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## **Environmental Performance in the E&P Industry: Data for 2007 and 2008**

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### **Abstract**

Since 2001, the International Association of Oil and Gas Producers (OGP) has collected environmental performance information from its member companies on an annual basis. This programme has continued and new sets of data for activities in 2007 and 2008 have now been produced.

The performance information has been collected under the following five categories:

- Emissions to air.
- Aqueous discharges.
- Discharges of non-aqueous drilling fluids on cuttings.
- Accidental spillages of oil and chemicals.
- Energy consumption and flaring.

The ultimate aim is to provide a representative statement on the environmental performance in the upstream oil and gas industry. Subsidiary objectives are to provide a basis for individual member companies to compare their environmental performance and to demonstrate the industry's wish for greater transparency concerning its activities to help identify better and more efficient ways of operating.

Performance results are presented on a global and regional basis, onshore and offshore, and normalised to hydrocarbon production. Results are shown, for ease of comparison, alongside the previous years' published results. The paper will address the emerging trends in environmental performance as well as factors that underpin the data.

32 OGP member companies took part in the survey representing about a third of known world production. Contributing companies provided data from 62 countries worldwide; however geographical coverage of the reported data remains uneven, ranging from 98% in Europe, to 20% of known production in the Middle East and 8% in the Former Soviet Union.

### **Introduction**

Over the past 10 years, the International Association of Oil & Gas Producers (OGP) has collected environmental information from its member companies on an annual basis. The ultimate aim of this project is to provide a representative statement on the environmental performance of the oil & gas E&P industry. Subsidiary objectives are to provide a basis for individual member companies to compare their environmental performance and to demonstrate the industry's wish for greater transparency concerning its activities. This will help them to identify better and more efficient ways of operating.

For over 20 years, OGP has collated and published information on safety performance in the upstream sector and by providing an international focus for the industry, this initiative led to substantial improvements in the performance of operators and their contractors. A parallel initiative on environmental performance was first considered in the mid 1990s but made little progress as companies debated questions of common definition, the representative nature of any data collected and the problems of maintaining effective anonymity for contributors. Nonetheless, the 1997 conference of international experts on the upstream oil and gas industry held in Noordwijk, the Netherlands, proved to be a watershed for the industry. The conference was jointly

organised by the governments of The Netherlands and Brazil under the banner of the United Nations Commission on Sustainable Development (CSD) and addressing undertakings from the world Summit on Environment and Development held in Rio de Janeiro 5 years previously. The conference provided a unique opportunity to bring industry together with a broad range of industrial and societal stakeholders. These groups delivered a clear message to the industry to go further than saying how well it conducted its business, but to show that delivery was achieved.

In response to this challenge, OGP members established a mechanism for collecting and collating information on environmental performance in the upstream sector as the basis for an annual sectoral report. The first summary of globally aggregated data from an annual reporting cycle was produced in 2003 for data representing performance in 2002; a more extensive report showing globally and regionally aggregated data representing performance in 2003 was published in 2004. Annual reports of activities in 2003, 2004, 2005, 2006, 2007 and 2008 and summary reports for activities in 2001 and 2002 have been published previously<sup>1</sup>.

## The Ground Rules

The Environmental Performance Indicators (EPI) project is focused on quantifiable emission and discharge data that are (or should be) collected as part of a company's regular business. Five indicator groups were agreed and a set of definitions for the indicators has been prepared and agreed by the member companies. The five indicator groups are:

- Emissions to air.
- Aqueous discharges.
- Discharges of non-aqueous drilling fluids on cuttings.
- Accidental spillages of oil and chemicals.
- Energy consumption and flaring.

For both gaseous emissions and spills, participants are encouraged to provide additional information. For the former, this would include information on the sort of activity that gives rise to the emission (such as flaring, venting, processing and treatment). On the latter and more recently, companies are providing information on the reasons for larger spillages of more than 100 bbl in size. Data are submitted by country and on an 'operated' rather than an 'equity share' basis. In addition there are provisions to try to capture information from Joint Venture (JV) operations. For normalisation, participants are asked to provide the relevant gross production associated with the activities in each of the indicator groups.

