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Update to Indonesia Associated Gas Survey and Upstream Natural Gas Data Management System Design

Executive Summary

1.1 Context of the Study

Every year about 150 bcm or 14 bscfd of natural gas associated with crude oil production are flared all around the world. Indonesia ranks as seventh highest on the list of flaring countries and in 2009 flared according to BP Migas – an Indonesia upstream oil and gas supervisory agency responsible among other things for collection of oil and gas upstream data – around 3.7 bcm (364 MMscfd).¹ The financial impact of this total flaring is the loss of about \$400~500 million annually. The revenue loss alone due to flaring at the new LNG facility is approximately \$100 million.

To phase out the practice that contributes to greenhouse gas (GHG) emissions and wastes valuable energy resources, in 2009 the government of Indonesia (GoI) announced the Green Oil and Gas Industry Initiative (GOGII) that aims at a 20 percent reduction in gas flaring in the short term, 40 percent by 2014 and elimination of all unnecessary flaring on a sustainable basis by 2025.

Venting of natural gas (primarily methane) and CO₂ in oil and gas upstream operations represents another noticeable source of the country's GHG emissions and energy resource waste. Preliminary analysis of CO₂ venting sources indicates that the amounts of CO₂ vented from natural gas fields with high CO₂ content during processing/treatment operations are close to the amounts emitted from flaring. Combined flaring and venting in Indonesia's oil and gas sector releases close to 17 million tonnes² of CO₂ in the atmosphere annually.

The availability of accurate, consistent, timely, sufficiently detailed, and easily retrievable historic data, forecasts and other information pertaining to upstream oil and gas operations and related infrastructure is the main prerequisite for addressing flaring and venting at country, company, and project levels. The data are equally important to:

- Assess the feasibility of announced targets and establishing the base line – the starting point against which the progress will be measured and monitored;
- Assess existing policies, regulations and guidelines and develop new ones;
- Develop country and company specific utilization plans for flared and vented gas and CO₂ abatement strategies which includes identification of flare and vent reduction opportunities, their prioritization and development of specific projects;
- Monitor progress at company and country levels.

1.2 Study's Objective

Recognizing the above, the GoI sought to assess the adequacy of its existing upstream natural gas data management system (DMS) for the above listed tasks of flare and vent management and update the information on flaring activities in Indonesia. As a member of the World Bank-led Global Gas Flaring Reduction Partnership (GGFR) the GoI through the Directorate General of Oil and Gas (DGOG) of the Ministry of Energy and Mineral Resources (MEMR) requested GGFR's co-sponsorship and assistance in conducting a study to:

- (a) Review the DMS with the ultimate objective to identify and outline measures for improving:
 - Quality (accuracy and consistency), adequacy/relevancy (availability of the data necessary for a defined task and its sufficient level of detail) and timeliness of data required for accurate

¹ The data includes 108 MMscfd of gas flared at the new LNG plant which was at a start up phase at the time of data collection.

² World Bank estimates.

identification and quantification of individual flares and analysis of flared gas utilization options including clustering; and

- Ease and effectiveness of data management for both reporting entities (companies) and recipients (government regulators) of the information.
- (b) Conduct a survey of current flaring activities in Indonesia to:
- Obtain data and information that may lead to identification and development of associated gas utilization projects;
 - Based on the collected data and information to develop the geographic information system (GIS) map for major flaring locations which is a useful commonly employed tool to identify and prioritize gas utilization projects.
- (c) Provide an initial government capacity building on regulatory best practices regarding flaring and venting.

The study *Update to Indonesia Associated Gas Survey and Upstream Natural Gas Data Management System Design* was undertaken by the consultant firm LMKR and the Research and Development Center for Oil and Gas Technology of the Indonesian Ministry of Energy and Mineral Resources (LEMIGAS) and benefited from the recommendations provided by the members of the specially constituted Steering Committee with representatives from government regulatory bodies, GGFR and the consultants.

1.3 Study's Findings and Recommendations

1.3.1 Findings on Flaring Trends and Flaring Reduction Opportunities

1.3.1.1 Indonesia 2009 Flaring Volumes Went Up

In 2009 Indonesia's volume of flared gas went up by 15 percent as compared to 2008. To revisit the flaring situation on the country level, the study launched in second half of 2009 looked at the data collected by BP Migas for the period of January – October 2009. According to this source in 2009 Indonesia flared on average 364 MMscfd (3.7 bcm). The annual change in country's total flare represents 52 MMscfd (0.54 bcm) increase in absolute terms.

