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GAS FLARING IN NIGERIA'S OIL SECTOR: ENVIRONMENTAL AND SOCIOECONOMIC CHALLENGES WITHIN EXISTING LEGAL FRAMEWORKS

QUEIMA DE GÁS NO SETOR PETROLÍFERO DA NIGÉRIA: DESAFIOS AMBIENTAIS E SOCIOECONÔMICOS DENTRO DOS QUADROS LEGAIS EXISTENTES

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Abstract
Gas flaring remains one of the most persistent environmental and socioeconomic challenges in Nigeria's oil industry. Despite decades of regulatory efforts, the practice continues to release large volumes of greenhouse gases and toxic pollutants into the atmosphere, contributing to global warming, air pollution, and ecosystem degradation. Communities located near flare sites face severe health risks such as respiratory illnesses, skin problems, and increased mortality rates. The constant exposure to intense heat and light also disrupts agricultural productivity and damages farmlands, leading to food insecurity and loss of livelihoods. Economically, gas flaring represents a significant waste of valuable natural resources that could be harnessed for domestic energy generation and industrial development. The Nigerian economy consequently loses substantial revenue while local populations bear the burden of environmental degradation and poverty. This paper examines the environmental and socioeconomic implications of gas flaring in Nigeria, highlighting the inefficiencies in regulatory enforcement, corporate negligence, and lack of sustainable energy policies. It also explores alternative strategies for gas utilization, community engagement, and cleaner production practices aimed at achieving environmental sustainability and social well-being in the oil-producing regions.

Resumo
A queima de gás natural continua sendo um dos desafios ambientais e socioeconômicos mais persistentes na indústria petrolífera da Nigéria. Apesar de décadas de esforços regulatórios, a prática continua liberando grandes volumes de gases de efeito estufa e poluentes tóxicos na atmosfera, contribuindo para o aquecimento global, a poluição do ar e a degradação dos ecossistemas. Comunidades localizadas próximas a áreas de queima de gás enfrentam graves riscos à saúde, como doenças respiratórias, problemas de pele e aumento das taxas de mortalidade. A exposição constante ao calor e à luz intensos também prejudica a produtividade agrícola e danifica as terras cultiváveis, levando à insegurança alimentar e à perda de meios de subsistência. Economicamente, a queima de gás natural representa um desperdício significativo de valiosos recursos naturais que poderiam ser aproveitados para a geração de energia doméstica e o desenvolvimento industrial. Consequentemente, a economia nigeriana perde receitas substanciais, enquanto as populações locais arcam com o fardo da degradação ambiental e da pobreza. Este artigo examina as implicações ambientais e socioeconômicas da queima de gás natural na Nigéria, destacando as ineficiências na aplicação das regulamentações, a negligência corporativa e a falta de políticas de energia sustentável. Também explora estratégias alternativas para a

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utilização do gás, o engajamento da comunidade e práticas de produção mais limpas, visando alcançar a sustentabilidade ambiental e o bem-estar social nas regiões produtoras de petróleo.

Palavras-chave: *Queima de gás. Degradação ambiental. Impactos na saúde. Nigéria. Práticas sustentáveis.*

1 INTRODUCTION

Since the discovery of crude oil in Oloibiri in 1956, Nigeria's oil and gas industry has remained the central pillar of the national economy, accounting for the dominant share of export earnings, fiscal revenue, and foreign exchange inflows.[1] The extractive sector's economic prominence, however, has been accompanied by profound environmental degradation, social dislocation, and regulatory contestation, most notably through the persistent practice of gas flaring. Gas flaring refers to the routine combustion of associated natural gas during crude oil extraction, a practice that has become structurally embedded in upstream petroleum operations in the Niger Delta.[2] Despite decades of legislative intervention, judicial pronouncements, and policy commitments, Nigeria remains one of the world's leading gas-flaring countries, revealing a deep-seated governance crisis in the regulation of petroleum resources.[3] This persistence raises critical legal questions regarding environmental justice, regulatory effectiveness, and the compatibility of Nigeria's petroleum regime with sustainable development imperatives.

