Waste Incineration	CO <sub>2</sub>		✓		22.5
SF <sub>6</sub> Emissions from Electrical Equipment	SF <sub>6</sub>		✓	✓	14.4
N <sub>2</sub> O Emissions from Adipic Acid Production	N <sub>2</sub> O		✓	✓	8.1
PFC Emissions from Aluminum Production	PFCs		✓		7.9
PFC, HFC, and SF <sub>6</sub> Emissions from Semiconductor Manufacturing	HFC, PFC, SF <sub>6</sub>			✓	7.4
<b>Subtotal</b>	<b>All gases</b>				<b>6,863.4</b>
<b>Total Emissions</b>	<b>All gases</b>				<b>7,001.2</b>
<b>Percent of Total</b>	<b>All gases</b>				<b>98.0%</b>

\* Qualitative criteria.

Notes: Sinks (e.g., LUCF, Landfill Carbon Storage) are not included in this analysis. The Tier 1 approach for identifying key source categories does not directly include assessment of uncertainty in emissions estimates.

Table 2 provides a complete listing of source categories by IPCC sector and with additional comments on the criteria used in identifying key source categories. Specifically, the level assessment was performed for each year that inventory data was available (i.e., 1990 to 2000). As the emissions change over time, categories may fall under or over the threshold for being key. The following points should be noted regarding the key sources identified.

Due to the relative quantity of CO<sub>2</sub> emissions from fossil fuel combustion—particularly from mobile source and stationary combustion of coal, gas, and oil—these sources contributed most to each year's level assessment. Additionally, the following sources were the largest contributors to the level assessments for each year (listed in descending order):

- CH<sub>4</sub> from solid waste disposal sites;
- N<sub>2</sub>O from agricultural soils;
- CO<sub>2</sub> emissions from mobile combustion in the aviation and marine sectors;
- Fugitive emissions from oil and gas operations;
- CH<sub>4</sub> from enteric fermentation in domestic livestock;
- CO<sub>2</sub> from other industrial processes;
- Fugitive emissions from coal mining;
- Indirect N<sub>2</sub>O from nitrogen used in agriculture; and
- N<sub>2</sub>O from mobile road source emissions.

The remaining key sources identified under the level assessment varied by year. The following four source categories were determined to be key using the level assessment for only part of the complete times series:

- HFC and PFC emissions from substitutes for ozone depleting substances (1997 to 2000);
- CO<sub>2</sub> emissions from cement production (1991, 1993-1997);
- HFC-23 emissions from HCFC-22 manufacture (1990, 1992, 1996, 1998); and
- CH<sub>4</sub> emissions from manure management (1995).

Although other sources have fluctuated by greater percentages since 1990, by virtue of their size, CO<sub>2</sub> emissions from stationary combustion

of coal, gas, and oil, and from mobile combustion from road vehicles are the greatest contributors to the overall trend for 2000.

Another large contributor to the overall trend is emissions of substitutes for ozone depleting substances, which are growing quickly with the Montreal Protocol phase-out of ozone depleting substances. Fugitive emissions from coal mining and PFC emissions from aluminum manufacturing have decreased by approximately 30 and 56 percent, respectively, from 1990 through 2000.

Four other source categories were determined to be key using the qualitative criteria. A brief discussion of the reasoning for the qualitative designation is given below:

- Nitrous oxide emissions from adipic acid plants have been dramatically reduced due to the installation of emission control technologies on 3 of the 4 production facilities in the United States. These changes in addition to the uncertainty in this emission source category suggest that it should be treated as key, although it has also been identified using the trend assessment.
- Estimates of SF<sub>6</sub> emissions from electrical equipment have been made using only a limited amount of data; therefore, there is a significant degree of uncertainty associated with them. Although future inventories are expected to incorporate improvements, the current lack of data and small margin under which the category missed both the trend and level assessment thresholds suggests that it should be treated as key.
- Emissions of HFCs, PFCs and SF<sub>6</sub> from semiconductor manufacturing have increased significantly from 1990 through 2000, almost tripling in size. This source category's potential future growth—in addition to historical growth that has already led to list listing as key using the trend assessment—suggests that it should be treated as key.
- Estimated CH<sub>4</sub> emissions from manure management have been significantly revised relative to the previous greenhouse gas inventory. This revision is due to both changes in the estimation methodology and

data sources. The reduction in estimated emissions for the entire time series by approximately 50 to 60 percent, suggests that it should be treated as key, although it

has also been identified using the level assessment.

The attached Annex also contains detailed data on each individual year's level assessment and the trend assessment for 1990 to 2000.

## Key Source Category Analysis

**Table 2: U.S. Greenhouse Gas Inventory Source Categories Based on Tier 1 Approach**

IPCC Source Categories	Gas	2000 Emissions (Tg CO <sub>2</sub> Eq.)	Key Source Category Flag?	Criteria for Identification (if key)	Comments
<b>Energy</b>					
CO <sub>2</sub> Emissions from Stationary Combustion - Coal	CO <sub>2</sub>	2,030.1	✓	Level, Trend	All years
CO <sub>2</sub> Emissions from Stationary Combustion - Oil	CO <sub>2</sub>	640.7	✓	Level, Trend	All years
CO <sub>2</sub> Emissions from Stationary Combustion - Gas	CO <sub>2</sub>	1,162.9	✓	Level, Trend	All years
CO <sub>2</sub> Emissions from Stationary Combustion - Geothermal	CO <sub>2</sub>	+			
CO <sub>2</sub> Emissions from Natural Gas Flaring	CO <sub>2</sub>	6.1			
Non-CO <sub>2</sub> Emissions from Stationary Combustion	CH <sub>4</sub>	7.5			
Non-CO <sub>2</sub> Emissions from Stationary Combustion	N <sub>2</sub> O	14.9			
Mobile Combustion: Road & Other	CO <sub>2</sub>	1,503.2	✓	Level, Trend	All years
Mobile Combustion: Road & Other	CH <sub>4</sub>	4.1			
Mobile Combustion: Road & Other	N <sub>2</sub> O	55.7	✓	Level	All years
Mobile Combustion: Aviation	CO <sub>2</sub>	196.5	✓	Level	All years
Mobile Combustion: Aviation	CH <sub>4</sub>	0.2			
Mobile Combustion: Aviation	N <sub>2</sub> O	1.9			
Mobile Combustion: Marine	CO <sub>2</sub>	89.9	✓	Level, Trend	All years
Mobile Combustion: Marine	CH <sub>4</sub>	0.1			
Mobile Combustion: Marine	N <sub>2</sub> O	0.6			
Fugitive Emissions from Coal Mining & Handling	CH <sub>4</sub>	61.0	✓	Level, Trend	All years
Fugitive Emissions from Oil & Gas Operations	CH <sub>4</sub>	138.2	✓	Level, Trend	All years
Indirect CO <sub>2</sub> Emissions from CH <sub>4</sub> Oxidation	CO <sub>2</sub>	26.3	✓	Trend	
<b>Industrial Processes</b>					
CO <sub>2</sub> Emissions from Cement Production	CO <sub>2</sub>	41.1	✓	Level	Level in 1991, 1993-1997
CO <sub>2</sub> Emissions from Lime Production	CO <sub>2</sub>	13.3			
CO <sub>2</sub> Emissions from Other Industrial Processes	CO <sub>2</sub>	107.6	✓	Level, Trend	All years
CH <sub>4</sub> Emissions from Other Industrial Processes	CH <sub>4</sub>	1.7			
N <sub>2</sub> O Emissions from Adipic Acid Production	N <sub>2</sub> O	8.1	✓	Trend, Qual	Mitigation efforts
N <sub>2</sub> O Emissions from Nitric Acid Production	N <sub>2</sub> O	19.8			
PFC Emissions from Aluminum Production	PFCs	7.9	✓	Trend	
SF <sub>6</sub> Emissions from Magnesium Production	SF <sub>6</sub>	4.0			
SF <sub>6</sub> Emissions from Electrical Equipment	SF <sub>6</sub>	14.4	✓	Trend, Qual	Uncertainty
PFC, HFC, and SF <sub>6</sub> Emissions from Semiconductor Manufacturing	HFC, PFC, SF <sub>6</sub>	7.4	✓	Qual	Anticipated growth
Emissions from Substitutes for Ozone Depleting Substances	HFC & PFC	57.8	✓	Level, Trend	Level from 1997-2000
HFC-23 Emissions from HCFC-22 Manufacture	HFCs	29.8	✓	Level, Trend	Level in 1990, 1992, 1996, 1998

(Table is continued on next page)

## Key Source Category Analysis

**Table 2.** (continued)

IPCC Source Categories	Direct GHG	2000 Emissions (Tg CO <sub>2</sub> Eq.)	Key Source Category Flag?	Criteria for Identification (if key)	Comments
<b>Agriculture</b>					
CH <sub>4</sub> Emissions from Enteric Fermentation in Domestic Livestock	CH <sub>4</sub>	123.9	✓	Level, Trend	All years
CH <sub>4</sub> Emissions from Manure Management	CH <sub>4</sub>	37.5	✓	Level, Qual	Level in 1995 Methodology changes
N <sub>2</sub> O Emissions from Manure Management	N <sub>2</sub> O	17.2			
Direct N <sub>2</sub> O Emissions from Agricultural Soils	N <sub>2</sub> O	217.8	✓	Level	All years
Indirect N <sub>2</sub> O Emissions from Nitrogen Used in Agriculture	N <sub>2</sub> O	79.8	✓	Level	All years
CH <sub>4</sub> Emissions from Rice Production	CH <sub>4</sub>	7.5			
CH <sub>4</sub> Emissions from Agricultural Residue Burning	CH <sub>4</sub>	0.8			
N <sub>2</sub> O Emissions from Agricultural Residue Burning	N <sub>2</sub> O	0.5			
<b>Waste</b>					
CH <sub>4</sub> Emissions from Solid Waste Disposal Sites	CH <sub>4</sub>	203.5	✓	Level, Trend	All years
CH <sub>4</sub> Emissions from Wastewater Handling	CH <sub>4</sub>	28.7			
N <sub>2</sub> O Emissions from Wastewater Handling	N <sub>2</sub> O	8.5			
CO <sub>2</sub> Emissions from Waste Incineration	CO <sub>2</sub>	22.5	✓	Trend	
N <sub>2</sub> O Emissions from Waste Incineration	N <sub>2</sub> O	0.2			

+ Does not exceed 0.05 Tg CO<sub>2</sub> Eq.

