Assessing and Controlling Emissions of Greenhouse Gases: A Pragmatic Perspective for the Oil and Gas Industry

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ABSTRACT

With last month's decision by California to begin to assess and regulate emissions of greenhouse gases, a whole new specter of environmental regulations may be casting its shadow over the oil and gas industry.

The purpose of this paper is to provide a pragmatic look at the recent California decision and similar initiatives being developed in other cities, States, and at the Federal level. The focus of the paper will be on the potential impact of these regulations on a representative oil and gas operation. Included in this presentation will be an assessment of different approaches for calculating emissions of greenhouse gases, an overview of such emissions for the oil and gas industry relative to other pollutant sources and a review of the issues involved in controlling and reducing these emissions in the future.

INTRODUCTION

The recent decision by California to begin to assess and regulate emissions of greenhouse gases can be interpreteed by some as a radical departure in legislation in the United States, where the focus is not on an exposure that will result in immediate danger to our nations residents, but to the long-term impact of releases on a future generation. However, such a legislation more likely represents the culmination of continuing concerns over the releases of Greenhouse Gases into the atmosphere.

With the potential impact of GHG controls within the United States growing, it is important to review the impact of upcoming regulatory interest on the Oil and Gas Exploration and Production Industry, and how such controls might affect continuing operations.

It is not the function of this paper to revisit all of the extensive efforts that have focused on grenhouse gas issues, but, rather, to try and place the available information into perspective as it relates to the oil and gas industry.

Greenhouse Gases

There are a number of chemicals that are classified as greenhouse gases, but the most important are carbon dioxide CO_2, nitrous oxide (N_2O), methane,(CH_4) and the class of compounds known as chlorofluro hydrocarbons, such as Sulfur Hexafluoride (SF_6). It is recognized that the greenhouse gas potential varies with the chemical.

The Global Warming Potential (GWP) represents the radiative effect resulting when the gas itself absorbs radiation (direct effects) or when it transforms into a chemical that does (indirect effect). It is presented as a ratio of the radiative effect of that gas relative to that of carbon dioxide. See Table 1. So from a Global Warming Potential perspecitve one ton of emissions of methane would be equivalent of 21 tons of emissions of carbon dioxide[(1)] .

Oil and Gas Production

Figures 1 and 2 present a summary of the oil and gas production for the nine top oil and gas producing states for 2004[(2, 3)]. These are Alaska, California, Colorado, Kansas, Louisiana, New Mexico, Oklahoma, Texas and Wyoming. So, when considering legislation by states associated with greenhouse gases, the activities of these states would be paramont.

STATE PROGRAMS

History/Politics/Legislation/Future

California's AB-32 signed by Governor Schwarzenegger on September 27, 2006 once again put the Sunshine State in the forefront of environmental protection. The bill, mentioned favorably by Tony Blair, New York Governor George Pataki, and Japanese Prime Minister Junichiro Koizumi requires a 25 percent reduction in carbon dioxide emissions by 2020 which effectively caps CO_2 emissions at 1990 levels. The bill includes provisions for achieving CO_2 reductions through market mechanisms as well as technology.

The CO_2 trading market is not new; seven Midwestern states are members of the Midwest Greenhouse Gas Registry, a program for voluntary CO_2 trading and nine northeastern states comprise the Regional Greenhouse Gas Initiative[1] or RGGI, formed in 2003, which uses a cap-and-trade system to reduce carbon dioxide emission from power plants.

In 2004, fifteen climate change bills were passed in eleven states. The bills' flavors varied: research, renewable energy portfolios, mobile sources regulation and CO_2 registries, but all were aimed at addressing greenhouse gases including CO_2. In 2005, despite the Federal silence on CO_2 regulation, 28 states had Climate Action Plans in place.

States like California, Washington and Oregon have begun to make head roads into CO_2 emissions control with established legislation capping emissions. California is in the process of convincing adjacent states and Mexican states that they should follow suit. Meanwhile, Texas, Wyoming and Utah are adopting a "wait and see" attitude.

At the Federal Level, the 2005 Energy Bill avoids any mention of climate change or greenhouse gas controls, the 2002 Climate Change Initiative sidesteps controls, the McCain-Lieberman Climate Stewardship Act aimed at capping power plant CO_2 emissions was defeated in 2003, and the US EPA does not regulate CO_2. However, the EPA's position has been challenged and is being challenged again at this time. In 1999 twelve states and three cities sued the US EPA claiming it had the authority and obligation to regulate CO_2. The EPA claimed the Clean Air Act did not give it the authority to regulate CO_2, and because CO_2 is not a pollutant with known health hazards, it does not fall under the Clean Air Act's purview. The EPA won the case in 2003 and a court of appeals upheld the decision in 2005. In August 2006, twelve states and ten environmental groups filed again(4). These were Massachusetts, California, Connecticut, Illinois, Maine, New Jersey, New Mexico, and New York, Oregon, Rhode Island, Vermont, and Washington. Later, Arizona, Iowa, Minnesota, Wisconsin, Maryland, and Delaware--also joined in the lawsuit against EPA as have two electric utility companies, Calpine and Entergy Corp.