The environmental consequences of gas flaring are extensive and multidimensional. Continuous flaring releases substantial volumes of greenhouse gases, including carbon dioxide and methane, alongside nitrogen oxides and particulate matter, thereby contributing to global climate change and severe localised air pollution.[4] Empirical studies and legal analyses consistently link prolonged exposure to flare emissions with respiratory diseases, cardiovascular complications, acid rain, soil

[1] Y Omorogbe, *Oil and Gas Law in Nigeria* (Malthouse Press 2001).
[2] D C Nwaogu and T U Akpoghome, 'Ending Gas Flaring in the Nigerian Oil and Gas Industry' (2022) 2 *J Envtl L & Pol'y* 79.
[3] World Bank, *Global Gas Flaring Tracker Report* (2023).
[4] U Afinotan, 'How Serious Is Nigeria about Climate Change Mitigation?' (2022) 24 *Environmental Law Review* 288.

infertility, deforestation, and biodiversity loss.[5] These environmental harms undermine the ecological integrity of oil-producing regions and disrupt the subsistence economies of communities that rely predominantly on farming and fishing.[6] The cumulative ecological damage caused by decades of flaring has rendered large swathes of arable land unproductive, contaminated freshwater ecosystems, and intensified food insecurity in the Niger Delta.[7] Importantly, these harms are not incidental but are structurally produced by an extractive governance model that prioritises economic returns over environmental protection.

Gas flaring also generates far-reaching socioeconomic consequences that reinforce existing patterns of marginalisation. Communities exposed to flaring experience declining agricultural yields, reduced fish stocks, rising health expenditures, and diminished income-generating opportunities.[8] The resulting economic deprivation fuels unemployment, youth restiveness, and social instability, contributing to cycles of conflict and militancy in the Niger Delta.[9] At the national level, the continued flaring of commercially valuable gas represents a paradox of energy poverty amid energy abundance, as Nigeria simultaneously flares billions of dollars' worth of gas while struggling with chronic electricity shortages.[10] Scholars have described this contradiction as emblematic of the resource curse, whereby natural resource wealth entrenches underdevelopment, institutional fragility, and environmental harm rather than inclusive growth.[11] The failure to harness flared gas for domestic energy use undermines industrialisation, energy security, and climate mitigation efforts, exacerbating Nigeria's developmental challenges.[12]

The unequal distribution of environmental and socioeconomic burdens arising from gas flaring situates the practice firmly within the framework of environmental

[5] A A Babalola and D S Olawuyi, 'Overcoming Regulatory Failure' (2022) 14 *Sustainability* 6800.
[6] E Aaron, *Oil Spillage and Environmental Justice Issues in the Niger Delta* (PhD Thesis, Charles University 2025).
[7] ibid.
[8] R T Ako, 'Nigeria's Land Use Act' (2009) 53 *Journal of African Law* 289.
[9] ibid.
[10] O J Olujobi and others, 'The Legal Framework for Combating Gas Flaring' (2022) 14 *Sustainability* 7626.
[11] D C Nwaogu and T U Akpoghome (n 2).
[12] C Hia, R N Imbwaseh and T D Achinge, 'Phase-Out of Gas Flaring under the PIA 2021' (2023) 5 *IJOCLLEP* 70.

injustice. Environmental justice scholarship emphasises the fair distribution of environmental benefits and burdens, meaningful public participation in environmental decision-making, and access to effective remedies.[13] In Nigeria, these elements are conspicuously absent in oil-producing regions, where marginalised communities bear the brunt of environmental harm while deriving minimal benefits from petroleum extraction.[14] As Ako demonstrates, Nigeria's legal and institutional arrangements systematically disadvantage host communities by concentrating environmental risks in areas characterised by poverty, weak political representation, and limited access to justice.[15] Olawuyi and Ako further argue that environmental injustice in Nigeria is sustained by regulatory fragmentation, weak enforcement institutions, and a governance culture that privileges economic interests over environmental rights.[16]

The persistence of gas flaring also implicates procedural and recognition dimensions of environmental justice. Host communities are routinely excluded from decision-making processes concerning petroleum licensing, environmental approvals, and enforcement actions, despite being the primary victims of pollution.[17] Judicial barriers, high litigation costs, evidentiary burdens, and restrictive standing rules further constrain access to environmental justice.[18] Okonkwo's analysis of oil pollution litigation highlights the judiciary's inconsistent role in enhancing access to environmental justice, often constrained by procedural technicalities and deference to executive agencies.[19] The Land Use Act compounds these injustices by vesting land ownership in the state, thereby weakening community claims to environmental protection and compensation.[20] Gas flaring thus exemplifies how environmental harm in Nigeria is sustained by legal structures that marginalise affected populations.