All data are treated as confidential; individual companies are identified by a unique letter code.

## Participation and representativeness

Since the inaugural call for data, the number of companies participating in the EPI programme has risen fairly steadily (see Figure 1) and in 2009 (reporting data for activities in 2008), 32 member companies reported data from activities in 62 countries. Thus around two thirds of OGP's upstream producing member companies now contribute data. There was a dip in those contributing in 2008 (reporting data for activities in 2007) due to a number of mergers and also the loss of one member company.

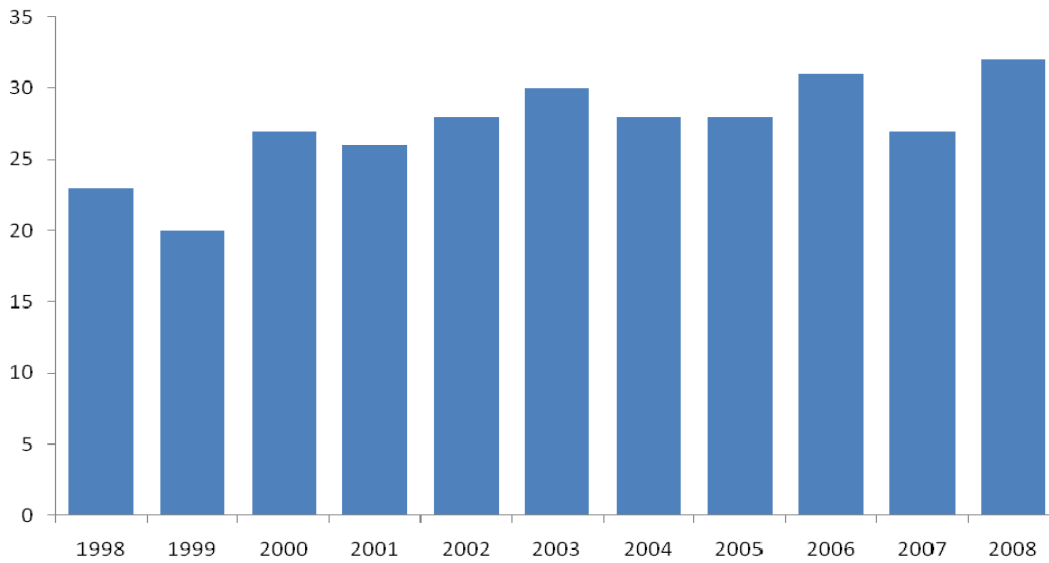
In terms of overall production of oil and gas, the 2007 data on emissions and discharges represented 2096 million tonnes oil equivalent, or about 32% global production, and for 2008 data represented 2,146 million tonnes of hydrocarbon production, which remained at around 32% global production (due to rising production levels worldwide) as reported in the BP Energy Review for 2008. As figure 2 shows, however, the geographical coverage of the reported data remains uneven, ranging from 98% in Europe, to 20% of known production in the Middle East and 8% in the Former Soviet Union.

With this geographical distribution, it is reasonable to assume that the data for Europe are fully representative of upstream activities but only partially so in Africa, Asia/Australasia, and North and South America. Data for the former Soviet Union are not representative and so are not included in the overall analysis in the report.