The BP Migas data suggests that the increase in flaring is largely attributed to flaring related to the commissioning of the new LNG operation. Due to technical problems at start up, on average 108 MMscfd (1.16 bcm) was flared as a result of this operation. This amounts to 30 percent of country's total flaring. If this data is correct, besides increased CO₂ emissions and permanent loss of energy resource the GoI lost a significant amount of revenues. It is unclear whether the relevant GoI's bodies were timely and fully informed about the scale of flaring, its causes and expected duration.

No regular reports on flaring volumes are generated for the relevant regulatory bodies which would allow them to continuously monitor the situation and alert them to sharp increases.

Four companies contribute 69 percent of country's total flaring. Together, the operator of the LNG plant and three other companies accounted for 69 percent of Indonesia's total flaring in 2009 with individual contributions of 108, 88, 33 and 22 MMscfd. While the LNG operator has concentrated flaring at one location the study did not have field specific data for other three companies and therefore could not determine whether their flaring is concentrated or dispersed geographically.

133 MMscfd (1.4 bcm) or 37 percent of currently flared gas is already committed to utilization projects reducing total flaring to 220 MMscfd (2.3 bcm). Stabilization of the new LNG operation which has sales agreements in place will reduce flaring by 108 MMscfd and make the 20 percent reduction target

achievable. According to BP Migas, signed gas sales agreements for onshore gas currently flared will deliver a further 24.6 MMscfd reduction.

The flared gas committed for sales will result only in 10 percent reduction in Indonesia's total flaring if flaring due to the commissioning of the new LNG operation is excluded from the total count (baseline). Ten percent reduction falls substantially below the announced targets. In addition the timeline for implementation of the onshore projects is unclear.

1.3.1.2 Data Currently Reported to GoI are Not Sufficient to Identify Further Flare Reduction Opportunities.

Since all data reported to BP Migas are at a company level rather than on a field specific basis, further opportunities for flare reduction and concrete projects could not be identified. While data at the company level illustrates the scale of the problem, it does not allow identification of concrete solutions as this requires knowledge of the characteristics of each specific field, its proximity to other fields and their characteristics, the existing gas processing and transportation infrastructure and markets.

Future flaring trends could not be forecasted due to lack of information. To make a sensible forecast of the future trend in country's flaring volumes information on both the timetable of committed projects and new oil and gas projects coming on stream in the next several years, their estimated gas to oil ratio (GOR), remaining reserves, expected production volumes and plans on associated gas use or flaring are required.

No information is currently reported on venting including CO₂ venting. The companies are not mandated to report the volume and composition of vented gases. Therefore, no systematic information is available to the GoI on the volumes of vented methane and CO₂ resulting from oil and gas production and gas processing operations. It should be noted that methane is 21 times more potent than CO₂ in terms of warming potential.

There may be significant errors in the flare volumes, which are estimated rather than metered, and reported combined with losses.

LEMIGAS survey of 25 fields including the new LNG plant confirmed the above findings. Since BP Migas data, available only at the company level, are not suitable for identifying opportunities for flared gas utilization and for developing the GIS map tool, LEMIGAS conducted its own field data collection exercise by visiting 25 locations. To survey all producing fields which are around 600 was not feasible within this study. Therefore the fields for LEMIGAS surveyed were selected from a group of 190 fields listed in DGOG 2007 report, based on the following criteria:

- Flaring volume of more than 1 MMscfd;
- Energy content greater than 400 BTU;
- Remaining proven gas reserves greater than 1 bscf.

The survey confirmed that companies:

- Estimate rather than meter flared gas;
- Do not report composition of gas except composition of gas for sale;
- Do not keep track of venting which leaves some large CO₂ emissions unaccountable;
- Do not regularly update the reservoir data such as remaining reserves and GOR.

The LEMIGAS survey indicated that associated gas produced in Indonesia often contains H₂S and CO₂ which depending on the concentration would require high investment costs for gas treatment before such gas can be utilized.

1.3.2 Flaring Trends and Flare Reduction Opportunities-Recommendations

The analysis of the BP Migas and LEMIGAS survey data reveals several areas that deserve close attention.

1.3.2.1 More Information Required to be Reported on Field/Processing Facility Basis.

Below are the key recommendations on improving data relevancy resulting from the review of the BP Migas and LEMIGAS survey data.

As the first priority the GoI should seek information from the four top flaring companies on a field by field basis. The data recommended for collection at a field or a gas processing facility level are discussed in more detail below and are also outlined in Chapter 5 of the report. Flaring figures associated with the commissioning of the new LNG plant need to be promptly investigated and verified since for a typical LNG start up this volume of flared gas is excessively high and duration -- too prolonged.

