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Gas Flaring

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ABSTRACT

In the petroleum industry, gas flaring is a major and significant environmental issue in oil-producing countries like Nigeria, involving the burning of excess natural gas associated with oil extraction, leading to the release of greenhouse gases (GHGs) like carbon dioxide, methane and other pollutants into the atmosphere. This practice contributes to climate change, air pollution, and health problems for nearby communities. Despite efforts to reduce flaring, it remains prevalent due to infrastructure challenges, regulatory gaps, and economic interests. The paper highlights the environmental, health, and economic impacts of gas flaring, with emphasis on the need for effective policies, technological innovations, and international cooperation to mitigate its effects.

KEYWORDS: *Gas flaring, oil extraction, greenhouse gases (GHGs), climate change, air pollutants, health problems, global warming, water and soil contamination, natural gas (associated gas), processing and transportation infrastructure, regulatory gaps, capture technologies.*

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INTRODUCTION

Gas flaring in the petroleum industry is the controlled burning of natural gas that is released during the extraction and processing of oil and gas, as shown in Figures 1 and 2. The gas being burned is usually associated gas, that is, natural gas that comes up with crude oil but is not captured for use or sale, as shown in Figure 3. Gas flaring has been in practice since the early days of the oil industry (over 160 years ago) and remains common where infrastructure or markets for natural gas are lacking [1]. Gas flaring happens for: (i) safety reasons to safely burn off excess gas to prevent pressure buildup and reduce the risk of explosions during oil and gas operations, (ii) technical and infrastructure constraints, as most often oilfields are in remote areas without pipelines or facilities to capture and transport gas, hence the flaring of the gas as the simplest disposal method, (iii) economic reasons due to high cost of building processing and transportation infrastructure, and (iv) regulatory gaps where in some jurisdictions, weak or incomplete laws do not require companies to capture or use associated gas, allowing routine flaring to continue [1].

Gas flaring releases large volumes of gas into the atmosphere (about 140 billion cubic meters of natural gas is flared globally each year), where it is burned rather than used as a productive energy source [2]. This is a major source of CO_2 emissions, methane and black soot, and is damaging to health. In the Net Zero Emissions by 2050 (NZE) Scenario, all non-emergency flaring would be eliminated globally by 2030, resulting in a 95% reduction in flared volumes and avoiding 365 Mt CO_2-equivalent [2]. In 2021, the top 10 flaring countries (on an absolute volume basis) accounted for 75% of all gas flaring and 50% of global oil production. Seven of the top 10 flaring countries have held this position consistently for the last 10 years: Russia, Iraq, Iran, the United States, Venezuela, Algeria, and Nigeria. The remaining three, Mexico, Libya, and China, have shown significant flaring increases in recent years [3].

HISTORY

The flaring of gas is the burning of natural gas associated with oil extraction and has been practiced for over 160 years as a method for disposing of unwanted or unusable gas, particularly in remote

locations lacking infrastructure. A gas flare is also known as flare stack, flare boom, ground flare, or flare pit. Historically, it is used for safety and waste management, but has become a major environmental and health concern, especially in regions like Nigeria's Niger Delta where it has persisted since the 1950s, as shown in Figure 4. It is well known that this has persisted globally for decades as a major environmental and energy waste issue, with over 150 billion cubic meters (bcm) burned annually as of 2024, the highest level since 2007 [4], and while The World Bank reports that between 150 to 170 billion m^3 of gases are flared or vented annually, an amount valued at about $30.6 billion, equivalent to one-quarter of the United States' gas consumption or 30% of the European Union's gas consumption annually – a reduction or recover of gas flaring is a crucial issue [5, 6].

WHY GAS FLARING?

Gas flaring could be for so many reasons including the following:

Safety Reasons

- Flaring is used to manage sudden pressure surges in equipment and reduce explosion risk during oil operations. It destroys toxic compounds in the gas that might otherwise pose safety hazards. Flaring allows production to continue rather than shutting in wells (for operational flexibility and continuity) [1].

Economic and Technical Reasons

- Oil fields are often remote with insufficient infrastructure (pipelines, compressors) to capture gas economically.
- Small or inconsistent gas volumes make investment in capture technologies less financially viable for operators [1].

Regulatory Reasons

- In places where regulations are weak, poorly enforced, or lack incentives for capturing gas, routine flaring continues at high levels [1], as shown in Figure 5.

ENVIRONMENTAL IMPACTS

Climate Change

- Flaring emits greenhouse gases (GHGs) like carbon dioxide (CO_2) and methane (CH4). Methane's global warming potential is significantly higher than CO_2 (28-36x over 100 years; ~80x over 20 years) [6], as shown in Figures 6 and 7.
- Annually, flaring releases hundreds of millions of tonnes of CO_2-equivalent emissions – for example, ~389 million tonnes in 2024 alone, comparable to some countries' total emissions [7].

