

GAO

Report to the Honorable Jeff Bingaman,
Ranking Minority Member, Committee on
Energy and Natural Resources, U.S.
Senate

July 2004

NATURAL GAS FLARING AND VENTING

Opportunities to Improve Data and Reduce Emissions



G A O

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Highlights of [GAO-04-809](#), a report to the Honorable Jeff Bingaman, Ranking Minority Member, Committee on Energy and Natural Resources, U.S. Senate

Why GAO Did This Study

Since 1995, the average price of natural gas in the United States has almost tripled as demand has grown faster than supply. Despite this increase, natural gas is regularly lost as it is burned (flared) and released into the atmosphere (vented) during the production of oil and gas. GAO was asked to (1) describe flaring and venting data and what the federal government could do to improve them; (2) report, on the basis of available information, on the extent of flaring and venting and their contributions to greenhouse gases; and (3) identify opportunities for the federal government to reduce flaring and venting.

What GAO Recommends

GAO recommends that the Secretary of Energy consider opportunities to improve data on flaring and venting. In addition, GAO recommends that the Secretary of the Interior consider regulatory changes for federal leases to reduce the most harmful emissions from flaring and venting and to improve oversight.

In commenting on the report, the Department of Energy and the Department of the Interior generally agreed with our findings and recommendations.

www.gao.gov/cgi-bin/getrpt?GAO-04-809.

To view the full product, including the scope and methodology, click on the link above. For more information, contact Jim Wells at (202) 512-3841 or wellsj@gao.gov.

NATURAL GAS FLARING AND VENTING

Opportunities to Improve Data and Reduce Emissions

What GAO Found

U.S. and global data on natural gas flaring and venting are limited. First, the Department of Energy's Energy Information Administration (EIA) collects and reports data voluntarily provided by oil- and gas-producing states. Because EIA has no authority to require states to report, some do not, leading to incomplete data. Second, EIA has provided limited guidance to states to promote consistent reporting. As a result, only about one-fourth of the states reporting provide data that EIA considers consistent. Third, the data EIA collects do not distinguish between flared gas and vented gas—an important distinction since they have dramatically different environmental impacts. Data on flaring and venting outside the United States are also limited, since many countries report unreliable data or none at all. To improve data on flaring and venting, EIA could use its authority to collect data directly from oil and gas producers; to obtain more consistent data, EIA could improve its guidelines for reporting. From an environmental perspective, EIA, the Minerals Management Service, and the Bureau of Land Management could require flaring and venting data to be reported separately from each other. Globally, the federal government could set an example by continuing to improve U.S. data, continuing to support global efforts, and using U.S. satellite data to detect unreported flaring.

On the basis of the limited data available, the amount of gas emitted through flaring and venting worldwide is small compared with global natural gas production and represents a small portion of greenhouse gas emissions. Nevertheless, flaring and venting have adverse environmental impacts and result in the loss of a significant amount of energy. Annually, over 100 billion cubic meters of gas are flared or vented worldwide—enough to meet the natural gas needs of France and Germany for a year. While flaring and venting do occur in the United States, less than 1 percent of global production is flared and vented.

Opportunities exist in several areas to help reduce flaring and venting, both in the United States and globally. For example, exploring ways to address market barriers affecting associated gas could help identify approaches to reduce global flaring and venting.

Worldwide Flaring Identified Using Satellite Technology



Source: National Oceanic and Atmospheric Administration.

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Abbreviations

BLM	Bureau of Land Management
DOE	Department of Energy
DOI	Department of the Interior
EIA	Energy Information Administration
EPA	Environmental Protection Agency
FERC	Federal Energy Regulatory Commission
GGFR	Global Gas Flaring Reduction Partnership
IEA	International Energy Agency
LNG	Liquid Natural Gas
NOAA	National Oceanic and Atmospheric Administration
mmBtu	million British thermal units
MMS	Mineral Management Service
USAID	U.S. Agency for International Development

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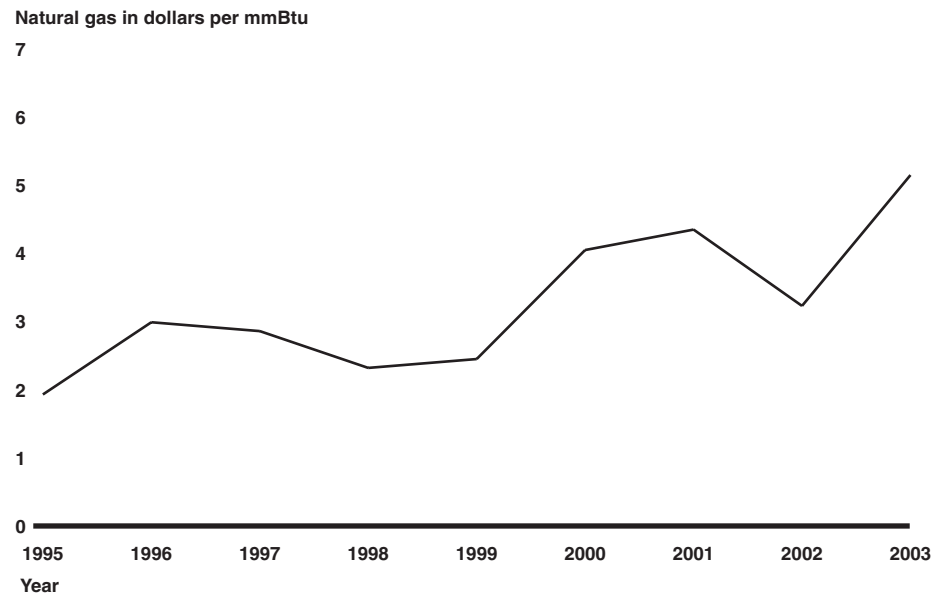
July 14, 2004

The Honorable Jeff Bingaman
Ranking Minority Member
Committee on Energy and Natural Resources
United States Senate

Dear Senator Bingaman:

Since 1995, the average price of natural gas in the United States has almost tripled as demand has grown faster than supply. Natural gas prices increased from \$1.93 per million British thermal units (mmBtu) in 1995 to \$5.15 per mmBtu in 2003—an average annual rate of increase of over 13 percent (see fig. 1).¹

Figure 1: U. S. Natural Gas Prices, 1995-2003



Source: GAO analysis of industry data.

Note: Dollars are adjusted for inflation.

¹Henry Hub natural gas prices adjusted for inflation in 2002 dollars. Henry Hub is one of the largest natural gas market centers in the United States. Its price often serves as a benchmark for wholesale natural gas prices across the country.