Total Indonesian flaring in 2008 rather 2009 should be used as the baseline for measuring flare reduction progress. This will allow to not count the flaring volume attributed to the commissioning of the new LNG. High flaring is not typical for an LNG operation and it is not expected to be continuous; the volume is expected to diminish once regular operations are established. Elimination of the LNG related flaring should not be counted towards achieving the flare reduction targets.

Reporting to the GoI on an individual field or gas processing facility basis, rather than company-wide basis is strongly recommended for all companies. Without field or facility specific data identification of potential flare reduction opportunities and subsequent development of utilization projects, cannot be accomplished. Field specific data will allow the GoI to conduct an informed dialogue with operators about concrete utilization opportunities. The availability of these data and having a better informed government regulator will also encourage the companies to focus more on flared and vented gas utilization. Location specific data is also key for safety and environmental monitoring as cumulative company data are not useful in identifying areas of undesirable concentrations of specific pollutants. From a purely company perspective accurate data on AG production, flaring, venting and utilization volumes benefits the understanding of reservoir behavior and therefore improves reservoir management. Most companies already capture data on the field and gas processing facility basis for own purposes but do not report them since it is not required by the regulators.

Companies should report volumes of deliberately or accidentally flaring/vented emissions at oil and gas production and gas processing facilities along with detail reasons for such flaring/venting.³

It is recommended that flared gas volumes are metered rather than estimated. For smaller gas volumes estimation is acceptable provided companies demonstrate that this estimation is done with the use of proper engineering methods. For larger flares, however, flare meters should be installed. Estimation of flared gas is typically of low accuracy, as the flare volume estimate is typically a rather small difference between two large numbers, the gas produced and the gas utilized, which are often also estimated with significant uncertainty. **It is advisable to develop and enforce meter and estimation requirements based on best international practice.**

³ Venting should include only deliberate or accidental venting and exclude non deliberate venting resulting from equipment leakages which should be reported as losses.

It is also recommended that data on flaring and venting volumes should be made publicly available. Having data in the public domain is a worldwide trend and standard practice in a number of countries such as Norway and Canada. Making these data easily accessible both encourages companies to strive to emulate their better performing peers, and promotes natural gas industry development and stranded gas utilization by allowing potential gas utilization project developers and investors to identify and participate in utilization projects.

Composition of flared and vented gas should be included in the reporting as it is one of the key variables influencing the selection of optimal utilization solution. Composition is also critical for safety and environmental monitoring, particularly where the gas is sour, i.e. contains H₂S. As composition will vary over time it should be reported more frequently than it is done at present, for example quarterly.

Where a field has more than one flare stack and/or venting source, and the volume of each are significant, it is recommended to consider reporting the volume and composition of flared and vented gas from each flare stack and venting source. In large fields with multiple flares or vents, these may be widely separated making utilization more costly. Also, the production and separation processes in the field may result in different compositions of gas going to each of the flares and or vents. It is recommended that a decision on this detail of reporting is made on a case-by-case basis to avoid an unnecessarily onerous reporting burden.

Flaring volumes should be reported separately from losses and not together as they currently are. Since a key objective of the reporting is to identify the volumes of gas that could be utilized, and losses in the majority of cases are very difficult to capture and put to use, it is important to measure and report them separately. In the majority of cases, losses are unintentional gas leakages from production facilities (tanks, compressor seals etc.) the volume of which can be estimated for all type of equipment.

Forecast of future predicted gas flare volumes over the life of field should be updated and reported annually.

In order to have a full inventory of emissions for environmental purposes, the government may consider requiring that flaring and venting volumes and composition from production testing of new oil and gas wells is also reported.

GIS map tool should be expanded, regularly updated and actively used for identification and screening of flare reduction opportunities.

1.3.2.2 Development of Regulatory Framework.

The analysis of BP Migas and LEMIGAS survey data also highlighted a number of issues which need to be addressed through policy decisions and changes to the flaring and venting regulatory framework.

The government needs to be quickly alerted to high surges in flaring. The overall regulatory framework for flaring and venting at a minimum needs to ensure that the relevant government entities responsible for flaring and venting management (regulators) are regularly informed about trends, and large increases are promptly brought to their attention. This could be done through monthly generated reports and for sudden large surges through emergency reporting. Timely reports will enable the GoI to make an informed decision regarding an operation generating high flaring and venting volumes. At a minimum the regulation needs to clearly specify:

- Data to be reported by companies and frequency of data reporting;
- List of regulators which will receive these data on a regular basis (preferably on a monthly basis for key data) and in case of emergency reporting;

- Procedures for generation and distribution of regular (monthly) reports to the regulators;
- The minimum daily flaring rate which triggers the immediate emergency reporting by an operator to the regulators;
- Additional information which has to be provided as part of the emergency reporting including the reason for flaring, expected duration and the action plan for reduction.