Air Pollution

- Flares emit black carbon (soot), sulfur dioxide (SO_2), nitrogen oxides (NOx), volatile organic compounds (VOCs), and other toxic substances, worsening air quality and contributing to smog [8].

Acid Rain and Ecosystem Damage

- Sulfur and nitrogen compounds from flaring contribute to acid rain, which damages water bodies, soil health, vegetation, and crops [8, 9].

Health and Local Environmental Impacts: People who live near flaring sites most often face heightened health risks:

- Respiratory diseases (e.g., asthma, chronic bronchitis) due to particulate inhalation and chemical exposure [9].
- Cancer and cardiovascular effects from carcinogenic pollutants like benzene and PAHS [9].
- Pregnancy complications as pregnant women living near flaring sites face higher risks of premature birth and low birth weight.
- Environmental degradation including soil acidification and contaminated water sources, threatening agriculture and fisheries [10].

In regions such as the Niger Delta, repeated flaring has been linked with chronic heath complaints and environmental harm [9].

ECONOMIC IMPACTS

Lost Energy and Revenue

- Billions of cubic meters of natural gas are wasted each year. About approximately 151 billion cubic meters were flared, for example in 2024, enough to power significant portions of developing regions if captured and used [4].

Cost to Economies

- The global economy loses tens of billions of US dollars annually due to wasted gas that could have fueled industry, produced power, or been exported.
- Local economies like Nigeria's have historically lost substantial revenues due to flaring rather than utilizing the gas – loss of roughly $9.05 billion in the last decade [11].

REGULATORY AND POLICY CONTEXT

Global Initiatives

- The Zero Routine Flaring by 2030 (ZRF) initiative involves governments and companies committing to end routine gas flaring, especially outside emergency operations [3, 4].

- International climate agreements (e.g., Global Methane Pledge) are encouraging deeper cuts in methane and flaring emissions [6]. Launched at COP26 in 2021 by the US and EU, the Global Methane Pledge (GMP) is a voluntary, international commitment to reduce global methane emissions by at least 30% from 2020 levels by 2030. As of late 2025, 159 countries, including Nigeria, are participating, aiming to limit global warming to 1.5^0C.

National Actions

- Some countries are adopting stricter fines and enforcement to reduce flaring, while others struggle with policy or rollback of limits [12].
- In Nigeria, the Gas Flare Commercialization Programme (NGFCP) aims to reduce routine flaring by enabling companies to capture and monetize flare gas, potentially cutting millions of tonnes of CO_2 emissions and generating electricity [13].

TECHNOLOGICAL AND PRACTICAL SOLUTIONS

Gas Capture and Utilization

- Capturing associated gas for power, conversion to LNG/LPG, or feeding into industrial markets can both reduce emissions and provide energy access [3, 4].

Infrastructure Investments

- Building pipelines, processing facilities, and compression technologies makes gas capture and sale commercially viable, reducing the need for flaring [4].

Best Practices and Innovation

- Guidance and technologies for managing and reducing flaring include improved measurement, operational management, and alternative use pathways for flaring gas [4].

CHALLENGES AND BARRIERS

- Economic feasibility: In remote or small fields, gas markets may not justify investment in capture infrastructure [3, 4].
- Regulatory enforcement: Weak or poorly enforced policies can perpetuate routine flaring [13].
- Security and logistical challenges: In some regions, insecurity and sabotage complicate infrastructure development [9].

Reducing gas flaring offers environmental benefits, economic opportunities, and improved local health outcomes, and is the target of international and national policies – including efforts to end routine flaring globally by 2030 [3, 4].

The benefits to gas flaring are cost-avoidance benefits, but environmental and energy policy debates stress that these "benefits" are generally outweighed by ling-term waste, climate, and health costs.

SOLUTIONS TO GAS FLARING

Some specific solutions to gas flaring include [14-18]:

- Gas monetization: Need to develop infrastructure to capture, process, and sell flared gas, creating economic value, for power generation, industrial use, or LNG production.
- Gas-to-power projects: Implement projects like the Oguru-Ama Community Gas-to-Power Project in Nigeria.
- Gas Re-injection: Enhance oil recovery and reduce emissions, as seen in Norway's Sleipner project.
- Flaring reduction technologies: Leverage technologies like flare minimization systems and advanced combustion devices.
- Regulatory enforcement: Strengthen enforcement of anti-flaring regulations and penalties.

