Effective PSD Permitting Strategies for GHG Emissions

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Background

The US Environmental Protection Agency (EPA) promulgated the *Prevention of Significant Deterioration and Title V Greenhouse Gas Tailoring Rule* (hereafter "Tailoring Rule") on June 3, 2010. By this action, the EPA began regulating emissions of greenhouse gases (GHG) through the Prevention of Significant Deterioration (PSD) program of the Clean Air Act (CAA). The provisions of the Tailoring Rule have since become effective on January 2, 2011. The legal basis for this regulation rests on EPA's *Endangerment Finding*, published December 15, 2009, which found that the aggregate of six well-mixed gases produced by human activity are reasonably anticipated to endanger public health and welfare. EPA found that these gases cause or contribute to an intensification of the naturally occurring greenhouse effect of Earth's atmosphere, resulting in climactic changes due to global warming.

Although EPA issued guidance to states in November of 2010 for evaluating PSD applications submitted under the Tailoring Rule (withdrawn and replaced by updated guidance in March 2011), permit applicants still face a regulatory paradox in which the Tailoring Rule mandates a review of GHG control options, yet little in the way of add-on control options are commercially available or demonstrated to be effective at reducing GHG emissions. There are even fewer precedents on which to rely when designing new projects and planning for environmental permits.

For the purposes of PSD regulation and permitting, GHG is defined as the aggregate of six well-mixed gases as described above, which are treated as the single pollutant *carbon dioxide equivalent,* or *CO_2e*. This aggregate quantity is calculated as the sum of each of the six gases, multiplied by an assigned factor for *global warming potential* (GWP). Factors published by EPA for GWP may be found in the *Mandatory Reporting for Greenhouse Gases* rule (aka Mandatory Reporting Rule or MRR), 40 CFR Part 98, Subpart A, Table 1. For the majority of industrial sources, the three components of CO_2e that result from combustion will be of primary importance, namely carbon dioxide, methane and nitrous oxide.

In an interesting divergence from typical criteria pollutant considerations, EPA has purposefully declined to establish a National Ambient Air Quality Standard (NAAQS) for CO_2e. This decision was the result of the observation that the ambient concentration of CO_2e at any given location cannot be attributed to any single, specific source. Rather, the accumulation of CO_2 and other greenhouse gases occurs as the aggregate of many thousands of sources outpacing natural sinks, and these gases then become well-mixed in the atmosphere. Additionally, even were the concentration at a specific location attributable to a specific source, there are no known acute or chronic biological health effects of CO_2 (at the concentrations of interest), upon which to base a concentration standard. Therefore any temporary concentration gradient of CO_2e, at any particular spot on the globe, has no specific health or climate change impact at that location. EPA described several aspects of its NAAQS rationale in the *Meyers Memo*[1], although this discussion was made in the context of *Endangered Species Act* review of federal permitting actions and predates the actual Tailoring Rule. Due to the fact that no NAAQS exists, the provisions of Non-attainment New Source Review (NNSR) do not apply to GHG emissions. Similarly, modeling reviews of CO_2e emissions against a NAAQS or PSD increment standard need not be considered.

PSD Applicability

New projects become subject to PSD under the provisions of the Tailoring Rule based upon the total increase of CO_2e emissions resulting from the project. Any project resulting in an actual-to-projected actual emissions increase of 100,000 tpy or more of CO_2e is subject to PSD review. Additionally, any project which is subject to PSD review for one or more criteria pollutants will also trigger PSD review for an increase of GHG emissions of 75,000 tpy CO_2e or more. EPA has referred to the latter category as "anyway" facilities or "anyway modifications", since those projects are subject to PSD review "anyway" for increases of criteria pollutant emissions.

It should be noted that the Tailoring Rule does not provide facility-wide applicability limits separate from significant increase thresholds when modifying an existing permit. These levels are the same, with the result that projects undergo the same process of applicability review whether they are new sources or simple modifications to existing facilities. The only differentiating criterion is whether or not a facility would trigger PSD review "anyway", which holds the 75,000 tpy threshold for GHG emissions, or if the project triggers PSD review solely for GHG emissions, in which case a 100,000 tpy threshold is applied.