Regulatory framework for flaring and venting should describe an algorithm of the procedures to be followed by oil and gas operators and the regulator in regard to flaring and venting activities. The government regulator may decide to address each flaring or venting situation on a case by case basis, but it is generally more advisable to use a systematic approach which follows clearly defined process. Under this systematic approach the regulations will typically specify:

- The circumstances under which flaring and venting is allowed;
- The process for enforcing flaring and venting restrictions if such are imposed; in many countries restrictions are administered through a combination of:
 - permits which specify allowed volumes and duration;
 - routine and emergency reporting requirements;⁴ and
 - auditing of the operators by the regulator.
- Procedures for applying for flaring and venting permits if these are required;
- Technical requirements to flare stacks and vents and their operation;
- The consequences for flaring and venting without permit, i.e. the measures the government can take if flaring and venting takes place without its approval (consent) depending on the scale of the problem;
- The process for monitoring operators' compliance with the regulations by the regulator;
- The regulator's response to noncompliance, including the consequences for flaring and venting without the permit, which typically will depend on the severity of the situation;
- The process for approval of gas utilization projects; it is important to make this process clear, efficient and speedy to allow for timely implementation of flare reduction projects.

Whether the government chooses a case by case or the systematic approach the regulation must clearly define the mandate, responsibilities, regulatory powers and budgeting mechanisms of the regulatory authority responsible for management of flaring and venting.

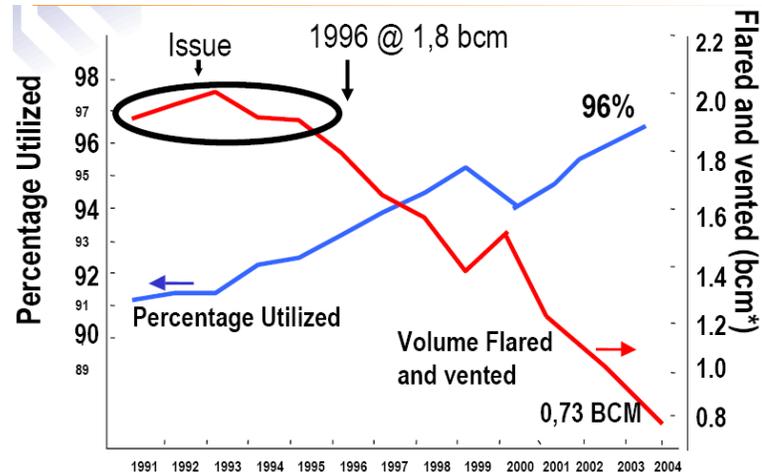
1.3.2.3 Best Practice in Flaring Policy and regulation—Alberta, Canada

The reduction of flaring and venting has been a priority for the government of Alberta since 1938, when the Turner Valley Gas Conservation Board was established to address problems with reservoir management, including flaring. A key element of flaring policy – the regulatory system - has evolved since that time from prescriptive regulation to a combination of voluntary targets and mandatory conditions related to flaring and venting reduction, which are set in cooperation with the oil and gas industry.

⁴ In January 2008 the EUB was split into two new regulatory bodies and the Energy Resource Conservation Board (ERCB) has become the new regulatory body responsible for oil and gas resources of Alberta including flare and vent management.

The Alberta government has demonstrated strong and consistent political will to address the issue of flaring and venting. It has not ceded to pressure from oil companies which, in the early days of regulation, lobbied strongly for a “soft” flaring policy; instead it empowered the energy regulator to challenge the oil industry to reduce flaring and venting while balancing the interests of the stakeholders. The regulator always attached the paramount importance to conservation of Alberta’s energy resources, public safety, and protection of the environment. As a result, Alberta has achieved remarkable results in reduction of flaring and venting, as illustrated in the figure below.

Figure 1.1 Flare and Vent reduction for Alberta



Evolution of Flaring Regulatory Framework

The sound market environment, namely economic pricing for gas, open access to transmission and export markets, together with prescriptive regulation in regard to flaring and venting enabled Alberta to achieve a level of associated gas utilization of above 90 percent by the early 1990s. However, the volumes of flaring and venting in absolute terms continued to be relatively high— about 2 billion cubic meters per year - and concern regarding human and animal health, waste of valuable and non-renewable energy resources was growing. In response to these concerns and in anticipation of regulatory actions, the Canadian Association of Petroleum Producers (CAPP) initiated multi-stakeholder consultations in 1996 aimed at finding solutions for further reduction of flaring and venting.