Despite this increase in its price, natural gas is regularly burned and released into the atmosphere during the production of oil and gas. While the exact amount of gas lost in this way is uncertain, given the vast extent of oil and gas production throughout the world, it could be significant. In addition to resulting in the loss of a potentially valuable resource, the burning and release of natural gas into the atmosphere contribute to greenhouse gas emissions, which are generally considered to be warming the earth's atmosphere.

Although most natural gas production involves extracting gas from wells drilled into underground gas reservoirs, some natural gas is generated as a by-product of oil production. Gas produced during oil production is called associated gas. During oil and gas production, it may be necessary to burn or release natural gas for a number of operational reasons, including lowering the pressure to ensure safety. Burning natural gas is known as flaring, while releasing natural gas directly into the atmosphere is called venting. In addition to the operational reasons for flaring and venting, in areas where the primary purpose of drilling is to produce oil, producers flare or vent associated natural gas because no local market exists for the gas and transporting it to a market may not be economically feasible.² Natural gas prices are a major determinant of whether associated gas is flared and vented or sold. Associated natural gas would be sold if prices were high enough over a long enough period to justify building the infrastructure—pipelines and ports—to transport the gas to a market. In the United States, there are well-developed natural gas markets and infrastructure to reduce the flaring and venting of associated natural gas. However, in parts of the world like Africa and the Middle East, where the natural gas market and infrastructure for transporting gas are not as well-developed, flaring and venting are generally more prevalent. With increases in natural gas prices, some countries have recognized the potential of increasing exports to high-demand countries like the United States using liquefied natural gas (LNG) technology. These countries liquefy the natural gas and transport it in specially designed tanker ships to the United States and other countries. When the liquefied gas arrives at an import facility, the liquid is returned to a gaseous state and transported to a market.

²Natural gas may sometimes be reinjected into the ground for possible future use as an alternative to flaring or venting. Reinjection can be more costly than flaring and venting, but in some cases it may enhance oil recovery by increasing pressure in the reservoir.

Although gas is sometimes flared or vented because it has too little economic value to justify its capture, flaring or venting this gas into the atmosphere has an environmental cost. In general, flaring emits carbon dioxide, while venting releases methane.³ These and other chemical compounds found in the earth's atmosphere create a greenhouse effect. Under normal conditions, when sunlight strikes the earth's surface, some of it is reflected back towards space as infrared radiation or heat. Greenhouse gases such as carbon dioxide and methane impede this reflection by trapping heat in the atmosphere. Methane is 23 times more potent than carbon dioxide in its ability to warm the atmosphere. While these gases occur naturally on earth and are emitted into the atmosphere, the expanded industrialization of the world over the last 150 years has increased the amount of emissions from human activity (known as anthropogenic emissions) beyond the level that the earth's natural processes can handle. Scientists generally agree that these increased greenhouse gases are contributing to global warming, which can have detrimental effects on the climate. In general, the environmental costs of flaring and venting are not borne by the responsible parties because there are no restrictions on greenhouse gas emissions. However, nations have proposed international agreements to limit greenhouse gas emissions, including those released during flaring and venting.

Numerous federal agencies have a role in oil and gas production and its emissions' impact on the environment. The Department of Energy's (DOE) Energy Information Administration (EIA) is the federal agency responsible for providing energy information to meet the needs of the public, the federal government, industry, and the Congress for making policy, fostering efficient markets, and improving public understanding. DOE has also provided funding support to a World Bank public-private partnership to reduce global gas flaring. The Environmental Protection Agency (EPA) has responsibility for monitoring and reporting on a wide range of environmental issues, including greenhouse gases such as carbon dioxide and methane. The Department of the Interior's Minerals Management Service (MMS) and Bureau of Land Management (BLM) have responsibility for regulation and oversight of oil and gas leases for offshore federal properties and onshore federal lands, respectively. In general, flaring and

³Besides carbon dioxide, flaring natural gas may emit small amounts of methane and trace amounts of other gases depending on the flare's burn efficiency. Venting methane may also release other hydrocarbons depending on the composition of the gas stream. In addition, due to the composition of the gas—for example when gas contains hydrogen sulfide—flaring may be required to control any associated air quality or human health impacts.

venting are not authorized on these properties except for standard operational reasons. In addition, both agencies require producers to report combined flaring and venting data for federal leases. The Federal Energy Regulatory Commission (FERC) has responsibility for determining public convenience and necessity for interstate transmission of natural gas through pipelines as well as for permitting onshore liquefied natural gas facilities. In addition, the U.S. Coast Guard plays a role in the LNG offshore permitting process. The U.S. Agency for International Development (USAID) supports various projects around the world, including energy projects, in partnership with other countries. The National Oceanic and Atmospheric Administration (NOAA), under the Department of Commerce, uses U.S. satellite technology to, among other things, monitor gas flaring activity around the world.

Regarding natural gas flaring and venting from oil and gas production, in both the United States and the rest of the world, you asked us to (1) describe the data collected and reported on natural gas flaring and venting and what the federal government could do to improve it; (2) report, on the basis of available information, on the extent of flaring and venting and its contribution to greenhouse gases; and (3) identify opportunities for the federal government to reduce such flaring and venting.

To do this work, we obtained currently available data on natural gas production and estimates of flaring and venting in the United States from EIA, MMS, and BLM. We obtained international data from Cedigaz, a French oil and gas industry association that gathers worldwide information on natural gas; the World Bank; the International Energy Agency, an intergovernmental energy policy body; and the United Nations. We determined that all the data we reviewed were sufficiently reliable for inclusion in this report after acknowledging the limitations of these data. We also interviewed officials from EIA, EPA, MMS, BLM, NOAA, USAID, the World Bank, the United Nations, various private corporations and organizations, and state governments regarding data collection and methodologies, quality of the data collected, and reporting practices. In addition, we contacted natural gas-producing states to determine their assessment of the reliability of data they collect and report. We also attended the World Bank Global Gas Flaring Reduction Partnership's Second International Gas Flaring Reduction Conference in May 2004 in Algeria with delegates from numerous other countries concerned about gas flaring and venting. We conducted our work from October 2003 through June 2004 in accordance with generally accepted government auditing

standards. A detailed description of our objectives, scope, and methodology is contained in appendix I.

Results in Brief

Overall, data collected and reported on the flaring and venting of natural gas associated with oil and gas production are limited in several ways. First, although the Department of Energy's EIA has authority to require U.S. oil- and gas-producing companies to report flaring and venting data, according to EIA officials, the agency has not used this authority because it considers these data a relatively low priority. Instead, EIA collects and publishes data provided voluntarily by the states on the amount of natural gas flared and vented. Because EIA has no authority to require states to report—and some do not—EIA data are incomplete and must be estimated by EIA. Compounding this problem, EIA has provided only limited guidance to states to promote consistency in the information that they voluntarily submit. As a result, only 8 of the 32 oil- and gas-producing states that EIA reports on provide data that EIA considers consistent, leaving the agency to estimate the amount of flaring and venting in the other 24 states. Finally, the information available to EIA does not distinguish between gas that is flared and gas that is vented, an important distinction from an environmental perspective because the methane emitted during venting is significantly more potent in its ability to warm the atmosphere than the carbon dioxide emitted during flaring.