Notes: Sinks (e.g., LUCF, Landfill Carbon Storage) are not included in this analysis. The Tier 1 approach for identifying key source categories does not directly include assessment of uncertainty in emissions estimates.

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**Annex: Detail of Level Assessments through 2000 and Trend Assessment 1990-2000**

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## Key Source Category Analysis

**Table A 1: Tier 1 Trend Assessment (1990-2000)**

IPCC Source Categories	Direct GHG	Base Year Estimate (Tg CO <sub>2</sub> Eq.)	Current Year Estimate (Tg CO <sub>2</sub> Eq.)	Percent Contribution to Trend	Cumulative Total
CO <sub>2</sub> Emissions from Stationary Combustion - Oil	CO <sub>2</sub>	662.5	640.7	16	16
CO <sub>2</sub> Emissions from Stationary Combustion - Coal	CO <sub>2</sub>	1,692.6	2,030.1	13	29
Mobile Combustion: Road & Other	CO <sub>2</sub>	1,235.5	1,503.2	13	42
CO <sub>2</sub> Emissions from Stationary Combustion - Gas	CO <sub>2</sub>	952.8	1,162.9	10	52
Emissions from Substitutes for Ozone Depleting Substances	Several	0.9	57.8	8	60
CH <sub>4</sub> Emissions from Solid Waste Disposal Sites	CH <sub>4</sub>	213.4	203.5	6	66
Fugitive Emissions from Coal Mining and Handling	CH <sub>4</sub>	87.1	61.0	5	71
CO <sub>2</sub> Emissions from Other Industrial Processes	CO <sub>2</sub>	123.6	107.6	5	76
Fugitive Emissions from Oil & Gas Operations	CH <sub>4</sub>	147.6	138.2	4	80
CH <sub>4</sub> Emissions from Enteric Fermentation in Domestic Livestock	CH <sub>4</sub>	127.9	123.9	3	83
Mobile Combustion: Marine	CO <sub>2</sub>	59.4	89.9	3	86
SF <sub>6</sub> Emissions from Electrical Equipment	SF <sub>6</sub>	31.2	14.4	3	89
PFC Emissions from Aluminum Production	PFCs	18.1	7.9	2	90
HFC-23 Emissions from HCFC-22 Manufacture	HFCs	35.0	29.8	1	92
Indirect CO <sub>2</sub> Emissions from CH <sub>4</sub> Oxidation	CO <sub>2</sub>	30.9	26.3	1	93
N <sub>2</sub> O Emissions from Adipic Acid Production	N <sub>2</sub> O	14.9	8.1	1	94
CO <sub>2</sub> Emissions from Waste Incineration	CO <sub>2</sub>	14.1	22.5	1	95
Mobile Combustion: Aviation	CO <sub>2</sub>	176.9	196.5	1	96
Indirect N <sub>2</sub> O Emissions from Nitrogen Used in Agriculture	N <sub>2</sub> O	73.6	79.8	1	97
CH <sub>4</sub> Emissions from Manure Management	CH <sub>4</sub>	29.2	37.5	1	97
PFC, HFC, and SF <sub>6</sub> Emissions from Semiconductor Manufacturing	SF <sub>6</sub>	2.9	7.4	1	98
Direct N <sub>2</sub> O Emissions from Agricultural Soils	N <sub>2</sub> O	193.5	217.8	0	98
CO <sub>2</sub> Emissions from Cement Production	CO <sub>2</sub>	33.3	41.1	0	99
SF <sub>6</sub> Emissions from Magnesium Production	SF <sub>6</sub>	5.5	4.0	0	99
Non-CO <sub>2</sub> Emissions from Stationary Combustion	CH <sub>4</sub>	7.9	7.5	0	99
Mobile Combustion: Road & Other	CH <sub>4</sub>	4.7	4.1	0	99
CH <sub>4</sub> Emissions from Wastewater Handling	CH <sub>4</sub>	24.3	28.7	0	99
N <sub>2</sub> O Emissions from Manure Management	N <sub>2</sub> O	16.0	17.5	0	99
CH <sub>4</sub> Emissions from Rice Production	CH <sub>4</sub>	7.1	7.5	0	100
N <sub>2</sub> O Emissions from Nitric Acid Production	N <sub>2</sub> O	17.8	19.8	0	100
CO <sub>2</sub> Emissions from Lime Production	CO <sub>2</sub>	11.2	13.3	0	100
N <sub>2</sub> O Emissions from Wastewater Handling	N <sub>2</sub> O	7.0	8.5	0	100
CH <sub>4</sub> Emissions from Other Industrial Processes	CH <sub>4</sub>	1.2	1.7	0	100
Non-CO <sub>2</sub> Emissions from Stationary Combustion	N <sub>2</sub> O	12.8	14.9	0	100
CO <sub>2</sub> Emissions from Natural Gas Flaring	CO <sub>2</sub>	5.5	6.1	0	100
CO <sub>2</sub> Emissions from Stationary Combustion - Geothermal Energy	CO <sub>2</sub>	0.2	0.0	0	100
Mobile Combustion: Marine	N <sub>2</sub> O	0.4	0.6	0	100
N <sub>2</sub> O Emissions from Waste Incineration	N <sub>2</sub> O	0.3	0.2	0	100
Mobile Combustion: Road & Other	N <sub>2</sub> O	48.9	55.7	0	100
Mobile Combustion: Marine	CH <sub>4</sub>	0.1	0.1	0	100
Mobile Combustion: Aviation	N <sub>2</sub> O	1.7	1.9	0	100
N <sub>2</sub> O Emissions from Agricultural Residue Burning	N <sub>2</sub> O	0.4	0.5	0	100
Mobile Combustion: Aviation	CH <sub>4</sub>	0.2	0.2	0	100
CH <sub>4</sub> Emissions from Agricultural Residue Burning	CH <sub>4</sub>	0.7	0.8	0	100
<b>TOTAL</b>		<b>6,130.7</b>	<b>7,001.2</b>	<b>100</b>	

Notes: Sinks (e.g., LUCF, Landfill Carbon Storage) are not included in this analysis.

**Key Source Category Analysis**
**Table A 2: Tier 1 Level Assessment (1990)**

IPCC Source Categories	Direct GHG	Base Year Estimate (Tg CO <sub>2</sub> Eq.)	Current Year Estimate (Tg CO <sub>2</sub> Eq.)	Level Assessment	Cumulative Total
CO <sub>2</sub> Emissions from Stationary Combustion - Coal	CO <sub>2</sub>	1,692.6	1,692.6	0.28	0.28
Mobile Combustion: Road & Other	CO <sub>2</sub>	1,235.5	1,235.5	0.20	0.48
CO <sub>2</sub> Emissions from Stationary Combustion - Gas	CO <sub>2</sub>	952.8	952.8	0.16	0.63
CO <sub>2</sub> Emissions from Stationary Combustion - Oil	CO <sub>2</sub>	662.5	662.5	0.11	0.74
CH <sub>4</sub> Emissions from Solid Waste Disposal Sites	CH <sub>4</sub>	213.4	213.4	0.03	0.78
Direct N <sub>2</sub> O Emissions from Agricultural Soils	N <sub>2</sub> O	193.5	193.5	0.03	0.81
Mobile Combustion: Aviation	CO <sub>2</sub>	176.9	176.9	0.03	0.84
Fugitive Emissions from Oil & Gas Operations	CH <sub>4</sub>	147.6	147.6	0.02	0.86
CH <sub>4</sub> Emissions from Enteric Fermentation in Domestic Livestock	CH <sub>4</sub>	127.9	127.9	0.02	0.88
CO <sub>2</sub> Emissions from Other Industrial Processes	CO <sub>2</sub>	123.6	123.6	0.02	0.90
Fugitive Emissions from Coal Mining and Handling	CH <sub>4</sub>	87.1	87.1	0.01	0.92
Indirect N <sub>2</sub> O Emissions from Nitrogen Used in Agriculture	N <sub>2</sub> O	73.6	73.6	0.01	0.93
Mobile Combustion: Marine	CO <sub>2</sub>	59.4	59.4	0.01	0.94
Mobile Combustion: Road & Other	N <sub>2</sub> O	48.9	48.9	0.01	0.95
HFC-23 Emissions from HCFC-22 Manufacture	HFCs	35.0	35.0	0.01	0.95
CO <sub>2</sub> Emissions from Cement Production	CO <sub>2</sub>	33.3	33.3	0.01	0.96
SF <sub>6</sub> Emissions from Electrical Equipment	SF <sub>6</sub>	31.2	31.2	0.01	0.96
Indirect CO <sub>2</sub> Emissions from CH <sub>4</sub> Oxidation	CO <sub>2</sub>	30.9	30.9	0.01	0.97
CH <sub>4</sub> Emissions from Manure Management	CH <sub>4</sub>	29.2	29.2	0.00	0.97
CH <sub>4</sub> Emissions from Wastewater Handling	CH <sub>4</sub>	24.3	24.3	0.00	0.98
PFC Emissions from Aluminum Production	PFCs	18.1	18.1	0.00	0.98
N <sub>2</sub> O Emissions from Nitric Acid Production	N <sub>2</sub> O	17.8	17.8	0.00	0.98
N <sub>2</sub> O Emissions from Manure Management	N <sub>2</sub> O	16.0	16.0	0.00	0.98
Non-CO <sub>2</sub> Emissions from Stationary Combustion	N <sub>2</sub> O	12.8	12.8	0.00	0.99
N <sub>2</sub> O Emissions from Adipic Acid Production	N <sub>2</sub> O	14.9	14.9	0.00	0.99
CO <sub>2</sub> Emissions from Waste Incineration	CO <sub>2</sub>	14.1	14.1	0.00	0.99
CO <sub>2</sub> Emissions from Lime Production	CO <sub>2</sub>	11.2	11.2	0.00	0.99
Non-CO <sub>2</sub> Emissions from Stationary Combustion	CH <sub>4</sub>	7.9	7.9	0.00	0.99
CH <sub>4</sub> Emissions from Rice Production	CH <sub>4</sub>	7.1	7.1	0.00	0.99
N <sub>2</sub> O Emissions from Wastewater Handling	N <sub>2</sub> O	7.0	7.0	0.00	1.00
SF <sub>6</sub> Emissions from Magnesium Production	SF <sub>6</sub>	5.5	5.5	0.00	1.00
CO <sub>2</sub> Emissions from Natural Gas Flaring	CO <sub>2</sub>	5.5	5.5	0.00	1.00
Mobile Combustion: Road & Other	CH <sub>4</sub>	4.7	4.7	0.00	1.00
PFC, HFC, and SF <sub>6</sub> Emissions from Semiconductor Manufacturing	SF <sub>6</sub>	2.9	2.9	0.00	1.00
Mobile Combustion: Aviation	N <sub>2</sub> O	1.7	1.7	0.00	1.00
CH <sub>4</sub> Emissions from Other Industrial Processes	CH <sub>4</sub>	1.2	1.2	0.00	1.00
Emissions from Substitutes for Ozone Depleting Substances	Several	0.9	0.9	0.00	1.00
CH <sub>4</sub> Emissions from Agricultural Residue Burning	CH <sub>4</sub>	0.7	0.7	0.00	1.00
N <sub>2</sub> O Emissions from Agricultural Residue Burning	N <sub>2</sub> O	0.4	0.4	0.00	1.00
Mobile Combustion: Marine	N <sub>2</sub> O	0.4	0.4	0.00	1.00
N <sub>2</sub> O Emissions from Waste Incineration	N <sub>2</sub> O	0.3	0.3	0.00	1.00
CO <sub>2</sub> Emissions from Stationary Combustion - Geothermal Energy	CO <sub>2</sub>	0.2	0.2	0.00	1.00
Mobile Combustion: Aviation	CH <sub>4</sub>	0.2	0.2	0.00	1.00
Mobile Combustion: Marine	CH <sub>4</sub>	0.1	0.1	0.00	1.00
<b>TOTAL</b>		<b>6,130.7</b>	<b>6,130.7</b>	<b>1.00</b>	