The Clean Air Strategic Alliance (CASA), which led the consultations, formed a multi-stakeholder team that developed recommendations for flaring and venting reduction. These became key inputs for the Guide # 60 “Upstream Petroleum Industry Flaring, Incineration, and Venting,” issued by the regulatory body - Alberta Energy and Utilities Energy Board (EUB)⁵ - in 1999. The key features of the Guide included voluntary annual reduction targets for the entire oil industry, decision tree and economic evaluation tools, measurement and reporting obligations by the operators, publication of flaring/venting data by the regulator, and an enforcement mechanism.

⁵ In January 2008 the EUB was split into two new regulatory bodies and the Energy Resource Conservation Board (ERCB) has become the new regulatory body responsible for oil and gas resources of Alberta including flare and vent management.

While it took time to build trust between the participants of the multi-stakeholder team and develop workable solutions, this approach produced better than expected results. The oil industry consistently exceeded the reduction targets for the four consecutive years 2000 to 2003 and reduced associated gas flaring and venting levels by more than 70 percent from the 1996 baseline level.

Taking into account lessons learned by the regulator and feedback from the oil industry and other concerned parties, the Guide has undergone a number of modifications since 1999. Following a new set of CASA recommendations in 2002 and continued extensive consultations with the stakeholders in the following years, the Guide was updated and transformed into Directive # 60,⁶ which became effective on January 31, 2007.

Directive # 60

Directive # 60 inherited most of the elements of the preceding Guide, including the decision tree and economic modeling tools, measurement and reporting requirements, and enforcement ladder. It also preserved the voluntary nature of regulation that is realized by establishing industry-wide reduction targets that are regularly reviewed downward. If the oil and gas industry collectively exceeds an agreed target, the ERCB will impose binding maximum flaring limits on individual sites.

In order to promote investments in flaring and venting reduction that otherwise would not take place; Directive # 60 requirements became applicable beyond continuous flaring of solution gas.⁷ It now also applies to venting, temporary flaring and venting, gas plants, pipeline, and non-associated gas infrastructure. In addition, Directive # 60 tightened economic and flaring performance requirements.

Key Elements of the Directive

Flaring/Venting Management Framework and Decision Tree

One of the main features of Directive #60 is the flaring and venting management framework and associated decision tree. The framework obliges operators to evaluate the following three options:

1. Eliminate flaring and venting.
2. Reduce flaring and venting.
3. Meet performance standards for any remaining flaring and venting.

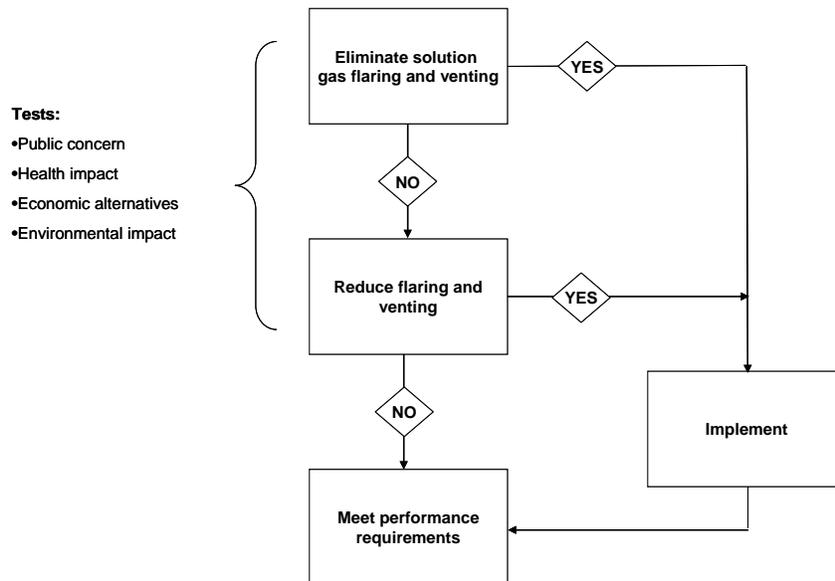
Directive # 60 requires operators to apply the management framework to a wide range of applications, including continuous and intermittent flaring and venting of both associated and non-associated gas at production, gathering, processing and transmission facilities.

Figure 1.2 illustrates the decision tree which addresses continuous flaring/venting of associated gas. Directive # 60 obliges operators to apply it to all associated gas flares and vents greater than 900m³/day. Any flaring or venting that remains should meet performance requirements with respect to conversion efficiency, smoke emissions, ignition, stack design, and so forth.