From a climate justice perspective, gas flaring reflects global inequalities in environmental governance. Ekhator and Okumagba argue that multinational oil

[13] R T Ako and D S Olawuyi, 'Environmental Justice in Nigeria' in S Holifield and others (eds), *Routledge Handbook of Environmental Justice* (Routledge 2017).
[14] Ako and Olawuyi (n 13).
[15] ibid
[16] R T Ako (n 8).
[17] E C Okonkwo, 'Role of Courts in Environmental Justice' (2020) 28 *African J Int'l & Comp L* 195.
[18] ibid
[19] ibid
[20] R T Ako (n 8).

corporations operating in Nigeria exploit regulatory gaps and weak enforcement to externalise environmental costs onto local communities, while contributing disproportionately to global greenhouse gas emissions.[21] This dynamic reinforces North–South asymmetries in climate responsibility and vulnerability, positioning Niger Delta communities as sacrificial zones within the global energy economy.[22] The continued tolerance of flaring therefore undermines Nigeria's commitments under international climate agreements and weakens its credibility in global climate governance.[23]

Nigeria's legal response to gas flaring has evolved through a series of statutory and policy interventions. The Associated Gas Re-Injection Act 1979 marked the first attempt to regulate flaring by mandating gas utilisation or reinjection, subject to ministerial exemptions.[24] Subsequent regulations and penalties, however, were undermined by weak enforcement and nominal fines that failed to deter non-compliance.[25] The Nigerian Gas Flare Commercialisation Programme introduced a market-based approach aimed at monetising flared gas, yet infrastructural deficits and policy inconsistencies limited its effectiveness.[26] These regulatory shortcomings culminated in the enactment of the Petroleum Industry Act (PIA) 2021, which represents the most comprehensive reform of Nigeria's petroleum sector to date.[27]

The PIA introduces new institutional arrangements, licensing regimes, and environmental obligations, including a formal prohibition of routine gas flaring and the imposition of penalties.[28] Nonetheless, scholarly assessments raise concerns about the Act's capacity to address entrenched environmental injustices. Omorogbe argues that the PIA reflects a governance compromise that prioritises economic efficiency and investment stability over environmental protection.[29] Akpambang's appraisal of the upstream licensing regime similarly highlights regulatory discretion and weak

[21] E O Ekhator and E Okumagba, 'Climate Change and Multinationals in Nigeria' in K Bouwer and others (eds), *Climate Litigation and Justice in Africa* (BUP 2024).
[22] ibid.
[23] G O Aigbe, L C Stringer and M Cotton, 'Optimizing Policies for Zero Routine Gas Flaring' (2025) 13 *Climate* 178.
[24] Associated Gas Re-Injection Act 1979.
[25] Nwaogu and Akpoghome (n 2).
[26] Babalola and Olawuyi (n 5).
[27] Petroleum Industry Act 2021.
[28] ibid.
[29] Y Omorogbe, 'The PIA from a Governance Perspective' (2022) 7 *Crescent Univ LJ* 22.

accountability mechanisms that may undermine environmental compliance.[30] Umukoro critiques the Host Communities Development Trust framework, noting that it inadequately secures environmental rights and fails to address legacy pollution.[31]

Further critiques suggest that the PIA reproduces historical patterns of regulatory failure by relying on administrative discretion and modest penalties that lack deterrent effect.[32] Afinotan questions Nigeria's seriousness about climate change mitigation through gas-flaring regulation, arguing that enforcement deficits persist despite legislative reform.[33] Olujobi and Ape's comparative analysis underscores the need for stricter enforcement, clearer sanctions, and alignment with international best practices.[34] Millicent Ele's examination of oil spills under the PIA reinforces the view that environmental protection remains subordinated to economic considerations.[35] Collectively, these critiques suggest that the PIA's promise of environmental reform remains largely aspirational.