Outside the United States, information on gas flared and vented is even more limited. Generally, international reporting is also voluntary. Moreover, there is no single organization responsible for collecting and reporting data. The United Nations requests data as part of its work on climate change, but few countries report meaningful data. EIA reports worldwide as well as U.S. data, but it largely relies on estimates developed by an oil and gas industry association that gathers information self-reported by countries. In some cases, countries do not report the information or report suspect numbers. For example, Russia reports no flaring, even though satellite data analyzed by the National Oceanic and Atmospheric Administration have confirmed significant flaring activity. Also, as with the U.S. data, the global data do not distinguish between the amounts flared and vented. More accurate data would provide a clearer understanding of the extent and location of the problem, as well as a basis for targeted actions designed to both prevent the loss of a potentially valuable resource and reduce harmful emissions into the atmosphere.

The federal government could consider a number of opportunities to improve information on flaring and venting activity, if it deems better data is a worthwhile priority. EIA could improve its guidelines to states for collecting and reporting flaring and venting data, which could provide EIA with more consistent data. EIA could also consider collecting data on flaring and venting directly from the roughly 20,000 domestic oil and gas producers. In addition, from an environmental perspective, EIA, MMS, and BLM could require oil and gas producers to distinguish between the amount of gas flared and the amount vented. On a worldwide basis, the government could set an example for the world by continuing to improve U.S. data. In addition, EIA could work with NOAA to assess the feasibility of using U.S. satellite technology to quantify the volumes of gas flaring around the world and identify the additional resource commitment necessary to obtain the information each year. Finally, the federal government could continue to support global efforts such as the World Bank's Global Gas Flaring Reduction Partnership (GGFR), which, in part, seeks to develop better standards for data.

On the basis of the limited data available, the amount of gas emitted through flaring and venting is small compared with overall natural gas production and represents a small portion of greenhouse gas emissions. Nevertheless, flaring and venting do have adverse environmental impacts and result in the loss of a significant amount of energy. The amount of gas flared and vented annually is conservatively estimated by the World Bank at over 100 billion cubic meters worldwide, or about 3 percent of all gas marketed in the world. While this amount is small in comparison with worldwide totals, it is enough gas to meet the natural gas needs of both France and Germany for a year. Flaring and venting are concentrated in certain parts of the world. According to the World Bank, eight nations account for 60 percent of the estimated natural gas flared and vented: Algeria, Angola, Indonesia, Iran, Mexico, Nigeria, Russia, and Venezuela. Some countries flare and vent most of the associated natural gas they produce. In contrast, EIA estimates that the United States flares or vents about 0.4 percent of its production, representing only 3 percent of the world's total amount of natural gas flared and vented. Within the United States, most of the reported flaring and venting has occurred in the active oil and gas production states of Alaska, Louisiana, Texas, and Wyoming and in the Gulf of Mexico. Regarding worldwide greenhouse gas emissions, flaring and venting is estimated to contribute, respectively, about 4 percent of the total methane emissions and about 1 percent of the total carbon dioxide emissions caused by human activity. Several countries have taken steps to reduce flaring and venting emissions that have the potential of

saving energy resources while reducing greenhouse gases. For example, some countries have imposed requirements on oil and gas producers to eliminate emissions of gas within the next few years.

The federal government has opportunities in several areas to help reduce natural gas flaring and venting. First, to address flaring and venting in the United States, MMS and BLM could consider regulatory changes that would reduce the most harmful emissions associated with flaring and venting and improve oversight of oil and gas production on federal lands and offshore areas leased to producers. Specifically, from an environmental perspective, it may be worth exploring the cost and benefit of requiring producers to flare rather than vent when they must release gas for standard operational purposes—for example, for safety reasons—since flaring is less detrimental to the atmosphere. In addition, while the identification of unauthorized flaring or venting is not commonplace on federal lands and offshore areas leased by oil and gas companies, unauthorized flaring and venting do occur. For example, a major oil and gas producer recently paid a \$49 million settlement for unauthorized flaring and venting that went undetected for several years. Requiring the use of meters to measure gas flared and vented could improve oversight. Second, the federal government could promote programs that identify, and help industry implement, best practices for reducing natural gas emissions. For example, EPA sponsors the Natural Gas STAR program, which, among other things, identifies ways to reduce the need to flare and vent during oil and gas production operations. On a global basis, the U.S. government could investigate market barriers and the public's perceptions of the risks associated with new infrastructure, such as those related to building LNG facilities, which could affect relevant markets. For example, the permit approval process for building an LNG facility in the United States can currently take more than a year. Finally, the federal government could continue to work with other countries and international corporations to reduce flaring and venting.

We are making recommendations to the Secretary of Energy to consider the opportunities to improve data on flaring and venting. We are also making recommendations to the Secretary of the Interior to consider regulatory changes to reduce the most harmful emissions from flaring and venting and to improve oversight for federal leases.

Flaring and Venting Data Are Limited, but the Federal Government Has Opportunities to Improve Them

In the United States, DOE's EIA collects and reports data provided voluntarily by the states on the amount of natural gas flared and vented, but the data are incomplete, inconsistent, and not as useful as they could be from an environmental perspective. Information on gas flared and vented outside the United States is also limited, since international reporting generally is voluntary and there is no single organization that is responsible for collecting and reporting this data. EIA could improve flaring and venting data by enhancing its guidance to states and collecting data directly from oil and gas producers; EIA, MMS, and BLM could also improve data by collecting and reporting data on venting separately from data on flaring. By taking these actions, the federal government could serve as a model for global data collection and reporting. EIA could also investigate improvements in global data collection and reporting by using satellite images and data to better estimate the volume of natural gas flared in other countries and by continuing to support international efforts to improve data.

Data Collected and Reported on Flaring and Venting Are Limited

In the United States, data collected and reported on the flaring and venting of natural gas associated with oil and gas production are incomplete, inconsistent, and not as useful as they could be from an environmental perspective. Regarding the completeness of the data, although MMS and BLM require companies that lease federal lands and offshore areas for oil and gas production to report flaring and venting statistics, EIA does not use its authority to require information on flaring and venting from all other U.S. oil- and gas-producing companies. According to EIA officials, the data on flaring and venting that EIA collects as part of overall oil and gas production data represent a relatively small portion of EIA's energy data reporting program. Since the agency has limited resources, these data are a relatively low priority. As a result, rather than requiring that the estimated 20,000 domestic oil- and gas-producing companies provide flaring and venting data—which would consume considerable resources—EIA collects this information from the oil- and gas-producing states on a voluntary basis. Many states do not provide this information, however, and EIA has no authority to require them to do so. Consequently, EIA's flaring and venting information is incomplete.