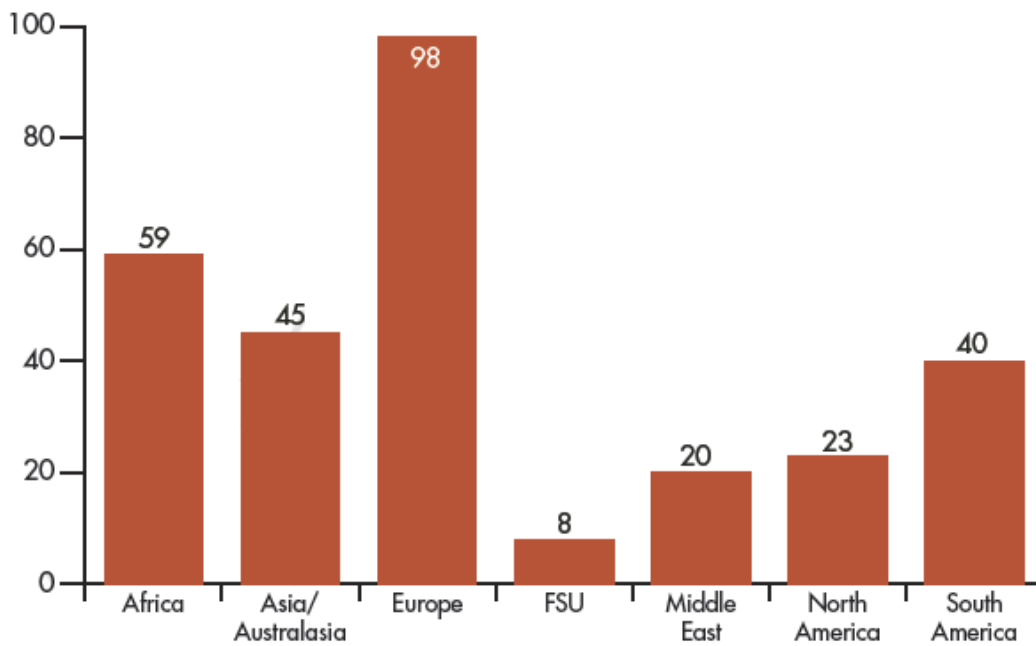
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<sup>1</sup> OGP reports 359, 372, 383, 399, 414, 429, 339s & 347s, OGP Publications: <http://www.ogp.org.uk/publications/>

**Figure 1. Number of OGP member companies providing data 1998-2008**



**Figure 2. Regional coverage expressed as percentage of total oil and gas produced\* - 2008**



\* As reported in BP Statistical Review

**Results**

**Gaseous Emissions**

A number of factors affect the quantity of gases emitted from upstream petroleum industry operations. Consequently, understanding the variations in performance in terms of normalised emission ratios is complex. The factors include: presence or absence of infrastructure for gas sales; gas-oil ratio; reservoir and field characteristics; use of hydrocarbon recovery techniques; regulatory and contractual aspects and the age of producing fields.

The overall global averages of gaseous emissions show little variation from year to year. Figure 3 shows the global and regional averages for carbon dioxide as an example. There are however significant regional variations. In particular, the CO<sub>2</sub> emission ratio (tonnes per thousand tonnes of hydrocarbon produced) is significantly higher (almost two times) than other regions. In Africa, there is little infrastructure to market and use the gas associated with the production of oil and

consequently, much of the associated natural gas is flared. This is improving however which is illustrated in Figure 3 by the continued drop in CO<sub>2</sub> from 262 in 2006 to 233 in 2008.

The regional variations for methane (see Figure 4), again reflect the availability of infrastructure to manage associated gas. Emission ratios for Africa and Asia/Australasia are significantly higher than in Europe where there is an established and mature infrastructure. Again, in Africa, this figure is now at it's lowest due to the increasing availability of infrastructure to manage associated gas.

Figure 3. Regional carbon dioxide emissions expressed as tonnes of CO<sub>2</sub> per thousand tonnes of hydrocarbon produced