The persistence of gas flaring also undermines the realisation of sustainable development within Nigeria's oil and gas sector. Sustainable development, as articulated in the Brundtland Report, demands the integration of environmental protection, economic development, and intergenerational equity.[36] Routine gas flaring erodes all three pillars by degrading ecosystems, wasting economically valuable resources, and exacerbating climate change.[37] Hia, Imbwaseh, and Achinge argue that the continued tolerance of flaring is fundamentally incompatible with sustainable development principles embedded in Nigerian environmental law.[38] Babalola and Olawuyi further contend that regulatory failure in gas-flaring governance reflects the absence of an energy justice-oriented approach that balances environmental protection with equitable energy access.[39]

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[30] E M Akpambang, 'Upstream Licensing under the PIA 2021' (2022) 25 *Juridical Current* 30.
[31] B Umukoro, 'Petroleum Host Communities' (2024) 15 *Revista Catalana de Dret Ambiental* 1.
[32] Olujobi and others (n 10).
[33] Afinotan (n 4).
[34] O J Olujobi and N T Ape, 'Reforming Legal Frameworks for Combating Gas Flaring' (2025) *Resources Policy* 105721.
[35] M Ele, 'Oil Spills and the PIA 2021' (2022) 13 *JSDLP* 130.
[36] World Commission on Environment and Development, *Our Common Future* (1987).
[37] Hia, Imbwaseh and Achinge (n 12).
[38] Ibid.
[39] Babalola and Olawuyi (n 5).

Recent scholarship on zero routine flaring and net-zero transitions reinforces the urgency of reform. Aigbe, Stringer, and Cotton demonstrate that effective gas-flaring regulation is essential to achieving climate mitigation and sustainable energy transitions.[40] The failure to eliminate flaring undermines Nigeria's progress towards the Sustainable Development Goals,[41] particularly Goals 3, 7, and 13.[42] Aaron's analysis of oil pollution and environmental justice in the Niger Delta further illustrates how persistent environmental harm entrenches social inequality and weakens community resilience.[43]

This study therefore interrogates gas flaring in Nigeria as a legal, environmental justice, and sustainable development challenge embedded within regulatory design and enforcement practices.[44] By examining Nigeria's gas-flaring regime through a doctrinal lens informed by environmental justice theory, the paper interrogates whether existing legal frameworks particularly the Petroleum Industry Act 2021 are capable of addressing the structural inequities that sustain environmental harm in oil-producing communities.[45] It argues that without robust enforcement, community participation, and a normative commitment to environmental justice, gas flaring will continue to undermine Nigeria's environmental sustainability, climate obligations, and socioeconomic development.[46]

2 ACID DEPOSITION, ECOSYSTEM DEGRADATION AND LIGHT POLLUTION FROM GAS FLARING IN NIGERIA

Gas flaring remains one of the most environmentally damaging by-products of petroleum extraction in Nigeria's Niger Delta region. Among its lesser-appreciated but scientifically established consequences are acid deposition, ecological imbalance, and chronic light pollution.[47] The burning of *sour gas* natural gas containing hydrogen sulphide (H_2S) produces a range of sulphur oxides (SO_x), primarily sulphur dioxide (SO_2)

[40] Aigbe, Stringer and Cotton (n 23).
[41] E O Ekhator, 'Environmental Justice in the Global South' in R C Brears and J Lindley (eds), *Palgrave Handbook on Environmental Policy and Law* (Palgrave 2025).
[42] United Nations, *Sustainable Development Goals* (2015).
[43] Aaron (n 6).
[44] D S Olawuyi, *Principles of Nigerian Environmental Law* (Afe Babalola UP 2015).
[45] E O Ekhator and P Obani, 'Women and Environmental Justice Issues in Nigeria' in J Dawuni (ed), *Intersectionality and Women's Access to Justice* (Lexington Books 2022).
[46] ibid.
[47] World Bank, *Global Gas Flaring Tracker Report 2024* (World Bank 2024) 9.

and sulphur trioxide (SO_3).[48]When these gases interact with atmospheric oxygen and water vapour, they form sulphurous and sulphuric acids, which subsequently precipitate as acid rain.[49] In the Niger Delta, this phenomenon has been implicated in soil degradation, water contamination, and the accelerated corrosion of metallic and asbestos materials in nearby settlements.[50]