Notes: Sinks (e.g., LUCF, Landfill Carbon Storage) are not included in this analysis.

**Key Source Category Analysis**
**Table A 3: Tier 1 Level Assessment (1991)**

IPCC Source Categories	Direct GHG	Base Year Estimate (Tg CO <sub>2</sub> Eq.)	Current Year Estimate (Tg CO <sub>2</sub> Eq.)	Level Assessment	Cumulative Total
CO <sub>2</sub> Emissions from Stationary Combustion - Coal	CO <sub>2</sub>	1,692.6	1,684.0	0.28	0.28
Mobile Combustion: Road & Other	CO <sub>2</sub>	1,235.5	1,215.6	0.20	0.48
CO <sub>2</sub> Emissions from Stationary Combustion - Gas	CO <sub>2</sub>	952.8	973.3	0.16	0.64
CO <sub>2</sub> Emissions from Stationary Combustion - Oil	CO <sub>2</sub>	662.5	637.7	0.10	0.74
CH <sub>4</sub> Emissions from Solid Waste Disposal Sites	CH <sub>4</sub>	213.4	213.2	0.04	0.78
Direct N <sub>2</sub> O Emissions from Agricultural Soils	N <sub>2</sub> O	193.5	195.3	0.03	0.81
Mobile Combustion: Aviation	CO <sub>2</sub>	176.9	169.3	0.03	0.84
Fugitive Emissions from Oil & Gas Operations	CH <sub>4</sub>	147.6	149.5	0.02	0.86
CH <sub>4</sub> Emissions from Enteric Fermentation in Domestic Livestock	CH <sub>4</sub>	127.9	127.2	0.02	0.88
CO <sub>2</sub> Emissions from Other Industrial Processes	CO <sub>2</sub>	123.6	114.5	0.02	0.90
Fugitive Emissions from Coal Mining and Handling	CH <sub>4</sub>	87.1	83.7	0.01	0.92
Indirect N <sub>2</sub> O Emissions from Nitrogen Used in Agriculture	N <sub>2</sub> O	73.6	74.8	0.01	0.93
Mobile Combustion: Marine	CO <sub>2</sub>	59.4	52.8	0.01	0.94
Mobile Combustion: Road & Other	N <sub>2</sub> O	48.9	51.2	0.01	0.95
CO <sub>2</sub> Emissions from Cement Production	CO <sub>2</sub>	33.3	32.5	0.01	0.95
SF <sub>6</sub> Emissions from Electrical Equipment	SF <sub>6</sub>	31.2	32.5	0.01	0.96
HFC-23 Emissions from HCFC-22 Manufacture	HFCs	35.0	30.8	0.01	0.96
Indirect CO <sub>2</sub> Emissions from CH <sub>4</sub> Oxidation	CO <sub>2</sub>	30.9	30.7	0.01	0.97
CH <sub>4</sub> Emissions from Manure Management	CH <sub>4</sub>	29.2	31.1	0.01	0.97
CH <sub>4</sub> Emissions from Wastewater Handling	CH <sub>4</sub>	24.3	24.6	0.00	0.98
N <sub>2</sub> O Emissions from Nitric Acid Production	N <sub>2</sub> O	17.8	17.8	0.00	0.98
N <sub>2</sub> O Emissions from Manure Management	N <sub>2</sub> O	16.0	16.5	0.00	0.98
CO <sub>2</sub> Emissions from Waste Incineration	CO <sub>2</sub>	14.1	15.8	0.00	0.98
PFC Emissions from Aluminum Production	PFCs	18.1	15.7	0.00	0.99
Non-CO <sub>2</sub> Emissions from Stationary Combustion	N <sub>2</sub> O	12.8	12.7	0.00	0.99
N <sub>2</sub> O Emissions from Adipic Acid Production	N <sub>2</sub> O	14.9	14.7	0.00	0.99
CO <sub>2</sub> Emissions from Lime Production	CO <sub>2</sub>	11.2	11.0	0.00	0.99
Non-CO <sub>2</sub> Emissions from Stationary Combustion	CH <sub>4</sub>	7.9	8.0	0.00	0.99
N <sub>2</sub> O Emissions from Wastewater Handling	N <sub>2</sub> O	7.0	7.2	0.00	0.99
CH <sub>4</sub> Emissions from Rice Production	CH <sub>4</sub>	7.1	7.0	0.00	1.00
CO <sub>2</sub> Emissions from Natural Gas Flaring	CO <sub>2</sub>	5.5	5.6	0.00	1.00
SF <sub>6</sub> Emissions from Magnesium Production	SF <sub>6</sub>	5.5	5.5	0.00	1.00
Mobile Combustion: Road & Other	CH <sub>4</sub>	4.7	4.6	0.00	1.00
PFC, HFC, and SF <sub>6</sub> Emissions from Semiconductor Manufacturing	SF <sub>6</sub>	2.9	2.9	0.00	1.00
Mobile Combustion: Aviation	N <sub>2</sub> O	1.7	1.6	0.00	1.00
CH <sub>4</sub> Emissions from Other Industrial Processes	CH <sub>4</sub>	1.2	1.2	0.00	1.00
Emissions from Substitutes for Ozone Depleting Substances	Several	0.9	0.8	0.00	1.00
CH <sub>4</sub> Emissions from Agricultural Residue Burning	CH <sub>4</sub>	0.7	0.6	0.00	1.00
Mobile Combustion: Marine	N <sub>2</sub> O	0.4	0.4	0.00	1.00
N <sub>2</sub> O Emissions from Agricultural Residue Burning	N <sub>2</sub> O	0.4	0.4	0.00	1.00
N <sub>2</sub> O Emissions from Waste Incineration	N <sub>2</sub> O	0.3	0.2	0.00	1.00
CO <sub>2</sub> Emissions from Stationary Combustion - Geothermal Energy	CO <sub>2</sub>	0.2	0.2	0.00	1.00
Mobile Combustion: Aviation	CH <sub>4</sub>	0.2	0.1	0.00	1.00
Mobile Combustion: Marine	CH <sub>4</sub>	0.1	0.1	0.00	1.00
<b>TOTAL</b>		<b>6,130.7</b>	<b>6,075.2</b>	<b>1.00</b>	

Notes: Sinks (e.g., LUCF, Landfill Carbon Storage) are not included in this analysis.

