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Gas Flaring and Global Public Goods

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Sammendrag/Abstract
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This report examines whether gas flaring in Nigeria would be a relevant and interesting 'case' for an international seminar on Global Public Goods. Due to efforts already underway in Nigeria to curb flaring and the likely insistence by the oil companies and the Nigerian government to regard Nigeria as a 'success story', it is recommended that such a seminar address the gas flaring problem more broadly, with issues and lessons from Nigeria as only one component.

Stikkord/Key Words
Global public goods, gas flaring, climate change, governance, oil industry

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Executive Summary

Abstract

In 1998 Nigeria flared gas equivalent to 45 per cent of Norwegian gas exports that year. The flaring represents both an environmental and a resource management problem. Since the flaring problem partly has a global reach, and global collective actions could contribute to the solution, flaring could represent a case study of providing Global Public Goods. This report examines whether gas flaring in Nigeria would be a relevant and interesting "case" for an international seminar on Global Public Goods. Due to efforts already underway in Nigeria to curb flaring and the likely insistence by the oil companies and Nigerian government to regard Nigeria as a "success story", it is recommended that such a seminar address the gas flaring problem more broadly, with issues and lessons from Nigeria as only one component.

Background

With a rapidly integrating world, the global dimension of development problems is increasingly important, and calls for global collective action. In the discussion of these challenges, "Global Public Goods" has become an important concept. Global Public Goods are shared benefits; i.e. commodities, services or resources that produce benefits that everyone is able to enjoy, and for which consumption by one individual does not detract from that of another. Examples of Global Public Goods are reduced emissions of greenhouse gases, eradication of deadly communicable diseases, and peace and security.

The Norwegian Minister for Development is considering hosting an international seminar on Global Public Goods. The aim is to discuss concrete solutions and actions for a case that contains elements of Global Public Goods, and further to address more general challenges related to Global Public Goods and global collective actions (Global Governance). This report examines whether flaring from associated gas production in Nigeria would be a relevant and interesting case.

Flaring of gas in Nigeria is a topical issue in view of international efforts to curb emissions of greenhouse gases. Moreover, productive use of gas can have significant positive economic and political ramifications for Nigeria and the region. From a Norwegian perspective, gas flaring is an important and relevant issue to address, due to the presence of Statoil and Norsk Hydro in countries with major unresolved gas flaring. Moreover, during intense efforts to curb gas flaring in the North Sea, Norwegian industry and public authorities have developed technology and environmental management experiences that are relevant on a broader scale.

Issue

Based on an empirical review of the gas flaring problem in Nigeria, this report examines the potential for solving this problem through collective actions of the petroleum industry, national governments and multilateral organisations. It then discusses whether this would be an interesting "case" that could form the basis for an international seminar in Oslo on the

theme of Global Public Goods. Such a seminar should have two aims; contributing to ongoing and new efforts to contain gas flaring, and contributing to the general discussion on Global Public Goods and Global Governance.

Conclusions and recommendations

Curbing gas flaring in Nigeria - environmental and resource management problem

Close to 20 per cent of recorded world gas flaring happens in Nigeria (excluding the states of former Soviet Union, for which statistics are not available). The flaring represents global, regional and local environmental problems. It contributes to global warming through CO_2 emissions, comparable to total emissions in Norway, and an unrecorded amount of vented methane, the latter a more potent greenhouse gas than CO_2. Emissions of SO_2 and NO_x are reported to have led to the destruction of freshwater and forests resources in the coastal areas of Nigeria, and heat and soot from smoky flares have had adverse environmental impacts on human health and on agriculture.

Nigeria is also losing considerable amounts of potential income from gas sales. Moreover, gas flaring reduces the opportunities for using gas for energy purposes in a region with large and unmet needs. The energy crisis in Nigeria and other countries in the region has resulted in major economic losses and human hardship.

Reduced gas flaring as Global Public Goods

Whichever way one defines and delineates the concept of Global Public Goods, several of the important benefits that accrue from reduced flaring could be characterised as such. Reduced emissions of greenhouse gases is generally recognised as a typical example of a Global Public Good. Moreover, diverting associated gas from flaring to sustainable use in Nigeria and neighbouring countries can contribute to poverty reduction and possibly to conflict prevention, through economic and political co-operation. Poverty reduction and conflict prevention can also be Global Public Goods. Although the latter effects will not be as explicit as the reduction of greenhouse gases, and will definitely be harder to achieve, they are potentially very important.

Ongoing efforts in Nigeria

Important steps are being taken to reduce gas flaring in Nigeria. The most important is processing associated gas to liquefied natural gas (LNG) for exports. Also converting gas to petroleum products is being discussed. These projects will enhance utilisation of associated gas (currently being flared) to about 28 billion Sm^3 per year in 2008. This amount corresponds to about 140 per cent of the volumes being flared in 1998. However, one should also take into account that production of associated gas is slated to increase due to increasing oil production. Thus, in order to eliminate flaring there would be a need to find outlets for some of the gas at the national Nigerian market or in the neighbouring countries.

The fate and timing of projects that depend on gas supplies to the Nigerian or regional markets in West Africa are, however, more uncertain. The West Africa Pipeline project and projects aiming to expand gas power generation in Nigeria could take up to 50 per cent of the volumes being flared in 1998, but they will only be finalised if private investors expect that they can earn a return on their investments in supply capacity. Under the prevailing political

and economic conditions, the risks of such investments must be perceived as high. Lowering these risks is therefore an important precondition for such investments.

A seminar on flaring in Nigeria

Gas flaring in Nigeria touches upon several aspects of Global Public Goods where global governance is required. Any seminar on gas flaring and Global Public Goods would therefore appear to benefit from inclusion of issues and lessons learnt from Nigeria.

We would, however, not recommend that such a seminar focus only on Nigeria. A large part of Nigerian gas flaring is already in the process of being significantly reduced, in response to governmental policies and active initiatives from the petroleum industry, and concrete plans exist for a total elimination of flaring. The petroleum companies, notably Shell and Chevron, would probably argue that they have the problem under control, and the attitude of the Nigerian authorities could be expected to be similar. In a seminar they would probably insist on referring to Nigeria as a success story and a show-case for fruitful industry–government interaction, rather than a case where global governance could make a contribution. The one flaring related issue that is unresolved, and where some collective efforts possibly could make a difference, is the development of markets for the un-flared gas in Nigeria and the region. That, however, would to some extent take the focus away from flaring as the main subject matter. Moreover, the market development issue is an inseparable part of the broader problem of political instability and institutional weaknesses that has hindered economic and social development for many decades. This issue is already a very common seminar theme, to which a Norwegian event is unlikely to contribute anything new. In conclusion, an agenda focussed on market development issues probably would have to be very broad and complex in order to stand out as something different from other seminars that address similar issues.

It should also be mentioned that UNIDO, the World Bank and the Norwegian Ministry of Foreign Affairs are financing a workshop in Abuja, Nigeria from 26th to 28th March of this year ("Workshop on Building Capacity to Facilitate CDM projects: Oil and Gas and Manufacturing Industry Sectors"). Though this workshop is targeted at very different group of people and with another objective, its thematic focus partly overlaps with that of the seminar in question.

Recommendation

Our recommendation is that the Minister should consider hosting a seminar that looks more broadly at the venting and flaring of gas.

The flaring issue is potentially very important from the standpoint of Global Public Goods. Since it is an issue that will require the participation of a number of different players to resolve, it should be well suited for collective efforts by industry, national governments and IFIs. It should be noted that the World Bank has expressed an interest in taking an active part in this issue, which is said to be a top priority in its petroleum sector assistance programme.

As an important aspect of the climate change problem, the flaring issue does not yet appear to be sufficiently addressed. Moreover, it is likely to be relatively concrete and manageable, due to the relatively few actors involved.

However, the statistics behind flaring, as well as what measures actually are being taken and can be taken are still poorly understood. A seminar on this issue therefore would be a good occasion to examine the situation in more detail. Such a seminar could create a good base on which further research and action could be undertaken. For example, the seminar could aim at launching an international initiative on venting and flaring. The Norwegian government, with the support and participation of industry and other partners, could help launch such an initiative, which could be managed by the World Bank. A seminar on the flaring issue – which could include an examination of the Nigerian experience, but would also cover the flaring issue more broadly -- could be the start of such a process.

1 Introduction

The Norwegian Minister for Development has asked ECON Centre for Economic Analysis and the Fridtjof Nansen Institute (FNI) to examine whether gas flaring in Nigeria is suitable as a case for an international seminar on Global Public Goods.

The study has three parts:

1. A review of the characteristics and scale of gas flaring in Nigeria and efforts to solve it. Economic, technological as well as institutional and political issues will be addressed, with emphasis on factors that represent obstacles and opportunities for a solution.
2. Examination of the potential role of various national and international bodies and funding mechanisms to play a role in bringing the issue forward toward to a solution.
3. Discuss whether the Norwegian Minister for Development should host a seminar on gas flaring in Nigeria. The seminar should possibly have a limited attendance (13-15) of high level decision makers and experts from institutions that are central in relation to the "case" and who can contribute to the broader discussion on Global Public Goods and Global Governance.

The project team from ECON and FNI has meet with representatives from the World Bank, Shell, Chevron and Statoil.

In this report quite some emphasis has been given to understanding of the characteristics and scale of gas flaring in Nigeria and, and on the status in efforts to solve it. This is presented in Chapter 2 and 3 in the report. The potential role of various institutions to solve the flaring problem, and the merits of holding a seminar on the issue are examined in Chapter 4 and 5.

2 Gas flaring

2.1 The flaring problem

Flaring of gas in Nigeria is a problem with two key dimensions; environment and resource management.

