

Estimates of Facilities that Emit CO₂ in Excess of 100 and 250 tpy Thresholds

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May 2008

This memo summarizes an assessment of the number of stationary sources that could be *newly* subject to permitting requirements under the Clean Air Act if emissions thresholds of 100 tons per year and 250 tons per year were applied to greenhouse gases (GHGs). The results of this assessment are discussed in the Advanced Notice of Proposed Rulemaking (ANPR). This memo and supporting documents provide additional technical detail.

The ANPR discusses possible approaches for limiting the number of sources covered by the Prevention of Significant Deterioration (PSD) preconstruction permitting program, and the Title V operating permit program, in the event that GHGs became regulated pollutants. The approaches include, for example, legal theories that might justify establishment of higher emissions thresholds for GHGs for CAA permitting programs. Examining the effect of those approaches is beyond the scope of this assessment.

1. Summary of Facility Counts by Sector

Existing major sources

We present estimates of the number of existing stationary sources with CO₂ emissions above 100 tpy. The 100 tpy level was chosen in part because it is the level at which sources generally become subject to title V permitting requirements.

We also present estimates of the number of existing stationary sources with CO₂ emissions above 250 tpy. Both the 100 tpy and 250 tpy thresholds are relevant to the PSD program. The 100 tpy level is the level at which existing sources in 28 industry categories listed in the CAA are classified as major for the PSD program. The 250 tpy level is the level at which existing sources in all other categories are classified as major for PSD purposes.¹

Being an existing major source does not require a facility to obtain a PSD permit; therefore, the number of *existing* major-emitting facilities is not an estimate of the number of facilities that would be required to obtain PSD permits. Only existing major-emitting facilities that undergo modifications (as defined by the CAA and EPA regulations), and new major-emitting facilities, must obtain PSD permits (See “New Sources” section below).

¹ Our estimate of the number of 250-tpy sources in Table 1 does not include the 100-tpy sources from the 28 100-tpy categories.

The estimates of existing stationary sources exceeding the 100 tpy and 250 tpy thresholds are presented in Table 1, and the attached documents provide supporting information.

Table 1. Estimates of Existing Facilities That Would Exceed 100 tpy and 250 tpy CO2 Major Source Thresholds

Sector	Total # of Existing Facilities	100 tpy CO2 Threshold (# of Facilities / % of sector total)	250 tpy CO2 Threshold (# of Facilities / % of sector total)
Residential ²	87,065,000	139,137 / 0.16%	61,280 / 0.07 %
Commercial ³	4,858,750	272,000 / 6%	88,000 / 2%
Industrial ⁴	341,482	139,554 / 41%	85,788 / 25%
Total⁵		550,691	235,068

The agriculture sector is not included in the facility counts because the stationary GHG sources from this sector are primarily fugitive, non-CO2 emission sources. Non-CO2 emissions are not included in this assessment and, except for the 28 industry source categories listed in the CAA, fugitive emissions of non-hazardous air pollutants are not included in determining whether a source is ‘major’ and subject to permitting. Agricultural GHG sources would generally not be included in any of the 28 listed categories.

New sources and modifications

In addition, new facilities constructed each year would be newly subject to permitting as title V sources and as new sources subject to PSD, if the 100- and 250-ton thresholds were applied to GHGs. Due to lack of data, as explained below in more detail, EPA was unable to estimate the number of modifications of existing sources that would require PSD permits. The new source estimates are presented in Table 2.

Table 2. Estimates of New Facilities Added Annually Exceeding 100 tpy and 250 tpy CO2 Major Source Thresholds

Sector	100 tpy CO2 Threshold	250 tpy CO2 Threshold
Residential ⁶	1,900	600
Commercial ⁷	4,000	1,000
Industrial ⁸	566	361
Total⁹	6,466	1,961

² Residential estimate from an EPA unpublished analysis based on residential unit energy loads from *Energy Data Sourcebook for the US Residential Sector* (LBNL, 1997) and national population of residential units from the *American Housing Survey: 2005* (US Census Bureau, 2006).