In addition to being incomplete, the data the states provide to EIA are also inconsistent. Since flaring and venting data are not a high priority for EIA, the agency has provided only limited guidelines to states to promote consistency in the information that they voluntarily submit. As a result,

only 8 of the 32 oil- and gas-producing states⁴ provide data that EIA considers consistent, leaving EIA to estimate the amount of flaring and venting in the other 24 states. When we asked state officials about EIA guidelines for reporting, officials from 15 states said they were unsure what information EIA wanted and how EIA wanted it presented. Most officials from the states answering our questions about the guidelines thought they needed improvement, and some officials said they would like to participate in developing improved guidelines to ensure that the states would be able to meet EIA's requests.

The data that EIA, MMS, and BLM collect are further limited because they do not distinguish between gas that is flared and gas that is vented. As a result, from an environmental perspective, the information is not as useful as it could be. EIA, MMS, and BLM do not collect separate flaring and venting data because their focus is on the amount of gas produced for the market and not on the gas that is lost through flaring and venting. EPA, on the other hand, considers flared and vented gas in the context of the damage it could inflict on the environment: vented gas emissions (methane), and to a lesser extent flared gas emissions (carbon dioxide), contribute to total greenhouse gases. According to EPA officials, differentiating data on flaring and venting could improve EPA estimates of each gas's contribution to total greenhouse gases in the atmosphere. Because EPA does not collect its own flaring and venting data, however, it must rely on the combined data that these other agencies collect.

EIA believes that the data the states voluntarily provide on production—from which the data on flaring and venting are taken—could be improved as well. In particular, because some states do not report information at all, EIA is considering using its authority to collect information on production directly from natural gas well operators. Toward that end, EIA has published for comment a proposed sample survey of monthly natural gas production in the Federal Register. If the survey were implemented, well operators would be required to provide EIA with production data and the form would include a category for flaring and venting data.⁵ Among other things, EIA has sought comments from well operators as to whether they can provide reliable measures of gas flared and vented. However, even if

⁴EIA does not report information for a 33rd state, Missouri, which produces a small amount of oil and gas.

⁵69 Fed. Reg. 22109 (Apr. 23, 2004).

the proposed sample form is implemented and, as proposed, collects information on flared and vented data, the focus will be on improving production data and not on flaring and venting data.

Outside the United States, information on gas flared and vented is even more limited. Generally, international reporting is also voluntary, and no single organization is responsible for collecting and reporting flaring and venting data. Although several organizations collect data voluntarily provided by countries with which they have a working relationship, the numbers countries report are sometimes questionable. For example, the United Nations requests data as part of its work on climate change, but few countries report meaningful data. In addition to U.S. data, EIA also reports worldwide information largely based on estimates developed by Cedigaz, an oil and gas industry association that gathers what is generally recognized as the best flaring and venting information available. A Cedigaz official told us that they rely on submissions from countries and companies around the world to make their estimates and that they accept the information the countries report unless Cedigaz has knowledge of a country's operations that could be used to improve the accuracy of the amounts reported. For example, on the basis of submissions by Russia and China—two important petroleum-producing countries—Cedigaz has reported that these countries do not flare or vent. World Bank officials told us, however, it is generally known that Russia regularly flares and vents gas. Satellite images created by NOAA have confirmed that Russia does, in fact, participate in flaring. In addition, as in the United States, the global data are limited from an environmental perspective because they do not distinguish between the amounts flared and the amounts vented. More accurate worldwide data would provide a clearer understanding of both the extent to which flaring and venting emissions contribute to total greenhouse gases and the countries that do the most flaring and venting. This would provide a basis for targeting actions designed to prevent the waste of a potentially valuable resource while at the same time reducing harmful emissions into the atmosphere.

The Federal Government Has Several Opportunities to Improve the Information on Flaring and Venting

Federal agencies have a number of opportunities available to them to improve the information on flaring and venting. EIA could clarify its guidelines to states for collecting and reporting flaring and venting data. Currently, EIA assumes that about 75 percent of the reports it receives from oil- and gas-producing states contain inconsistent data. State officials believe that they could better meet EIA's data needs—that is, provide EIA with more consistent data—if they had more comprehensive guidance from

EIA on the data it wants and how to report them. Similarly, as the reporting of greenhouse gas emissions has become more widespread globally, the oil and gas industry has begun to recognize the need for guidance on how emissions, such as carbon dioxide and methane, should be collected and reported. In December 2003, three petroleum industry associations jointly issued a report, "Petroleum Industry Guidelines for Reporting Greenhouse Gas Emissions," to promote consistency in collecting and reporting petroleum industry greenhouse gas emissions. EIA could consider using these guidelines while working with industry and state officials to improve their state guidelines for reporting emissions from flaring and venting of natural gas.

Another opportunity for improving the data is for EIA to consider using its general energy information collecting authority⁶ to collect data on flaring and venting directly from the oil and gas producers, rather than relying on voluntary submissions by states. (Producers with federal leases are already required to collect and report this information to MMS and BLM.) While EIA considers these data a relatively low priority, and while collecting data from all 20,000 domestic producers could involve extensive resources, there may be efficient and cost-effective methods of collecting sample data. In addition, from an environmental perspective, the federal government could broaden the usefulness of flaring and venting information by distinguishing between the amounts of gas flared and the amounts vented. Since natural gas that is vented has a more significant effect on the atmosphere than natural gas that is flared, reporting these emissions separately could enable EPA to better estimate methane's and carbon dioxide's contributions to greenhouse gases.

Finally, on a worldwide basis, the federal government could improve flaring and venting data in several ways. First, the U.S. government could continue to improve its own data, thereby providing an example for other countries. Second, EIA, working with NOAA, could investigate the feasibility of supplementing the data already available by using U.S. satellite images. For example, figure 2 (see p. 14) shows worldwide flaring identified in 2002 using satellite technology. According to a NOAA physical scientist, analyzing these satellite data could validate the amount of flaring reported by countries. For example, some countries, like Russia, report no flaring, while satellite images show substantial flaring is actually occurring. Third, the federal government could continue to support efforts such as the World

⁶15 U.S.C. § 772(b).

Bank Global Gas Flaring Reduction Partnership (GGFR)⁷ that, in part, seeks to develop guidance for data collection and reporting. According to a 2004 GGFR report, such guidance could improve natural gas flaring and venting data.