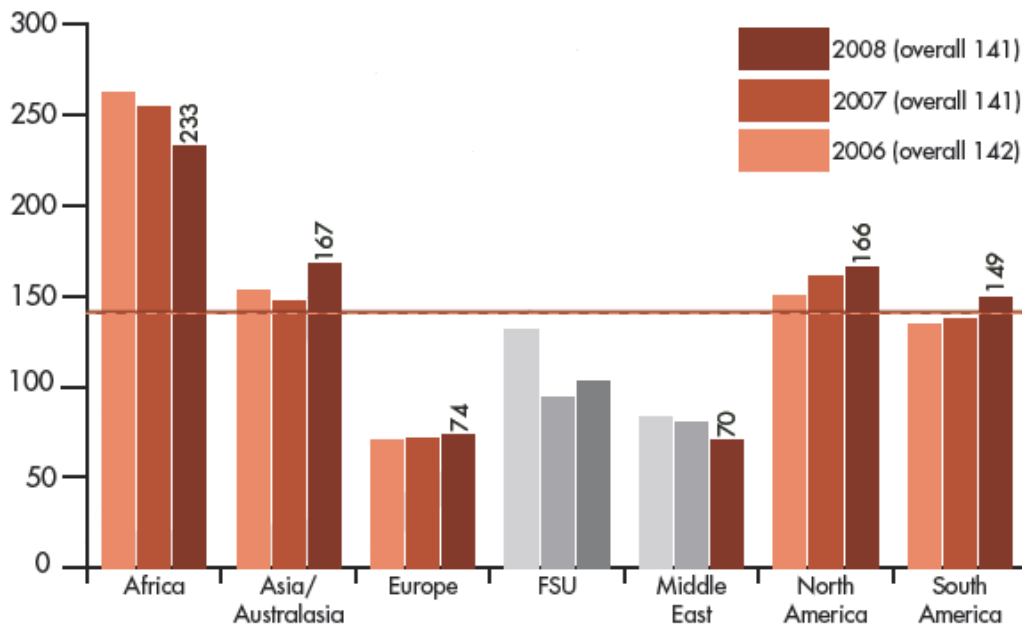
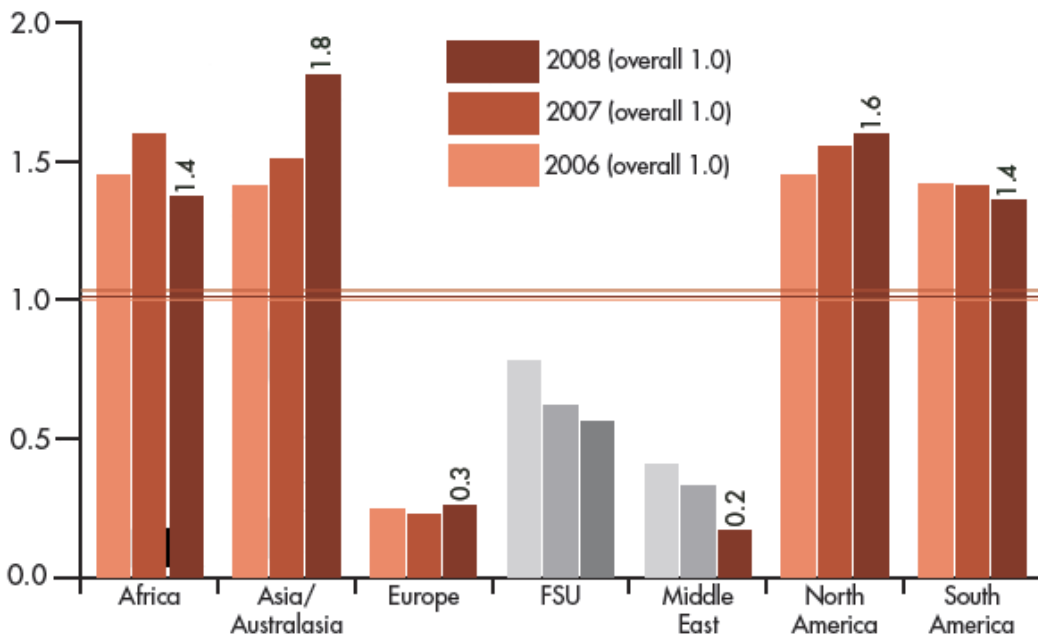