## Key Source Category Analysis

**Table A 4: Tier 1 Level Assessment (1992)**

IPCC Source Categories	Direct GHG	Base Year Estimate (Tg CO <sub>2</sub> Eq.)	Current Year Estimate (Tg CO <sub>2</sub> Eq.)	Level Assessment	Cumulative Total
CO <sub>2</sub> Emissions from Stationary Combustion - Coal	CO <sub>2</sub>	1,692.6	1,702.2	0.27	0.27
Mobile Combustion: Road & Other	CO <sub>2</sub>	1,235.5	1,238.3	0.20	0.47
CO <sub>2</sub> Emissions from Stationary Combustion - Gas	CO <sub>2</sub>	952.8	1,002.8	0.16	0.64
CO <sub>2</sub> Emissions from Stationary Combustion - Oil	CO <sub>2</sub>	662.5	657.9	0.11	0.74
CH <sub>4</sub> Emissions from Solid Waste Disposal Sites	CH <sub>4</sub>	213.4	215.8	0.03	0.78
Direct N <sub>2</sub> O Emissions from Agricultural Soils	N <sub>2</sub> O	193.5	202.5	0.03	0.81
Mobile Combustion: Aviation	CO <sub>2</sub>	176.9	167.0	0.03	0.84
Fugitive Emissions from Oil & Gas Operations	CH <sub>4</sub>	147.6	150.4	0.02	0.86
CH <sub>4</sub> Emissions from Enteric Fermentation in Domestic Livestock	CH <sub>4</sub>	127.9	130.2	0.02	0.88
CO <sub>2</sub> Emissions from Other Industrial Processes	CO <sub>2</sub>	123.6	113.8	0.02	0.90
Fugitive Emissions from Coal Mining and Handling	CH <sub>4</sub>	87.1	81.4	0.01	0.91
Indirect N <sub>2</sub> O Emissions from Nitrogen Used in Agriculture	N <sub>2</sub> O	73.6	75.6	0.01	0.93
Mobile Combustion: Marine	CO <sub>2</sub>	59.4	67.7	0.01	0.94
Mobile Combustion: Road & Other	N <sub>2</sub> O	48.9	54.4	0.01	0.95
HFC-23 Emissions from HCFC-22 Manufacture	HFCs	35.0	34.9	0.01	0.95
CO <sub>2</sub> Emissions from Cement Production	CO <sub>2</sub>	33.3	32.8	0.01	0.96
Indirect CO <sub>2</sub> Emissions from CH <sub>4</sub> Oxidation	CO <sub>2</sub>	30.9	30.5	0.00	0.96
SF <sub>6</sub> Emissions from Electrical Equipment	SF <sub>6</sub>	31.2	30.2	0.00	0.97
CH <sub>4</sub> Emissions from Manure Management	CH <sub>4</sub>	29.2	30.7	0.00	0.97
CH <sub>4</sub> Emissions from Wastewater Handling	CH <sub>4</sub>	24.3	25.2	0.00	0.98
N <sub>2</sub> O Emissions from Nitric Acid Production	N <sub>2</sub> O	17.8	18.3	0.00	0.98
CO <sub>2</sub> Emissions from Waste Incineration	CO <sub>2</sub>	14.1	16.3	0.00	0.98
N <sub>2</sub> O Emissions from Manure Management	N <sub>2</sub> O	16.0	16.3	0.00	0.98
Non-CO <sub>2</sub> Emissions from Stationary Combustion	N <sub>2</sub> O	12.8	12.9	0.00	0.99
PFC Emissions from Aluminum Production	PFCs	18.1	14.5	0.00	0.99
N <sub>2</sub> O Emissions from Adipic Acid Production	N <sub>2</sub> O	14.9	12.6	0.00	0.99
CO <sub>2</sub> Emissions from Lime Production	CO <sub>2</sub>	11.2	11.4	0.00	0.99
Non-CO <sub>2</sub> Emissions from Stationary Combustion	CH <sub>4</sub>	7.9	8.3	0.00	0.99
CH <sub>4</sub> Emissions from Rice Production	CH <sub>4</sub>	7.1	7.9	0.00	0.99
N <sub>2</sub> O Emissions from Wastewater Handling	N <sub>2</sub> O	7.0	7.3	0.00	1.00
CO <sub>2</sub> Emissions from Natural Gas Flaring	CO <sub>2</sub>	5.5	5.1	0.00	1.00
SF <sub>6</sub> Emissions from Magnesium Production	SF <sub>6</sub>	5.5	5.5	0.00	1.00
Mobile Combustion: Road & Other	CH <sub>4</sub>	4.7	4.7	0.00	1.00
PFC, HFC, and SF <sub>6</sub> Emissions from Semiconductor Manufacturing	SF <sub>6</sub>	2.9	2.9	0.00	1.00
Mobile Combustion: Aviation	N <sub>2</sub> O	1.7	1.6	0.00	1.00
Emissions from Substitutes for Ozone Depleting Substances	Several	0.9	1.5	0.00	1.00
CH <sub>4</sub> Emissions from Other Industrial Processes	CH <sub>4</sub>	1.2	1.3	0.00	1.00
CH <sub>4</sub> Emissions from Agricultural Residue Burning	CH <sub>4</sub>	0.7	0.8	0.00	1.00
Mobile Combustion: Marine	N <sub>2</sub> O	0.4	0.4	0.00	1.00
N <sub>2</sub> O Emissions from Agricultural Residue Burning	N <sub>2</sub> O	0.4	0.4	0.00	1.00
N <sub>2</sub> O Emissions from Waste Incineration	N <sub>2</sub> O	0.3	0.3	0.00	1.00
CO <sub>2</sub> Emissions from Stationary Combustion - Geothermal Energy	CO <sub>2</sub>	0.2	0.2	0.00	1.00
Mobile Combustion: Aviation	CH <sub>4</sub>	0.2	0.1	0.00	1.00
Mobile Combustion: Marine	CH <sub>4</sub>	0.1	0.1	0.00	1.00
<b>TOTAL</b>		<b>6,130.7</b>	<b>6,194.8</b>	<b>1.00</b>	

Notes: Sinks (e.g., LUCF, Landfill Carbon Storage) are not included in this analysis.

**Key Source Category Analysis**
**Table A 5: Tier 1 Level Assessment (1993)**

IPCC Source Categories	Direct GHG	Base Year Estimate (Tg CO <sub>2</sub> Eq.)	Current Year Estimate (Tg CO <sub>2</sub> Eq.)	Level Assessment	Cumulative Total
CO <sub>2</sub> Emissions from Stationary Combustion - Coal	CO <sub>2</sub>	1,692.6	1,764.1	0.28	0.28
Mobile Combustion: Road & Other	CO <sub>2</sub>	1,235.5	1,271.2	0.20	0.48
CO <sub>2</sub> Emissions from Stationary Combustion - Gas	CO <sub>2</sub>	952.8	1,036.3	0.16	0.65
CO <sub>2</sub> Emissions from Stationary Combustion - Oil	CO <sub>2</sub>	662.5	647.7	0.10	0.75
CH <sub>4</sub> Emissions from Solid Waste Disposal Sites	CH <sub>4</sub>	213.4	217.8	0.03	0.78
Direct N <sub>2</sub> O Emissions from Agricultural Soils	N <sub>2</sub> O	193.5	195.6	0.03	0.81
Mobile Combustion: Aviation	CO <sub>2</sub>	176.9	168.0	0.03	0.84
Fugitive Emissions from Oil & Gas Operations	CH <sub>4</sub>	147.6	154.0	0.02	0.87
CH <sub>4</sub> Emissions from Enteric Fermentation in Domestic Livestock	CH <sub>4</sub>	127.9	128.5	0.02	0.89
CO <sub>2</sub> Emissions from Other Industrial Processes	CO <sub>2</sub>	123.6	106.9	0.02	0.90
Indirect N <sub>2</sub> O Emissions from Nitrogen Used in Agriculture	N <sub>2</sub> O	73.6	77.5	0.01	0.92
Fugitive Emissions from Coal Mining and Handling	CH <sub>4</sub>	87.1	69.7	0.01	0.93
Mobile Combustion: Marine	CO <sub>2</sub>	59.4	63.4	0.01	0.94
Mobile Combustion: Road & Other	N <sub>2</sub> O	48.9	56.5	0.01	0.95
CO <sub>2</sub> Emissions from Cement Production	CO <sub>2</sub>	33.3	34.6	0.01	0.95
SF <sub>6</sub> Emissions from Electrical Equipment	SF <sub>6</sub>	31.2	34.1	0.01	0.96
HFC-23 Emissions from HCFC-22 Manufacture	HFCs	35.0	31.8	0.01	0.96
Indirect CO <sub>2</sub> Emissions from CH <sub>4</sub> Oxidation	CO <sub>2</sub>	30.9	29.5	0.00	0.97
CH <sub>4</sub> Emissions from Manure Management	CH <sub>4</sub>	29.2	31.6	0.01	0.97
CH <sub>4</sub> Emissions from Wastewater Handling	CH <sub>4</sub>	24.3	25.6	0.00	0.97
N <sub>2</sub> O Emissions from Nitric Acid Production	N <sub>2</sub> O	17.8	18.6	0.00	0.98
CO <sub>2</sub> Emissions from Waste Incineration	CO <sub>2</sub>	14.1	17.2	0.00	0.98
N <sub>2</sub> O Emissions from Manure Management	N <sub>2</sub> O	16.0	16.7	0.00	0.98
Non-CO <sub>2</sub> Emissions from Stationary Combustion	N <sub>2</sub> O	12.8	13.1	0.00	0.99
N <sub>2</sub> O Emissions from Adipic Acid Production	N <sub>2</sub> O	14.9	13.9	0.00	0.99
PFC Emissions from Aluminum Production	PFCs	18.1	13.9	0.00	0.99
CO <sub>2</sub> Emissions from Lime Production	CO <sub>2</sub>	11.2	11.6	0.00	0.99
CO <sub>2</sub> Emissions from Natural Gas Flaring	CO <sub>2</sub>	5.5	6.5	0.00	0.99
Non-CO <sub>2</sub> Emissions from Stationary Combustion	CH <sub>4</sub>	7.9	7.8	0.00	0.99
N <sub>2</sub> O Emissions from Wastewater Handling	N <sub>2</sub> O	7.0	7.5	0.00	1.00
CH <sub>4</sub> Emissions from Rice Production	CH <sub>4</sub>	7.1	7.0	0.00	1.00
SF <sub>6</sub> Emissions from Magnesium Production	SF <sub>6</sub>	5.5	5.4	0.00	1.00
Emissions from Substitutes for Ozone Depleting Substances	Several	0.9	5.2	0.00	1.00
Mobile Combustion: Road & Other	CH <sub>4</sub>	4.7	4.6	0.00	1.00
PFC, HFC, and SF <sub>6</sub> Emissions from Semiconductor Manufacturing	SF <sub>6</sub>	2.9	3.6	0.00	1.00
Mobile Combustion: Aviation	N <sub>2</sub> O	1.7	1.6	0.00	1.00
CH <sub>4</sub> Emissions from Other Industrial Processes	CH <sub>4</sub>	1.2	1.4	0.00	1.00
CH <sub>4</sub> Emissions from Agricultural Residue Burning	CH <sub>4</sub>	0.7	0.6	0.00	1.00
Mobile Combustion: Marine	N <sub>2</sub> O	0.4	0.4	0.00	1.00
N <sub>2</sub> O Emissions from Agricultural Residue Burning	N <sub>2</sub> O	0.4	0.3	0.00	1.00
N <sub>2</sub> O Emissions from Waste Incineration	N <sub>2</sub> O	0.3	0.3	0.00	1.00
CO <sub>2</sub> Emissions from Stationary Combustion - Geothermal Energy	CO <sub>2</sub>	0.2	0.2	0.00	1.00
Mobile Combustion: Aviation	CH <sub>4</sub>	0.2	0.1	0.00	1.00
Mobile Combustion: Marine	CH <sub>4</sub>	0.1	0.1	0.00	1.00
<b>TOTAL</b>		<b>6,130.7</b>	<b>6,302.2</b>	<b>1.00</b>	

Notes: Sinks (e.g., LUCF, Landfill Carbon Storage) are not included in this analysis.