Although the Amount of Gas Flared and Vented Is Small, It Represents a Significant Amount of Lost Energy and Contributes to Global Greenhouse Gas Emissions

According to the limited data available, the amount of natural gas emitted through flaring and venting is small compared with overall natural gas production, but these emissions represent a significant amount of lost energy. Flaring and venting are concentrated in several parts of the world and, in the United States, in four states and the Gulf of Mexico. Although worldwide estimates of flaring and venting constitute a small portion of total greenhouse gas emissions, many countries have undertaken efforts to reduce flaring and venting.

Three Percent of the World Production of Natural Gas Is Flared or Vented, Which Represents a Significant Amount of Unused Resources

While flaring and venting represent only 3 percent of the total natural gas production, the natural gas flared and vented—about 100 billion cubic meters a year—is enough to meet the annual natural gas consumption of both France and Germany. In general, the amount of flaring and venting emissions is related to the amount of oil produced: the higher the production, the more gas flared and vented. Since 1990, the quantity of oil produced has increased, but because of various global reduction initiatives, the quantity of natural gas flared and vented has remained constant. Consequently, natural gas emissions as a percentage of oil production have decreased.

⁷GGFR is a public-private partnership that in May 2004 included BP, ChevronTexaco, ENI, ExxonMobil, NorskHydro, Royal Dutch Shell, SNH, Statoil, TOTAL, and Sonatrach; and the governments of Angola, Canada, Chad, Ecuador, Equatorial Guinea, Indonesia, Nigeria, Norway, and the United States.

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Figure 2: Worldwide Flaring Identified Using Satellite Technology, 2002

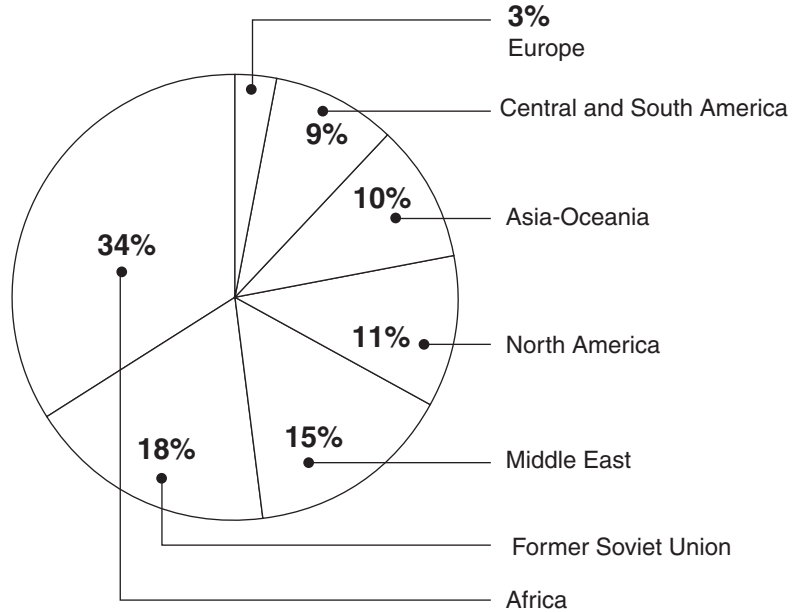




Source: National Oceanic and Atmospheric Administration.

Flaring and venting of natural gas are concentrated in certain parts of the world, with Africa, the Middle East, and the former Soviet Union contributing about two-thirds of the global emissions from flaring and venting (see fig. 3).

Figure 3: Regional Flaring and Venting As a Percentage World Flaring and Venting, 2000



Source: The World Bank.

Working with available data, the World Bank has estimated that three countries—Nigeria (16%), Russia (11%), and Iran (10%)—are responsible for over one-third of global flaring and venting (see table 1).

Table 1: Estimated Gas Flared and Vented by Selected Countries, 2000

Country	Flared gas(bcm) ^a	Percentage of world total (%) ^b
Algeria	6.8	6.0
Angola	4.3	4.0
China	3.2	3.0
Egypt	0.9	1.0
Indonesia	4.5	4.0
Iran	10.5	10.0
Mexico	5.6	5.0
Nigeria	17.2	16.0
North Sea ^c	2.7	3.0

(Continued From Previous Page)

Country	Flared gas(bcm) ^a	Percentage of world total (%) ^b
Russia	11.5	11.0
United States	2.8	3.0
Venezuela	4.5	4.0
Other Countries	33.0	30.0
Total	107.5	100.0%

Source: The World Bank—which included data from Cedigaz, EIA, OPEC, IEA, World Bank, and IHS Energy Group.

Note:

^aBillion cubic meters.

^bPercentages are rounded.

^cNorth Sea includes only Denmark, Norway, and the United Kingdom, since Germany and the Netherlands did not flare in 2000, according to Cedigaz.

According to World Bank estimates, in 2000 eight nations accounted for 60 percent of the natural gas flared and vented: Algeria, Angola, Indonesia, Iran, Mexico, Nigeria, Russia, and Venezuela. In addition, some countries—for example, Angola and Cameroon—flare and vent most of the natural gas they produce. In contrast, EIA estimates that the United States flares or vents about 0.4 percent of its production annually. Within the United States, most of reported flaring and venting has occurred in the active oil and gas production states and in the Gulf of Mexico (see table 2).

Table 2: Estimated U. S. Natural Gas Produced and Flared and Vented, 2002

In millions of cubic feet

State	Gas derived from gas wells	Associated gas from oil production	Total gas produced	Gas flared and vented	Flared and vented gas as percentage of total gas produced
Alaska	194,198	3,283,239	3,477,437	7,312	0.21%
Louisiana	1,282,137	100,324	1,382,461	10,957	0.79
Texas	4,828,188	832,816	5,661,004	27,379	0.48
Wyoming	1,572,728	174,748	1,747,476	12,356	0.71
Gulf of Mexico	3,850,708	858,332	4,709,040	20,092	0.43
All other states	5,999,921	999,945	6,999,866	21,077	0.30
Total	17,727,880	6,248,404	23,977,284	99,173	0.41%

Source: EIA.

Note: EIA reported totals may not equal sum of components due to independent rounding.

Four states—Alaska, Louisiana, Texas, and Wyoming—plus the federal leases in the Gulf of Mexico account for almost 80 percent of all reported U.S. flaring and venting. None of these states flare and vent more than 0.8 percent of their total natural gas production.