The *environmental problems* caused by flaring are mainly global, but to some extent also regional and local. Global environmental impact is due to the burning of associated or solution gas, which produces carbon dioxide (CO_2) and methane (CH_4). These emissions increase the concentration of greenhouse gases (GHG) in the atmosphere, which in turn contributes to global warming[1]. Flaring may furthermore contribute to local and regional environmental problems, such as acid rain with attendant impact on agriculture, forests and other physical infrastructure. In a review on progress made in implementation of Agenda 21, the Nigerian Government argued that "gas flaring and the resultant problems of ecosystem heat stress, acid rain and acid precipitation have prompted destruction of freshwater and forests resources in the coastal areas of the country"[2]. (However, Shell has argued that it is "unlikely that oil flaring is a major contributor to acid rain as the gas is very low in sulphur"[3].) Heat, soot from smoky flares and emissions of noxious gases (NO_x) may also have adverse environmental impacts, in particular on agriculture, and may also contribute to health problems[4].

Gas flaring is furthermore a waste of a resource with potentially high economic value. As such, it represents a *resource management problem*. Flaring reduces the opportunities for using gas for energy purposes in a region with large and unmet needs. Nigeria and other countries in the region are facing a serious energy crisis due to declining supply capacity in several energy sub-sectors. In the power sector, persistent shortages of generation capacity and frequent power outages caused by deteriorating infrastructure result in major economic losses and human hardship. Currently, only 10 per cent of rural households and about 40 per

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1 In its 3rd assessment report the IPCC concludes that "most of the observed warming over the past 50 years is likely to have been due to the increase in greenhouse gas concentrations" IPCC WG1 (2001) *Third Assessment Report: Summary for Policymakers*, p. 6.

2 Document available at http://www.un.org/esa/earthsummit/nigeriac.htm#chap8, [23.02.01]. See also news brief containing a statement by the Minister of state for environment, available at http://www.gasandoil.com/goc/news/nta04849.htm, [22.02.2001], and EIA (2000), *Nigeria: Environmental Issues*, April 2000, http://www.eia.doe.gov/emeu/cabs/nigenv.html, [22.02.01].

3 Shell, *Information resource*, http://www.shellnigeria.com/info.

4 Nitrogen oxides are formed whenever combustion take place, whilst in most countries such emissions stem mainly from the burning of fossil fuels. The quantity and compisition depends on how combustion takes place and at what temperatures. In general, the amount of nitrogen oxides increases with increasing temperature. See McCormick (1997) and Elvingson and Ågren (1997) for an overview of environmental and health problems associated with the burning of natural gas and other fossil fuels.

cent of Nigeria's population have access to electricity[5]. Gas is also an important potential driver for rural energy development. However, due to low demands and underdeveloped gas markets, it represents only about 4 of total energy consumption in Nigeria[6]. Traditional energy sources, such as biomass, account for about 56.6 per cent of total energy consumption.

Nigeria is also losing considerable potential income from gas sales. Nigeria's estimated 3,5 trillion standard cubic meters (Sm^3) (124 trillion cubic feet) of proven natural gas reserves constitute the 10^{th} largest gas reserves in the world, and are double the country's crude oil reserves in terms of energy content[7]. About 30 per cent of these gas reserves are located offshore.

The environmental and resource management problems are inextricably coupled. Ameliorating one of the problems may thus facilitate the reduction of the other, whilst also bringing ancillary economic and social benefits. For example, reducing flaring is an important measure to curb emissions of greenhouse gases, whereas recovering and distributing the associated gas currently being flared may contribute to solving domestic and regional energy problems. Enhancing local and regional utilisation of gas may furthermore improve resource management, provide access to modern and clean energy, and halt desertification and deforestation by substituting gas for traditional fuelwood and other biofuels. Giving the rural population access to modern energy is often a prerequisite for poverty alleviation. It brings major economic, social and environmental benefits, including health improvements from the elimination of indoor smoke and pollution from traditional fuel use.

2.2 Why flaring?

Associated or solution gas is a blend of different hydrocarbons that is released when crude oil is brought to the surface. The composition and amount of such gases vary between different oil fields. For a platform facility and the operating personnel the flare is commonly recognised as a vital safety system. In the event of emergency shutdowns, non-planned maintenance or disruptions in the processing system (e.g., pressure build up), the gas can be diverted to the flare and disposed of safely. Hence, there are circumstances under which some *non-routine* use of flaring will always be present, such as for safety purposes and unplanned shutdowns (e.g., for maintenance operations). However, the oil industry and national authorities in many countries are increasingly seeking options and actions for the optimal management of gas flaring, with the overall goal of ending continuous or *routine* flaring of associated gas. The advent of new technical options shows that it is indeed possible for such continuous flaring to cease.

Other than flaring, there are in principle three alternative routes for the management of associated gas resources, in terms that the gas can be:

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5 EIA (2000) *Nigeria: Country Analysis Brief*, August 2000, http://www.eia.doe.gov/emeu/cabs/nigeria.html, [08.01.01].

6 EIA (2000), *Nigeria: Environmental Issues*, April 2000, http://www.eia.doe.gov/emeu/cabs/nigenv.html, [22.02.01].

7 *Op.cit*.

- Re-injected into the reservoir to maintain pressure and enhanced oil recovery (EOR) or stored in underground formations;
- Used for energy purposes on the production facility or nearby facilities;
- Collected, cleaned and sold.

Choosing the appropriate route depends on 'upstream' conditions, such as field characteristics and the oil-to-gas ratio, as well as offset opportunities ('downstream') for the recovered gas and the energy demand of the production facility. In cases where associated gas cannot easily be captured or used for energy purposes, flaring or burning of gas has traditionally been considered a safe and effective means for disposing of 'unwanted' associated gas. Moreover, flaring is preferred to venting, since most of the methane (most volatile component) is transformed to CO_2 with lower environmental impact. In fact, efficient flaring reduces methane emissions by 98 per cent compared with venting[8]. As we shall describe in more detail below, the extent of flaring depends on a range of technical, economic and political factors, including national legislation and regulations.

There are several factors rooted in economics, history and geography that account for the large volumes of gas currently being flared around the world. However, in Nigeria, as in many other countries, three factors stand out as particularly important:

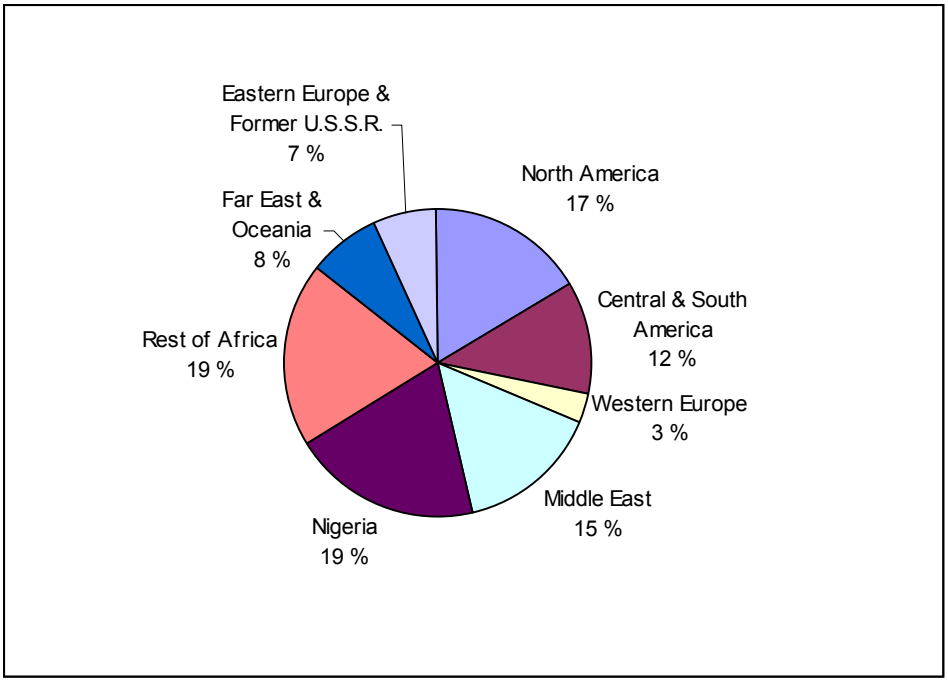
- Many of the production facilities were constructed between the 1960s and early 1980s, subject to the technical standards and (low) environmental awareness prevailing at the time. Little was done at the time to develop an infrastructure for gathering and distributing associated gas.
- There has traditionally been minimal domestic demand or other offset-opportunities for gas. In Nigeria, today's commercial demand for gas is approximately 9 million Sm^3 per day, which represents only some 15 per cent of the total volumes of associated gas currently being flared, or about 57 million Sm^3/d in 1998. Thus, simply replacing the small commercial volumes with non-associated gas cannot by itself solve Nigeria's flaring problem.
- The volumes of associated gas produced from a single field are often small and of low pressure, which increases the cost of recovery, treatment and distribution.

[8] Freund, P., P. Riemer and P. McMullan (1998) "Technologies for Reducing Methane Emissions", Paper presented at GHGT-4 in Interlaken, Switzerland, 30 August - 2 September 1998, Available at http://www.ieagreen.org.uk/, [27.02.01].

2.3 The scale of gas flaring in Nigeria

Nigeria flares more gas than any other country for which statistics are available[9]. As shown in Figure 2.1, Nigeria was in 1997 responsible for 21 billion standard cubic metres (BSm^3), or some 19 per cent of recorded gas flared worldwide. (Africa as a whole accounted for 38 per cent.)[10]

Figure 2.1 Amount of gas flared/vented worldwide in 1997



Source: EIA

In comparison, the amount of gas flared in Norway that year was only about 0.44 BSm^3, despite the fact that Norwegian crude oil production was about 50 per cent larger than Nigeria's (~2 million barrels per day), and that Norway's natural gas production was more than double that of Nigeria's. A more comprehensive overview of worldwide flaring and production statistics is given in Annex 1.

It has been estimated that Nigeria flares as much as 70 per cent of the gas it produces. The remaining is used for energy purposes on production facilities, re-injected to enhance oil recovery, or sold to industries[11]. A graphical illustration of the physical flows of natural gas for the year 1998 is given in Figure 2.2.