⁶ Directive #60 is available at <http://www.ercb.ca/docs/documents/directives/Directive060.pdf>

⁷ In Canada associated gas is called solution gas.

Figure 1.2: Continuous Solution Gas Flaring/Venting Decision Tree



Similar decision trees are included in Directive # 60 for specific situations, e.g. flaring of gas containing H₂S.

Economic Evaluation of Alternatives to Flaring and Venting

One of the major requirements of the Directive #60 is that flaring or venting be evaluated to determine if there are economical feasible alternatives to flaring and venting. Directive #60 outlines the economic evaluation criteria which must be followed. These include (i) forecasts of commodity and power prices, (ii) rules regarding estimation of capital and operating costs of the gas utilization projects, (iii) long-term inflation rate and discount rate.

A gas utilization project is considered economic, and the operator must then implement it, if the investment generates a Net Present Value (NPV) before-tax greater than Can\$ -50 thousand. If an NPV is below that level, the operator can apply for a royalty waiver to reduce the cost of utilizing the gas (Note: No royalty is payable on flared gas).

In addition, there are “clustering” requirements whereby multiple potentially flaring/venting facilities that are in close proximity to one another (within 3 kilometers) must consider the economics of gas utilization on a combined basis. While utilizing gas at an individual facility may not be economic, it may be feasible if the gas from multiple facilities is combined.⁸ The operator with the largest flare and vent volumes is responsible for taking the lead in coordinating such a collective effort.

In case flaring/venting goes ahead, the economics of a potential utilization project must be re-evaluated annually using latest price/cost estimates. The results of the economic evaluations are not required to be submitted to the ERCB but, should the regulator request so, operators must provide the evaluation to the ERCB within five working days.

⁸ Also, where gas utilization is determined by an operator to be uneconomic but a third party is able to utilize the gas, the ERCB recommends that the operator either utilizes the gas or makes it available at the lease boundary at no charge within three months of a request for the gas by the third party.

While there are many other requirements in Directive #60, the decision tree and economic evaluation have probably played the key role in reducing associated gas flaring in Alberta.

Even when gas utilization has been shown to be uneconomic, flaring/venting must also meet other tests if it is to be continued. Specifically, it is subject to resource conservation and public concerns, and assessment of health and environmental impact. For instance, no continuous flaring/venting is allowed from wells with gas-to-oil ratios $>3000\text{m}^3/\text{m}^3$, or where combined flaring and venting volumes $>900\text{m}^3/\text{day}$ and the flare/vent is located $<500\text{ m}$ from a residence.

Flaring/Incineration Permits

Due to potential risk of health hazards, flaring of sour gas is strictly regulated. Specifically, operators must obtain permits for any flaring/incineration of the gas (except for small sulfur emission rates or gas flow rates⁹) with concentration of $\text{H}_2\text{S} >5$ percent and conduct dispersion modeling in the concentration is above 1 percent. Venting of gas with $>1\%$ of H_2S is prohibited.

Measurement and Reporting

Operators must report on a monthly basis all flaring/venting volumes greater than $100\text{ m}^3/\text{month}$. Volumes must be metered if flow rates are $>500\text{ m}^3/\text{day}$, otherwise an acceptable estimation method should be applied. The accuracy of metering equipment must be ± 5 percent.

Monitoring and Enforcement

The ERCB conducts thousands of audits, inspections, and investigations each year, many on-site, in order to verify compliance of the industry with Directive #60. The consequences of non-compliance are described in Directive #60 so that operators are all aware. While the ERCB's preference is to help industry to comply with the requirements, it will impose penalties where an operator is unable or unwilling to comply with the regulations. The ERCB does not issue fines, but does impose increasingly severe penalties depending on the magnitude of the infringement, up to rescinding an operator's right to produce oil and gas from any upstream facility in Alberta. Clearly this has a very significant monetary impact.

Publication

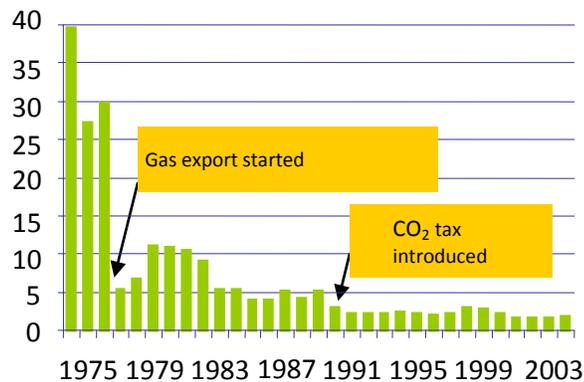
The ERCB publishes a report every year containing the total volumes of gas flared and vented in Alberta, and includes a breakdown of flaring and venting by company. The total volume provides a transparent measure of progress on flaring and venting in Alberta, while the individual company statistics provide a positive pressure and recognition for companies to continually improve their performance.