Natural Gas Flaring and Venting Emissions Contribute a Small Percentage of Global Greenhouse Gas Emissions, and Countries Have Undertaken Initiatives to Reduce These Emissions

Worldwide flaring and venting is estimated to contribute, respectively, about 4 percent of the total methane and about 1 percent of the total carbon dioxide emissions caused by human activity. Despite these small contributions, several countries have undertaken efforts to reduce flaring and venting emissions that have the potential to reduce greenhouse gases while saving an energy resource. Specifically, many countries have imposed requirements on oil and gas producers to eliminate emissions of gas within the next few years. For example, Norway no longer allows the burning of petroleum in excess of the quantity needed for normal operational safety without the approval of the Ministry of Petroleum and Energy, and in 2003 Canada reported having achieved, through monitoring and regulation, a 70 percent reduction in flaring and venting emissions. In addition, corporations in several countries, in order to market their associated natural gas, either have constructed or are planning LNG plants to liquefy the gas for export or have developed on-site and local uses for the gas. For example, corporations operating in Nigeria currently have six LNG projects in development and have also begun using gas that otherwise would have been flared or vented to operate the platform equipment as well as to produce cement and fertilizer and gas that is usable as fuel for automobiles. Finally, some countries are exploring the potential of reinjecting carbon dioxide into wells instead of emitting it into the atmosphere. According to an oil company official, carbon dioxide reinjection in Algeria has prevented over one million tons of emissions—the equivalent of taking 200,000 cars off the road.

The Federal Government Could Take a Larger Role in Reducing Flaring and Venting

The federal government has opportunities in several areas to help reduce flaring and venting both within the United States and globally. First, in the United States, on federal lands and offshore areas leased to producers, the federal government could consider regulatory changes to reduce the most harmful emissions resulting from venting and improve oversight of oil and gas production. Second, the federal government could promote programs that identify, and help industry implement, best practices for reducing natural gas emissions. On a global basis, exploring ways to address market

barriers affecting associated natural gas, and continuing to work with other countries, could help reduce flaring and venting.

Improving Federal Regulation and Oversight Could Reduce Flaring and Venting on Federal Lands

The government has an opportunity to help reduce flaring and venting in the United States by considering regulatory changes and improving oversight of oil and gas production on federal lands and offshore areas leased to producers. If MMS and BLM required producers to flare gas (rather than allowing them to vent gas) when emitting the gas for operational purposes, the emissions impact on the atmosphere could be reduced. Since the impact of methane (venting) on the earth's atmosphere is about 23 times greater than that of carbon dioxide (flaring), a small change in the ratio of flaring to venting could cause a disproportionate change in the impact of emissions. For example, if 90 percent of the associated gas volume was flared and 10 percent was vented, the amount vented would have more than twice the effect on the atmosphere as the amount flared.

In addition, although MMS and BLM require federal lessees to self-report estimated flaring and venting volumes, the agencies could require the use of flare and vent meters at production facilities, which could improve oversight by detecting how much gas is actually flared and vented. Currently, such meters are used by some oil- and gas-producing companies. The meters are placed in or adjacent to the stream of flared or vented gas to measure the volume emitted. While the identification of unauthorized flaring or venting is not commonplace on federal lands and offshore leases in the United States, unauthorized flaring and venting do occur. A major oil and gas producer recently paid a \$49 million settlement in response to charges of unauthorized flaring and venting in the Gulf of Mexico that went undetected for several years. The lawsuit alleged that the company both improperly flared and vented gas under various offshore federal leases and failed to properly report the flared and vented gas. Improved oversight could help prevent similar problems in the future. The International Energy Agency has recommended such meters for accurately monitoring emissions from production facilities, and some producers that we interviewed said they already use these meters on many of their offshore production facilities. According to these producers, flare and vent meters are fairly inexpensive if installed when the facility is initially built, but

retrofitting facilities that are already producing may not be cost effective.⁸ To improve oversight, MMS and BLM, working with producers, could consider the cost and benefit of requiring the installation of these meters, particularly at new, major production facilities.

Promoting Best Practices Could Reduce Emissions Caused by Flaring and Venting

The federal government could also help reduce flaring and venting by continuing to support programs that identify, and help industry implement, best practices for reducing natural gas emissions. EPA has sponsored the Natural Gas STAR program, which identifies and promotes the implementation of cost-effective technologies and practices that reduce methane emissions. About 65 percent of the U.S. natural gas industry is represented in this program. From 1993 through January 2004, according to EPA officials the STAR program identified over 100 best practices and technologies that reduce methane emissions from the oil and natural gas industry. In addition, STAR participants have reported total emissions reductions of more than 275 billion cubic feet worth over \$825 million—which EPA estimates is enough natural gas to heat more than 4 million homes for 1 year or is comparable to the removal of the emissions of 24 million cars from the nation’s highways for 1 year. The two largest sources of overall oil and gas emissions identified by the STAR program are pneumatic devices and compressors. According to EPA officials, the STAR Program has identified 15 practices and technologies that would reduce methane emissions from these sources.

Investigating Market Barriers Affecting Associated Gas and Continuing to Work with Other Countries Could Help Reduce Global Flaring and Venting

The government could also have an effect on flaring and venting worldwide by (1) addressing market barriers affecting gas produced outside the United States that would otherwise be flared or vented and (2) continuing to work with other countries. First, the government could identify regulatory barriers to economically feasible infrastructure development, such as building pipelines or LNG facilities for transporting gas that is usually flared or vented. For example, currently, four LNG import facilities exist in the United States—three on the East Coast and one on the Gulf of Mexico coast—but more than 15 federal permit applications are awaiting approval (from either FERC or the Coast Guard), which can take more than

⁸For example, industry officials told us that some of the older platforms have limited space, so to add meters would require additional construction, which could be cost prohibitive.

a year.⁹ In addition, the government could investigate the public's perceptions of the risk associated with new infrastructure. For example, some communities have resisted LNG facilities because they are worried about the safety and security procedures in place to protect them from an accidental explosion or a terrorist attack. Finally, the federal government could continue to work with other countries and corporations to reduce flaring and venting. For example, USAID provided much of the funding for training regulators in Kazakhstan, where improved regulation has virtually eliminated the routine flaring of natural gas. In addition, the United States could continue to support the work of the World Bank's Global Gas Flaring Reduction Partnership (GGFR), which recently issued standards on how to achieve reductions in the flaring and venting of gas worldwide.¹⁰

Conclusions

By itself, the reduction of natural gas flaring and venting will not solve the problem of meeting increasing natural gas demands or eliminate all greenhouse gas emissions; however, it would be a helpful step in that direction. Although the emissions from flaring and venting are small in comparison with those from other sources, such as fossil fuel combustion, reducing flaring and venting from oil and gas production would help eliminate harmful emissions and possibly preserve an energy resource that is currently being lost.