The Supreme Court will hear the case and is expected to render a decision in the Spring of 2007. Ten states joined the suit in support of the EPA's decision not to regulate greenhouse gases on the Federal Level. These were Alaska, Idaho, Kansas, Ohio, Michigan, Nebraska, North Dakota, South Dakota, Texas, and Utah

[1] Currently New York, Connecticut, Delaware, Maine, Massachusetts, New Hampshire, New Jersey, Rhode Island and Vermont. Maryland is slated to join in 2007.

When the EPA won its case not to regulate CO_2 in 2003, the scientific community was still relatively divided over the validity of global warming. Since that time, scientific inquiry has intensified and additional data appears to make the case for global warming stronger. The role of CO_2 in global warming is, by some accounts, much clearer now than a few years ago. The world-wide scientific community is less divided over global warming and management of greenhouse gases is becoming a focus of environmental and energy policies throughout the industrialized nations.

Emissions markets, which include CO_2 trading, are already in place in the European Union where CO_2 emissions are regulated and trading is not voluntary. The Kyoto Protocol, rejected by the US in 2001, was ratified by Russia in 2004 and became an official international policy in February 2005. The Kyoto Protocol requires industrialized nations to reduce CO_2 emissions by 10 percent of 1990 levels by the year 2012. European oil and gas companies are already addressing CO_2 emissions through technology as well as trading. The Norwegian company Statoil, has been injecting one million tons of CO_2 generated annually by its Sleipner off-shore platform back into the seafloor. They have avoided paying $53 million each year in taxes on CO_2 emissions. "Sequestration" of CO_2 is well proven and is used in the US to enhance oil recovery from waning fields, and as a CO_2 disposal method.

At present, power plants are currently the largest stationary source emitter of CO_2 comprising one third of all CO_2 emissions in the US. In an effort to get into the barn before the door shuts, utilities have accelerated their plans for building power plants to meet future electricity demands, According to some estimates, as many as 120 coal-fired power plants are currently on the drawing board nationwide. The demand for electricity is anticipated to increase nearly 50 percent over the next 25 years.

Yet, even without regulatory pressure, emissions from coal-fired power plants are being scrutinized and criticized by environmental groups, who have exercised some clout during the permitting process. For example, the Western Resource Advocates, in its attempts to fight Excel Energy's Pueblo Colorado plant, ended up settling out of court with the provision that Excel agree to account for the cost of global warming due to greenhouse gas emissions in its resource acquisition decisions.

The competition for power generation will be between renewables and natural gas. Wind, ethanol, biodiesel and even solar are currently receiving significant attention, funding, grants, and private investment. If greenhouse gas control continues to climb in national and global concern, then those options with the lowest CO_2 emissions will grow the fastest. The Bush administration, in May 2006, discussed an "Advanced Energy Initiative" which addresses the same four aspects of energy generation as the 2005 Energy Bill: nuclear power, research and development for cleaner coal burning plants, liquefied natural gas and renewable sources. The initiative also offers to "work… to boost oil and gas supplies to relieve high gas prices" through refinery permit streamlining, and increased off-shore drilling. While the initiative does not address climate change, its content implies that the US cannot continue to increase fossil-fuel based power sources with complete disregard for greenhouse gas emissions.

So what to watch for? Most of the oil and gas producing states have yet to actively participate in the greenhouse gas discussions. California and New Mexico have joined the lawsuit to require EPA to develop regulations of CO_2, while Texas and Kansas are supporting EPA in that lawsuite. The Supreme Court's decision on whether EPA can or cannot regulate CO_2 will be an important milestone in greenhouse gas emissions management in the US. Regardless of whether the EPA

regulates CO_2 emissions, the emphasis by state regulators and the Whitehouse on producing a larger percentage of our power through renewable sources and clean-burning power plants is being heard throughout the power producing industry.

GREENHOUSE GAS EMISSIONS

Emission Categories

The EPA has been preparing an annual summary of greenhouse gas emissions for a number of years. These reports present a relative comparison of the various sources to greenhouse gas emissions. Figure 3 presents a summary of the major sources of greenhouse gases between 1990 and 2004. Overall, emissions of CO_2 from fossil fuel combustion represent nearly two-thirds of the total emissions of greenhouse gases, up from 61 percent in 1990. Several categories have been combined in this representation. Coal mining includes active and inactive coal mines, Livestock includes both Enteric Fermentation and manure management, and natural gas systems include natural gas lines and petroleum systems.

Oil and Gas Operations

Greenhouse gas emissons from oil and gas operations, (essentially methane) decreased from 161.4 Tg (as CO_2) to 145 Tg, which is a reduction from 2.1 % of the total to 1.7 %. A further breakdown of the methane emissions from natural gas operations are summarized in Figure 4, while Figure 5 shows a similar distribuion of methane emisisons from petroleum prodction field operations.