EPA has repeatedly stated its position that all other aspects of the PSD program should remain the same for the review GHG emissions, as they have been applied in the past to criteria pollutant increases. In this regard, a permitting specialist should exclude any emissions which the facility could have accommodated and are attributable to product demand growth. An applicant should be certain that any projected demand growth can be thoroughly documented. Also, project planners should keep in mind that even

[1] "Endangered Species Act and GHG Emitting Activities," Robert J. Meyers, USEPA Office of Air and Radiation, October 3, 2008

though a project does not trigger PSD review, it may become subject to monitoring and reporting requirements imposed by the permitting authority if the projected actual emissions increase is more than 50% of the PSD threshold due to the "reasonable possibility" ruling of *New York v. EPA*. In this way, permitting authorities can be assured that projected actual emissions from a project do not fall far short of realized actual emissions to a degree that would have triggered PSD review.

A netting analysis remains a viable means of reducing the potential to emit (PTE) of a project, in order to stay beneath PSD review thresholds. However, most facilities have not reported actual emissions of GHG to regulatory agencies prior to the 2010 reporting year, resulting in a lack of actual emissions data to use for netting purposes for at least the next several years. Applicants may calculate these historical emissions in order to determine a 24-month baseline for use in a netting analysis; however, great care should be taken to vet these actual emissions estimates in order to assure a high degree of defensibility. For instance, many companies and facilities produced internal estimates of GHG emissions for years prior to the promulgation of either the Tailoring Rule or the MRR. However, due to the fact that the GWP factor of many gases have been cited differently based on the research or study used in the effort to build the internal emissions estimates, which likely differ from the factors published by EPA, an applicant should be sure that GWP factors are being applied consistently when estimating past actual emissions for comparison with projected future actual emissions. This may require a re-work of the source data used in past internal estimates, and an applicant should default to using the GWP factors published by EPA in the MRR.

BACT Analysis

Of course, Best Achievable Control Technology (BACT) must be applied to any source which becomes subject to PSD review, and such BACT controls are determined on a case-by-case basis. EPA maintains that BACT for GHG is an *emissions limitation* as it is with any criteria pollutant, whether such a limitation is achieved by the installation of add-on control technology or by the application of a process, technique or raw material which limits the PTE of the emitting source.

Traditionally, BACT has been determined using the five step Top-Down process described in the NSR Workshop Manual[2], although this process has never been made formal through rulemaking. Although EPA has maintained that it believes the top-down BACT process should not differ greatly from established PSD review processes, it has recognized some important differences when evaluating controls of GHG emissions. These differences, and EPA's views on their implications for the PSD review process, were addressed in the *PSD and Title V Permitting Guidance for Greenhouse Gases* document published in March, 2011 by the Office of Air Quality Planning and Standards (OAQPS). These implications will be addressed in a step-by-step fashion in following sections.

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[2] DRAFT New Source Review Workshop Manual, USEPA, October 1990

Step 1: Identify All Available Control Technologies

The most basic step in any BACT analysis is to identify the potentially available control technologies for the emissions source. However, this step can be the most difficult of the top-down steps for new projects addressing GHG emissions. This is due in large degree to a lack of control technologies currently operating in the marketplace. EPA has been consistent with general PSD guidance in stating that all potentially applicable control technologies should be included in Step 1 of a top-down BACT analysis, even if the control in question has not previously been applied to the specific source in question.

It is useful at this point to revisit how BACT controls are frequently categorized. Control technologies have often been categorized as either Add-On Controls, or as Inherently Lower Polluting Processes or Designs. BACT may be selected as a strategy from either one of these categories, or may also be determined to be a combination of strategies from these categories if economic, environmental and energy costs favor the grouping.

A lower polluting process is often one that must be implemented as part of the initial project design, and attempts to apply such strategies to already existing equipment can quickly become cost prohibitive. Improved combustion strategies such as low-NO_X burners or fuel switching are the most frequently applied lower-polluting strategies, but further reductions often require a complete redesign of the emissions source.

Therefore, traditional BACT analyses have often relied upon add-on control devices as the most effective control strategy. This is because an add-on control is typically much simpler and cheaper to install on existing equipment. Unfortunately, there are very few options for controlling GHG emissions in this fashion. The most recognized and widely-discussed of potential control technologies has been carbon capture and storage (CCS). CCS schemes aim to physically separate CO_2 from other gases in a vent stream, typically a combustion flue gas, and then sequester the resulting pure CO_2 by injecting it into an acceptable geologic formation.