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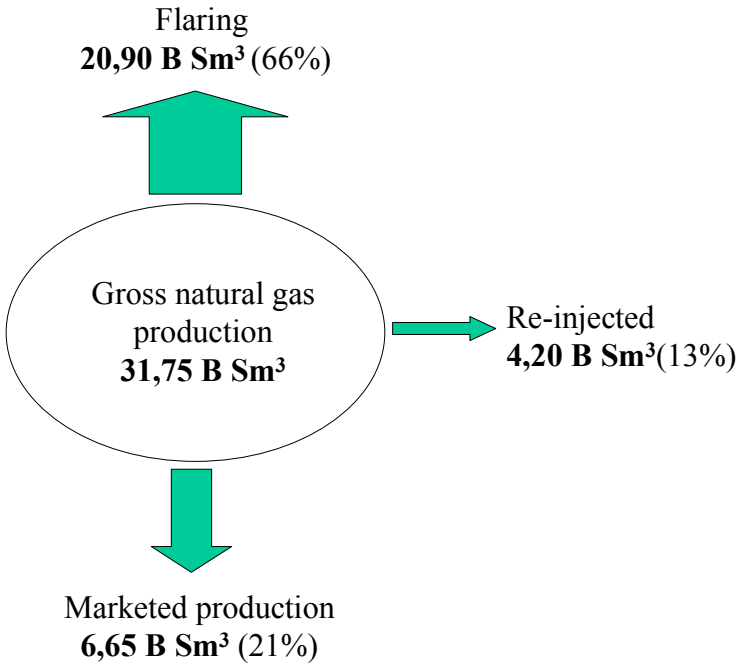
9 Flaring in Russia is not included in the data presented here due to lack of official statistics. Flaring in Russia is considered to be on a significant scale, particularly of associated gas produced by the oil industry in West Siberia, which has hitherto had little incentive to sell gas to the *de facto* gas monopoly Gazprom.

10 Statistics provided by the US Energy Information Administration, http://www.eia.doe.gov, [22.01.01].

11 EIA (2000) *Nigeria: Country Analysis Brief*, August 2000, http://www.eia.doe.gov/emeu/cabs/nigeria.html [08.01.01].

Figure 2.2 Flow statistics of Nigerian gross gas production in 1998



Source: EIA

Marketed production of 6,65 BSm^3 of natural gas is used for power generation and other industrial uses. Dry gas production represents 5,90 Sm^3 of this amount, which means that in fact more than 80 per cent of associated gas (AG) production was flared in 1997 (20,90 out of 25,85 BSm^3). Statistics furthermore reveal that flaring decreased somewhat from 1997, when about 70 per cent of gross gas production and 85 per cent of AG was flared.

Shell Petroleum Development Company (SPDC) produces about half of the gas flared in Nigeria, and is the largest oil multinational in Nigeria with just under half of the country's daily production of oil and about 95 per cent of supplies to the domestic gas market. Statistics for Shell operations over the years 1997-99 are given in Table 2.1, which shows that more than 97 per cent of the AG produced by Shell was flared in 1999, even though the volume of gas being flared is decreasing[12]. However, the main reason for this reduction is the selective closing of wells producing a high ratio of gas compared to oil.

Table 2.1 Gas flaring from Shell operations in Nigeria (Source: Shell, 1999)

	1997	1998	1999
Oil production (b/d)	899,000	769,000	706,000
AG produced (million Sm^3/d)	25,3	22,4	20,4
AG flared (million Sm^3/d)	24,3	21,0	19,9
per cent of AG flared	96,0	93,8	97,5

[12] Shell (1999) *Environment Report*, http://www.shellnigeria.com/info/env_1999/envreport_t.htm, [22.01.01].

Because of low gas demand in the domestic and regional markets and the lack of a gas utilisation infrastructure, most of Nigeria's gas production is currently aimed at European markets and the West-Africa sub-region. There is currently no supply of natural gas for domestic and commercial heating purposes in Nigeria. The share of associated gas used for re-injection is also relatively low compared to other producing regions, such as the North Sea, where about 30-40 per cent of the associated gas is re-injected for enhanced oil recovery[13]. However, according to Shell "most reservoirs are unsuitable for large-scale reinjection"[14].

The high rate of flaring demonstrates that Nigeria has been unable to capitalise on its vast resources of natural gas.

[13] Interview with researcher at Sintef Petroleum Research.

[14] *Information resource* on harnessing gas in Nigeria, Avaliable on Shell's web-site http://www.shellnigeria.com, [15.02.01].

3 Curbing gas flares

3.1 Overview: opportunities and barriers

Opportunities for reducing and eventually eliminating flaring of associated gas (AG) in Nigeria depends firstly on *technological* and *commercial/market factors*. This chapter starts with a general overview of technological options to curb flaring, stressing in particular the need for 'downstream' developments in order to enhance utilisation of AG. The chapter also reviews the current status of efforts and commercial projects aimed at reducing flaring. It also looks at the broader *organisational* and *politico-economic framework*, which is of critical importance for the viability of investments to curb flaring. These factors are discussed in a brief outline of Nigerian policy on gas flaring, and are also covered in the subsequent chapter (Chapter 4).

There are also a number of *barriers* or *impediments* that may constrain the formulation and implementation of emissions abatement strategies. Such impediments are commonly divided into categories such as *technical*, *economic* (market), *political* and *social*.

Technical impediments to reduce flaring include safety considerations, low-pressure associated gas, reservoirs unsuitable for re-injection, location of production sites, and distance to processing and consumption centres. Technological progress may to some extent remove these barriers, and investments that earlier were considered prohibitively expensive are gradually becoming economic. Still, there are cases where an entire phase-out of flaring are not feasible, and where the realistic target is to reduce the volume being flared or increase the efficiency of the flaring.

In addition to the direct costs of investments, the economics of flaring projects are sensitive politico-economic factors such as regulations and financial incentives provided by the national government. The Nigerian government has for a long time had explicit policies for gas flaring, but it has only been recently, after the introduction of significant tax breaks, that governmental policies have had any major impact. This, together with a proactive attitude on the part of the international petroleum industry operating in Nigeria, has helped to initiate a number of projects to reduce and eventually eliminate flaring. However, what will actually be implemented depends critically on developments in domestic and regional gas markets that offer a potential outlet for the gas. The gas can be exported out of the region by ship as LNG, or it can be consumed in Nigeria or in neighbouring countries. The latter will again depend on political and economic factors (to be further discussed in Chapter 4).

3.2 Technological opportunities to reduce flaring

Decision tree

Since commercially available solutions do not (yet) exist for separating CO_2 from the flue gases, the only viable 'upstream' option for emissions abatement is to reduce the amount of flare gas. The following policy objective hierarchy thus represents possible abatement strategies[15]:

1. Eliminate flaring
2. Reduce flaring
3. Improve flaring efficiency.

This objective hierarchy or 'decision tree' requires the operator to consider first whether or not a flare is necessary (see Figure 3.1). This in turn requires careful assessment of technological, economic, environmental and social factors. If assessments reveal that a flare is required for safety or other operational reasons, the operator needs to consider different measures and technical options for reducing the volume of associated gas flared. Finally, the operator should identify and implement appropriate measures so as to ensure the maximum efficiency of the burner configuration in order to minimise emissions.

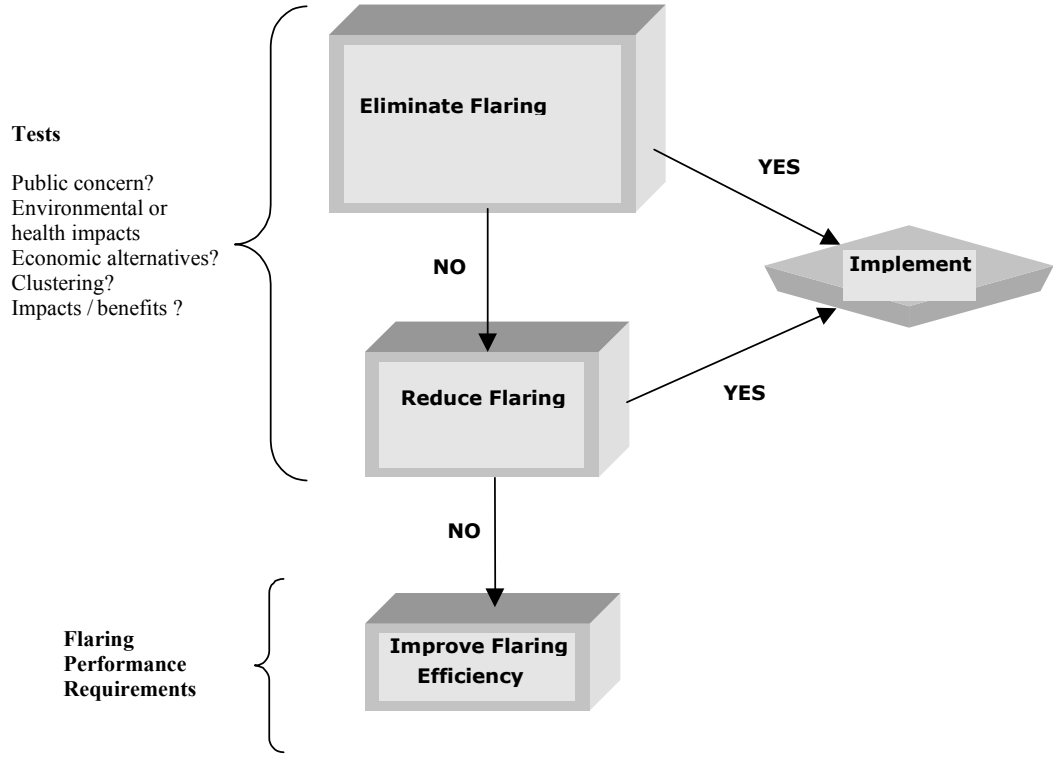
Regarding the third level of the decision tree, there are several requirements that may be imposed to increase flare efficiency and mitigate environmental problems. A report from the Clean Air Strategic Alliance suggests the following flare performance requirements[16]:

- Gas directed to a flare should have a certain minimum heating value.
- A flame must be present whenever hydrocarbons are directed to a flare.
- Never direct liquid hydrocarbons to a flare.
- Visible emissions should not exceed a certain opacity limit over a given period of time.
- Flares should be designed in compliance with ambient air quality standards.
- Radiant heat density at ground level shall not exceed a certain level.