Reductions in Greenhouse Gas Emissions

There are 10 potential sources of pollutants which may be generated in the exploration and production industry[5]: (*1*) unreacted raw materials; (*2*) impurities in the reactants; (*3*) undesirable by-products; (*4*) emissions from auxilliary equipment, such as engines and boilers; (*5*) off-spec product; (*6*) maintenance, ie, wastes and materials; (*7*) exhausts generated during start-up and shutdown; (*8*) exhausts generated from process upsets and spills; (*9*) exhausts generated from product and waste handling, sampling, storage, and treatment; and (*10*) fugitive sources.

There are two broad strategies for reducing emissions from a production facility[6]: (*1*) altering the design, operation, maintenance, or manufacturing strategy so as to reduce the quantity or type of air emissions produced, or (*2*) installing after-treatment controls to destroy or dispose of the pollutants in the generated air emission stream. As an example, in the first case, special efforts could be made to reduce the releases of methane containing gases during start-ups and shut-downs, maintenance or upsets. In the latter case, more of these gases would be sent to a flare, where they would be converted to CO_2.

Natural Gas Star Program

There have been extensive efforts focused on reducing the releases of greenhouse gases from oil and natural gas operations. Since 1995, the EPA with support from a number of trade associations has been assisting companies in assessing emisison reduciton opportunities through the Natural Gas Star Program[7]. Through this program guidance has been provided on calculating and controlling emissions and sharing experiences between facilities. Initially the emphasis of the program was focused on such sources of emissions as releases from well heads, losses from start-ups and shut-down and from upsets and spills. Through this program a significant reduction in methane emissions from natural gas operations has been achieved. The reductions through 2004 are summarized in Figure 6. Again, the largest reductions were from the natural gas production and transmission & storage sectors. The reductions from gas processing operations were much more modest.

Representative Natural Gas Processing Plant

The greenhouse gas emissions from a representative oil and gas processing plant were also estimated. This plant processed some 5.5 billion cubic feet of gas per year, and generated some one million bbls of liquids annually. The gas stream contained some 8 percent CO_2, which is reduced down to 3 percent before distribution. The plant contained boilers and heaters totalling some 60 MMbtu/hr, and ten engines that consumed some 55 mmcf/yr. The site includes a dehydrator as well as the amines plant. The emissions of presently regulated air pollutants are less than 100 tons per year, making this site a minor source of air emissions.

Figure 7 presents a summary of the calculated emissions of CO_2 and CH_4 for this facility[8, 9, 10]. The methane emissions total some 1300 tons per year, which is more than three times that of the regulated pollutants (NO_x, CO, SO_2, VOC, PM) combined. But, the CH_4 emissions are dwarfed by the emissions of CO_2, which totalled nearly 50,000 tons per year. When considering that the GWP of CH_4 is 21 tines greater than that of CO_2, the relative contribution as greenhouse gases of these emissions becomes more comparable.

An examination of the sources of these emissions (Figure 8) indicates that the the CO_2 emissions come primarily from combustion, and from the scrubbing operation in the amines unit. The CH_4 emissions are released in the tank battery (including flash emissions) and from auxilliary uses of the natural gas in the process, such as in pneumatic devices.

Some significant efforts at this facility were initiated to reduce the emissions of methane. In particular, the tank battery emissions were controlled, and the use of methane in the pneumatic devices curtailed and replaced with air.

With these modifications, emissions of CH_4 were reduced by nearly 80 %, and the total GWP reduced by 30% (Figure 9 and 10). However, to reduce the GWP of this facility further the CO_2 emissions would need to be curtailed, either by eliminating or modifying the combustion sources or by capturing the CO_2 released from the amines unit. Such emissions, if captured, would need to be sequestered.

CO_2 Sequestration

Executives at utility companies intent on building power plants and the Electric Power Research Institute are well aware of the global and now national move toward CO_2 regulation and have secured funding from congress for CO_2 sequestration at a demonstration plant called FutureGen. The utility industry knows that more expensive technologies such as coal gasification and circulating fluidized bed, which emit relatively low amounts of CO_2, may become the necessary options, making the cost to generate electricity from coal comparable to that of generating electricity from natural gas at current prices. Utilities at a local level have acknowledged that greenhouse gases need to be controlled and are taking action to meet what they view as inevitable national regulations. One such move was headed by the Colorado Springs Utilities department who have begun formation of a coalition of municipal utilities from Texas, Florida and Georgia to lobby Congress on the regulation of CO_2.