Although the role of the federal government in reducing flaring and venting of natural gas during oil and gas production may be limited, especially at the international level, opportunities exist for the government to make worthwhile contributions in this area. Given the immense challenges the government faces in the energy and environmental arenas and the limited resources available, however, any actions to reduce flaring and venting will have to be based on careful consideration of the potential costs and benefits of such actions. Moreover, since flaring and venting are not viewed as major problems in this country, it may be difficult to justify devoting much attention to them. Nonetheless, the government could consider

⁹Three additional facilities were recently approved but have not yet been built. Eleven other projects are in various planning stages. According to DOE officials, streamlined approval procedures require offshore deepwater port terminals to be processed in less than a year by the U.S. Coast Guard and onshore facility permitting is being streamlined by FERC through pre-filing consultations with project proponents to minimize approval time.

¹⁰*A Voluntary Standard for Global Gas Flaring and Venting Reduction* (World Bank: May 2004).

several potentially cost-effective actions that would improve data reporting, help reduce the most harmful effects of flaring and venting, and improve oversight of federal leases.

Improving flaring and venting data reporting would be an important first step because it would add information about the scope of the problem and allow actions to be targeted to those areas where flaring and venting are most significant. However, our review identified several limitations of the data currently reported that hinder such targeting. First, reliance on oil- and gas-producing states to voluntarily provide flaring and venting information has led to incomplete data, since some states do not submit reports. Second, because of the limited guidance on what data to report, EIA considers most of the information it receives from the states to be inconsistent. Third, the data collected do not distinguish between flared gas and vented gas—an important distinction, since the methane emitted during venting is potentially much more harmful to the atmosphere than the carbon dioxide emitted during flaring. Consequently, these combined data are less useful than they could be in shedding light on the extent of methane emitted into the atmosphere during venting. Finally, on a global basis, some countries that flare and vent considerable amounts of gas report that they do not, and others underreport their flaring and venting. For these and other reasons, the worldwide data are considered even less accurate than U.S. data.

In addition, for federal lands and offshore areas leased for oil or gas production, opportunities exist to help reduce the most harmful effects of flaring and venting and improve oversight on these leases. Specifically, although flaring and venting are authorized only under certain circumstances, when these circumstances occur, oil and gas producers may choose to either flare or vent. Since the emissions released during venting are much more harmful to the atmosphere than those associated with flaring, this choice is an important one. Moreover, although flaring and venting are generally not authorized, no oversight mechanism currently exists for routinely monitoring the amount of flaring and venting that actually takes place. As a result, MMS and BLM cannot always be assured that companies are appropriately restricting their flaring and venting.

Overall, however, as is evident in the example of the United States, a robust natural gas market, along with a supporting infrastructure, would have the most significant impact on the reduction of flaring and venting. Therefore, changes to natural gas markets, and to the transportation infrastructure for

moving gas to these markets, will likely be needed to offer producers an economic incentive to sell the associated gas rather than flare or vent it.

Recommendations for Executive Action

We are making four recommendations to the Secretary of Energy to explore opportunities for improving data on flaring and venting and to weigh the cost and benefit of making such improvements. Such opportunities could include

- considering the use of the department's authority to collect flaring and venting information directly from the producing companies;
- working with industry and state officials, and using guidance already in existence, to enhance guidelines for reporting consistent flaring and venting data;
- considering, in consultation with EPA, MMS, and BLM, how to best collect separate statistics on flaring and venting; and
- considering working with the Secretary of Commerce to provide EIA access to NOAA's analysis of satellite data to improve the accuracy of worldwide data on flaring.

We are also making two recommendations to the Secretary of the Interior. Specifically, for federal oil and gas leases, we are recommending that the Secretary direct MMS and BLM to consider the cost and benefit of requiring that companies

- flare the natural gas, whenever possible, when flaring or venting is necessary and
- use flaring and venting meters to improve oversight.

Agency Comments and Our Evaluation

We requested comments on a draft of this report from the Secretaries of Energy and the Interior, as well as the Administrator of the Environmental Protection Agency. The Department of Energy and Department of the Interior provided written responses, including technical and clarifying comments, which we included in our report as appropriate.

The Administrator of the Energy Information Administration (EIA), who responded on behalf of the Department of Energy, concurred with our findings and recommendations while acknowledging that the implementation of the recommendations would need to be balanced with other priorities. EIA stated it has revised the instructions on all natural gas forms and has committed to continue efforts to improve data quality, timeliness and coverage of production data that states collect. Further, EIA agreed to work with agencies with satellite technology to determine the feasibility of improving data worldwide. EIA's comments are reprinted in appendix II.

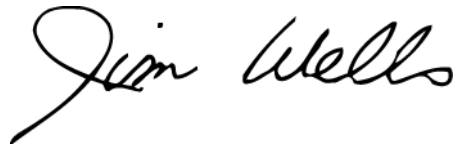
The Assistant Secretary of Land and Minerals Management, who responded on behalf of the MMS and BLM within the Department of the Interior, generally agreed with our findings and recommendations. MMS and BLM agreed that requiring operators to flare instead of vent whenever possible would reduce greenhouse gases. Further, MMS acknowledged that this would enhance the agency's ability to enforce existing regulations because inspectors could easily view a flare; whereas inspectors cannot be detected venting visually and thus they must rely on the accuracy of operators' records. The two agencies also agreed to evaluate the cost effectiveness of installing and maintaining flare tips. In addition, MMS agreed that requiring flaring and venting meters would improve its oversight. MMS acknowledged that recent incidents have shown that reliance on the accuracy of the operators' calculations and recordkeeping may not sufficiently or accurately capture actual flaring and venting volumes. MMS stated that it is currently revising its Federal Outer Continental Shelf regulations to require installation of meters. Finally, MMS agreed that flaring and venting data should be reported separately and has taken initial steps to update its database and reporting requirements to accommodate this change. However, MMS stated that such a change would take time to complete and would only minimally add to the reporting burden of operators. The Department of the Interior's comments are reprinted in appendix III.

EPA provided oral comments and agreed with our findings and recommendations. In addition, EPA noted that our recommendations, if implemented, would greatly advance flaring and venting data availability and quality. EPA also provided technical comments, which we included in the report, as appropriate.

As agreed with your office, unless you publicly announce the contents of this report earlier, we plan no further distribution until 30 days from the date of this letter. At that time, we will send copies of this report to the Secretary of Energy, the Secretary of the Interior, the EPA Administrator, and other interested parties. We also will make copies available to others upon request. In addition, the report will be available at no charge at GAO's Web site at <http://www.gao.gov>.

Questions about this report should be directed to me at (202) 512-3841. Key contributors to this report are listed in appendix IV.

Sincerely yours,

A handwritten signature in black ink that reads "Jim Wells". The signature is written in a cursive style with a large, sweeping initial "J".