Benefits of gas flaring:

The primary "benefits" of gas flaring are: (i) limited to operational safety and the disposal of unwanted gas when no infrastructure for its use exists, (ii) to manage pressure and to safely dispose of gases that cannot be processed or sold at that time, (iii) emergency and maintenance disposal, and (iv) destruction of toxic compounds.

However, from an economic cum environmental standpoint, flaring is considered a major waste of valuable natural resources with significant negative impacts [1].

What is being done about gas flaring?

While oil production has increased by around 28% since 1996, the amount of associated gas flared has decreased by 9%. Overall, this gas resulted in a drop in flaring intensity, the amount of flaring per barrel of oil produced, of around a third. This means that the oil industry has made some progress, as we have seen a gradual decoupling of a long-standing correlation between oil production and gas flaring volumes. Many oil field operators who flare associated gas, are making the investments necessary to reduce flaring. Many have also made commitment to end routine flaring. In 2015, the World Bank's President and the UN Secretary-General launched the World Bank's Zero Routine Flaring by 2030 (ZRF) Initiative. ZRF commits governments and oil companies to not routinely flare gas in any new oil field development and to end existing (legacy) routine flaring as soon as possible and no later than 2030 [1].

CONCLUSION

Gas flaring which is the burning of associated natural gas during oil extraction, remains a significant environmental and economic challenge worldwide, leading to climate change and air pollution via the release of greenhouse gases (GHGs) and other harmful pollutants. This as well results to wastes of valuable natural gas that could be used for energy production. This was originally intended as a safety measure, but routine flaring has persisted due to inadequate infrastructure, weak regulatory enforcement, and economic constraints. Reducing and ultimately eliminating routine gas flaring is both an environmental necessity (essential for environmental protection and promoting sustainable development) and an economic opportunity. To achieve this will require stronger regulatory frameworks, investment in gas capture infrastructure, adoption of cleaner technologies, and global cooperation which is aligned with climate change mitigation goals. More information about Gas Flaring can be obtained in the books in [19-28] and the following associated journals:

International Journal of Greenhouse Gas Control

Environmental Science and Pollution Research

The extractive Industries and Society

Sustainability

Anthropocene Science

Asian Journal of Environment & Ecology

Journal of Environment and Earth Science

Faculty of Natural and Applied Sciences Journal of Scientific Innovations

Environmental Research (Springer/Elsevier)

Oil, Gas and Energy Law

Journal of Petroleum Science and Engineering

Energy Policy

Environmental Sciences & Technology

Journal of Environmental Management

REFERENCES

[1] World Bank Group, "Global flaring and methane reduction partnership (GFMR)," https://www.worldbank.org/en/programs/gasflaringreduction/gas-flaring-explained

[2] "What is gas flaring?" https://www.iea.org/energy-system/fossil-fuels/gas-flaring

[3] The World Bank, "2022 Global Gas Flaring Tacker Report," https://thedocs.worldbank.org/2022-Global-gas-Flaring-Tracker-Report

[4] World Bank (July 18, 2025), "Global gas flaring hits highest level since 2007, undermining energy security, access, and emission goals," https://www.worldbank.org

[5] E. A. Emam (January 2015), "Gas flaring in industry: An overview," https://www.researchgate.net

[6] "Gas flare," Wikipedia, the free encyclopedia, https://en.wikipedia.org/gas-flare

[7] The Guardian "Gas flaring created 389m tonnes of carbon pollution last year, report finds," 18 July 2025, https://www.theguardian.com/environment/2025/jul/18/gas-flaring-created-389m-tonnes-carbon-pollution-last-year-report

[8] P. Amaechi (August 23, 2025), "Gas flaring: Causes, impacts, and solutions for a cleaner future – Environment Go," https://www.environment.com/gas-flaring

[9] "Nigerian Gas Flare Tracker," https://nosdra.gasflaretracker.ng/about.html

[10] Abuad Law Review, "Gas flaring in Nigeria: An assessment of its environmental and human rights implication," https://www.djetlawyer.com

[11] U. Orizu, "House to investigate $9bn revenue loss to gas flaring," https://www.thisdaylive.com

[12] "Of gas flaring, global reduction and monetisation," 14 April 2023, https://www.guardian.ng

[13] Reuters (December 12, 2025), "Nigeria issues permits for gas-flaring project, targets $2 billion investment and 3 GW power potential," https://www.reuters.com

[14] World Bank, "Gas Flaring reduction."

[15] Nigerian National Petroleum Corporation (NNPC) Annual Report 2020.

[16] International Energy Agency (IEA), "Gas Flaring."

[17] Global Gas Flaring Reduction Partnership (GGFP).

[18] Nigerian Petroleum Industry Act (2021).