[15] Clean Air Strategic Alliance (CASA) (1998) *Management of Routine Solution Gas Flaring in Alberta: Report and Recommendations of The Flaring Project Team*, CASA: Edmonton, June 17, 1998.

[16] Ibid.

Figure 3.1 Decision tree



Source: CASA (1998)

Implementing measures to eliminate or reduce flaring

Even though it is in many cases technically feasible to eliminate routine gas flaring, as has been done on some production facilities in the North Sea[17], it is evident that flaring strategies also hinge upon 'downstream' opportunities. This again depends on the availability and costs of technologies to make use of and/or safely deposit the recovered gas, as well as the potential demand for gaseous products at the domestic, regional and international level. Technical assessments made by the oil industry reveal that there are indeed several options for enhanced utilisation of AG:

- Electricity production using (micro) gas turbines or reciprocating engines;
- Combined heat and power production (co-generation);
- Gathering and compression for further processing or sales;
- Re-injection into the oil field for enhanced oil recovery (EOR); and
- Temporary deposits in exhausted reservoirs or aquifers for later use.

There are also technological options that require co-operation and collaboration between production facilities and companies, e.g.,

[17] See Christiansen, A.C (2000) *On the Effectiveness of Environmental Taxes: The Impacts of CO2 Taxes on Environmental Innovation in the Norwegian Petroleum Sector*, FNI Report 10/20, The Fridtjof Nansen Institute: Lysaker, Norway.

- *Clustering* of gas from several flares in order to aggregate supplies and improve economics; and
- *Clustering* of production facilities in order to optimise energy requirements and uses.

Taking into account the underdeveloped gas markets and lack of infrastructure for collection and distribution at the domestic and regional level, however, it is evident that reducing flaring will require investments in order to make the gas available for other beneficial uses or third parties (e.g., end-users). Hence, even though it is technically feasible to reduce and even eliminate flaring, the costs of technology to facilitate gathering, processing and distribution of recovered gas could be considerable. In Nigeria, the lion's share of investments for expanded use of gas will be needed for infrastructure developments, including pipelines, gathering and processing facilities, as well as production plants for the conversion of associated gas to marketable products.

3.3 Nigerian policy on gas flaring

In 1979 the Nigerian Government passed the so-called Associated Gas Re-injection Decree, under which oil producing companies were expected to develop projects aiming at utilising associated gas. The companies were given four years to reach compliance, and gas flaring was to cease by January 1 1984[18]. Lack of economic incentives and regulations, however, deterred investments in associated gas utilisation projects, and no project of any substantive size was undertaken by the companies within this time span, except for some re-injection projects. Failing to comply, the companies were instead fined a penalty for flaring.

In 1985 a new Decree permitted companies to continue flaring if issued a Certificate by the Minister stating that gas utilisation or re-injection was inappropriate for the field in question. The issuing of such certificates was subject to payments by the companies. In 1995 this penalty was increased 20-fold from 0.50 Naira to 10 Naira (about 0.12 USD) for every 1,000 cubic feet (28.32 standard cubic meter) of natural gas. It is not quite clear whether the government's motive was to end flaring or to raise revenue.

The Government has also introduced generous economic incentives for investments in gas-to-liquid projects and for companies dedicated to enhancing utilisation of gas-resources. These incentives are spelt out in the Associated Gas Utilisation Fiscal Incentives (AGUFI). In January 1998 the Government decided to cut income taxes for gas projects from 85 per cent to 35 per cent. Gas projects would thus be treated under usual company income tax rates instead of the higher tax rates applicable to income from oil production. (For integrated oil and gas projects, oil operation is to be separated from gas operation.) The Government has also introduced associated gas utilisation clauses in production sharing contracts (PSCs) with oil companies, and requires all companies to come up with a plan (forecasts) for the management of associated gas.

More recently, president Obasanjo has also threatened more stringent regulatory action, warning that unless the companies work actively to cut flaring, more drastic penalties would be imposed. In the current policy it is clearly stated that flaring should cease by 2005. This

[18] http://www.mbendi.com/adc/nngas02htm, [22.01.01].

has caused some concern within the oil multinationals, which have responded that accelerating the flare-out target to any date earlier than 2008 would require huge investments in order to acquire the requisite technology. Subject to availability of funds, the companies have said they would be able to meet the following phase-out dates: Chevron, 2008; Elf, 2008; Shell (SPDC) 2008; Texaco, 2005/6, Agip, 2005; and Mobil 2004. However, flaring could possibly be brought to an end at an earlier date, if for instance all the terminal power stations in the country were made to utilise the gas now available in the oil fields.

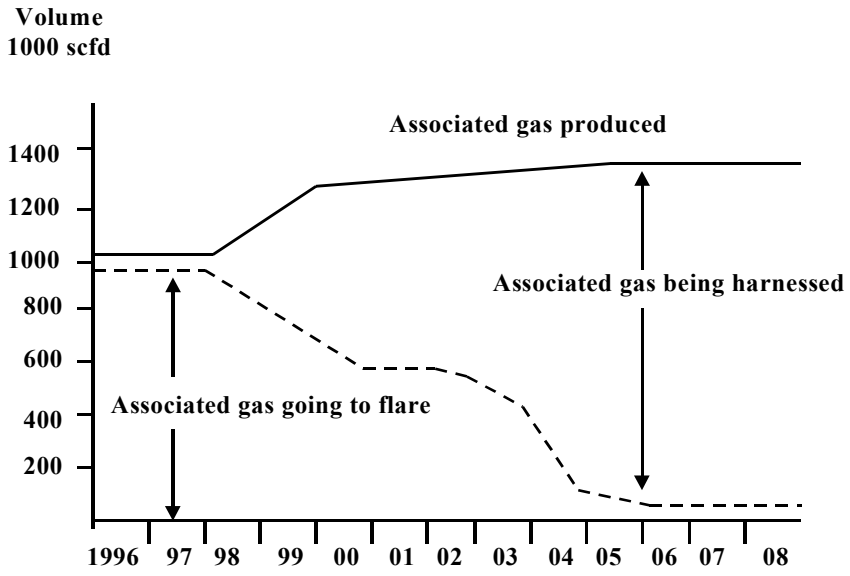
3.4 Projects to curb gas flaring

There are currently about 10 on-going or planned projects aimed at enhancing the utilisation of associated and non-associated gas in Nigeria[19]. Provided all of these projects are implemented, the total gas demands will in fact exceed the amounts of associated gas currently being flared. That said, it should be noted that some of the key projects, such as the Nigerian Liquefied Natural Gas (NLNG) project, and the Escravos project, aim primarily to provide gas-products (LNG, LPG, NGL, GTL) to export markets. Projects conducive to supporting and facilitating regional developments (beyond employment in gas export related industries), such as investments in domestic industries, the domestic energy sector, and infrastructure investments (pipeline projects), are inherently of a different character, and are thus treated separately.

The following sections provide more details on the most important of these projects. For the purpose of illustration, Figure 3.2 provides forecasts for the harnessing of AG currently being flared from Shell's operations in Nigeria, projected until the estimated phase-out date of *routine* flaring in 2008. The Figure shows that by implementing project plans that are now in the pipeline, Shell would reach the target of practically eliminating flaring by 2008, though with a 5 per cent flare allowance for non-routine flaring.

[19] Overview of Nigerian Gas Industry, Available at http://www.mbendi.com/adcg/nggas01.htm, [22.01.01].

Figure 3.2 Projections of associated gas utilisation and flaring from Shell's operations



Source: Shell

The solid (upper) line represents Shell's production of AG, for which the increase is due to projected increasing oil production. The dashed line is Shell's projection for the amount of AG going to flare, whilst the area between these two lines represents the amount of AG to be harnessed for various purposes.

The Nigerian Liquefied Natural Gas project

The largest single project to harness natural gas in Nigeria is the Nigerian Liquefied Natural Gas (NLNG) project, which originally began back in 1985. Put briefly, the objective of the NLNG project is to transport associated and non-associated gas by pipelines to a liquefaction plant on Bonny Island. At the plant, natural gas is processed to remove water and carbon dioxide. The processed LNG, which is a blend of lighter hydrocarbons with methane as the primary component, is then shipped to markets in Europe and the US.

A framework agreement was signed between NNPC, Shell, Cleag Bermuda (TotalFinaElf) and Agip in November 1985, with Shell as the technical partner and largest foreign investor, holding a 25.6 share of the joint venture (JV). However, a construction contract for NLNG was not signed until December 1995, with construction work only starting in 1996. The plant came on stream in September 1999 and made the first overseas shipment of LNG in October of that year. Total project costs are estimated to some 3,8 billion USD, including a two-train liquefaction plant, a 218-km gas pipeline system, associated gas utilities, storage and loading facilities as well as other infrastructure investments, which together makes it Nigeria's single biggest investment project[20]. The plant is expected to produce some 7.15 billion Sm^3 of LNG per year. Owing to the lack of domestic and regional offset-markets, all production volumes will be exported.

[20] http://www.shellnigeria.com, [22.01.01].

Initially, about 5,6 million Sm^3/d (200 million scf/d) or some 40 per cent of the feed to the LNG plant will be associated gas currently being flared[21]. As work continues, total gas supplies from the Soku and other fields is expected to grow to about 14 million Sm^3/d (500 million scf/d) for production trains 1 and 2[22]. If associated gas makes up half of these supplies - 7 Sm^3/d - the NLNG project will alone reduce Shell's flared gas by 35 per cent compared to 1999 levels (see Table 1).