## Key Source Category Analysis

**Table A 6: Tier 1 Level Assessment (1994)**

IPCC Source Categories	Direct GHG	Base Year Estimate (Tg CO <sub>2</sub> Eq.)	Current Year Estimate (Tg CO <sub>2</sub> Eq.)	Level Assessment	Cumulative Total
CO <sub>2</sub> Emissions from Stationary Combustion - Coal	CO <sub>2</sub>	1,692.6	1,782.6	0.28	0.28
Mobile Combustion: Road & Other	CO <sub>2</sub>	1,235.5	1,313.3	0.20	0.48
CO <sub>2</sub> Emissions from Stationary Combustion - Gas	CO <sub>2</sub>	952.8	1,056.2	0.16	0.65
CO <sub>2</sub> Emissions from Stationary Combustion - Oil	CO <sub>2</sub>	662.5	656.8	0.10	0.75
CH <sub>4</sub> Emissions from Solid Waste Disposal Sites	CH <sub>4</sub>	213.4	217.8	0.03	0.78
Direct N <sub>2</sub> O Emissions from Agricultural Soils	N <sub>2</sub> O	193.5	215.2	0.03	0.81
Mobile Combustion: Aviation	CO <sub>2</sub>	176.9	175.9	0.03	0.84
Fugitive Emissions from Oil & Gas Operations	CH <sub>4</sub>	147.6	151.9	0.02	0.87
CH <sub>4</sub> Emissions from Enteric Fermentation in Domestic Livestock	CH <sub>4</sub>	127.9	130.1	0.02	0.89
CO <sub>2</sub> Emissions from Other Industrial Processes	CO <sub>2</sub>	123.6	111.9	0.02	0.90
Indirect N <sub>2</sub> O Emissions from Nitrogen Used in Agriculture	N <sub>2</sub> O	73.6	79.9	0.01	0.92
Fugitive Emissions from Coal Mining and Handling	CH <sub>4</sub>	87.1	70.3	0.01	0.93
Mobile Combustion: Marine	CO <sub>2</sub>	59.4	62.2	0.01	0.94
Mobile Combustion: Road & Other	N <sub>2</sub> O	48.9	57.9	0.01	0.95
CO <sub>2</sub> Emissions from Cement Production	CO <sub>2</sub>	33.3	36.1	0.01	0.95
HFC-23 Emissions from HCFC-22 Manufacture	HFCs	35.0	31.6	0.00	0.96
SF <sub>6</sub> Emissions from Electrical Equipment	SF <sub>6</sub>	31.2	31.4	0.00	0.96
CH <sub>4</sub> Emissions from Manure Management	CH <sub>4</sub>	29.2	33.8	0.01	0.97
Indirect CO <sub>2</sub> Emissions from CH <sub>4</sub> Oxidation	CO <sub>2</sub>	30.9	29.3	0.00	0.97
CH <sub>4</sub> Emissions from Wastewater Handling	CH <sub>4</sub>	24.3	26.2	0.00	0.97
N <sub>2</sub> O Emissions from Nitric Acid Production	N <sub>2</sub> O	17.8	19.6	0.00	0.98
CO <sub>2</sub> Emissions from Waste Incineration	CO <sub>2</sub>	14.1	17.9	0.00	0.98
N <sub>2</sub> O Emissions from Manure Management	N <sub>2</sub> O	16.0	16.7	0.00	0.98
Non-CO <sub>2</sub> Emissions from Stationary Combustion	N <sub>2</sub> O	12.8	13.4	0.00	0.98
N <sub>2</sub> O Emissions from Adipic Acid Production	N <sub>2</sub> O	14.9	15.4	0.00	0.99
PFC Emissions from Aluminum Production	PFCs	18.1	12.2	0.00	0.99
CO <sub>2</sub> Emissions from Lime Production	CO <sub>2</sub>	11.2	12.1	0.00	0.99
CO <sub>2</sub> Emissions from Natural Gas Flaring	CO <sub>2</sub>	5.5	6.6	0.00	0.99
Emissions from Substitutes for Ozone Depleting Substances	Several	0.9	8.4	0.00	0.99
CH <sub>4</sub> Emissions from Rice Production	CH <sub>4</sub>	7.1	8.2	0.00	0.99
Non-CO <sub>2</sub> Emissions from Stationary Combustion	CH <sub>4</sub>	7.9	7.8	0.00	1.00
N <sub>2</sub> O Emissions from Wastewater Handling	N <sub>2</sub> O	7.0	7.7	0.00	1.00
SF <sub>6</sub> Emissions from Magnesium Production	SF <sub>6</sub>	5.5	5.2	0.00	1.00
Mobile Combustion: Road & Other	CH <sub>4</sub>	4.7	4.6	0.00	1.00
PFC, HFC, and SF <sub>6</sub> Emissions from Semiconductor Manufacturing	SF <sub>6</sub>	2.9	3.9	0.00	1.00
Mobile Combustion: Aviation	N <sub>2</sub> O	1.7	1.7	0.00	1.00
CH <sub>4</sub> Emissions from Other Industrial Processes	CH <sub>4</sub>	1.2	1.5	0.00	1.00
CH <sub>4</sub> Emissions from Agricultural Residue Burning	CH <sub>4</sub>	0.7	0.8	0.00	1.00
N <sub>2</sub> O Emissions from Agricultural Residue Burning	N <sub>2</sub> O	0.4	0.5	0.00	1.00
Mobile Combustion: Marine	N <sub>2</sub> O	0.4	0.4	0.00	1.00
N <sub>2</sub> O Emissions from Waste Incineration	N <sub>2</sub> O	0.3	0.3	0.00	1.00
CO <sub>2</sub> Emissions from Stationary Combustion - Geothermal Energy	CO <sub>2</sub>	0.2	0.2	0.00	1.00
Mobile Combustion: Aviation	CH <sub>4</sub>	0.2	0.1	0.00	1.00
Mobile Combustion: Marine	CH <sub>4</sub>	0.1	0.1	0.00	1.00
<b>TOTAL</b>		<b>6,130.7</b>	<b>6,435.7</b>	<b>1.00</b>	

Notes: Sinks (e.g., LUCF, Landfill Carbon Storage) are not included in this analysis.

**Key Source Category Analysis**
**Table A 7: Tier 1 Level Assessment (1995)**

IPCC Source Categories	Direct GHG	Base Year Estimate (Tg CO <sub>2</sub> Eq.)	Current Year Estimate (Tg CO <sub>2</sub> Eq.)	Level Assessment	Cumulative Total
CO <sub>2</sub> Emissions from Stationary Combustion - Coal	CO <sub>2</sub>	1,692.6	1,792.7	0.28	0.28
Mobile Combustion: Road & Other	CO <sub>2</sub>	1,235.5	1,341.0	0.21	0.48
CO <sub>2</sub> Emissions from Stationary Combustion - Gas	CO <sub>2</sub>	952.8	1,102.9	0.17	0.65
CO <sub>2</sub> Emissions from Stationary Combustion - Oil	CO <sub>2</sub>	662.5	609.9	0.09	0.75
CH <sub>4</sub> Emissions from Solid Waste Disposal Sites	CH <sub>4</sub>	213.4	216.6	0.03	0.78
Direct N <sub>2</sub> O Emissions from Agricultural Soils	N <sub>2</sub> O	193.5	204.8	0.03	0.81
Mobile Combustion: Aviation	CO <sub>2</sub>	176.9	171.4	0.03	0.84
Fugitive Emissions from Oil & Gas Operations	CH <sub>4</sub>	147.6	149.9	0.02	0.86
CH <sub>4</sub> Emissions from Enteric Fermentation in Domestic Livestock	CH <sub>4</sub>	127.9	133.2	0.02	0.88
CO <sub>2</sub> Emissions from Other Industrial Processes	CO <sub>2</sub>	123.6	114.4	0.02	0.90
Indirect N <sub>2</sub> O Emissions from Nitrogen Used in Agriculture	N <sub>2</sub> O	73.6	78.6	0.01	0.91
Fugitive Emissions from Coal Mining and Handling	CH <sub>4</sub>	87.1	73.5	0.01	0.92
Mobile Combustion: Marine	CO <sub>2</sub>	59.4	66.9	0.01	0.93
Mobile Combustion: Road & Other	N <sub>2</sub> O	48.9	58.3	0.01	0.94
CO <sub>2</sub> Emissions from Cement Production	CO <sub>2</sub>	33.3	36.8	0.01	0.95
CH <sub>4</sub> Emissions from Manure Management	CH <sub>4</sub>	29.2	34.8	0.01	0.95
Indirect CO <sub>2</sub> Emissions from CH <sub>4</sub> Oxidation	CO <sub>2</sub>	30.9	29.5	0.00	0.96
HFC-23 Emissions from HCFC-22 Manufacture	HFCs	35.0	27.0	0.00	0.96
CH <sub>4</sub> Emissions from Wastewater Handling	CH <sub>4</sub>	24.3	26.8	0.00	0.97
SF <sub>6</sub> Emissions from Electrical Equipment	SF <sub>6</sub>	31.2	26.5	0.00	0.97
Emissions from Substitutes for Ozone Depleting Substances	Several	0.9	21.8	0.00	0.97
N <sub>2</sub> O Emissions from Nitric Acid Production	N <sub>2</sub> O	17.8	19.9	0.00	0.98
CO <sub>2</sub> Emissions from Waste Incineration	CO <sub>2</sub>	14.1	18.6	0.00	0.98
N <sub>2</sub> O Emissions from Adipic Acid Production	N <sub>2</sub> O	14.9	17.9	0.00	0.98
N <sub>2</sub> O Emissions from Manure Management	N <sub>2</sub> O	16.0	16.4	0.00	0.99
Non-CO <sub>2</sub> Emissions from Stationary Combustion	N <sub>2</sub> O	12.8	13.5	0.00	0.99
CO <sub>2</sub> Emissions from Natural Gas Flaring	CO <sub>2</sub>	5.5	8.7	0.00	0.99
CO <sub>2</sub> Emissions from Lime Production	CO <sub>2</sub>	11.2	12.8	0.00	0.99
PFC Emissions from Aluminum Production	PFCs	18.1	11.8	0.00	0.99
Non-CO <sub>2</sub> Emissions from Stationary Combustion	CH <sub>4</sub>	7.9	8.2	0.00	0.99
N <sub>2</sub> O Emissions from Wastewater Handling	N <sub>2</sub> O	7.0	7.7	0.00	1.00
CH <sub>4</sub> Emissions from Rice Production	CH <sub>4</sub>	7.1	7.6	0.00	1.00
PFC, HFC, and SF <sub>6</sub> Emissions from Semiconductor Manufacturing	SF <sub>6</sub>	2.9	5.9	0.00	1.00
SF <sub>6</sub> Emissions from Magnesium Production	SF <sub>6</sub>	5.5	5.5	0.00	1.00
Mobile Combustion: Road & Other	CH <sub>4</sub>	4.7	4.5	0.00	1.00
Mobile Combustion: Aviation	N <sub>2</sub> O	1.7	1.7	0.00	1.00
CH <sub>4</sub> Emissions from Other Industrial Processes	CH <sub>4</sub>	1.2	1.5	0.00	1.00
CH <sub>4</sub> Emissions from Agricultural Residue Burning	CH <sub>4</sub>	0.7	0.7	0.00	1.00
Mobile Combustion: Marine	N <sub>2</sub> O	0.4	0.5	0.00	1.00
N <sub>2</sub> O Emissions from Agricultural Residue Burning	N <sub>2</sub> O	0.4	0.4	0.00	1.00
N <sub>2</sub> O Emissions from Waste Incineration	N <sub>2</sub> O	0.3	0.3	0.00	1.00
Mobile Combustion: Aviation	CH <sub>4</sub>	0.2	0.1	0.00	1.00
CO <sub>2</sub> Emissions from Stationary Combustion - Geothermal Energy	CO <sub>2</sub>	0.2	0.1	0.00	1.00
Mobile Combustion: Marine	CH <sub>4</sub>	0.1	0.1	0.00	1.00
<b>TOTAL</b>		<b>6,130.7</b>	<b>6,481.8</b>	<b>1.00</b>	

Notes: Sinks (e.g., LUCF, Landfill Carbon Storage) are not included in this analysis.