1.3.2.4 Best Practice in Flaring Policy and Regulation—Norway

Flaring and venting in Norway has been strictly regulated from a resource management standpoint since the beginning of oil production on the Norwegian Continental Shelf. This, together with a carbon dioxide tax introduced in the early 1990s, and a collaboration between petroleum industry stakeholders produced tangible results - the total flaring and venting volume has been remarkably low (only about 0.16 percent of the total production was flared in 2004) and has been following a downward trend during the last two decades, as illustrated in the figure below.

⁹ Total sulfur emission rates should not exceed 1 ton per day; sour gas flow rates should not exceed $10,000\text{ m}^3/\text{day}$, nor does the total volume exceed $50,000\text{ m}^3$ over the duration of the event.

Figure 1.3 Norway: Gas flaring and venting (m3) per m3 (oil equivalent) sold



Gas Flaring Regulation Authorities

The Norwegian Petroleum Directorate (NPD), which is part of the Ministry of Petroleum and Energy (MPE), is responsible for energy efficiency and safety on installations and for gas flaring and venting operations. The NPD enforces legislation concerning the carbon dioxide (CO₂) tax.

Associated Gas Use and Permission to Flare

Operators may re-inject, use for fuel on-site, or market associated gas. Flaring and venting is strongly regulated and subject to relevant consents and approval of a development plan. The Norwegian government does not set specific gas flaring and venting targets, but permission to flare gas is very restricted. Gas flaring or venting, other than volumes necessary for safety reasons during normal operation, is not permitted under the Petroleum Act without the approval of the MPE. Applications for annual flaring and venting permits are evaluated directly by the NPD, and the permits are issued by MPE. Permit applications must specify the type and level of atmospheric emissions and the technology applied to avoid or reduce pollution. Emission limits are set on a case-by-case basis, with consideration of relevant and applicable national and regional standards.

Before an operator can develop a discovery, the Petroleum Act requires that a Plan for Development of the Operation (PDO), and possibly a Plan for Installation and Operation (PIO), be approved by the relevant authorities. These plans must address the utilization of associated gas, and no approval will be given for a development that includes any routine flaring or venting. In a number of cases, major new developments were only approved after significant investments were made to avoid flaring/venting; the Draugen field gas was re-injected into a nearby aquifer while a gas export pipeline was built; for the Heidrum field, development could only proceed in parallel with construction of a methanol plant and connecting gas pipeline.

In addition, in the context of the PDO-PIO process, the operator must submit an environmental impact assessment (EIA). The EIA describes any environmental effects of expected emissions and discharges (including flaring and venting) and includes a systematic review of costs and benefits of any mitigating measures. Both the program and the actual impact assessment are subject to public consultation.

Measuring, Reporting, and Monitoring

Operators are responsible for metering gas-to-fuel, flaring, and venting during the operational phase and are obliged to establish an internal control system that ensures that the requirements of the regulations are

met. The amount of gas to the flare system is measured through a metering system with an accuracy of plus or minus 5 percent. This system is subject to audits from the authorities.

The licensee has to operate within the flaring permit and report the amount of flared gas daily; it has to notify the authorities if it reaches the permit's limits. For tax purposes, the amount of flared and vented gas is reported every six months. Operators are required to keep an emissions inventory, which must be submitted to the NPD annually.

The NPD is responsible for monitoring the operator's compliance with the environmental regulations, as well as its internal control system. It also supervises the equipment that measures the volumes of gas flared and vented, and collects the CO₂ tax.

Fiscal Regime and Gas Flaring

In 1991, the government introduced a CO₂ tax for oil operations to encourage operators to reduce non-routine gas flaring volumes. The CO₂ tax, computed based on the volume of gas flared and vented, is at a rate of US\$120 per thousand cubic meters. The tax has been a driving force for development of new technologies, e.g. "closed flare system" that minimize non-routine flaring. The CO₂ tax is deductible as a cost for corporate income tax purposes. Besides, the CO₂ tax, there are no other fiscal incentives to encourage usage of associated gas.

Access to Transmission Pipelines and Commercialization

The requirement for an associated gas utilization plan for all oil production facilities has promoted construction of a gas transport infrastructure by the various field operators.



Figure 14.1 Existing and projected pipelines
(Source: Norwegian Petroleum Directorate)

The resulting extensive network of gas transmission pipelines connects the producing fields with markets in Norway, UK, Germany, Belgium, and France. New developments have access to this infrastructure and can use it to commercialize their associated gas.