The result of pressure on coal-fired power plants to reduce CO_2 emissions, combined with the renewable energy bent of most State's Climate Action Plans puts renewables and natural gas at the forefront of preferred power generation options. Oil and gas companies are well ahead of the curve on sequestration. CO_2 injection to enhance oil recovery has been conducted since the 1970's. In 2004, the depleted South Liberty oil field near Dayton Texas received 1,600 tons of CO_2 at a depth of 5,000 feet. Kinder Morgan reportedly pipes 1 billion cubic feet per day of CO_2, much of it from Colorado to West Texas oil fields. Part of the cost of CO_2 sequestration revolves around its transportation. Solutions to this dilemma include construction of pipelines dedicated to CO_2 transportation, identifying reservoirs amenable to sequestration, and strategic location of power plants to take advantage of mapped reservoirs.

CONCLUSION

Reductions of greenhouse gases in the oil and gas industry may be looming on the horizon, either voluntarily, or at through regulations at the state or federal level. Over the short term, it appears that reductions of more than 10 percent of greenhouse gases can be achieved through control of methane releases. However, pragmatically, over the long haul, controls of CO_2 will need to be considered. With sequestration of captured CO_2 being the most likely option.

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11.

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Gas	GWP
CO2	1
CH4	21
N2O	310
SF6	23,900

Table 1: Global Warming Potential of Representative Greenhouse Gases Relative to Carbon Dioxide