**Key Source Category Analysis**
**Table A 8: Tier 1 Level Assessment (1996)**

IPCC Source Categories	Direct GHG	Base Year Estimate (Tg CO <sub>2</sub> Eq.)	Current Year Estimate (Tg CO <sub>2</sub> Eq.)	Level Assessment	Cumulative Total
CO <sub>2</sub> Emissions from Stationary Combustion - Coal	CO <sub>2</sub>	1,692.6	1,878.4	0.28	0.28
Mobile Combustion: Road & Other	CO <sub>2</sub>	1,235.5	1,374.7	0.21	0.49
CO <sub>2</sub> Emissions from Stationary Combustion - Gas	CO <sub>2</sub>	952.8	1,123.4	0.17	0.66
CO <sub>2</sub> Emissions from Stationary Combustion - Oil	CO <sub>2</sub>	662.5	646.0	0.10	0.75
Direct N <sub>2</sub> O Emissions from Agricultural Soils	N <sub>2</sub> O	193.5	212.3	0.03	0.78
CH <sub>4</sub> Emissions from Solid Waste Disposal Sites	CH <sub>4</sub>	213.4	211.5	0.03	0.82
Mobile Combustion: Aviation	CO <sub>2</sub>	176.9	180.2	0.03	0.84
Fugitive Emissions from Oil & Gas Operations	CH <sub>4</sub>	147.6	150.7	0.02	0.87
CH <sub>4</sub> Emissions from Enteric Fermentation in Domestic Livestock	CH <sub>4</sub>	127.9	129.6	0.02	0.89
CO <sub>2</sub> Emissions from Other Industrial Processes	CO <sub>2</sub>	123.6	109.8	0.02	0.90
Indirect N <sub>2</sub> O Emissions from Nitrogen Used in Agriculture	N <sub>2</sub> O	73.6	80.3	0.01	0.91
Fugitive Emissions from Coal Mining and Handling	CH <sub>4</sub>	87.1	68.4	0.01	0.92
Mobile Combustion: Marine	CO <sub>2</sub>	59.4	63.8	0.01	0.93
Mobile Combustion: Road & Other	N <sub>2</sub> O	48.9	57.9	0.01	0.94
CO <sub>2</sub> Emissions from Cement Production	CO <sub>2</sub>	33.3	37.1	0.01	0.95
HFC-23 Emissions from HCFC-22 Manufacture	HFCs	35.0	31.1	0.00	0.95
CH <sub>4</sub> Emissions from Manure Management	CH <sub>4</sub>	29.2	34.2	0.01	0.96
Emissions from Substitutes for Ozone Depleting Substances	Several	0.9	30.6	0.00	0.96
Indirect CO <sub>2</sub> Emissions from CH <sub>4</sub> Oxidation	CO <sub>2</sub>	30.9	28.9	0.00	0.97
CH <sub>4</sub> Emissions from Wastewater Handling	CH <sub>4</sub>	24.3	27.0	0.00	0.97
SF <sub>6</sub> Emissions from Electrical Equipment	SF <sub>6</sub>	31.2	26.8	0.00	0.97
N <sub>2</sub> O Emissions from Nitric Acid Production	N <sub>2</sub> O	17.8	20.7	0.00	0.98
CO <sub>2</sub> Emissions from Waste Incineration	CO <sub>2</sub>	14.1	19.6	0.00	0.98
N <sub>2</sub> O Emissions from Adipic Acid Production	N <sub>2</sub> O	14.9	17.8	0.00	0.98
N <sub>2</sub> O Emissions from Manure Management	N <sub>2</sub> O	16.0	16.8	0.00	0.99
Non-CO <sub>2</sub> Emissions from Stationary Combustion	N <sub>2</sub> O	12.8	14.1	0.00	0.99
CO <sub>2</sub> Emissions from Lime Production	CO <sub>2</sub>	11.2	13.5	0.00	0.99
CO <sub>2</sub> Emissions from Natural Gas Flaring	CO <sub>2</sub>	5.5	8.2	0.00	0.99
PFC Emissions from Aluminum Production	PFCs	18.1	12.5	0.00	0.99
Non-CO <sub>2</sub> Emissions from Stationary Combustion	CH <sub>4</sub>	7.9	8.4	0.00	0.99
N <sub>2</sub> O Emissions from Wastewater Handling	N <sub>2</sub> O	7.0	7.8	0.00	1.00
CH <sub>4</sub> Emissions from Rice Production	CH <sub>4</sub>	7.1	7.0	0.00	1.00
SF <sub>6</sub> Emissions from Magnesium Production	SF <sub>6</sub>	5.5	5.5	0.00	1.00
PFC, HFC, and SF <sub>6</sub> Emissions from Semiconductor Manufacturing	SF <sub>6</sub>	2.9	5.4	0.00	1.00
Mobile Combustion: Road & Other	CH <sub>4</sub>	4.7	4.4	0.00	1.00
Mobile Combustion: Aviation	N <sub>2</sub> O	1.7	1.8	0.00	1.00
CH <sub>4</sub> Emissions from Other Industrial Processes	CH <sub>4</sub>	1.2	1.6	0.00	1.00
CH <sub>4</sub> Emissions from Agricultural Residue Burning	CH <sub>4</sub>	0.7	0.7	0.00	1.00
N <sub>2</sub> O Emissions from Agricultural Residue Burning	N <sub>2</sub> O	0.4	0.4	0.00	1.00
Mobile Combustion: Marine	N <sub>2</sub> O	0.4	0.4	0.00	1.00
N <sub>2</sub> O Emissions from Waste Incineration	N <sub>2</sub> O	0.3	0.3	0.00	1.00
Mobile Combustion: Aviation	CH <sub>4</sub>	0.2	0.1	0.00	1.00
CO <sub>2</sub> Emissions from Stationary Combustion - Geothermal Energy	CO <sub>2</sub>	0.2	0.1	0.00	1.00
Mobile Combustion: Marine	CH <sub>4</sub>	0.1	0.1	0.00	1.00
<b>TOTAL</b>		<b>6,130.7</b>	<b>6,669.8</b>	<b>1.00</b>	

Notes: Sinks (e.g., LUCF, Landfill Carbon Storage) are not included in this analysis.

**Key Source Category Analysis**
**Table A 9: Tier 1 Level Assessment (1997)**

IPCC Source Categories	Direct GHG	Base Year Estimate (Tg CO <sub>2</sub> Eq.)	Current Year Estimate (Tg CO <sub>2</sub> Eq.)	Level Assessment	Cumulative Total
CO <sub>2</sub> Emissions from Stationary Combustion - Coal	CO <sub>2</sub>	1,692.6	1,930.5	0.29	0.29
Mobile Combustion: Road & Other	CO <sub>2</sub>	1,235.5	1,399.7	0.21	0.49
CO <sub>2</sub> Emissions from Stationary Combustion - Gas	CO <sub>2</sub>	952.8	1,125.2	0.17	0.66
CO <sub>2</sub> Emissions from Stationary Combustion - Oil	CO <sub>2</sub>	662.5	654.9	0.10	0.76
Direct N <sub>2</sub> O Emissions from Agricultural Soils	N <sub>2</sub> O	193.5	217.5	0.03	0.79
CH <sub>4</sub> Emissions from Solid Waste Disposal Sites	CH <sub>4</sub>	213.4	206.4	0.03	0.82
Mobile Combustion: Aviation	CO <sub>2</sub>	176.9	178.9	0.03	0.85
Fugitive Emissions from Oil & Gas Operations	CH <sub>4</sub>	147.6	146.8	0.02	0.87
CH <sub>4</sub> Emissions from Enteric Fermentation in Domestic Livestock	CH <sub>4</sub>	127.9	126.8	0.02	0.89
CO <sub>2</sub> Emissions from Other Industrial Processes	CO <sub>2</sub>	123.6	119.1	0.02	0.90
Indirect N <sub>2</sub> O Emissions from Nitrogen Used in Agriculture	N <sub>2</sub> O	73.6	80.0	0.01	0.92
Fugitive Emissions from Coal Mining and Handling	CH <sub>4</sub>	87.1	68.1	0.01	0.93
Mobile Combustion: Road & Other	N <sub>2</sub> O	48.9	57.6	0.01	0.94
Mobile Combustion: Marine	CO <sub>2</sub>	59.4	50.2	0.01	0.94
CO <sub>2</sub> Emissions from Cement Production	CO <sub>2</sub>	33.3	38.3	0.01	0.95
Emissions from Substitutes for Ozone Depleting Substances	Several	0.9	38.0	0.01	0.95
CH <sub>4</sub> Emissions from Manure Management	CH <sub>4</sub>	29.2	35.8	0.01	0.96
HFC-23 Emissions from HCFC-22 Manufacture	HFCs	35.0	30.0	0.00	0.96
Indirect CO <sub>2</sub> Emissions from CH <sub>4</sub> Oxidation	CO <sub>2</sub>	30.9	28.4	0.00	0.97
CH <sub>4</sub> Emissions from Wastewater Handling	CH <sub>4</sub>	24.3	27.5	0.00	0.97
SF <sub>6</sub> Emissions from Electrical Equipment	SF <sub>6</sub>	31.2	24.5	0.00	0.98
CO <sub>2</sub> Emissions from Waste Incineration	CO <sub>2</sub>	14.1	21.3	0.00	0.98
N <sub>2</sub> O Emissions from Nitric Acid Production	N <sub>2</sub> O	17.8	21.2	0.00	0.98
N <sub>2</sub> O Emissions from Manure Management	N <sub>2</sub> O	16.0	17.1	0.00	0.98
Non-CO <sub>2</sub> Emissions from Stationary Combustion	N <sub>2</sub> O	12.8	14.2	0.00	0.99
CO <sub>2</sub> Emissions from Lime Production	CO <sub>2</sub>	11.2	13.7	0.00	0.99
CO <sub>2</sub> Emissions from Natural Gas Flaring	CO <sub>2</sub>	5.5	7.6	0.00	0.99
N <sub>2</sub> O Emissions from Adipic Acid Production	N <sub>2</sub> O	14.9	11.5	0.00	0.99
PFC Emissions from Aluminum Production	PFCs	18.1	11.0	0.00	0.99
N <sub>2</sub> O Emissions from Wastewater Handling	N <sub>2</sub> O	7.0	7.9	0.00	0.99
Non-CO <sub>2</sub> Emissions from Stationary Combustion	CH <sub>4</sub>	7.9	7.5	0.00	1.00
CH <sub>4</sub> Emissions from Rice Production	CH <sub>4</sub>	7.1	7.5	0.00	1.00
SF <sub>6</sub> Emissions from Magnesium Production	SF <sub>6</sub>	5.5	6.9	0.00	1.00
PFC, HFC, and SF <sub>6</sub> Emissions from Semiconductor Manufacturing	SF <sub>6</sub>	2.9	6.5	0.00	1.00
Mobile Combustion: Road & Other	CH <sub>4</sub>	4.7	4.4	0.00	1.00
Mobile Combustion: Aviation	N <sub>2</sub> O	1.7	1.7	0.00	1.00
CH <sub>4</sub> Emissions from Other Industrial Processes	CH <sub>4</sub>	1.2	1.6	0.00	1.00
CH <sub>4</sub> Emissions from Agricultural Residue Burning	CH <sub>4</sub>	0.7	0.8	0.00	1.00
N <sub>2</sub> O Emissions from Agricultural Residue Burning	N <sub>2</sub> O	0.4	0.4	0.00	1.00
Mobile Combustion: Marine	N <sub>2</sub> O	0.4	0.3	0.00	1.00
N <sub>2</sub> O Emissions from Waste Incineration	N <sub>2</sub> O	0.3	0.3	0.00	1.00
Mobile Combustion: Aviation	CH <sub>4</sub>	0.2	0.2	0.00	1.00
CO <sub>2</sub> Emissions from Stationary Combustion - Geothermal Energy	CO <sub>2</sub>	0.2	0.1	0.00	1.00
Mobile Combustion: Marine	CH <sub>4</sub>	0.1	0.1	0.00	1.00
<b>TOTAL</b>		<b>6,130.7</b>	<b>6,748.1</b>	<b>1.00</b>	