While expensive, separating CO_2 from a flue gas stream is a technically feasible unit process, and has been well demonstrated with the use of selective amine absorption. It is the second stage of the CCS design, geological sequestration, which has faced technical challenges. There are some examples of successful sequestration projects, most notably when the gas has been used for enhanced oil recovery (EOR) projects. This represents the most economically viable means of sequestering CO_2 due to the costs recovered through increased production at aging or depleted fields. Sequestration in other geologic formations has been met with limited success.

It is here that CCS projects should be separated into two separate categories, which should be evaluated in very different manners. The first category we will call On-Site Sequestration (OSS) projects. These OSS projects may be considered for facilities that happen to be very closely located near EOR opportunities or favorable geology, such that any captured CO_2 can be easily transported to the proposed injection site. While not necessarily implying that CO_2 injection will be conducted on the same site as the project, it does mean that the transportation distance to the injection well is short enough that the project could economically and logistically support the sequestration effort as a stand-alone effort, or within a few miles.

The second category of CCS project will be referred to as Carbon Capture and Transport (CCT) projects. These are projects where an individual facility will capture the CO_2 from combustion or processes, yet there are no local options for storing the captured gas. However, a third-party provider offers the option of transporting the captured gas via pipeline a long distance for eventual injection, such as for an EOR activity. The long distance involved, perhaps hundreds of miles, offers certainty that the effort could not be undertaken if supported solely by the single stationary facility. The differing aspects of these approaches will be fully evaluated in later Steps in this review of the top-down BACT process for GHG emissions.

EPA has stated clearly its position that CCS projects should be considered as an "available" technology for large CO_2 emitters in Step 1 of the top-down BACT process. The PSD guidance document identifies large sources which should consider CCS as an available control technology:

> *"[I]ncluding fossil fuel-fired power plants, and…industrial facilities with high-purity CO_2 streams (e.g. hydrogen production, ammonia production, natural gas processing, ethanol production, ethylene oxide production, cement production, and iron and steel manufacturing)"*

While delegated state permitting authorities do have the latitude to review a BACT analysis that excludes CCS control, an applicant seeking an expeditious permit review should not fail to include CCS as an identified control option for one of the industries identified by EPA. Projects in this group which decide to exclude CCS as an available technology will almost certainly face adverse public comments, public petitions, or even an objection by EPA over the lack of a proper BACT analysis identifying all available control technologies.

Control strategies which constitute inherently lower polluting process designs should also be identified in Step 1 of the BACT analysis. EPA has focused its statements toward inherently lower emitting designs almost exclusively upon the energy efficiency aspects of a given project, which reasonable given the direct relationship between most forms of energy and CO_2 emissions. These control options become much more facility- or equipment-specific than the single add-on control scheme of CCS that currently dominates public discussion. Such options may be as simple as the selection of an efficient fuel (such as natural gas over coal), or a more complex arrangement promoting overall process efficiency. The intent of this exercise should not be to micromanage the relative performance of every energy-consuming device in a facility (such as light bulbs or office computers), but rather to drive efficiency in the capital process equipment at a high level. Therefore, an applicant should be prepared to design a GHG emissions unit with a high level of energy efficiency at the process level.

It is at this point that many design engineers and business managers will balk at the premise being made in the discussion on energy efficiency. "Why would EPA or the public believe that we would not design our process to be as efficient as possible? Don't they understand that any facility wants to reduce operating costs as much as possible?" The reason for this disconnect is a difference in paradigm. Engineers and business managers will value the cost of energy savings from the viewpoint of a return on investment. Commercial ROI calculations have relatively quick standards for payback on invested capital. However, BACT has always been applied from the viewpoint of having a cost to the facility, not a return, and a facility should not rely on a permitting authority to view efficiency improvements in a different manner. Requirements for deeper capital investments under the PSD program, producing similar efficiency benefits to a less costly ROI-based project can be expected to evolve over time.