Figure 4. Regional methane emissions expressed as tonnes of CH<sub>4</sub> per thousand tonnes of hydrocarbon produced

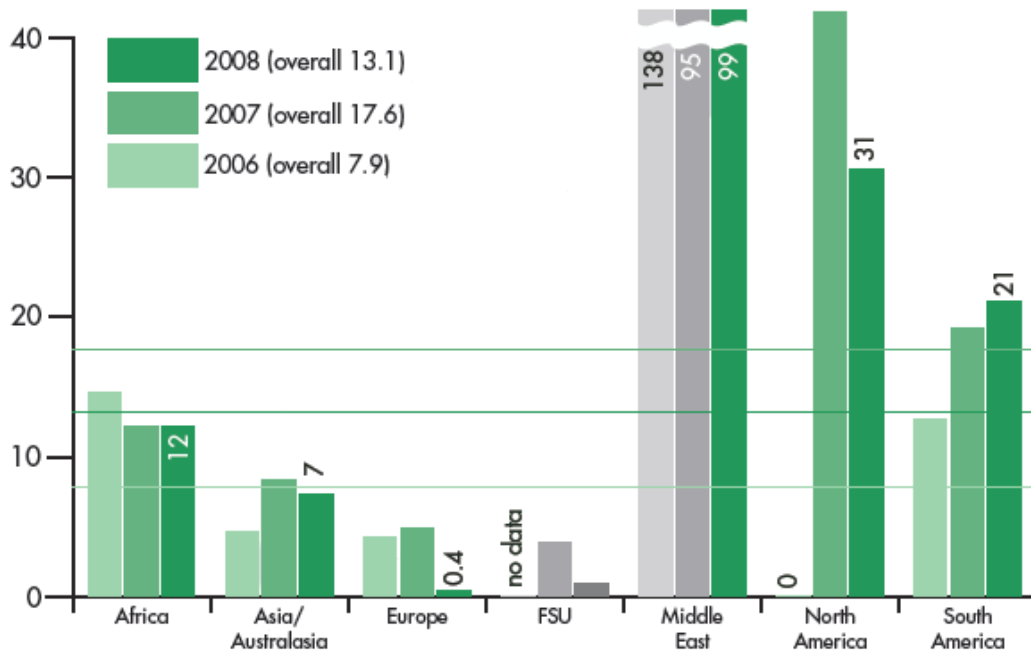


**Aqueous Discharges**

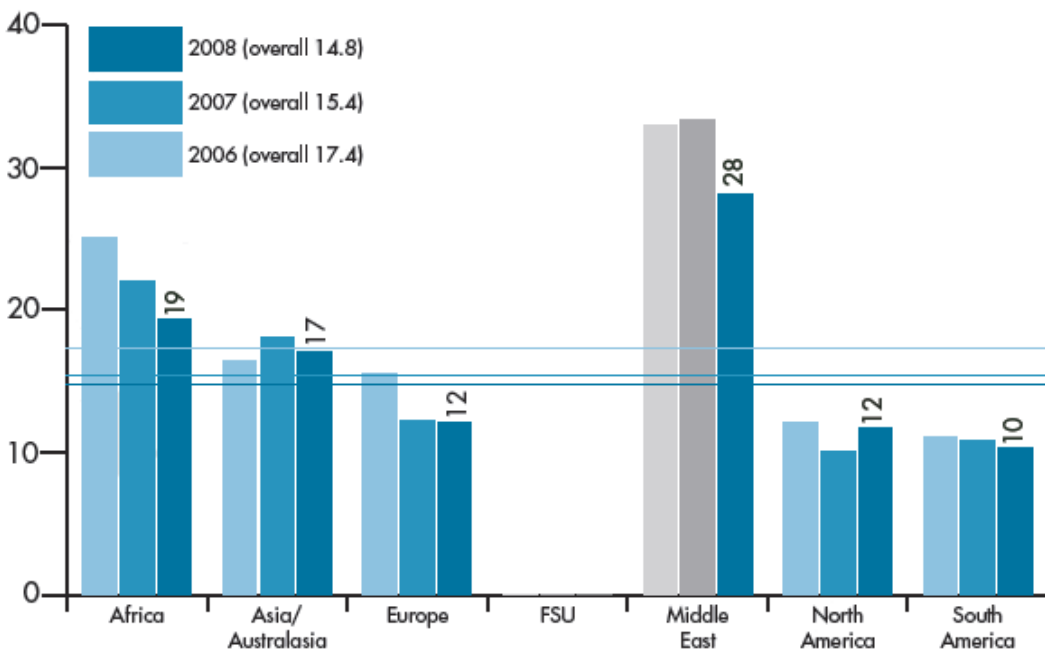
Produced water is the highest volume liquid discharge generated during the production of oil and gas. It consists of formation water (water present naturally in the reservoir), floodwater (water previously injected into the reservoir) and/or condensed water (in the case of some gas production).