Notes: Sinks (e.g., LUCF, Landfill Carbon Storage) are not included in this analysis.

**Key Source Category Analysis**
**Table A 10: Tier 1 Level Assessment (1998)**

IPCC Source Categories	Direct GHG	Base Year Estimate (Tg CO <sub>2</sub> Eq.)	Current Year Estimate (Tg CO <sub>2</sub> Eq.)	Level Assessment	Cumulative Total
CO <sub>2</sub> Emissions from Stationary Combustion - Coal	CO <sub>2</sub>	1,692.6	1,949.7	0.29	0.29
Mobile Combustion: Road & Other	CO <sub>2</sub>	1,235.5	1,424.2	0.21	0.50
CO <sub>2</sub> Emissions from Stationary Combustion - Gas	CO <sub>2</sub>	952.8	1,090.9	0.16	0.66
CO <sub>2</sub> Emissions from Stationary Combustion - Oil	CO <sub>2</sub>	662.5	660.5	0.10	0.76
Direct N <sub>2</sub> O Emissions from Agricultural Soils	N <sub>2</sub> O	193.5	218.6	0.03	0.79
CH <sub>4</sub> Emissions from Solid Waste Disposal Sites	CH <sub>4</sub>	213.4	201.0	0.03	0.82
Mobile Combustion: Aviation	CO <sub>2</sub>	176.9	183.0	0.03	0.85
Fugitive Emissions from Oil & Gas Operations	CH <sub>4</sub>	147.6	145.6	0.02	0.87
CH <sub>4</sub> Emissions from Enteric Fermentation in Domestic Livestock	CH <sub>4</sub>	127.9	124.9	0.02	0.89
CO <sub>2</sub> Emissions from Other Industrial Processes	CO <sub>2</sub>	123.6	111.1	0.02	0.90
Indirect N <sub>2</sub> O Emissions from Nitrogen Used in Agriculture	N <sub>2</sub> O	73.6	79.8	0.01	0.92
Fugitive Emissions from Coal Mining and Handling	CH <sub>4</sub>	87.1	67.9	0.01	0.93
Mobile Combustion: Road & Other	N <sub>2</sub> O	48.9	57.1	0.01	0.93
Mobile Combustion: Marine	CO <sub>2</sub>	59.4	47.8	0.01	0.94
Emissions from Substitutes for Ozone Depleting Substances	Several	0.9	44.9	0.01	0.95
HFC-23 Emissions from HCFC-22 Manufacture	HFCs	35.0	40.2	0.01	0.95
CO <sub>2</sub> Emissions from Cement Production	CO <sub>2</sub>	33.3	39.2	0.01	0.96
CH <sub>4</sub> Emissions from Manure Management	CH <sub>4</sub>	29.2	38.0	0.01	0.97
Indirect CO <sub>2</sub> Emissions from CH <sub>4</sub> Oxidation	CO <sub>2</sub>	30.9	28.2	0.00	0.97
CH <sub>4</sub> Emissions from Wastewater Handling	CH <sub>4</sub>	24.3	27.8	0.00	0.97
N <sub>2</sub> O Emissions from Nitric Acid Production	N <sub>2</sub> O	17.8	20.9	0.00	0.98
CO <sub>2</sub> Emissions from Waste Incineration	CO <sub>2</sub>	14.1	20.3	0.00	0.98
SF <sub>6</sub> Emissions from Electrical Equipment	SF <sub>6</sub>	31.2	20.1	0.00	0.98
Non-CO <sub>2</sub> Emissions from Stationary Combustion	N <sub>2</sub> O	12.8	14.3	0.00	0.99
N <sub>2</sub> O Emissions from Manure Management	N <sub>2</sub> O	16.0	17.1	0.00	0.99
CO <sub>2</sub> Emissions from Lime Production	CO <sub>2</sub>	11.2	13.9	0.00	0.99
PFC Emissions from Aluminum Production	PFCs	18.1	9.0	0.00	0.99
N <sub>2</sub> O Emissions from Wastewater Handling	N <sub>2</sub> O	7.0	8.1	0.00	0.99
CH <sub>4</sub> Emissions from Rice Production	CH <sub>4</sub>	7.1	7.9	0.00	0.99
N <sub>2</sub> O Emissions from Adipic Acid Production	N <sub>2</sub> O	14.9	7.7	0.00	0.99
Non-CO <sub>2</sub> Emissions from Stationary Combustion	CH <sub>4</sub>	7.9	7.0	0.00	1.00
PFC, HFC, and SF <sub>6</sub> Emissions from Semiconductor Manufacturing	SF <sub>6</sub>	2.9	7.3	0.00	1.00
SF <sub>6</sub> Emissions from Magnesium Production	SF <sub>6</sub>	5.5	6.2	0.00	1.00
Mobile Combustion: Road & Other	CH <sub>4</sub>	4.7	4.3	0.00	1.00
CO <sub>2</sub> Emissions from Natural Gas Flaring	CO <sub>2</sub>	5.5	6.3	0.00	1.00
Mobile Combustion: Aviation	N <sub>2</sub> O	1.7	1.8	0.00	1.00
CH <sub>4</sub> Emissions from Other Industrial Processes	CH <sub>4</sub>	1.2	1.7	0.00	1.00
CH <sub>4</sub> Emissions from Agricultural Residue Burning	CH <sub>4</sub>	0.7	0.8	0.00	1.00
N <sub>2</sub> O Emissions from Agricultural Residue Burning	N <sub>2</sub> O	0.4	0.5	0.00	1.00
Mobile Combustion: Marine	N <sub>2</sub> O	0.4	0.3	0.00	1.00
N <sub>2</sub> O Emissions from Waste Incineration	N <sub>2</sub> O	0.3	0.2	0.00	1.00
Mobile Combustion: Aviation	CH <sub>4</sub>	0.2	0.1	0.00	1.00
CO <sub>2</sub> Emissions from Stationary Combustion - Geothermal Energy	CO <sub>2</sub>	0.2	0.1	0.00	1.00
Mobile Combustion: Marine	CH <sub>4</sub>	0.1	0.1	0.00	1.00
<b>TOTAL</b>		<b>6,130.7</b>	<b>6,756.2</b>	<b>1.00</b>	

Notes: Sinks (e.g., LUCF, Landfill Carbon Storage) are not included in this analysis.