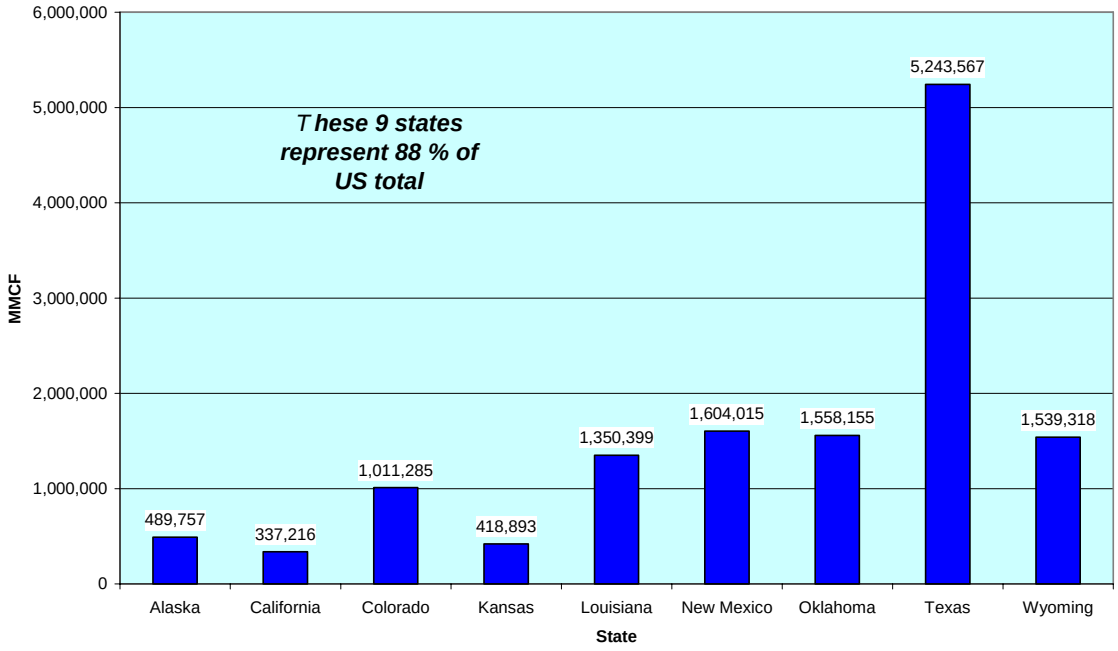

Figure 1: Annual US Production of Natural Gas -- 2003

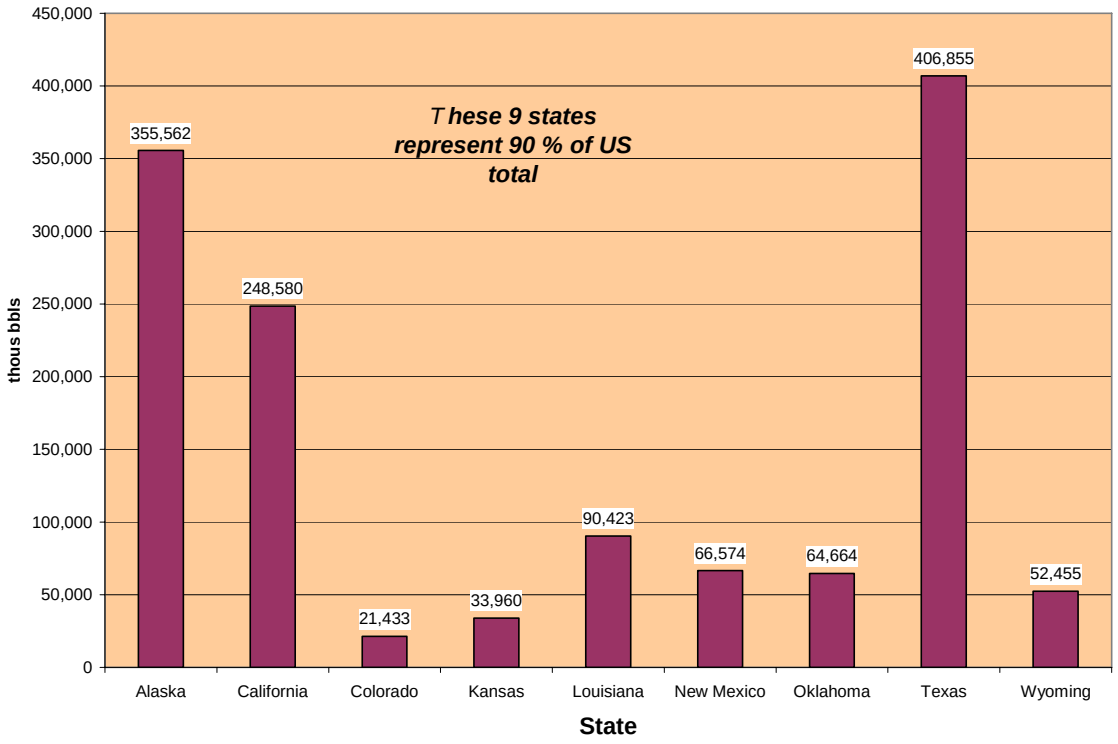

Figure 2: Annual US Production of Crude Oil --2003

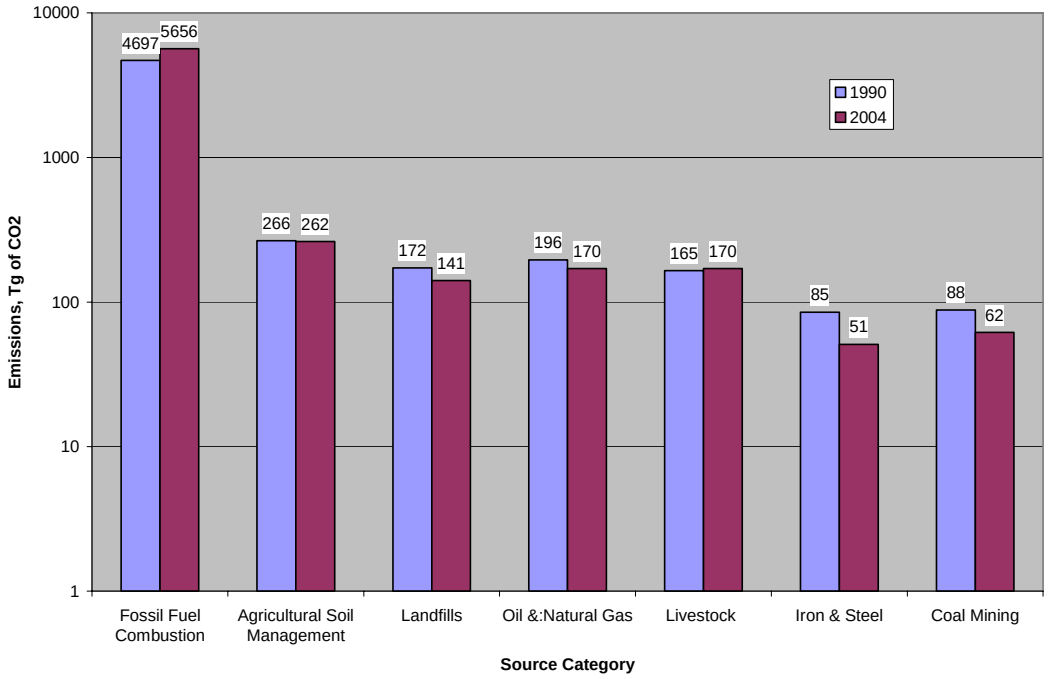

Figure 3: US Emissions of Greenhouse Gases, 1990 & 2004

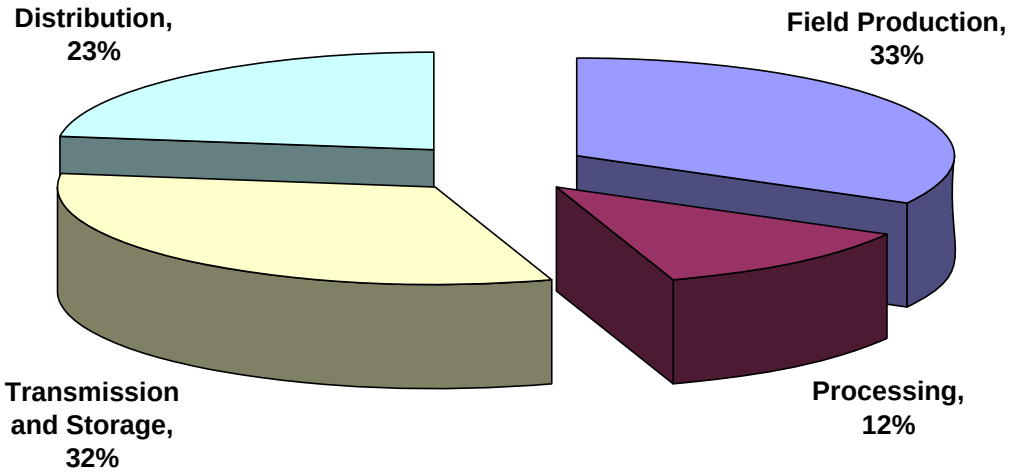