In mid-1999 the Joint Venture confirmed that a *third* LNG production train would be built, expanding the overall LNG processing capacity to 10.85 billion Sm^3. Construction work has begun with a target commissioning date of 2003. If and when the third train becomes fully operational, it is slated to increase gas supplies to about 25 million Sm^3/d (870 million scf/d), with associated gas as the primary supply[23]. In comparison, Shell's flared gas amounted to 19,9 25 million Sm^3/d in 1999, whilst the total volume of gas being flared in 1998 was about 57 million Sm^3/d, or about twice the size of the NLNG project.

The launching of the third train is the key building block in Shell's plan for an *integrated* oil and natural gas development project, involving four big offshore oil fields and offshore and onshore gas gathering pipeline networks. The overall cost of this plan is estimated to be some 8.5 billion USD, making it the biggest industrial investment made in sub-Saharan Africa. In fact, the Joint Venture has already pre-sold all output from the third train to European customers, and Shell is planning to introduce a fourth and fifth train, which would provide a further boost to the utilisation of Nigeria's gas reserves.

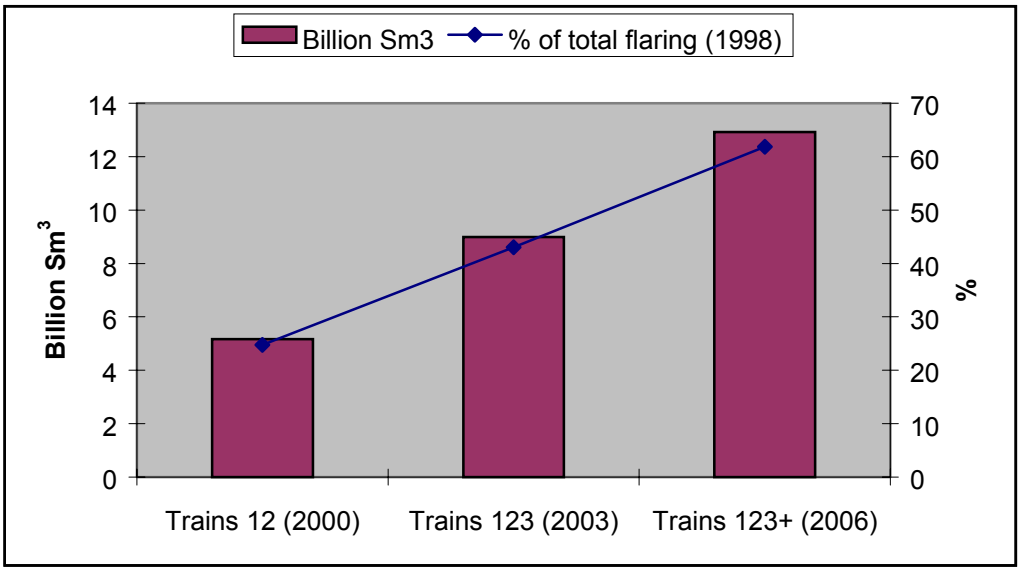
Figure 3.3 provides an illustration of plans for the NLNG project and its contributions to reduce flaring. The Figure shows that the NLNG project alone will utilise a considerable amount of AG. If and when production train 3 is fully operational (target commissioning date of 2003), the NLNG plant will mop up about 45 per cent of the AG currently being flared, whilst further expansions (additional production trains) may decrease the AG going to flare by more than 60 per cent.

21 http://www.shellnigeria.com/shell/nlng_rhs.asp, [22.01.01].

22 http://www.shellnigeria.com/info/env_1999/envreport.htm, [22.01.01].

23 http://www.shellnigeria.com/info/env_1999/envreport.htm, [22.01.01

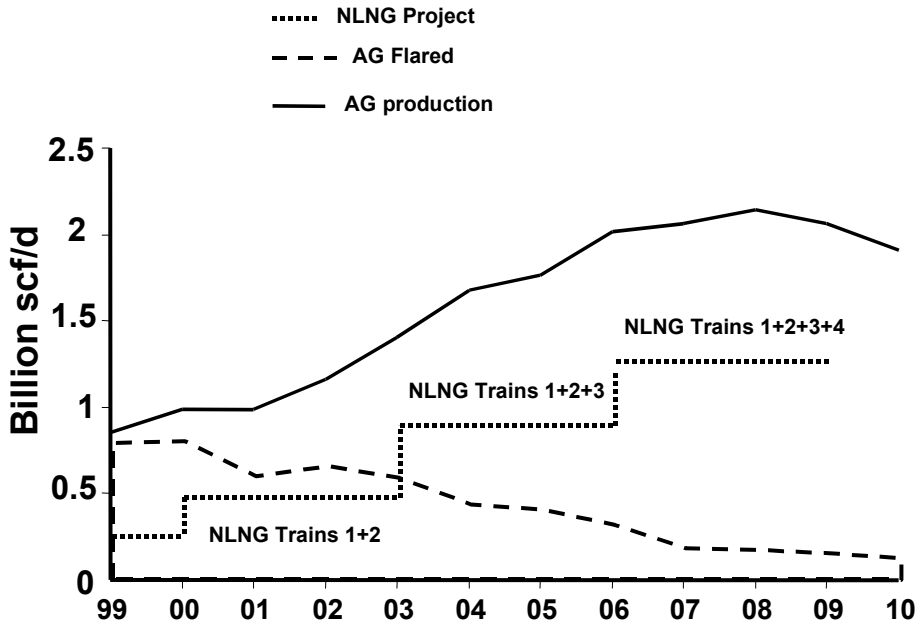
Figure 3.3 Gas supplies to NLNG project and contributions to end flaring



Source: Shell, 1999

However, one must also take into account that the amount of AG will increase with increasing oil production. As shown in the figure above the production of AG is projected to increase from about 722 million scf/d in 1999 to more than 2 billion in 2008, or about three times the production capacity of Trains 1, 2 and 3 of the NLNG project. That said, Shell is also investing in several other projects to mop up the AG, as will be discussed briefly in the next section.

Figure 3.4 Shell Nigeria assoiciated gas production and utilisation



Source: Shell

Investments in industry developments

In order to underpin Shell's efforts to enhance gas utilisation, the company also invests in domestic gas industry developments. This firstly involves investments in maintaining and upgrading gas gathering systems, for which Shell alone uses about 800 million USD per year. Shell also invests in re-furbishing the power sector, whilst making efforts to provide gas to industrial centres in order to develop a local market for gas. Other plans include supplying 85 million scf/d of gas as fuel for a new aluminium smelting plant (ALSCON), as well as the Nigerian Fertiliser Company gas supply (NAFCON). Including supplies to local industries, Shell projects regional offset opportunities for its associated gas production of about 19 billion Sm^3 annually in 2008, compared to total flaring of about 21 billion Sm^3 in 1998.

The Escravos Gas Project

In November 1997 Chevron Nigeria Ltd. (CNL) started the processing of previously flared gas into natural gas liquids (NGL) and associated liquefied petroleum gases (LPG) and condensate at its Escravos Gas Plant[24]. This first phase of the Escravos Gas Project (EGP1) was completed at a cost of about 550 million USD, and resulted in a capacity to process about 4.7 million Sm^3/d (165 million scf/d) of AG from offshore fields in the Western Niger Delta[25]. The AG is taken from two offshore fields in the Western Niger Delta and piped via an offshore gas gathering and compression platform, a floating storage and off-loading vessel to an onshore gas processing plant for the removal of LPG and condensate. The plant produces about 4.1 million Sm^3 (145 million scf/d) of NGL and 8,000 barrels per day (bpd) of LPG for export, whilst condensate is blended with the crude oil stream. The remaining dry gas is sold to the state-owned Nigerian Gas Company (NGC) for resale to local end-users. The first shipment of some 334,000 barrels of oil-equivalents of LPG was exported in September 1997 to a Houston based company in which Chevron holds an interest.

In late 1997 Chevron initiated the second phase in this project (EGP2) with the aim of expanding the gas processing capacity by an additional 3.4 million Sm^3/d (120 million scf/d) of AG. When EGP2 is fully operational it will thus nearly double the capacity for utilising AG to about 8 million Sm^3/d (285 million scf/d). Construction of EGP2 is well underway and scheduled for completion in second quarter of 2000, at a cost of some 82 million USD[26]. With EGP2, LPG and condensate exports could increase to 14,000 bpd[27]. The aim is eventually to sell conditioned gas also to regional markets via the West African Gas Pipeline Project (WAGPP).

On September 8th 2000 Chevron and NNPC announced the launch of the third phase of the EGP (EGP3) and the Escravos Gas to Liquids (EGTL) project, which are targeted for completion in 2005[28]. The EGTL project aims to extract NGL and prepare it for use in a Gas-to-Liquids (GTL) plant adjacent to the gas processing plant. The primary products will be

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[24] NGL is a general term for all liquid products separated from natural gas in gas processing or cycling plants. LPG denotes a group of hydrogen-based gases derived from crude oil refining or natural gas fractionation, and commonly include ethane, ethylene, propane, propylene, normal butane, butylene, isobutane, and isobutylene (EIA).

[25] Alexander's Gas and Oil Connections, http://www.gasandoil.com/goc/company/cna85044.htm, [23.02.01].

[26] Ibid.

[27] http://www.chevron.com/newsvs/frame.html, [23.02.01].

[28] Press release September 8, 2000, http://www.chevron.com/newsvs/frame.html, [23.02.01].

synthetic diesel with low or 'no' sulphur contents and naphtha. In September 2000 Sasol, a South African energy and chemical company, and Chevron announced they had signed the final agreements to set up a global joint venture (JV) to deal with GTL projects[29]. The venture is founded on Sasol's international leadership in developing Fischer-Tropsch gas-to-liquids technology, whilst Chevron brings strengths and resources in international upstream gas development and production. Both companies have technical strengths and experience in marketing premium GTL products. In the eyes of the Sasol, Chevron Global Joint Venture GTL projects are easier to *implement* than LNG projects, on the grounds that the products (diesel and naphtha) can be fed quite simply into the existing value chain (oil). Thus, despite relatively high costs compared to those of other alternatives for utilising natural gas, Chevron considers GTL a long-term solution in Nigeria.