## Key Source Category Analysis

**Table A 11: Tier 1 Level Assessment (1999)**

IPCC Source Categories	Direct GHG	Base Year Estimate (Tg CO <sub>2</sub> Eq.)	Current Year Estimate (Tg CO <sub>2</sub> Eq.)	Level Assessment	Cumulative Total
CO <sub>2</sub> Emissions from Stationary Combustion - Coal	CO <sub>2</sub>	1,692.6	1,956.9	0.29	0.29
Mobile Combustion: Road & Other	CO <sub>2</sub>	1,235.5	1,478.5	0.22	0.50
CO <sub>2</sub> Emissions from Stationary Combustion - Gas	CO <sub>2</sub>	952.8	1,105.0	0.16	0.66
CO <sub>2</sub> Emissions from Stationary Combustion - Oil	CO <sub>2</sub>	662.5	658.4	0.10	0.76
Direct N <sub>2</sub> O Emissions from Agricultural Soils	N <sub>2</sub> O	193.5	216.5	0.03	0.79
CH <sub>4</sub> Emissions from Solid Waste Disposal Sites	CH <sub>4</sub>	213.4	203.1	0.03	0.82
Mobile Combustion: Aviation	CO <sub>2</sub>	176.9	186.7	0.03	0.85
Fugitive Emissions from Oil & Gas Operations	CH <sub>4</sub>	147.6	140.8	0.02	0.87
CH <sub>4</sub> Emissions from Enteric Fermentation in Domestic Livestock	CH <sub>4</sub>	127.9	124.5	0.02	0.89
CO <sub>2</sub> Emissions from Other Industrial Processes	CO <sub>2</sub>	123.6	107.9	0.02	0.90
Indirect N <sub>2</sub> O Emissions from Nitrogen Used in Agriculture	N <sub>2</sub> O	73.6	79.8	0.01	0.92
Fugitive Emissions from Coal Mining and Handling	CH <sub>4</sub>	87.1	63.7	0.01	0.93
Mobile Combustion: Marine	CO <sub>2</sub>	59.4	63.0	0.01	0.93
Mobile Combustion: Road & Other	N <sub>2</sub> O	48.9	56.4	0.01	0.94
Emissions from Substitutes for Ozone Depleting Substances	Several	0.9	51.3	0.01	0.95
CO <sub>2</sub> Emissions from Cement Production	CO <sub>2</sub>	33.3	40.0	0.01	0.96
CH <sub>4</sub> Emissions from Manure Management	CH <sub>4</sub>	29.2	37.6	0.01	0.96
HFC-23 Emissions from HCFC-22 Manufacture	HFCs	35.0	30.4	0.00	0.97
CH <sub>4</sub> Emissions from Wastewater Handling	CH <sub>4</sub>	24.3	28.3	0.00	0.97
Indirect CO <sub>2</sub> Emissions from CH <sub>4</sub> Oxidation	CO <sub>2</sub>	30.9	27.0	0.00	0.97
CO <sub>2</sub> Emissions from Waste Incineration	CO <sub>2</sub>	14.1	21.8	0.00	0.98
N <sub>2</sub> O Emissions from Nitric Acid Production	N <sub>2</sub> O	17.8	20.1	0.00	0.98
Non-CO <sub>2</sub> Emissions from Stationary Combustion	N <sub>2</sub> O	12.8	14.6	0.00	0.98
N <sub>2</sub> O Emissions from Manure Management	N <sub>2</sub> O	16.0	17.1	0.00	0.99
SF <sub>6</sub> Emissions from Electrical Equipment	SF <sub>6</sub>	31.2	15.5	0.00	0.99
CO <sub>2</sub> Emissions from Lime Production	CO <sub>2</sub>	11.2	13.5	0.00	0.99
PFC Emissions from Aluminum Production	PFCs	18.1	8.9	0.00	0.99
N <sub>2</sub> O Emissions from Wastewater Handling	N <sub>2</sub> O	7.0	8.4	0.00	0.99
CH <sub>4</sub> Emissions from Rice Production	CH <sub>4</sub>	7.1	8.3	0.00	0.99
PFC, HFC, and SF <sub>6</sub> Emissions from Semiconductor Manufacturing	SF <sub>6</sub>	2.9	7.7	0.00	0.99
Non-CO <sub>2</sub> Emissions from Stationary Combustion	CH <sub>4</sub>	7.9	7.3	0.00	1.00
N <sub>2</sub> O Emissions from Adipic Acid Production	N <sub>2</sub> O	14.9	7.7	0.00	1.00
SF <sub>6</sub> Emissions from Magnesium Production	SF <sub>6</sub>	5.5	6.1	0.00	1.00
Mobile Combustion: Road & Other	CH <sub>4</sub>	4.7	4.1	0.00	1.00
CO <sub>2</sub> Emissions from Natural Gas Flaring	CO <sub>2</sub>	5.5	6.7	0.00	1.00
Mobile Combustion: Aviation	N <sub>2</sub> O	1.7	1.8	0.00	1.00
CH <sub>4</sub> Emissions from Other Industrial Processes	CH <sub>4</sub>	1.2	1.7	0.00	1.00
CH <sub>4</sub> Emissions from Agricultural Residue Burning	CH <sub>4</sub>	0.7	0.8	0.00	1.00
N <sub>2</sub> O Emissions from Agricultural Residue Burning	N <sub>2</sub> O	0.4	0.4	0.00	1.00
Mobile Combustion: Marine	N <sub>2</sub> O	0.4	0.4	0.00	1.00
N <sub>2</sub> O Emissions from Waste Incineration	N <sub>2</sub> O	0.3	0.2	0.00	1.00
Mobile Combustion: Aviation	CH <sub>4</sub>	0.2	0.2	0.00	1.00
Mobile Combustion: Marine	CH <sub>4</sub>	0.1	0.1	0.00	1.00
CO <sub>2</sub> Emissions from Stationary Combustion - Geothermal Energy	CO <sub>2</sub>	0.2	0.0	0.00	1.00
<b>TOTAL</b>		<b>6,130.7</b>	<b>6,829.5</b>	<b>1.00</b>	

Notes: Sinks (e.g., LUCF, Landfill Carbon Storage) are not included in this analysis.

**Key Source Category Analysis**
**Table A 12: Tier 1 Level Assessment (2000)**

IPCC Source Categories	Direct GHG	Base Year Estimate (Tg CO <sub>2</sub> Eq.)	Current Year Estimate (Tg CO <sub>2</sub> Eq.)	Level Assessment	Cumulative Total
CO <sub>2</sub> Emissions from Stationary Combustion - Coal	CO <sub>2</sub>	1,692.6	2,030.1	0.29	0.29
Mobile Combustion: Road & Other	CO <sub>2</sub>	1,235.5	1,503.2	0.21	0.50
CO <sub>2</sub> Emissions from Stationary Combustion - Gas	CO <sub>2</sub>	952.8	1,162.9	0.17	0.67
CO <sub>2</sub> Emissions from Stationary Combustion - Oil	CO <sub>2</sub>	662.5	640.7	0.09	0.76
Direct N <sub>2</sub> O Emissions from Agricultural Soils	N <sub>2</sub> O	193.5	217.8	0.03	0.79
CH <sub>4</sub> Emissions from Solid Waste Disposal Sites	CH <sub>4</sub>	213.4	203.5	0.03	0.82
Mobile Combustion: Aviation	CO <sub>2</sub>	176.9	196.5	0.03	0.85
Fugitive Emissions from Oil & Gas Operations	CH <sub>4</sub>	147.6	138.2	0.02	0.87
CH <sub>4</sub> Emissions from Enteric Fermentation in Domestic Livestock	CH <sub>4</sub>	127.9	123.9	0.02	0.89
CO <sub>2</sub> Emissions from Other Industrial Processes	CO <sub>2</sub>	123.6	107.6	0.02	0.90
Mobile Combustion: Marine	CO <sub>2</sub>	59.4	89.9	0.01	0.92
Indirect N <sub>2</sub> O Emissions from Nitrogen Used in Agriculture	N <sub>2</sub> O	73.6	79.8	0.01	0.93
Fugitive Emissions from Coal Mining and Handling	CH <sub>4</sub>	87.1	61.0	0.01	0.94
Emissions from Substitutes for Ozone Depleting Substances	Several	0.9	57.8	0.01	0.94
Mobile Combustion: Road & Other	N <sub>2</sub> O	48.9	55.7	0.01	0.95
CO <sub>2</sub> Emissions from Cement Production	CO <sub>2</sub>	33.3	41.1	0.01	0.96
CH <sub>4</sub> Emissions from Manure Management	CH <sub>4</sub>	29.2	37.5	0.01	0.96
HFC-23 Emissions from HCFC-22 Manufacture	HFCs	35.0	29.8	0.00	0.97
CH <sub>4</sub> Emissions from Wastewater Handling	CH <sub>4</sub>	24.3	28.7	0.00	0.97
Indirect CO <sub>2</sub> Emissions from CH <sub>4</sub> Oxidation	CO <sub>2</sub>	30.9	26.3	0.00	0.98
CO <sub>2</sub> Emissions from Waste Incineration	CO <sub>2</sub>	14.1	22.5	0.00	0.98
N <sub>2</sub> O Emissions from Nitric Acid Production	N <sub>2</sub> O	17.8	19.8	0.00	0.98
Non-CO <sub>2</sub> Emissions from Stationary Combustion	N <sub>2</sub> O	12.8	14.9	0.00	0.98
N <sub>2</sub> O Emissions from Manure Management	N <sub>2</sub> O	16.0	17.5	0.00	0.99
SF <sub>6</sub> Emissions from Electrical Equipment	SF <sub>6</sub>	31.2	14.4	0.00	0.99
CO <sub>2</sub> Emissions from Lime Production	CO <sub>2</sub>	11.2	13.3	0.00	0.99
N <sub>2</sub> O Emissions from Wastewater Handling	N <sub>2</sub> O	7.0	8.5	0.00	0.99
PFC Emissions from Aluminum Production	PFCs	18.1	7.9	0.00	0.99
Non-CO <sub>2</sub> Emissions from Stationary Combustion	CH <sub>4</sub>	7.9	7.5	0.00	0.99
CH <sub>4</sub> Emissions from Rice Production	CH <sub>4</sub>	7.1	7.5	0.00	0.99
N <sub>2</sub> O Emissions from Adipic Acid Production	N <sub>2</sub> O	14.9	8.1	0.00	1.00
PFC, HFC, and SF <sub>6</sub> Emissions from Semiconductor Manufacturing	SF <sub>6</sub>	2.9	7.4	0.00	1.00
Mobile Combustion: Road & Other	CH <sub>4</sub>	4.7	4.1	0.00	1.00
SF <sub>6</sub> Emissions from Magnesium Production	SF <sub>6</sub>	5.5	4.0	0.00	1.00
CO <sub>2</sub> Emissions from Natural Gas Flaring	CO <sub>2</sub>	5.5	6.1	0.00	1.00
Mobile Combustion: Aviation	N <sub>2</sub> O	1.7	1.9	0.00	1.00
CH <sub>4</sub> Emissions from Other Industrial Processes	CH <sub>4</sub>	1.2	1.7	0.00	1.00
CH <sub>4</sub> Emissions from Agricultural Residue Burning	CH <sub>4</sub>	0.7	0.8	0.00	1.00
Mobile Combustion: Marine	N <sub>2</sub> O	0.4	0.6	0.00	1.00
N <sub>2</sub> O Emissions from Agricultural Residue Burning	N <sub>2</sub> O	0.4	0.5	0.00	1.00
N <sub>2</sub> O Emissions from Waste Incineration	N <sub>2</sub> O	0.3	0.2	0.00	1.00
Mobile Combustion: Aviation	CH <sub>4</sub>	0.2	0.2	0.00	1.00
Mobile Combustion: Marine	CH <sub>4</sub>	0.1	0.1	0.00	1.00
CO <sub>2</sub> Emissions from Stationary Combustion - Geothermal Energy	CO <sub>2</sub>	0.2	0.0	0.00	1.00
<b>TOTAL</b>		<b>6,130.7</b>	<b>7,001.2</b>	<b>1.00</b>	

Notes: Sinks (e.g., LUCF, Landfill Carbon Storage) are not included in this analysis.