EPA has recognized that individual BACT analyses may be skirting the edge of "redefining a source" under the guidance toward energy efficiency. Redefining the source is most often interpreted as attempting to dictate through the permitting process what type of product a facility should be allowed to produce, or what raw material must be used in the manufacturing process. The current GHG permitting guidance seems to acknowledge that the PSD review process does not grant EPA the authority to redefine the source. That being said, the industry-specific white papers issued in conjunction with the PSD guidance seem to blur this line in some important ways, including the favoring of one intermediate product over another. Applicants must remain alert that it is in addressing this aspect of Step 1 of a BACT analysis that they may enter a legal gray area.

Step 2: Eliminate Technically Infeasible Options

In Step 2, a BACT analysis must look at the physical and technical aspects of a give control strategy, and determine whether or not it can possibly be applied to the source in question. This analysis should be done irrespective of cost or other impacts, and will most often be employed when addressing technology transfers. Transfers are scenarios where controls applied to a different industry or type of source are being considered for a new application. Whenever a control technology is eliminated in Step 2 which has been used successfully in the past for the same type of source or industry, the permit applicant should extensively document the reasons for technical infeasibility, so that the BACT determination is defensible.

It is here that one may decide to eliminate OSS options from further consideration. If a facility has been sited in a location lacking in nearby EOR opportunities, and where the sequestration of CO_2 in local geologic formations remains unproven, it may be determined that OSS is not a feasible approach to GHG control. The applicant should document to the extent possible the determination that favorable receiving formations do not exist. Aside from determining that well fields do not exist in the local area, the applicant should form a knowledge of the local geology in order to make a determination that OSS will or will not be feasible at a particular location. As a starting point in this review, applicants should look to the *Carbon Sequestration Atlas of the US and*

Canada, which is published by the National Energy Technology Laboratory (NETL). This initial tool may help to identify the general geographic areas where stand-alone CCS should be investigated further, or abandoned as infeasible.

Step 3: Rank Remaining Control Technologies

After Step 2, in which technically infeasible control options are eliminated from consideration, the applicant must rank the remaining technologies or approaches by their pollutant-specific control efficiency in Step 3 of the top-down process. This ranking is made irrespective of any secondary impacts to the project's economics, or undesirable environmental or energy effects.

Step 4: Evaluate Most Effective Controls and Document Results

It is in Step 4 of the top-down PSD review process that indentified control technologies may be eliminated on the basis of adverse environmental, energy or economic impacts. Facilities should be careful in this step that their rationale for eliminating a BACT control option is very properly and thoroughly documented. Remaining projects should be ranked based on their overall effectiveness, including the economic, environmental and energy impacts already discussed. It is at this step that many control options for GHG control may face tough analysis.

One consideration that should be made explicit is the treatment of CCT project for carbon storage. Long-distance transport of isolated CO_2 emissions would seem to make a great deal of sense, where independent pipelines collect emissions from several sources along the route, perhaps for eventual sequestration in a large EOR project. However, some basic aspects of this arrangement make for very difficult permitting.

Outside of CCS activities, the few existing CO_2 pipelines have been developed as for-profit enterprises where CO_2 is delivered for EOR injection at a profit. Although connecting to such a pipeline may make very practical sense in getting captured CO_2 to an appropriate storage site, questions have arisen as to the appropriateness of permit requirements that may mandate the use of third-party infrastructure, such as CO_2 pipelines. Facilities that must maintain compliance with a federally-enforceable control requirement to pipeline captured CO_2 would sacrifice any negotiating position they may have with the pipeline company that is nominally providing a utility service. Currently permits do not contain such requirements that a facility contract with a specific entity which is not regulated as a public monopoly. Thus, while BACT may be based in part on the premise that a facility will sell CO_2 for enhanced oil recovery, over time it will eventually come to pass that the facility must buy the right to dispose of CO_2 into the third-party pipeline, as long as such an arrangement is not subject to the public service regulation of a typical utility or other natural monopoly. Additionally, concerns arise from the reliance upon a third party where compliance with permit terms is effectively outside of the permit holder's control. Applicants should make a strong case that third-party CO_2 pipelines are economically infeasible as a BACT control, due to the inherent monopoly that will be created by permit conditions mandating their use.

Inherently lower emitting processes may also undergo scrutiny during Step 4 of the top-down BACT process. These strategies should be evaluated against the normal considerations for adverse environmental impacts, such as generating undue amounts of waste water or solid waste in relation to the reductions achieved. Due to their very nature as energy efficiency improvements, the vast majority of GHG control strategies should not be associated with adverse energy impacts, and so this rationale will rarely be considered in Step 4.