Jim Wells
Director, Natural Resources
and Environment

Objectives, Scope, and Methodology

Regarding natural gas flaring and venting from oil and gas production in the United States and the rest of the world, you asked us to (1) describe the data collected and reported on natural gas flaring and venting and what the federal government could do to improve it; (2) report, on the basis of available information, on the extent of flaring and venting and its contribution to greenhouse gases; and (3) identify opportunities for the federal government to reduce such flaring and venting.

To do this work, we obtained currently available data on natural gas production and estimates of flaring and venting in the United States from EIA, MMS, and BLM. We determined that all the data we reviewed were sufficiently reliable for inclusion in this report after acknowledging the limitations of these data. We also interviewed officials from EIA, EPA, MMS, BLM, the World Bank, the United Nations, various private corporations and organizations, and state governments regarding data collection, quality of the data collected, and reporting practices. In addition, we contacted natural gas-producing states to determine their assessment of the reliability of data they collect and report. To determine what the federal government could do to improve data collecting and reporting, we interviewed officials from EIA, MMS, BLM, EPA, NOAA, and state officials. In addition, we obtained international data from Cedigaz, a French oil and gas industry association that gathers worldwide information on natural gas; the World Bank; the International Energy Agency (IEA), an intergovernmental energy policy body; and the United Nations. We discussed with officials of these organizations the reliability as well as the methods of collecting and estimating these data.

Finally, to determine what the federal government could do to help reduce flaring and venting of natural gas, we reviewed the literature and interviewed officials from private industry, MMS, BLM, state governments, EPA's Natural Gas STAR program, USAID, and various world organizations, including the World Bank, the United Nations, and IEA. In May 2004, we also attended the World Bank Global Gas Flaring Reduction Partnership's Second International Gas Flaring Reduction Conference in Algeria with delegates from numerous other countries concerned about gas flaring and venting. This conference featured speakers from countries and corporations around the world who addressed data collection and reporting issues, current regulations and oversight issues, and best practices within their respective countries. We conducted our work from October 2003 through June 2004 in accordance with generally accepted government auditing standards.

Comments from the Department of Energy



Department of Energy
Washington, DC 20585

JUL 02 2004

Mr. Jim Wells
Director, Natural Resources and Environment
United States General Accounting Office
441 G Street NW
Washington, DC 20548

Dear Mr. Wells:

Thank you for providing the Energy Information Administration (EIA) with the opportunity to review and comment on the draft report, *Natural Gas Venting and Flaring: Opportunities to Improve Data and Reduce Emissions*. The report addresses both U.S. and international data series. The report is correct in its statement that there are opportunities to improve natural gas venting and flaring data and to reduce emissions but these opportunities must be evaluated in light of available resources and other priorities.

U.S. Data: The source of venting and flaring data about the United States is information provided voluntarily by State offices rather than directly by well operators. Volumes vented and flared are requested from the States because they represent a decrease in the flow of gas from the wellhead and help to define the concept of marketed production. EIA's goal is to provide energy supply and demand information for decisionmaking and energy markets and other general and analytic purposes. Given limited resources, other larger-volume issues related to energy supply and demand data, and the small (0.4 percent) role of venting and flaring in natural gas supply, the development of better vented and flared data has not been given a high a priority.

The report includes a recommendation that EIA improve its guidelines to the States regarding the data it wishes to collect. In its latest forms clearance effort, EIA revised its instructions to clarify reporting requirements and definitions on all natural gas data forms including the one with production and production-related data submitted by States. Further, EIA currently is working with the Interstate Oil and Gas Compact Commission (an organization of oil and gas producing States that are each responsible for the development and regulation of the oil and gas resources within that State) to improve data quality, timeliness and coverage, of production data collected by the States and subsequently submitted to EIA. We will continue these efforts.

As noted in the report, the Energy Information Administration has recently proposed a natural gas production survey to be completed by well operators for the purpose of improving the timeliness and accuracy of natural gas marketed production. Vented and flared volume was proposed as a possible component of the accounting for gas production. However, several commenters have indicated that they cannot provide



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Appendix II
Comments from the Department of Energy

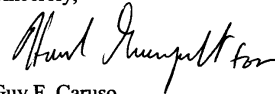
detailed components of the disposition of gross withdrawals and hence it is premature to say whether this series will be part of a future data program.

International Data: EIA does not have a program for collection of venting and flaring data from international well operators or from other countries. EIA relies upon data provided to international agencies. Regarding international data on vented and flared gas, I suggest that the report note that the general availability of global vented and flared data could be enhanced by further efforts by the International Energy Agency and the World Bank to obtain separate statistics for natural gas venting and flaring in foreign countries. EIA does not presently have the expertise or resources to assess satellite imagery, but we may be able to investigate whether agencies which do assess such expertise and resources can provide information about this subject.

EIA will consider the recommendations provided by GAO in light of available resources and all other priorities for possibilities to improve but cannot commit to any specific action at this time.

Editorial comments have been enclosed.

Sincerely,



Guy F. Caruso
Administrator
Energy Information Administration

Enclosure

Comments from the Department of the Interior



United States Department of the Interior

MINERALS MANAGEMENT SERVICE
Washington, DC 20240



JUN 30 2004

Mr. Jim Wells
Director, Natural Resources and Environment
U.S. General Accounting Office
441 G Street, N.W.
Washington, D.C. 20548

Dear Mr. Wells:

We appreciate having the opportunity to review the Draft Report entitled "Natural Gas Flaring and Venting: Opportunities to Improve Data and Reduce Emissions" (GAO-04-809). Our general comments are provided below and more specific comments are enclosed.

In general, we concur with the report's recommendation that requiring operators to flare instead of vent, whenever possible, would reduce greenhouse emissions. We also agree flaring and venting meters should be required to improve oversight and that flaring and venting data should be reported separately. We will assess the cost effectiveness of implementing these changes and will propose new regulations as appropriate.

The GAO report mentions specific programs, such as USAID and the Global Gas Flaring Reduction Initiative, that address global flaring and venting issues. The Department of the Interior will work in partnership with state agencies and other nations in order to assist them in improving their regulation of flaring and venting activities.

Again, thank you for providing the opportunity to review and comment on this report. If you have any questions, please call Ms. Angela Herring, Minerals Management Service's Audit Liaison Officer, at (202) 208-6405.

Sincerely,

Rebecca W. Watson
Assistant Secretary
Land and Minerals Management

Enclosure



GAO Contacts and Staff Acknowledgments

GAO Contacts

Jim Wells (202) 512-3841
Mark Gaffigan (202) 512-3168

Acknowledgments

In addition to the individuals named above, James W. Turkett, James Rose, Carol Bray, and Nancy Crothers made key contributions to this report.

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