Discharge of produced water is regulated in most countries. Regulations usually vary between onshore and offshore, and from one region to another. Differences in onshore and offshore regulations reflect differing environmental conditions and sensitivities. For example, salt content and biochemical oxygen demand (BOD) can be important aspects where discharges are to rivers or where these may have an impact on potable aquifers.

**Figure 5. Oil content of produced water discharged onshore (milligrammes oil per litre of produced water discharged – approximately equivalent to tonnes per million tonnes)**



**Figure 6. Oil content of produced water discharged offshore (milligrammes oil per litre of produced water discharged – approximately equivalent to tonnes per million tonnes)**



Figures 5 and 6 illustrate the regional distribution of oil in water for onshore and offshore operations. Consistent with the relative strictness of discharge criteria, the average content of oil in water for onshore discharges is significantly lower than that for offshore discharges. The overall averages offshore and onshore are reasonably consistent year-on-year. Offshore, while there are some regional differences, the average concentrations are generally significantly lower than broadly accepted regulatory norms. On the whole, concentrations are also reducing annually.

## Non-aqueous drilling fluids (NADF) on cuttings

While most drilling in the offshore oil and gas industry is achieved using water-based drilling fluids (muds), technical challenges often require the use of drilling fluids that provide higher lubricity, stability at higher temperatures and well-bore stability – non-aqueous drilling fluids (NADF). These challenges arise especially with new techniques such as extended-reach and directional drilling, both of which may be required to develop many new reservoirs or to improve recovery from previously identified resources.

Non aqueous drilling fluids contain more than 30% non-aqueous base fluid (NABF) as a continuous phase (typically 50-80% by volume), the remainder consists of brine, barite and other materials such as gels and emulsifiers. The data gathered as part of the OGP EPI project relate only to NADF adhering to cuttings that are discharged to the Marine environment. Three categories of NADF have been defined, principally on the basis of their aromatic content: Group I fluids (diesel and conventional mineral oil) containing >5% aromatics; Group II fluids (such as low toxicity mineral oil) containing 0.5-5.0% aromatics; Group III fluids (such as enhanced mineral oil and synthetics) containing less than 0.5% aromatics.

Relatively few companies provided information on quantities of NADF-containing cuttings discharges. No data were received on discharges of Group I fluids and although this does not automatically lead to a conclusion that these fluids are no longer used, we believe that there is a growing presumption against their application in drilling programmes (at least where cuttings are to be discharged to sea).

## Oil & Chemical Spills

Spills are an important environmental performance indicator for the oil and gas industry, since they can have a significant and visible impact on the environment. The degree of impact is highly dependent on the nature of the release, where it occurred and how it was subsequently managed. For the purpose of this study, a spill is defined as:

*“any loss of containment that reaches the environment irrespective of the quantity recovered”.*

The majority of spills in the upstream sector are oil spills. Chemical spills occur only infrequently and quantities released are generally small.