Figure 4: Distribution of Methane Emissions From Natural Gas Operations

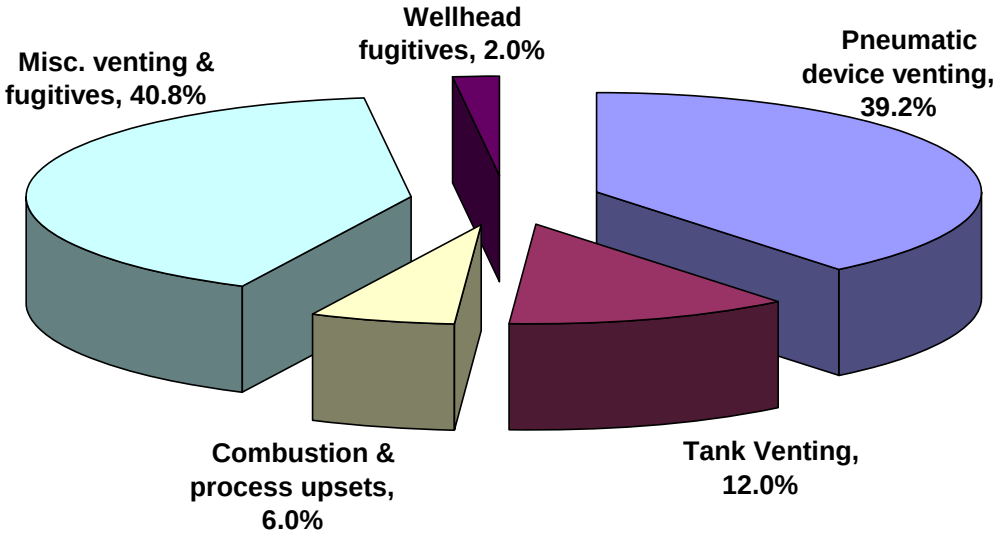

Figure 5: Methane Emissions From Petroleum Production Field Operations

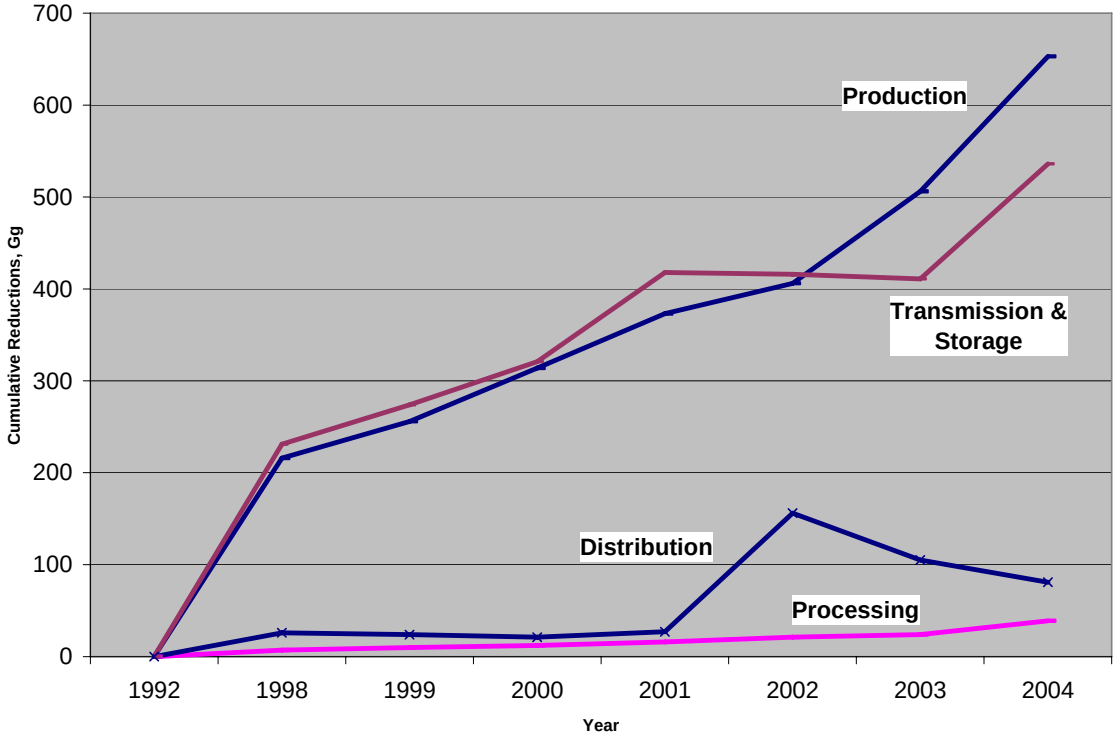

Figure 6: Methane reductions derived from the Natural Gas STAR program (Gg)