Environmental scientists argue that acid rain explains the elevated iron content and reduced pH levels of surface and groundwater across several oil-producing communities.[51] As acidic precipitation infiltrates soils, it dissolves metals such as iron and aluminium, which then leach into rivers and aquifers.[52] Field studies in Akwa Ibom and Rivers States have demonstrated that groundwater samples near flare sites often record pH values below 5.5, far beneath the World Health Organization's recommended threshold for potable water.[53] Local communities frequently attribute the reddish coloration of their wells and boreholes to prolonged acid infiltration.[54] In response, oil companies operating in the region particularly multinational corporations such as Shell Petroleum Development Company (SPDC) and Chevron Nigeria Limited have consistently denied direct culpability.[55] They maintain that, while emissions exist, their contribution to global carbon or sulphur output is negligible relative to worldwide industrial activity.[56] Nevertheless, independent assessments by the World Bank and Nigeria's National Oil Spill Detection and Response Agency (NOSDRA) confirm that Nigeria ranks among the top ten gas-flaring nations globally, with the Niger Delta experiencing localised pollutant concentrations far exceeding international safety standards.[57]

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[48] ME Ogolo, 'Sour Gas and Sulphur Emissions in Nigeria's Oil Industry' (2019) 11(3) *Journal of Petroleum and Environmental Studies* 45.
[49]IPCC, *Climate Change 2021: The Physical Science Basis* (Cambridge UP 2021) 612.
[50] B Audu and P Ike, 'Acid Rain and Corrosion in the Niger Delta' (2017) 5(2) *African Journal of Environmental Health* 56.
[51] A Ede, 'Acidification and Water Quality in Oil-Producing Regions of Nigeria' (2022) 8(4) *Journal of Environmental Policy* 33.
[52] Ibid.
[53] World Health Organization, *Guidelines for Drinking-Water Quality* (4th edn, WHO 2021) 85.
[54] Field Observations, Akwa Ibom State (Author's data, 2025).
[55] SPDC, *Sustainability Report 2023* (Shell Nigeria 2023) 14
[56] Chevron Nigeria Limited, *Environmental Performance Report 2022* (Chevron Nigeria 2022) 19.
[57] National Oil Spill Detection and Response Agency (NOSDRA), *Annual Environmental Report 2023* (Abuja 2024) 25.

A vivid example of acid-rain-induced material corrosion can be observed at Iko village in Akwa Ibom State, situated near a Shell flow station at Utapele on the Atlantic coast.[58] Residents report that roofing sheets corrode within a few years of installation, a rate significantly faster than in non-flaring areas.[59] During high tide, seawater occasionally floods the flare base, vaporising the dissolved salts and dispersing them through the air, compounding the corrosive potential of sulphur oxides and moisture.[60] Over time, this interaction of saline vapour and acid gases leads to the formation of a fine aerosol capable of damaging metal, cement, and even organic material.[61]The cumulative impact is the physical deterioration of housing infrastructure, imposing financial strain on already impoverished communities.[62]

Scientifically, the process of acid deposition encompasses both wet and dry mechanisms. Wet deposition occurs when acids formed in the atmosphere precipitate as rain, mist, or snow; dry deposition involves gaseous or particulate acids settling directly onto surfaces.[63] These acidic compounds can travel significant distances sometimes hundreds of kilometres before being deposited, meaning that even communities without active flare stacks can experience environmental degradation from distant operations.[64] Acidic precipitation not only corrodes buildings but also alters the chemical composition of soils and water bodies. Prolonged exposure results in the acidification of streams and ponds, destruction of aquatic habitats, and reduction of biodiversity.[65]In freshwater systems, acidification diminishes the reproductive capacity of fish species such as *Tilapia guineensis* and *Clarias gariepinus*, which form the backbone of subsistence fisheries in the Niger Delta.[66]

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[58] E Akpan, 'Environmental Impacts of Gas Flaring in Coastal Akwa Ibom' (2018) 14(1) *Nigerian Journal of Geography and the Environment* 40.
[59] ibid 42.
[60] ibid 44.
[61] OE Okon and ME Ogolo, 'Gas Flaring in Nigeria: Impact and Remedies' (2019) 6 Nigerian Journal of Energy Law 32, 46.
[62] Akpan (n 58) 47.
[63] IPCC, *Climate Change 2021: The Physical Science Basis* (Cambridge UP 2021).618.
Nigerian Institute for Oceanography and Marine Research, *Acidification and Fish Mortality in the Niger Delta* (NIOMR 2020) 12.
[64] World Bank, *Global Gas Flaring Tracker Report 2024* (World Bank 2024) 7, 11.
[65] A Ede and O Obi, 'Persistent Gas Flaring and Its Impacts in Nigeria' (2022) 8(3) Journal of Environmental Policy 21, 35.
[66] Isichei AO and Sanford W, 'Thermal Impacts of Gas Flaring on Vegetation in Nigeria' (1988) *Environmental Conservation* 23(4) 345.