[19] N. P. Cheremisinoff (April 2013), "Industrial gas flaring practices," Wiley & Sons Ltd., https://www.wiley-vch.de/en/areas-

interest/engineering/industril-gas-flaring-practices

[20] E. G. Pereira (ed.), "Natural gas flaring & energy transition: Laws, policies and regulations."

[21] B. Bukarambe, O. A. Agbu & S. Wapmuk, "Gas flaring in the Niger Delta: The internal and external dimensions."

[22] H. Enoabasi, "The impact of gas flaring in Nigeria: Causes and ways of reduction."

[23] Mokhatab et al., "Handbook of natural gas transmission and processing."

[24] GPSA Engineering Data Book.

[25] A. Olajide (2018), "Gas flaring in Nigeria: Challenges and prospects."

[26] O. O. Olaniyi (2015), "The economics of gas flaring in Nigeria."

[27] E. O. A. Akinwale (2020), "Gas flaring and environmental management in Nigeria."

[28] T. O. Adegoke (20170, "Petroleum industry and gas flaring in Nigeria."

Figure 1. Gas flaring
Source: https://en.wikipedia.org/wiki/Gas_flare

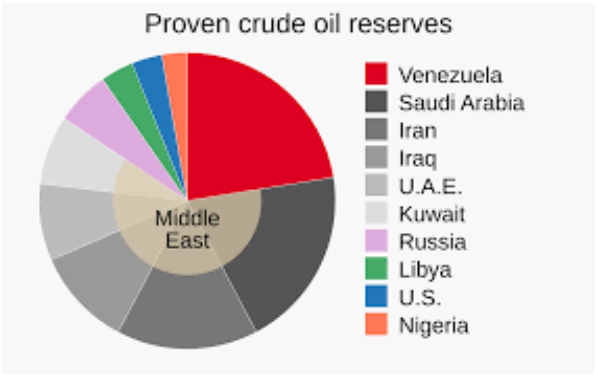

Figure 2. Petroleum industry
Source:
https://en.wikipedia.org/wiki/Petroleum_industry

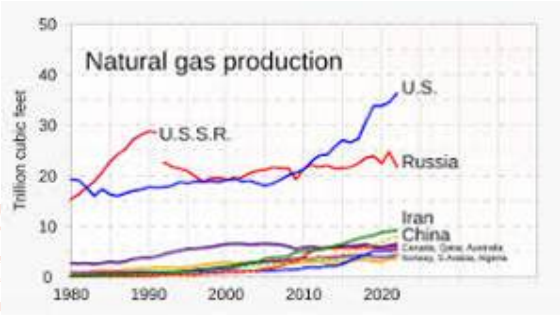

Figure 3. Natural gas
Source: https://en.wikipedia.org/wiki/Natural_gas

Figure 4. Environmental issues in the Niger Delta
Source:
https://en.wikipedia.org/wiki/Environmental_issues_in_the_Niger_Delta

Figure 5. Routine flaring
Source:
https://en.wikipedia.org/wiki/Routine_flaring

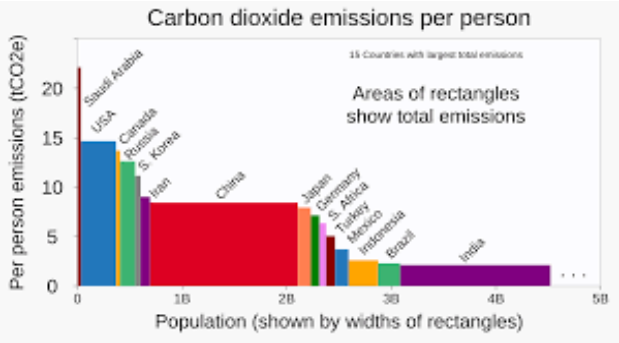

Figure 6. Greenhouse gas emissions
Source: https://en.wikipedia.org/wiki/Greenhouse_gas_emissions

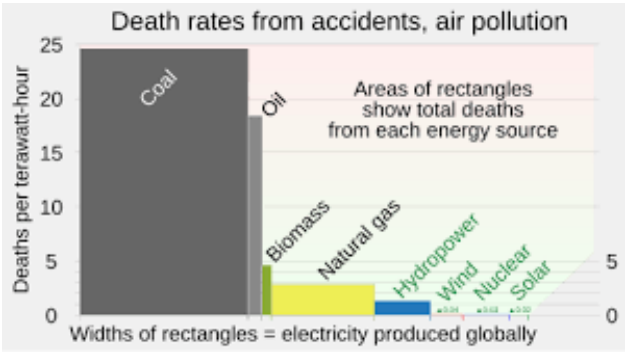

Figure 7. Natural gas (death rates from accidents, air pollution)
Source: https://en.wikipedia.org/wiki/Natural_gas