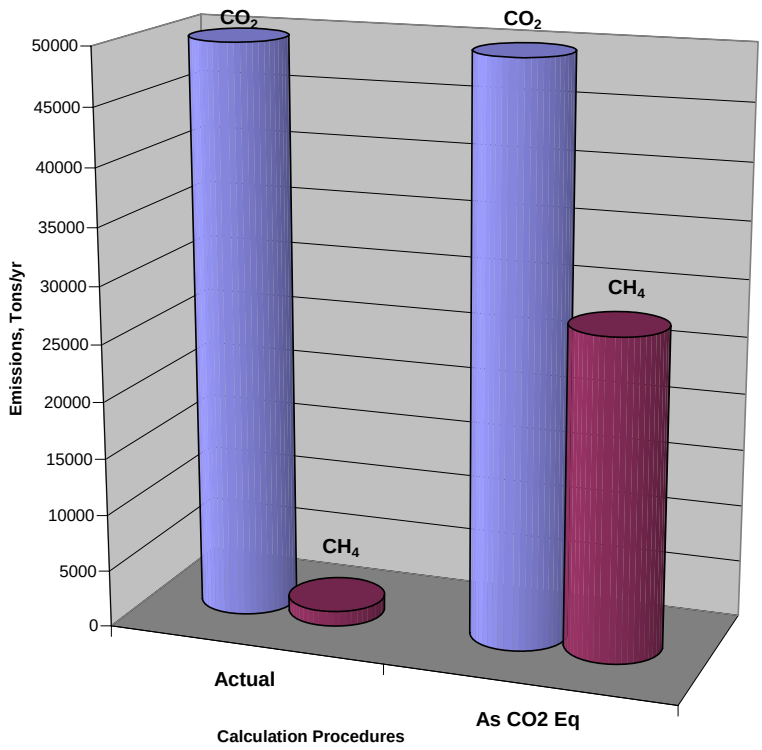

Figure 7: Total Emissions of Greenhouse Gases from Representative Gas Processing Facility

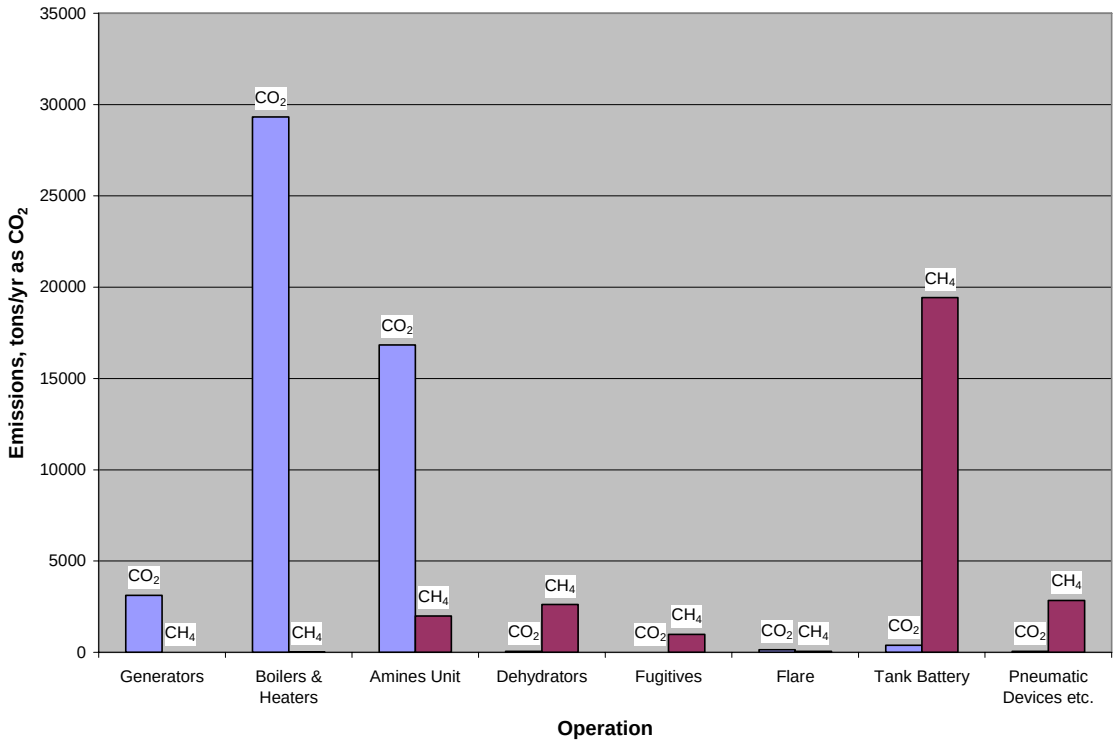

Figure 8: Distribution of Greenhouse Gas Emissions from Representative Gas Processing Plant