From the data received for activities in 2007, 3,036 oil spills greater than 1 bbl in size were reported, releasing a total of 13,416 tonnes of oil. In 2008, there was a drop to 2,978 oil spills (greater than 1 bbl in size) reported but the total released was 18,266 tonnes of oil. The rise in the total volume spilled resulted from a single incident that occurred in Angola where 2,781 tonnes of oil were spilled i.e. 13% of the total volume spilled. The accident occurred as a result of equipment failure (not linked to corrosion) during tanker loading. 6% of the material spilled in that incident was recovered.

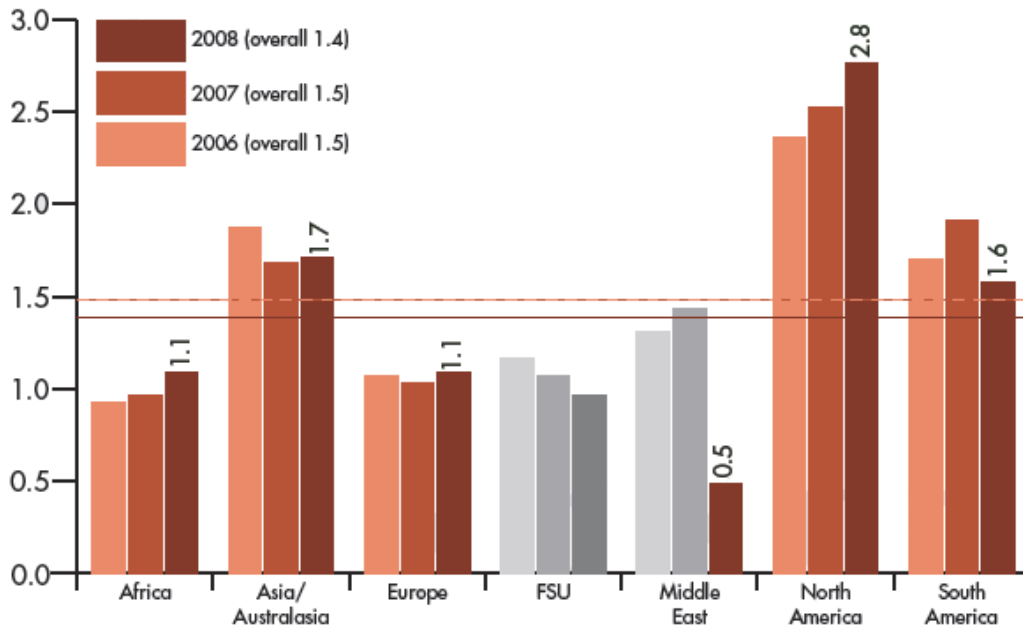
## Energy Consumption and Flaring

Establishing a reliable and meaningful measure for Energy Consumption has proved to be one of the less tractable indicators in the project. Energy consumption will vary widely depending upon the specific local circumstances and operational conditions. In many oilfields the energy is derived from locally produced gas used as fuel in turbines to produce electricity and drive compressors. Other uses include:

- Driving pumps that produce the hydrocarbons (and any associated produced water).
- Heating produced oil for separation.
- Producing steam for enhanced oil recovery.
- Driving the pumps to re-inject produced water, inject water for water-flooding and transport the produced oil through pipelines.
- Powering compressors to re-inject produced gas or to export it through pipelines.
- Driving turbines to generate electricity needed for the operations and for living quarters e.g. at offshore platforms.

As shown in Figure 7, the overall average normalised energy production is fairly stable year-on-year. In 2008, OGP reporting companies consumed on average 1.4 GigaJoules of energy for every tonne of hydrocarbon produced. This is a 7% reduction compared to the 2007 average and is influenced by new reporting of energy and production data by companies operating in the Middle East region.