³ Commercial estimate from an April 2008 unpublished study, *Analysis of Greenhouse Gas Emissions and New Source Review, Final Report*, prepared for EPA by E.H. Pechan & Associates, Perrin Quarles Associates, and Alpine Geophysics. Estimate based on gas and oil consumption survey data from 2006 EIA’s *Commercial Buildings Energy Consumption Survey* (CBECS) and extrapolation to national level based on building type representation obtained from EIA sampling weights.

⁴ Industrial estimate based on employment category and employee energy consumption estimates from 2005 EIA’s *Manufacturing Energy Consumption Survey* (MECS) and number of manufacturing establishments in each employment size category from 2002 *Economic Census* (US Census Bureau 2005).

⁵ Existing major sources that are currently subject to Title V permitting under CAA are not included in the totals. There are approximately 14,700 Title V permits issued nationwide.

⁶ Annual growth based on projected number of households from the 2007 EIA’s *Annual Energy Outlook*.

⁷ Annual growth based on 1990-2003 average annual growth rate in commercial buildings from EIA CBECS database.

⁸ Annual growth based on industry-specific growth rates between 1997 and 2002 from US Census Bureau’s 1997 and 2002 *Economic Census*.

⁹ Modifications, as defined for the purposes of PSD permitting, are not included in the totals for new facilities.

2. Uncertainties

Our estimates indicate that a 100 or 250 tpy CO₂ threshold would add a significant number of sources to the universe of those potentially subject to NSR and Title V permitting. However, significant uncertainties exist in the exact magnitude of our current estimate, which stem from constraints imposed by the data limitations and the assumptions necessary to address those constraints. Most of these assumptions had the effect of excluding groups of sources from our estimate, so that our total estimates of numbers of existing sources exceeding the 100- or 250-ton thresholds are likely to be conservative (i.e., the actual numbers would be higher).

In order to estimate the number of facilities that exceed a 100 or 250 tpy CO₂ emission threshold, it is necessary to have emissions inventory data at the facility or building level, including numerous small sources in the residential and commercial sectors (e.g., apartment buildings and office buildings). Historically, however, EPA has not collected facility-level information for GHG emissions under the CAA (with the exception of information from electric generating units required to report CO₂ emissions under the Acid Rain Program reporting requirements). To date, national EPA inventories of GHG sources have primarily focused on ‘top-down’ estimates of GHG emissions from sectors and sources, and not facility-level estimates. EPA does have a long history of developing criteria and hazardous air pollutant inventories at a facility-level in support of CAA program areas; however, these inventories do not contain emissions data for residential and most commercial source categories at a building or facility level and therefore could not be used for this assessment. In addition, many industrial sector facilities that would emit in excess of a 100 or 250 tpy CO₂ emission threshold are not included in current criteria or hazardous pollutant inventories because their emissions of criteria or hazardous air pollutants do not exceed existing ‘major source’ levels under the CAA. As a result, many of the uncertainties described below result from the absence of a comprehensive data set of facility-level GHG emissions across all sectors.

Uncertainties include:

- Our current analysis relies on sample facility datasets, prototype modeling (e.g., for building energy loads) and top-down sector data (e.g., fuel usage and/or building characteristics). Due to inadequate facility-level GHG data across all sectors, the methodologies are based to a high degree on aggregate data and are not of a high enough resolution at this point to fully evaluate impacts and burdens beyond a general nature.
- Uncertainties in the estimates of the total number of facilities affected are also introduced due to the differences in methodologies used across the three sectors. For example, if all estimates had been derived from bottom-up calculations of individual facility/building emissions there would be more certainty in evaluating and comparing the facility counts across sectors.
- EPA’s estimate is based on *actual* emissions, and thus excludes a potentially very large number of sources that would be major if they operated at their full potential to emit (PTE). PTE is defined as the maximum capacity of a stationary source to emit a pollutant under its physical and operational design, including certain legal limitations, for example, on emissions or hours of operation. NSR and Title V programs both use PTE for defining major sources. In practice, however, for the residential sector and for many of the facilities in the commercial sector, where CO₂ emissions are primarily due to space heating/appliance usage, the combustion units are not likely to be used constantly at their maximum rated capacity, for example, because heating is not needed year-round and heating systems have thermostats. Nonetheless, the number of sources brought into either the NSR or Title V programs due solely to their PTE would depend on how EPA interprets PTE for various types of emitting equipment (e.g., space-heating furnaces in residential and commercial buildings), and the extent to which streamlined mechanisms are made

available for sources to obtain legal limits on their PTE so that the programs are not applicable. (See ANPR for further discussion.)