About 2 billion USD will be invested in the two projects[30]. The EGP3 and EGTL could further expand processing capacity by an additional 11 million Sm^3/d (400 million scf/d)[31]. With the conclusion of these projects, the EGP will have the capacity to process more than 19 million Sm^3/d of AG or 7 billion Sm^3 per year. This means that Chevron will not only have developed plans to eliminate routine gas flaring from its operations, but also taken steps towards commercialising Nigeria's natural gas resources.

Figure 3.5 Escravos Gas Project (EGP) for enhanced utilisation of associated gas and reduced flaring

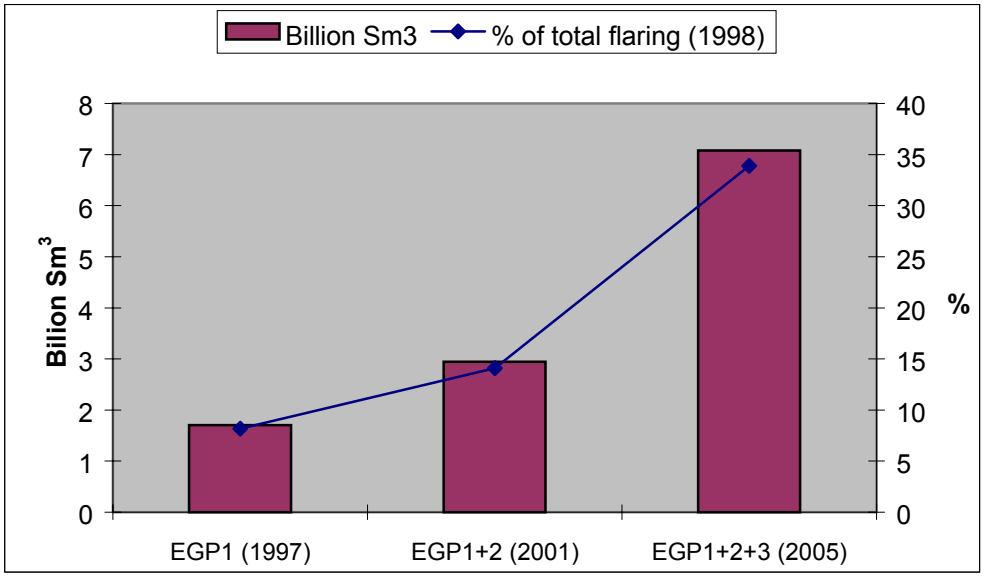

Figure 3.5 illustrates the contribution from the different phases of the EGP to reduce flaring in Nigeria. Upon completion of Phase 2 in 2000/2001, the project will utilise almost 3 billion Sm^3 per year, corresponding to some 14 per cent of total volumes of flared gas in 1998. Adding another production train in Phase 3 would in fact decrease the total volume of flared gas by some 34 per cent compared to 1998 levels.

[29] Press release October 16 2000, http://www.chevron.com/newsvs/frame.html.

[30] Ibid.

[31] Ibid.

In 1998 Chevron also began production from its Gbokoda field, the first 'zero flare' oil field development in Nigeria[32]. The associated gas will be processed for commercial use through the Escravos gas project.

OSO NGL Recovery Project

NGLs are liquids derived from the processing of natural gas by means of subjecting the gas stream to very low temperatures or pressure reduction. There are currently two Natural Gas Liquids (NGL) projects under implementation in Nigeria[33]. One of the NGL projects under implementation in Nigeria is the OSO NGL Recovery project located on Bonny Island. Mobil (now ExxonMobil) holds a 51 per cent interest in the joint venture project, with the NNPC holding the remaining 49 per cent.

The commissioning of the second stage of this 800 million USD project in 1998 marked a key step in the joint venture's efforts to reduce flaring. When fully operational, the Oso NGL project is expected to produce an anticipated 50,000 bpd of mixed propane/butane for exports, recovering a total of 350 million barrels of NGL over its lifetime. Feed gas of some 17 million Sm^3 /d (600 million scf/d), or more than 6 billion Sm^3 per year, will be supplied from the OSO condensate field and other fields operated by Mobil[34]. This makes up about 30 per cent of the AG being flared in 1998.

The bulk of the gas is expected to be used at a proposed 30-MW power station being built by Mobil to expand power supply by NEPA[35].

The West African Gas Pipeline Project (WAGPP)

Another important project development conducive to reducing flaring is the proposed West African Gas Pipeline Project (WAGPP), estimated to cost about 400 million USD. Early plans for this project were first developed in 1991, and conceptual studies funded by the World Bank were initiated in 1992 to determine its feasibility. The WAGPP may not only greatly reduce GHG emissions and local environmental problems by reducing and eventually eliminating routine flaring, but may also create the basic infrastructure that could alleviate the energy crisis on the region. The project could also generate an additional $1.4 billion of investments from private and public investors in power plants ($600 million) and new secondary industries ($800 million).

In 1998 Chevron Nigeria Limited (CNL), the Nigerian National Petroleum Corporation (NNPC) and Shell Petroleum Development Company (SPDC), formed a consortium to develop the project. Six months later, the Societe Togolese de Gaz SA, and Societe Beninoise de Gaz SA joined the consortium. The plans established by Chevron and partners are to build a 620-mile offshore line capable of initially shipping some 5 million Sm^3/d (180 million scf/d) or about 1.9 billion Sm^3 annually for sale to utilities (power plants) and other major gas users in Ghana, Togo and Benin. This represents about 9 per cent of AG being flared in 1998.

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32 Press Release April 16, 1998, Available at http://www.chevron.com/newsvs/frame.html, [23.02.01].

33 *Nigeria - Gas Industry*, http://www.mbendi.com/adcg/nggas04.html, [22.01.01].

34 Alxander's Gas & Oil Connections, http://www.gasandoil.com/goc/company/cna80968.htm, [22.01.01].

35 Ibid.

The WAGPP is connected to the Chevron/Nigeria National Petroleum Corporation (NNPC) joint venture in the Escravo area, which is the first large-scale project that focussing on enhancing regional utilisation of associated gas. In 1999 the first engineering feasibility study (EFS) concluded that the pipeline project was technically as well as commercially viable, and identified no major legal aspects that could obstruct project implementation[36]. Since then, several important steps have been taken. In 1999 the four governments signed a Memorandum of Understanding (MoU), including provisions for the establishment of appropriate legal structures for investment and the securing of commercial contracts for gas transportation. During 1999 and 2000 several high-level talks and workshops took place.

That said, taking into account the current pipeline of projects, including the LNG-projects and Escravos Gas Project, the WAGPP is probably more important for regional developments than for moping up associated gas currently being flared. However, given the low demand and currently underdeveloped gas markets in the region, the uncertainties involved are much higher than for projects aimed predominantly at export markets.

Electricity production

The electricity sector in Nigeria is in a deep crisis. Of a total generating capacity of 5,900 MW only about 2000 MW are operable. Some 50 out of 70 units have been de-rated due to lack of maintenance, and high outages on the transmission and distribution networks add to the power crisis. Consequently, huge numbers of industrial, commercial and residential establishments run their own power generators, producing electricity at a high cost to themselves and to the Nigerian economy.

In order to improve this situation, Nigeria plans to invest heavily in infrastructure and generation capacity, with a long term goal of reaching 25,000 MW in generating capacity and increasing the share of the population with access to the grid from about 40 per cent presently to 85 per cent by 2010. Owing to the country's vast resource base, natural gas would seem an obvious choice for boosting the development of the power sector.

An efficient and accountable power sector would certainly be able to absorb a considerable share of AG currently being flared, whilst also bringing large benefits to the Nigerian society at large, and business opportunities to energy enterprises active in the country. For example, if the current generating capacity of 5900 MW was fuelled on associated gas, this could mop up about 8.5 billion Sm^3 of AG per year[37], representing more than 40 per cent of the volumes being flared in 1998.

However, modernisation of the power sector, including transition to gas as the principal fuel, will realistically take time, and at present it appears unlikely that Nigeria will reach the level of generating capacity forecasted by the government. As with the West African Gas Pipeline Project the outlet for gas to the power sector in Nigeria will hinge on a number of factors, of which political stability and "rule of law" are the most important. This, and other critical factors for implementing effective and efficient measures to curb flaring are further discussed in the next chapter.

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36 http://cometnews.com.ng/15082000/bn41206.htm.

37 We have here used a nominal heating value for natural gas of 40 MJ/Sm^3, a thermodynamic efficiency of 50 per cent, and 8.000 operating hours per year (h/y). Using a conversion factor of 1MW=3.600 MJ/h, we find that total gas supplies for a generating capacity of 5900 MW would be 5.900 MW * 3.600 MJ/h * 1/40 Sm^3/MJ * 8.000 h/y * 0.5 = 8.5 billion Sm^3/y.