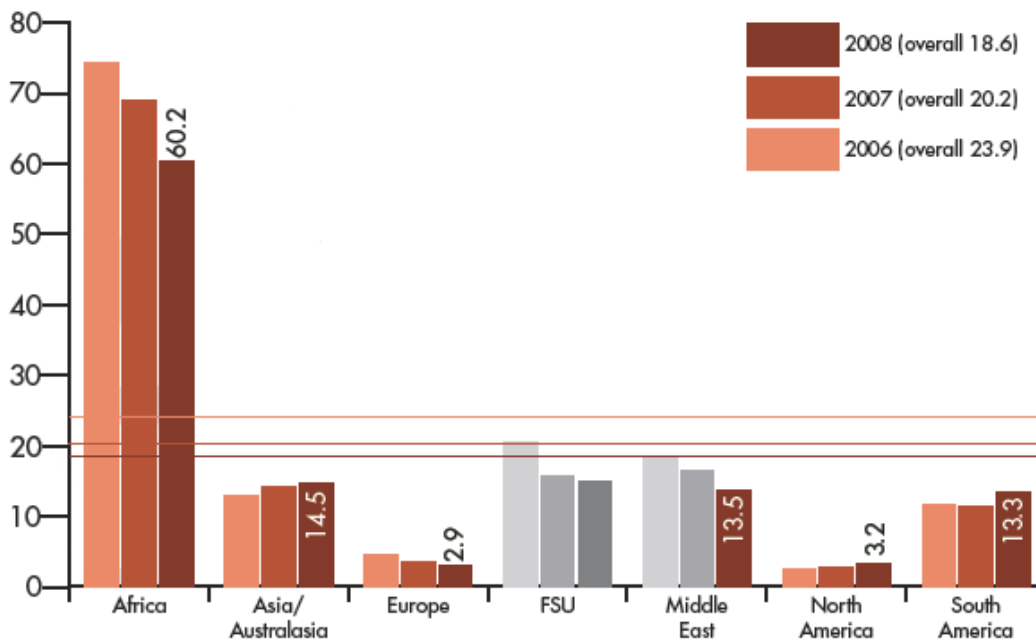
Figure 7. Energy consumption per unit of production – by region (GigaJoules per tonne)



Flaring is the controlled burning of natural gas produced in the course of oil & gas exploration and production operations. It includes the controlled and safe burning of gas which cannot be used because of commercial or technical reasons. Flaring is a major source of gaseous emissions detailed in this report.

Figure 8 shows the flaring per unit of hydrocarbon production as reported by the participating companies by region. In 2008, 18.6 tonnes of gas was flared for every thousand tonnes of hydrocarbon produced versus 20.2 in 2007 and 23.9 in 2006. These reductions in flaring rates are driven by major infrastructure improvement projects which are increasing capability to inject gas for reservoir maintenance and deliver gas to markets. Intensities are higher in the Africa region where there is limited gas sales infrastructure. Projects improving the infrastructure in Africa have helped reduce flare from 74.2 tonnes of gas flared for every thousand tonnes of hydrocarbon produced in 2006 to 60.2 in 2008. This is also reflected in the decreasing CO<sub>2</sub> and methane totals for Africa in figures 3 and 4.

Figure 8. Flaring per unit of hydrocarbon production by region (tonnes per thousand tonnes)



## Conclusions

Over the past 10 years, OGP has established a robust system of data collection and reporting for a limited range of key operational factors that form the basis of an assessment of performance. Almost half the Association's member companies now participate each year and the data are derived from activities that represent a substantial proportion of world oil and gas production. Internal quality control measures including an agreed User Guide and partly interactive data entry system have helped to reduce transcription errors and the year to year stability in key ratios gives confidence that the data are a good reflection of performance amongst the contributing companies.

New challenges continue to appear for the future direction of the programme. OGP is currently working closely with the International Petroleum Industry Environmental Conservation Association (IPIECA) and the American Petroleum Institute (API) in their work to update industry guidance on sustainability reporting parameters. OGP's EPI project will evolve with this to ensure that the data categories and thus the results reported remain useful across the industry. Alongside this, OGP will continue to expand the number of contributing companies, again focusing on bringing in national oil companies.