Oil producers are free to utilize their associated gas themselves, or to sell it to customers in either the Norwegian domestic market or in export markets.

Collaboration among Stakeholders

Cooperation among stakeholders has been an important element in determining effective ways of protecting the environment and conserving natural resources in Norway. A number of bodies (the "Miljøsok" and more recently the "Environment Forum") have been used in Norway to promote cooperation between the authorities, stakeholders and industry in developing environmental strategy and cost effective measures for oil production activities, including reducing flaring and venting volumes.

1.3.3 Key Findings of Upstream Natural Gas Data Management System

Review of the upstream natural gas data management system conducted by LMKR consisted of two main parts:

- Assessment of the current DMS' efficiency and
- Design of upgrade options which address the main weaknesses of the existing system.

The DMS assessment was based on the information received through:

- The LMKR designed questionnaires distributed to DMS users;
- Review of the data forms, databases and reports generated from the existing databases;
- Face to face discussions with a number of key DMS users.

Below are the observations resulting from the review of the DMS:

Presently reported data are not sufficient and detailed enough for addressing flare and vent reduction. The key observations and conclusions on data adequacy were to large extent addressed above (see MORE INFORMATION NEEDS TO BE REPORTED ON A FIELD OR GAS PROCESSING FACILITY BASIS IN ORDER TO IDENTIFY LARGEST FLARES AND FLARE REDUCTION OPPORTUNITIES). The report gives additional recommendations on the desired frequency of reporting of specific data.

The additional important conclusion of the DMS review pertaining to the adequacy of the reported data is that the current BP Migas data request form is not designed for the specific purpose of collecting information on flared and vented gas.

Accuracy and consistency of data suffer from a number of factors inherent to the existing DMS including:

- Multiple data collection systems result in multiple entries of the same data which inevitably leads to errors;
- Multiple formats of data input and output even into and out of the same data collection system;
- Lack of a methodology or guidelines for metering and estimation of GOR, production and flared volumes of gas that all companies have to follow; as a result data from different reporting entities are not comparable because different companies might use different metering and estimation practices;
- No data quality control procedures either within the companies or in the government.

Current system does not allow for easy design and generation of the regular reports on flaring and venting.

1.3.4 Recommendations on Upstream Natural Gas Data Management System (DMS).

To address the above weaknesses several options are available some of which could be combined to achieve better results.

Option 1: Use the existing DMS but modify the existing data request/reporting template. The new template should request data by field or gas processing facility and additional data recommended in the report. If GoI chooses to adopt this approach the study recommends to:

- Develop detailed instructions for filling these templates and

- Introduce a quality control system; one option is to introduce a signing off system where the GoI requires all data submitted by companies to be approved by a designated company manager;
- Develop and adopt guidelines on metering and estimation of GOR and flared and vented gas volumes.

This is a low cost but partial solution since it will address mainly data adequacy and data quality to some extent if the quality control system is introduced. However, the organization of data reporting and use will still be prone to errors since multiple modes and channels for data input and output will remain in place.

Option 2: Replace the current upstream natural gas DMS with the new automated web based system using software which will have a hub at the regulatory body and terminals at operators. Such system will allow:

- A single mode and single channel web based reporting of the data from operator to the Regulator;
- Easy design and generation of appropriate reports with data stored in the database;
- Establishment of different authorization levels which will allow different stakeholders to gain access to different levels of data stored in the database for different stakeholders (different stakeholders will have access to different levels of data).

While this approach certainly is more efficient, friendly and eventually less time consuming for both operators and the GoI, it has higher costs and will require training of staff responsible for this activity. The implementation process including the design of the system, selection and procurement of the appropriate software and hardware, its installation and staff training takes time. It is advisable not to implement approach 2 without approach 1, and they can be addressed in the sequence or in parallel. The rough cost estimate of this system is around US\$ 400,000 and time required for the implementation of this would be approximately 5–6 months.

Option 3: Replace GoI's multiple data collection, storage and retrieval systems with the single integrated data system for the oil and gas industry. Simultaneously merging multiple systems into one and upgrading it could be an alternative to the second approach and is the most efficient solution in the long term. However, it is the most costly, effort intensive and time consuming. It cannot be implemented without close collaboration of different government agencies. If the GoI is interested in this approach more investigation needs to be done on what oil and gas industry data are required by different government agencies to eliminate duplicate data requests and address the missing data. The data model suggested in second approach can also be integrated with this single data system. The hardware and software cost of this is approximately US\$ 2 million and the cost of resources involved for the implementation of this complete solution is separate and depends upon quantity and quality of exiting data to be migrated and archived.