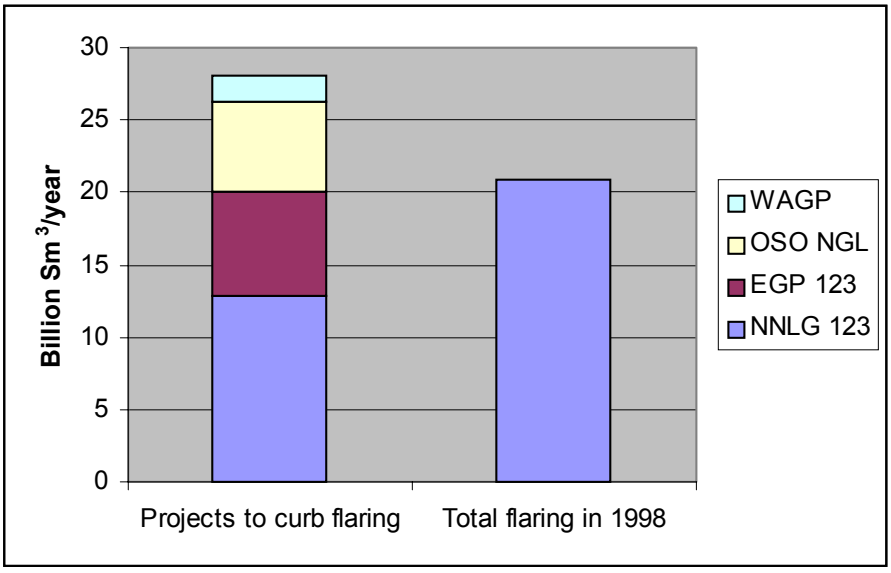
Summary – effects of on-going and planned projects

In the absence of projects to market and sell associated gas, total flaring in Nigeria would have increased considerably between 1998 and 2008. Official forecasts are not available for total production of associated gas but Shell indicate that their production will increase from about 7 billion Sm^3 in 1999 to more than 20 billion Sm^3 in 2008.

Figure 3.6 illustrates that important steps are being taken to reduce gas flaring. Provided that all projects described in the previous sections are implemented, notably the NLNG, EGP, OSO NGL, and the WAGPP projects, these will by themselves enhance utilisation of AG to about 28 billion Sm^3 per year in 2008. This amount corresponds to about 140 per cent of the volumes being flared in 1998. Among these projects, the NLNG, EGP and OSO NGL are well underway, even though uncertainty still prevails concerning the amount of AG being utilised. However, one should also take into account that production of associated gas is slated to increase due to increasing oil production. Thus, in order to eliminate flaring there would be a need to find outlets for some of the gas at the national Nigerian market or in the neighbouring countries.

The fate and timing of projects that depend on gas supplies to the Nigerian or regional markets in West Africa are, however, uncertain. The WAGP project and projects aiming to expand gas power generation in Nigeria could take up to 50 per cent of volumes being flared in 1998, but they will only be finalised if private investors expect that they can earn a return on their investments in supply capacity. Under the prevailing political and economic conditions, the risks of such investments must be perceived as high. Bringing these risks down is therefore of critical importance in order for investments to be forthcoming.

Figure 3.6 Contributions to reduced gas flaring from different investment projects



4 Political factors and global governance

The presentation above shows that there are major investments projects ongoing in Nigeria that will substantially reduce the volume of gas being flared. Pressure from the Nigerian authorities and initiatives from the petroleum industry have set this development in motion. The World Bank and other donor agencies have participated during the planning process of some projects, but their role in actual project financing and implementation has been minor.

Projects where gas is being exported (LNG and NGL) are less sensitive to political developments in Nigeria than are projects where the gas is meant for use in the region. Given the political situation, it is not surprising that the LNG projects are more advanced than those for gas supplies to domestic or regional markets.

This chapter addresses issues that are of particular importance for the development of domestic and regional projects, including the general climate for investments and economic growth, energy sector developments and regional energy co-operation. The potential role of global governance will also be touched upon.

4.1 Prospects for economic growth and investments

Two potential customers for deliveries of associated gas production are new fertiliser and aluminium producers. These investments are highly sensitive to the general political development in Nigeria, as well as to the more specific financial and regulatory conditions that investors face.

The most fundamental concern is the lack of political stability and predictability, and the absence of “rule of law” that has prevailed in Nigeria for several decades. Although the prospects may look better since Olusegun Obasanjo came to power, Nigeria is still characterised by widespread corruption, social and ethnic unrest, and crime. An unwieldy, ineffective and corrupt state bureaucracy contributes to the problems.

Still, the petroleum industry has been able operate fairly efficiently within this environment for a number of decades already. The political leadership has always given the sector preferential treatment, largely because it is has provided the state apparatus with the bulk of its revenues. The situation is different for most other (land-based) manufacturing industries. Although the national authorities seem committed and willing to offer conditions conducive of foreign investments, the more modest contribution to state revenues by other industries means that top governmental officials are less inclined to intervene so as to protect investors from the unpredictable and corrupt bureaucracy and judiciary.

Security risks of employees, lack of local competence and poor infrastructure adds to the unattractive climate for foreign investments. A recent report published by the Economist Intelligence Unit listed Nigeria as one of the worlds “most hostile environments” for foreign

direct investments, behind only to Iran, Algeria and Ukraine. This of course has major negative knock-on effects for the growth prospects of small manufacturing industries, not to mention the growth potential of the economy and the development of a well functioning domestic energy market.

4.2 Energy sector development

There is a striking contrast between the state of affairs in the upstream petroleum industry-- which in terms of safety standards and economic efficiency operates according to international standards-- and the rest of the energy sector, which is in a deep and chronic crisis.

Nigeria has a large refinery sector designed largely for the domestic market. Petroleum prices are regulated at a level far below world market prices, giving rise to parallel markets where significant quantities are traded at prices many times the regulated price level. As a consequence, distribution companies in the regulated market are left in an extremely difficult financial situation, resulting in lack of maintenance and investment, while actors in the parallel markets make large profits.

As mentioned above, the electricity sector is also in an extremely difficult situation, with a run-down capital base and poor operational performance, caused in part by low professional capabilities, lack of management accountability and the dire financial status of the National Electricity Authority (NEPA). NEPA is a vertically integrated monopoly for generation, transmission and distribution of electricity that depends heavily on fuel subsidies (over 70 per cent) and funding of capital projects by the Government. NEPA is technically insolvent given that some 220 million US$ is owned by the Government in overdue debt service obligations.

Past attempts by the Government to improve the performance of the power sector have failed. The present Government has decided to carry out a comprehensive reform program consisting of two efforts moving in parallel. One is an emergency program to restore a reasonable level of power supplies, and the other is privatisation of the sector, including the required restructuring and regulatory measures to make the new system sustainable. Given the prevailing political and institutional conditions, it is likely that this restructuring process will need to be lengthy, and it is hard to see how privatisation currently is possible, given the great uncertainty that inevitably will continue regarding future market conditions and return on investments.

In summary, the prospect is bleak in the short and medium term for a sizeable domestic or regional gas market. Currently there are no institutions, either in power generation or other sectors, that can act as credible purchases of gas, and hence offer the petroleum industry the required security to invest in production processing plants and infrastructure. The problem of finding anchor customers can be difficult enough in more developed countries seeding to create a gas industry. Obstacles deeply rooted in political instability and institutional weakness that prevails in the region compound such problems. Lack of purchasing power in the market is also a barrier, but again this is primarily linked to political and institutional factors. Once these problems are removed, the market will be there, since gas clearly enjoys a cost advantage over petroleum products, even in the short-term, and the population base of the region represents a vast potential for gas use in the longer term.

4.3 Global governance

Global Governance for the provision of Global Public Goods

As we shall discuss in some more detail in the next chapter, there are important aspects of reduced gas flaring in Nigeria that can be considered as Global Public Goods, e.g., reduced emissions of greenhouse gases, poverty alleviation, regional political and economic co-operation, and conflict prevention. Hence there potentially should be an important role for international institutions, national governments and the industry through co-operative efforts to contribute to the beneficiary use of associated gas.

The World Bank in Nigeria

The World Bank has been the leading donor agency providing energy sector assistance to Nigeria. A principal beneficiary for financial and technical support has been NEPA. For a period of 20 years until about 1990, NEPA received loans totalling some US$ 470 million. As the government's compliance with World Bank conditions for loans deteriorated, the scale of assistance decreased significantly.

In 1995 the International Finance Corporation (IFC) decided not to present its Board of Directors a proposed investment in an LNG project. IFC had considered providing a loan of US$ 100 million as well as taking a 2- percent equity stake in Nigeria LNG. In the end it pulled out of the project due to "insufficient progress in certain critical areas of macroeconomic reform". However, there are reasons to believe that the principal reason for not proceeding with the loan, and for a major scale back of World Bank operations in Nigeria, was the execution of the author and activist Ken Saro-Wiwa, and the related general escalation in political repression in the country.

More or less the same thing happened to a grant from the Green Environment Facility (GEF) to the Escravos Gas Project. The grant for US$ 20 million was meant to make up for revenue losses the Nigerian authorities would suffer as a consequence of tax breaks being offered to the project investors (see section 3.4). The grant passed the GEF criteria but was withdrawn after Saro-Wiwa was convicted and executed. It should be noted, however, that the project would not have passed the current criteria for GEF grants (see below). It should also noted that the Escravos project went ahead without the GEF grant, i.e. the Nigerian authorities covered the "incremental climate costs" of the project.

Green financing

In addition to GEF there are two other instruments for "green funding" of energy projects in Nigeria: the clean development mechanism (CDM) and the World Banks' Prototype Carbon Fund (PCF). It should be noted, however, that the CDM is not yet operational and it may be some time before many of the political and technical issues are resolved. These instruments are reviewed below and their relevance for a gas flaring project in Nigeria is assessed.

The Clean Development Mechanism

Many issues surrounding the CDM are unresolved in the climate change negotiations. Because of the lack of clarity in the negotiating text for this mechanism, it is difficult to say whether there is potential for gas flaring projects to be accepted. Among some groups within

the negotiation there is a desire to limit project types acceptable under the CDM. If a list of projects is agreed to then it is almost certain that a gas flaring by itself, would not constitute an acceptable project, since one would need to go further downstream in order to have any emission reductions certified. Moreover, preference is likely to go to renewable or energy efficiency projects. Another factor in the CDM will be the perceived risk involved in a project. Some developing countries have argued that, unless projects could be undertaken unilaterally (i.e., without an Annex B partner), developing countries would be at a disadvantage, since investors from more developed countries might be hesitant to invest in high-risk countries. If, as is the case with Nigeria, there is a perceived risk of political and institutional instability, there is a low probability that investors will place their money in that country.