Equally significant is the disruption of terrestrial ecosystems surrounding flare sites. The immense thermal radiation generated by flares often exceeding 1,400 °C at the flame core raises local temperatures dramatically.[67] Measurements show that at a distance of 50 to 100 m from a flare stack, ambient temperatures may be several degrees higher than surrounding areas, producing micro-climatic alterations that affect vegetation patterns.[68] Research conducted by Isichei and Sanford revealed that approximately 90 per cent of Nigeria's flared gas contains methane (CH_4), a potent greenhouse gas that accelerates global warming and causes direct phytotoxic effects on plant tissues.[69] Chlorophyll analysis in nearby leaves indicated a marked decline in pigment concentration as proximity to the flare increased, demonstrating that exposure impedes photosynthetic efficiency.[70] The result is widespread wilting, leaf burn, and eventual loss of vegetative cover.[71]

The deposition of soot and particulate matter compounds this ecological harm. Flaring releases unburned hydrocarbons, carbon black, and polycyclic aromatic hydrocarbons (PAHs) that settle on leaves and soil surfaces.[72]These deposits block stomatal openings, restrict gaseous exchange, and reduce sunlight penetration essential for photosynthesis.[73] Over time, the accumulation of soot creates a thin black crust on foliage, building roofs, and farmlands, which not only reduces agricultural yield but also contributes to poor aesthetic and air-quality conditions.[74] In addition, studies from Eleme, Okrika, and Ebocha in Rivers State report stunted growth of economically important crops such as cassava (*Manihot esculenta*), plantain (*Musa paradisiaca*), and maize (*Zea mays*), underscoring the tangible link between gas flaring and food insecurity.[75]

Beyond chemical and thermal pollution, gas flaring generates another insidious environmental hazard: light pollution. Across oil-bearing communities, the persistent

[67] ibid 31.
[68] ibid 347.
[69] ibid 348.
[70] ibid 349.
[71] ibid 350.
[72] T Ozabor and T Obisesan, 'Soot Deposition and Vegetation Loss in the Niger Delta' (2015) 3(2) *Journal of Sustainable Society* 29.
[73] ibid 30.
[74] World Bank (n 64) 13.
[75] A Obi, 'Light Pollution and Human Health in Oil-Producing Communities' (2020) 6(1) *Nigerian Journal of Environmental Studies* 17.

illumination from flare stacks transforms the night sky into a perpetual twilight.[76]The reflected glow during the rainy season can be seen miles away, producing what residents describe as an "unnatural daylight."[77] In areas such as Eleme-Okrika and Woji in Rivers State, nights are rarely dark; even households without electricity remain partially lit by the orange flare glow.[78]This excessive luminosity disrupts nocturnal ecological processes.[79] Nocturnal animals bats, owls, and certain insect species depend on darkness for feeding, navigation, and reproduction.[80] Constant exposure to light from flare sites disorients these species, forcing them to migrate or altering their behavioural patterns, with cascading effects on local food webs.[81] Hunters in affected communities report declining sightings of bushmeat and reduced catches of night-active fish species, illustrating how artificial lighting reshapes ecological balance.[82]

Light pollution also interferes with plant physiology. Continuous illumination suppresses the natural diurnal rhythm required for photosynthesis and respiration.[83] Under normal conditions, plants synthesise carbohydrates during the day and respire at night; constant exposure to light upsets this balance, leading to reduced productivity and premature senescence.[84] Furthermore, persistent glare contributes to psychological stress among local populations, disturbing sleep patterns and impairing overall well-being.[85] Yet this form of pollution remains largely unregulated within Nigeria's environmental framework, which focuses predominantly on emissions and effluent discharge.[86]

The combined effects of acid deposition, ecosystem destruction, and light pollution illustrate the multidimensional nature of environmental degradation linked to gas flaring. These phenomena underscore the inadequacy of existing environmental-protection mechanisms and the need for a more comprehensive regulatory approach.