- Our estimate of the number of additional permits does not include NSR permits that will be required for *modifications* to sources. Due to the lack of data on facility changes across the sectors, we cannot estimate the increase in the number of modifications that would trigger NSR if the 100-ton and 250-ton thresholds were applied to GHGs.¹⁰ Nonetheless, we anticipate that the inclusion of GHGs as regulated pollutants would increase NSR permitting because the larger universe of major sources will bring in additional sources at which modifications could occur. In addition, sources currently defined as major that undergo many small modifications which are classified as insignificant modifications for ‘traditional’ pollutants, could become subject to PSD review for modifications whose GHG emissions increases exceed the significance levels. Modifications at minor sources could also be subject to permitting if they result in increases that exceed major source thresholds for GHGs. All of these newly classified significant and major modifications could substantially increase the number of PSD permits. Based on our limited preliminary information, we expect that some industrial sectors could see an order of magnitude increase in the number of modification projects that trigger NSR review.
- We did not include in this assessment the impacts of increased permits for increases in “traditional” pollutants due to the ‘major for one, major for all’ aspect of the PSD regulations. For example, a source previously not defined as major for any pollutant would, after becoming major for CO₂, be potentially subject to PSD review for modifications involving other regulated pollutants that exceed significance levels. While this would not add to the facility count in Table 1, it could substantially increase the number of modifications that would be subject to NSR PSD requirements (e.g., BACT, air quality modeling) for NSR regulated pollutants.
- The facility counts in Tables 1 and 2 are based on direct emissions of CO₂ from fossil fuel combustion. Non-energy (i.e., process-related) emissions of CO₂ are not included in the emission estimates. However, less than 6 percent of CO₂ emissions nationwide result from non-energy sources and we expect that most of these sources are already classified as ‘major’ sources for either criteria or HAP pollutant emissions. These sources include aluminum plants, ferroalloy production, lime and cement manufacturing, and petrochemical production.
- Non-CO₂ GHG emissions have not been considered in compiling the facility counts in Tables 1 or 2. EPA’s preliminary estimates suggest that a relatively small number of point source facilities (1000 to 2000) would exceed either a 100 or 250 tpy threshold limit based solely on mass emissions of non-CO₂ gases. Also, since fugitive non-HAP emissions are excluded from applicability considerations for all but the 28 listed PSD source categories and many of the larger non-CO₂ GHG emission sources are fugitive sources (e.g., agricultural soils, livestock, equipment/transmission leaks), these non-CO₂ emissions would not subject these sources to permitting. However, this exclusion for fugitives depends upon whether or not GHGs are listed as HAPs. For HAPs, fugitives must be included for all source applicability determinations. An additional consideration regarding non-CO₂ gases is that if one were to consider alternative emissions metrics such as CO₂-equivalent (CO₂e) or Carbon Equivalent (CE) emissions and PTE scenarios, facility counts would change, as would the relative contribution of sources of each GHG to the total number of facilities.

¹⁰ Among other things, any estimate of modifications must take into account the netting provisions of NSR, in which sources can avoid NSR if the increase of pollutant emissions from a project is below the significance level for that pollutant, after taking into account other increases and decreases of emissions that are contemporaneous with the project. It is not possible at this time to determine which modifications might be able to avoid permit requirements through netting.

3. Methodologies

Following is a brief summary of the methodologies that were used to estimate the 100 and 250 tpy facility counts presented in Tables 1 and 2. It is important to note that all counts are based on actual emissions. Heat contents and CO₂ emission factors for fuels used in the methodologies described below were all obtained from the *Inventory of U.S Greenhouse Gas Emissions and Sinks* (EPA, 2007).

Although this assessment focuses on actual emissions, we note that the attached contractor report entitled “Analysis of Greenhouse Gas Emissions and New Source Review, Final Report” includes some statements concerning calculation of potential emissions or potential to emit, or statements that certain equipment has a potential to emit exceeding certain tonnage thresholds. EPA is drawing no regulatory conclusions in this assessment. To the extent that PTE calculations in the report for certain equipment are based on year-round constant operation (8760 hours), EPA may or may not agree with that assumption; this can depend on considerations specific to the type of source.