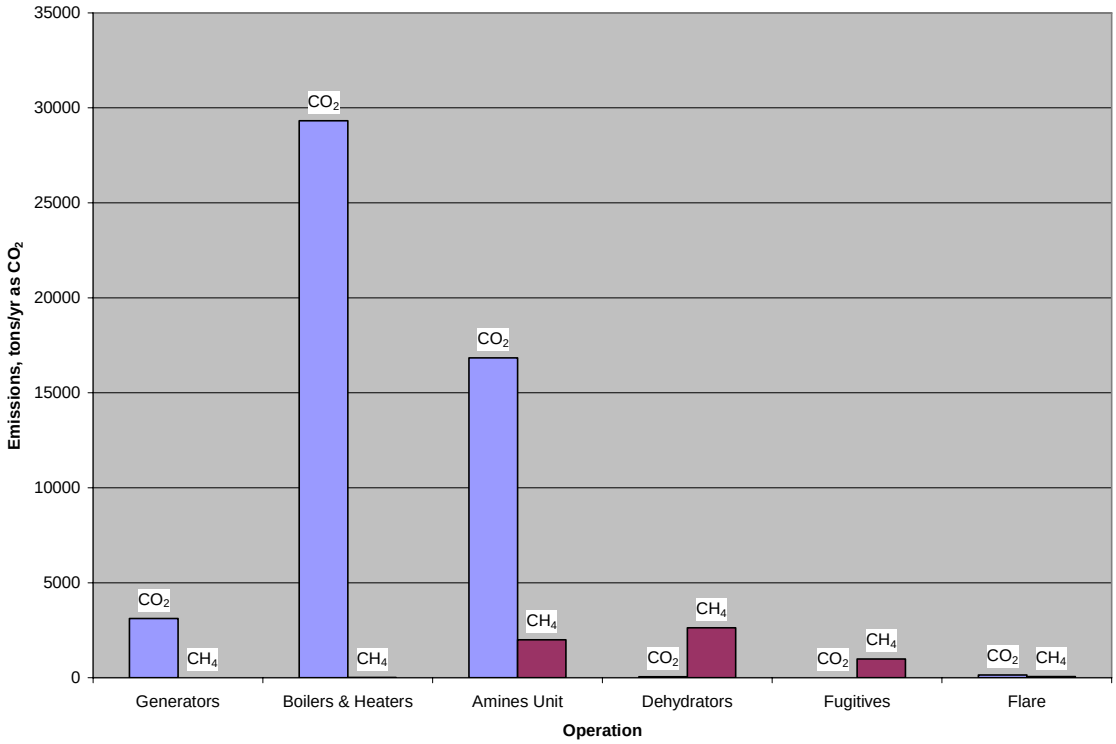

Figure 9: Greenhouse Gas Emissions from Representative Gas Processing Plant After Methane Controls

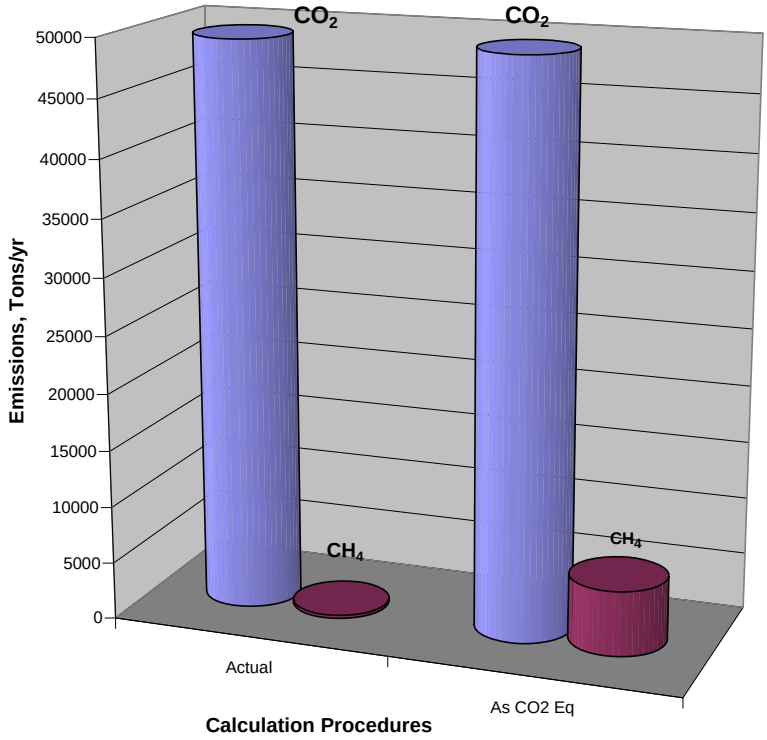

Figure 10: Total Emissions of Greenhouse Gases from Representative Gas Processing Facility, after Methane Controls