The final consideration in this step is of adverse economic impacts. Facilities making a case for eliminating a particular control scheme, other than CCT designs for CCS, should be prepared to extensively document such decisions for review by the permitting authority and the public. Applicants face a conundrum when approaching the issue of economic feasibility, since there are no domestic decisions upon which to base a BACT determination. In general, benchmarking a process against an existing limitation has a high degree of defensibility, and this method should be sought out wherever possible. One benchmarking method may be to compare a project's control costs with the price of CO_2 as it is assigned in one or more carbon-constrained economies, such as the European Union (EU). Although the cost of carbon from such economies should be evaluated, they should not be considered to be the final word on the economic feasibility of GHG controls in the BACT process.

Through the PSD guidance document, EPA has established that energy efficiency project should be reviewed for the benefits they provide off-site from a project, and not just from directly-emitting equipment on the project site. This aspect of the evaluation should promote the acceptance of more efficient process equipment when powered by off-site electrical generation, even though the selection of such equipment will not directly effect project emissions. Scenarios that would require such an evaluation should include the installation of equipment that consumes relatively large amounts of electricity, when such electricity is generated off-site from the facility. For example, a permit applicant should provide benchmarking data to justify the energy efficiency of an electric arc furnace, while small additive pumps in a blending operation may properly be excluded.

Due to the fact that most new projects are designed with many energy efficiency considerations in mind, a large part of the BACT review process should be an exercise in documenting the efficiency of the selected design. Investments in energy efficiency that many designers would consider routine for a state-of-the-art facility should be highlighted in the public record for their beneficial aspects.

Step 5: Select BACT

After the elimination of technically infeasible control strategies, and the subsequent ranking of remaining options based on control efficiency, and environmental, economic and energy effectiveness, a final list of control options for the project should result. Of the remaining options, the control strategy offering the greatest reductions should be selected as BACT.

In the PSD guidance document, EPA stated that whenever possible it is best to establish a proposed BACT limit, particularly an efficiency limit, on a per-unit of output basis. EPA established a preference for such limits in the PSD guidance, so that similar facilities of different size within a same industry might be compared on a similar basis. When proposing such an output-based limit, such as units of energy per unit of production, a facility should propose them with an averaging time that allows for a long-term rolling average, such as 12 months.

Conclusive Summary

Developing a BACT analysis for emissions of GHG may appear to be a daunting task from the beginning, due to the general lack of current permitting decisions or available control technologies. However, the combination of existing EPA guidance and practical experience may provide a basis for establishing an appropriate BACT determination. Applicants for PSD permits containing should keep the following techniques and strategies in mind when building a BACT analysis for CO_2e emissions:

- When establishing a baseline period of actual emissions for testing the actual-to-projected actual emissions increase against PSD thresholds, be sure that past emissions are calculated in a consistent manner with future emissions estimates. The global warming potential factors published by EPA in the Mandatory Reporting Rule should be used as a default.
- For new projects that will be large CO_2 emitters, be sure to include carbon capture and storage control as an available technology under Step 1 of the top-down process. Although this technology does not have an establish track record in a commercial setting, and may not be technically feasible at the project site, failure to include this control option is likely to result in adverse comments from both the public and EPA.
- When evaluating the technical feasibility of CCS control options, document the availability of reservoirs with the potential for enhanced oil recovery projects which are located very near to the project site. This form of dedicated CO_2 sequestration has the most established track record so far for this technology.
- Applicants should be careful that their permits do not include requirements to dispose of captured CO_2 through a third-party pipeline. As a voluntary control scheme this option may be very attractive. However, when CO_2 disposal with a for-profit entity is required for permit compliance, it raises a host of contractual, economic and liability concerns which are likely to make the strategy untenable.
- An application should include a thorough documentation of process and equipment design features which promote energy efficiency over traditional methods. This effort should focus on equipment with large energy demands, and benchmark the design or equipment against industry norms.

- When proposing a specific and measurable emissions limitation for the BACT control strategy that is selected, sources should make output-based standards their preferred standard. Measuring energy efficiency on a per unit of production basis allows the process flexibility to scale up or down. The use of rolling averages to determine compliance with this metric have been endorsed by EPA in the currently available guidance.