Residential

The residential methodology is based on the assumption that only multi-family residential buildings would exceed either the 100 tpy or 250 tpy CO₂ thresholds based on actual emissions. Based on estimates of actual emissions from an internal analysis prepared by ICF International for EPA it is estimated that the square footage necessary to exceed a 100 and 250 tpy thresholds would be approximately 30,000 and 68,000 square feet, respectively. This would exclude most single family households based on actual emissions.

For the residential sector, where emissions are primarily due to space heating/appliance usage, utilization is not likely to be constant; for example, it would be unreasonable for heating to occur all year round in an apartment building. Studies concerning PTE for residential sources should address reasonable scenarios that have some probability of occurring, which might include such scenarios as an extended heating season.

The building counts for residential included in Table 1 are based on an EPA unpublished analysis using residential unit energy loads obtained from the Energy Data Sourcebook for the US Residential Sector, Energy Analysis Program, Lawrence Berkeley National Laboratory (LBNL, 1997) and estimates of the number of buildings/family units from the American Housing Survey 2005 (US Census Bureau, 2006).

LBNL, 1997 provides national average, residential unit energy consumption estimates (UECs) for fossil fuel-fired appliances and equipment. Appliances and equipment include gas and oil-fired furnaces, water heaters, dryers, and stoves. The UECs represent national average estimates for energy consumption for housing units in multifamily residential facilities. Almost 90% of the multifamily housing units that rely on fossil-fuel fired equipment for heating or appliances use natural gas, with the remaining 10 percent using primarily fuel oil.

UECs were then converted to estimates of CO₂ emissions. Based on the converted UECs, it was estimated how many units within a residential multifamily building would cause the building’s total emissions to exceed the 100 and 250 tpy CO₂ thresholds. In order to get the total number of multifamily buildings nationwide that contain the threshold number of units, information on the population of multifamily units from the American Housing Survey was used (US Census Bureau, 2006). In order to get better representation of buildings and units that rely on fossil-fired equipment (and which therefore would have direct CO₂ emissions from fossil fuel combustion), only survey counts for units that identified the main heating equipment as a warm-air furnace, steam/hot water systems, hot-air units, or flued room heaters were used to compile national totals.

The American Housing Survey data provides populations of units in different size categories of multifamily buildings. The size categories, which are based on ranges of unit populations within a building, do not match identically with the single point threshold levels for number of units that exceed 100 and 250 tpy CO₂ emissions. The result of cross-walking the UEC-based estimates to the housing survey data is that a slight overestimate of multifamily buildings is likely since some of the buildings at the low end of the unit size category ranges may not exceed the threshold levels for CO₂ emissions.

It should also be noted that the UEC estimates showed that newer buildings (post-1980) tend to have lower emissions per residential unit. The housing survey data could not be broken down by age and heating device type, so this differentiation in emission levels by age is not represented in the building counts. However, it is expected that this trend towards more efficient buildings and appliances over recent years would reduce the number of newer buildings that exceed the 100 and 250 tpy thresholds on an actual basis.

Growth estimates shown in Table 2 for the residential sector are developed from predicted average annual growth rates for 2007 to 2017. The growth rates for new buildings were derived from projected multifamily housing data from the Energy Information Administration's Annual Energy Outlook (DOE, 2007).

See attached spreadsheet entitled "multifamily residential.xls" for calculations of existing buildings for the residential sector shown in Table 1. For growth rate calculations shown in Table 2, see attached spreadsheet entitled "residential growth rates.xls".

Commercial

See the attached report entitled "Analysis of Greenhouse Gas Emissions and New Source Review, Final Report", Chapter 5.0 for a detailed description of the methodology and results for the commercial sector. The report was prepared for EPA by E.H. Pechan & Associates, Perrin Quarles Associates, and Alpine Geophysics in April 2008. Commercial sector estimates are based on the Energy Information Administration's Commercial Building Energy Consumption Survey (CBECS) and covers a wide range of commercial building categories, including office, food service, shopping malls, warehouse, hospitals, hotels, etc.