The Global Environment Facility

The GEF is the interim mechanism of the UN Framework Convention on Climate Change. Although Nigeria is eligible for GEF funds, it must compete not only with other developing countries, but with projects in the other core areas. In March 1998, US$2.75 billion was committed to the replenishment of the GEF as a whole. However, from 1991 to 1998, climate change projects accounted for only 38 per cent of all GEF projects. (The other core areas are…) It is important to note that GEF funding can only be used for the incremental cost of changes to existing projects or planned (baseline) activities in order to make the revised activities benefit the global environment. In this case, only the incremental cost involved in carrying out or planning a project in order to make it reduce GHG emissions would receive the funding.

Several levels of funding are available from the GEF. The Small Grants Program provides grants up to US$50,000 to community-based projects. Medium sized projects are those that require no more than US$1 million in GEF financing. The approval procedure, at between 6 – 12 months from development, is expedited compared to that for "full scale" projects. [38] Projects with a GEF portion of the budget under US$750,000, do not even require Council approval and can be approved in a relatively short amount of time.

"Full-scale" projects generally average US$5.5 million per project. However, since the GEF process can be overly bureaucratic, approval and implementation of these projects can actually take several years. According to the UNDP-GEF guidebook[39], project development and approval from the GEF Council can take between 12 – 18 months, although in practice has often taken from three to six years. Full-scale and medium sized projects must meet the same requirements, the most important of which are the following:

- It should be undertaken in an eligible country.
- It should be consistent with national priorities and programs and be country-driven, i.e. originate in the country and be supported by many national stakeholders.
- It should address one or more of the GEF focal areas.
- It should be consistent with the GEF program guidance for preparing initiatives, i.e., removing barriers to energy conservation and energy efficiency; promoting the adoption

[38] http://www.gefweb.org/operport/msp/mspbroch.htm.

[39] http://www.undp.org/gef/guide/main.htm.

of renewable energy by removing barriers and reducing implementation costs; and reducing the long-term costs of low greenhouse gas-emitting energy technologies.

- It should involve the public in the project design and implementation.
- It should be endorsed by the host government.

As mentioned above, one large GEF project related to flaring was considered in the mid 1990s, and it had actually passed all the GEF criteria for approval. Currently, however, it is unlikely that a project of that sort should be supported. It is more realistic with smaller project further downstream in the gas value chain. Hence, GEF is unlikely to play any noticeable role for the market penetration of associated gas in Nigeria.

The Prototype Carbon Fund (PCF)

The World Bank launched the PCF in January 2000. Although this mechanism is related to the Kyoto Protocol, it remains outside of the climate process, and it is unclear how and whether it will be accepted under the CDM once it becomes operational. The fund has three guiding principles: 1) to finance projects that achieve high quality GHG reductions; 2) to facilitate an equitable distribution between the participants and the recipients; and 3) to disseminate and capture knowledge gained as a result of its development. The World Bank has stated that the PCF will give priority to renewable energy projects. Therefore it is highly unlikely that any project related to gas flaring, irrespective of its location, would be accepted under the PCF.

5 Seminar on Global Public Goods and gas flaring

The objective of a seminar on Global Public Goods, with gas flaring in Nigeria as a case study, is twofold. First, to identify how collective actions and co-operation between national authorities, industry and international organisations can contribute to a solution of the gas flaring problem in Nigeria. Second, to contribute more generally to the understanding of how industry, national governments and international organisation can work together in order to provide Global Public Goods.

However, before examining the merits of a seminar with Nigeria as a case study, it will be necessary to establish an understanding of the content and meaning of the concept, "Global Public Goods", as well as its relevance to gas flaring in Nigeria.

The concept Global Public Goods

Public goods have two important characteristics that distinguish them from private goods; non-rivalry and non-excludability. Non-rivalry means that many people can consume or enjoy a public good at the same time, and the consumption by one person does not reduce the benefit that others can obtain from consuming the same good. Non-excludability means that it is difficult to exclude persons who do not pay for or otherwise contribute to the supply of the good in question.

Global Public Goods, as opposed to national or local public goods, are characterised by their reach; people in many countries can benefit from the public good at the same time. There is a growing literature on Global Public Goods, and the concepts received a high profile during the Development Committee Meeting in September 2000 through the publication of the paper, "Poverty Reduction and Global Public Goods" by the World Bank and the International Monetary Fund[40]. A main reference on the subject is the book, *Global Public Goods,* [41] published by UNDP and edited by Inge Kaul and others. According to Kaul there are six main categories of Global Public Goods:

1. Environment and cultural heritage;
2. Health/disease, and technological research;
3. Peace and security, including the curtailment of small arms proliferation;
4. Knowledge and information;

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[40] Poverty Reduction and Global Public Goods.Issues for the World bank in Supporing Collective Action. Development Committee, 6th September 2000.

[41] Global Public Goods. International Cooperation in the 21st Century. Edited by Inge Kaul, Elisabeth Grunberg and Marc A. Stern. UNDP and Oxford University Press 1999.

5. Equity and justice; and
6. Global market efficiency.

The definition offered in the paper from the Development Committee would appear to be somewhat broader:

> *As a working definition for the Bank's purposes, then, global public goods are commodities, resources, services – and also systems of rules or policy regimes -- with substantial cross-border externalities that are important for development and poverty-reduction, and that can be produced in sufficient supply only through co-operation and collective action by developed and developing countries.*

According to this definition, the characteristics of the commodity, resource or service are not the essential thing, but rather the fact that co-operation and collective action is needed to make them available in sufficient supply.

Reduced gas flaring as a Global Public Goods

Whichever way one defines and delineates the concept of Global Public Goods, important benefits that may accrue from reduced flaring can be characterised as such. Some of these benefits are tangible and already in the process of being realised, whereas others may be harder to achieve and more difficult to discern.

Reduced emissions of greenhouse gases is generally recognised as a typical Global Public Good, and the elimination of gas flaring in Nigeria would make a sizeable contribution in this respect. The recorded flaring of gas in 1998 (21 billion Sm^3) translates to some 40 million tons of CO_2 emissions which only slightly less than the current emission level in Norway.

Diverting associated gas from flaring to sustainable use in Nigeria and neighbouring countries can contribute to poverty reduction and possibly to conflict prevention, through economic and political co-operation; also considered as Global Public Goods. These effects will not be as explicit as the reduction of greenhouse gases and they will definitely be harder to achieve, but they are potentially very important.

Gas is by and large the least-cost option for power generation within the existing and planned infrastructure of power supplies. Gas is also in many cases the most attractive option for making modern energy accessible to rural poor, both with respect to costs and environmental quality. In a strategy for poverty elimination, Nigerian gas can certainly play a central role; also beyond its national borders. The West African Pipeline, if realised, would similarly provide neighbouring countries with a cheap and clean fuel, compared to their present consumption pattern, and as in Nigeria, access to gas offers opportunities to apply new small-scale gas-fired technology in energy access to the poor. Gas trade across national borders requires a commitment to economic and political co-operation. On the face of it there should be strong political and economic benefits for all parties to engage in collaboration on gas supplies. If gas trade arrangements were concluded, for example with a successfully West Africa Pipeline project, such an achievement could also be considered to hold a promise of Global Public Goods such as peace and security in a densely populated region with has had a turbulent past.

Gas flaring in Nigeria as a case study for a seminar on global public goods

It follows from the discussion above that gas flaring in Nigeria touches upon several aspects of Global Public Goods where global governance is required. Any seminar on gas flaring and Global Public Goods would therefore appear to benefit from inclusion of issues and lessons learnt from Nigeria.

We would, however, not recommend that such a seminar focus only on Nigeria. As this report has documented, a large part of Nigerian gas flaring is already in the process of being eliminated. The petroleum companies, notably Shell and Chevron, would probably argue that they have the problem under control. The attitude of the Nigerian authorities can be expected to be similar. In a seminar they would probably insist on referring to Nigeria as a success story, a show-case for fruitful industry–national authority interaction rather than a case where global governance can make a contribution. The one issue which is unresolved, and where some collective efforts possibly could make a difference, is the development of markets for the un-flared gas in Nigeria and the region. That, however, would to some extent take the focus away from flaring as the main subject matter. Moreover, the market development issue is, as explained in Chapter 4, an inseparable part of the broader problem of political instability and institutional weaknesses that has hindered economic and social development for many decades. This issue is a very common seminar theme, to which a Norwegian event is unlikely to contribute anything new. In conclusion, an agenda focussed on market development issues probably would have to be very broad and complex in order to stand out as something different from other seminars that address similar issues.

It should also be mentioned that UNIDO, the World Bank and the Norwegian Ministry of Foreign Affairs are financing a workshop in Abuja, Nigeria from 26th to 28th March of this year ("Workshop on Building Capacity to Facilitate CDM projects: Oil and Gas and Manufacturing Industry Sectors"). Though this workshop is targeted at very different group of people and with another objective, its thematic focus partly overlaps with that of the seminar in question.

Recommendation

Our recommendation is that the Minister should consider hosting a seminar that looks more broadly at the venting and flaring of gas.

The flaring issue is potentially very important from the standpoint of Global Public Goods. Since it is an issue that will require the participation of a number of different players to resolve, it should be well suited for collective efforts by industry, national governments and IFIs. It should be noted that the World Bank has expressed an interest in taking an active part in this issue, which is said to be a top priority in its petroleum sector assistance programme.

As an important aspect of the climate change problem, the flaring issue does not yet appear to be sufficiently addressed. Moreover, it is likely to be relatively concrete and manageable, due to the relatively few actors involved.

However, the statistics behind flaring, as well as what measures actually are being taken and can be taken are still poorly understood. A seminar on this issue therefore would be a good occasion to examine the situation in more detail. Such a seminar could create a good base on which further research and action could be undertaken. For example, the seminar could aim at launching an international initiative on venting and flaring. The Norwegian government, with

the support and participation of industry and other partners, could help launch such an initiative, which could be managed by the World Bank. A seminar on the flaring issue – which could include an examination of the Nigerian experience, but would also cover the flaring issue more broadly -- could be the start of such a process.