CBECS is a national sample survey that collects information on the stock of U.S. commercial buildings, their energy-related building characteristics, and their energy consumption and expenditures. The 2003 survey—the most recent CBECS survey and the one used in this assessment—resulted in 5,215 completed building interviews representing all the commercial building categories. The CBECS sample is designed so that survey responses could be used to estimate characteristics of the entire commercial buildings stock nationwide. To make national estimates from the sample, EIA calculated base sampling weights for each building (the reciprocal of the probability of that building being selected into the sample). For this assessment, CO₂ emissions were calculated for each sample building type based on CBECS fuel consumption data from the survey. Then, based on extrapolated national estimates of buildings associated with each sample type using the EIA sampling weights, national building counts were assigned to the appropriate CO₂ emission threshold level.

Growth rates for the commercial sector are based on the average annual growth rate in the number of new commercial buildings from 1990 to 2003 as reported in the CBECS database. Since this is an historical-based growth rate, there is considerable uncertainty in how well this growth rate reflects current trends in the commercial real estate sector. New building in the commercial sector is extremely susceptible to changing market conditions such that recent downturns in the economy in some areas of country could affect the current growth rate.

Refer to the attached files entitled “GHG Emissions & New Source Review.doc” and “Appendix D - CBECS Fuel Based CO2.xls” for documentation of the methodology and results for the commercial sector estimates shown in Tables 1 and 2.

Industrial

The methodology for the industrial sector is described in the attached memorandum (file name “GHG Industrial Threshold Methodology.doc”) prepared by ICF International and regarding subject matter “Methodology Description for Industrial Sector GHG Threshold Analysis”. The ICF memorandum was prepared for EPA and describes a preliminary assessment of facility counts based on different GHG threshold levels.

The general approach for the industrial sectors facility counts is based on the following steps. For each industry, an average number of manufacturing establishments that exceeded the CO2 tpy threshold were estimated for different employment categories (e.g., 1-4 employees, 5-9 employees...up to 2500+ employees). To determine whether establishments in an employment category exceed the CO2 tpy threshold, average CO2 emissions per employee—which were estimated using data on fuel consumption (by each manufacturing category), CO2 emission factors, and number of employees—was multiplied by the average number of employees per establishment in different employment categories. The average emission per establishment for each employment size category was then used to estimate the total percentage of facilities in that industry that emitted greater than the CO2 tpy threshold (e.g., 250 tpy) of CO2.

In order to reflect only sources that would be newly permitted under a 100 or 250 tpy CO2 threshold in Table 1, it was necessary to adjust the ICF values to account for industrial facilities that are already permitted under current Title V regulations. There are approximately 14,700 facilities that have a Title V permit and meet the definition of ‘major source’ under Title V due to either criteria or hazardous air pollutant emissions. These facilities, with the exception of 2,800 facilities associated with EGUs that were already removed from the ICF background totals, were subtracted from the total counts for the industrial sector. Mining facilities, which were not included in the manufacturing sector, were also added to the industrial sector totals.

Estimates of the annual number of new industrial facilities shown in Table 2 are based on average annual, industry-specific growth rates for new establishments between 1997 and 2002 and are described in the ICF GHG analysis referenced above. The 1997 to 2002 historical growth rates for each manufacturing subcategory (e.g., wood products manufacturing, machinery manufacturing, food products manufacturing) were obtained from the US Census Bureau’s 1997 and 2002 *Economic Census*. The methodology assumes a linear growth rate between 1997 and 2002.

For industrial sector calculations, see the attached spreadsheet entitled “industry summary.xls”.

4. References

Lawrence Berkeley National Laboratory (LBNL) (1997). *Energy Data Sourcebook for the U.S. Residential Sector*. Prepared by Energy Analysis Program, Environmental Energy Technologies Division, LBNL, University of California, Berkeley, CA. September, 1997. Available online at http://enduse.lbl.gov/info/Pubs95_99.html.

DOE (2007). Energy Information Administration’s Annual Energy Outlook 2007 with Projections to 2030. DOE/EIA-0383 (2007). Available online http://www.eia.doe.gov/oiaf/aeo/aeoref_tab.html.

EPA (2007). *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2005*. U.S. Environmental Protection Agency, EPA 430-R-07-002. April 2007. Available online at <http://www.epa.gov/climatechange/emissions/usinventoryreport.html>.

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