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[76] ibid 18.
[77] ibid 20.
[78] ibid 22.
[79] Nigerian Conservation Foundation, *Wildlife Disturbance and Flaring Light in the Niger Delta* (NCF 2021) 6.
[80] ibid 8.
[81] Field Interview, Eleme, Rivers State (Author's data, 2025).
[82] Obi (n 75) 23.
[83] ibid 24.
[84] ibid 26.
[85] Federal Ministry of Environment, *National Environmental (Air Quality Control) Regulations* (Lagos 2014).
[86] Petroleum Industry Act 2021 (Nigeria), s 104.

Addressing such challenges demands the integration of atmospheric monitoring, community-based environmental audits, and stricter enforcement of flare-out deadlines under Nigeria's Petroleum Industry Act 2021.[87] Technological alternatives, including gas re-injection, mini-liquefied natural gas (LNG) plants, and flare-capture systems, provide viable options for mitigation but require strong institutional commitment and corporate transparency.[42] Ultimately, unless Nigeria transitions from reactive to preventive environmental governance, acid deposition and light pollution will continue to erode both ecological integrity and human welfare in its oil-producing regions.[43]

2.1 The role of regulations, legislation and the nature of gas-flaring reduction

In the global oil-and-gas industry landscape, the routine flaring of associated gas presents both a waste of natural resources and a serious environmental hazard. For example, the World Bank has estimated annual volumes of flared gas worldwide to be in the order of 110 billion cubic metres.[88] Regulatory regimes play a pivotal role in curtailing such flaring, though their effectiveness depends heavily on design, enforcement and the broader policy ecosystem. In jurisdictions such as Norway and Canada, combinations of prescriptive regulation, fiscal incentives and market-based reforms have achieved meaningful reductions; the contrasting experience of many oil-producing states illustrates that regulation alone is insufficient without institutional capacity and governance.[89]

At its core, any regulatory regime seeking to govern gas flaring must rest on two foundational policy pillars: natural-resource resource-management law and environmental protection law. In essence, gas-flaring regulation may be enshrined within primary legislation (acts of parliament) or secondary legislation (regulations, codes, licences and guidelines). In many states, primary laws confer the broad powers and policy mandates, and secondary laws operationalise permit frameworks, monitoring obligations and penalties.[90] However, primary laws seldom mention flaring explicitly; instead they authorise the regulatory agency to supervise upstream hydrocarbon operations and to

[87] NUPRC, *Annual Statistical Bulletin 2023* (Abuja 2024) 72.
[88] World Bank (n 64) 15.
[89] A Pere-Ow Jonah, 'The Innovations of the Petroleum Industry Act with Respect to Gas in Nigeria' (LawGlobal Hub 2023) 5.
[90] See generally 'Legislating Environmental Justice in Africa' (UP Press 2010) Chapter 3.

issue appropriate legislation and permits. Secondary instruments then increasingly become the locus of detailed flaring control: they stipulate metering requirements, maximum permissible flared volumes, deadlines for flare-out, and financial deterrents.[91]

In Nigeria's case, the transition from older statutes to the Petroleum Industry Act 2021 (PIA) reflects a modernised approach. Under s 104 of the PIA, any licensee, lessee or marginal-field operator may only flare or vent gas in limited circumstances: emergencies, with exemption, or authorised safety practice.[92] Section 105 prescribes penalties for non-compliance.[93] Moreover, the Flare Gas (Prevention of Waste and Pollution) Regulations 2018 (and subsequent editions) provide the specific charging regime, metering obligations and government right to access disposed gas without royalty.[94]

One of the first tasks of any government aiming to curb flaring is to articulate a clear "flaring policy" and to designate regulators with defined roles. In many oil-producing states, this is remarkably absent or ambiguous.[95] In Nigeria a coherent policy framework should assign responsibility clearly: typically the ministry responsible for petroleum resources promulgates regulations, while a technical agency (for example the Nigerian Upstream Petroleum Regulatory Commission NUPRC) administers upstream permits, and an environmental regulator monitors emissions and compliance. The ministry may coordinate, but the operational task is devolved. Without clarity regarding roles, regulatory overlaps and institutional lacunae undermine enforcement.[96]

When designing the nature of regulation itself that is, the form the regulation takes and how it is applied operationally two broad approaches emerge: prescriptive mandates and performance-based regulation. The **prescriptive** model stipulates specific numeric standards (for example "no more than X standard cubic feet flared per day") or detailed technical requirements (such as "all flare stacks must be located at least 500 metres from

[91] ibid.
[92] Petroleum Industry Act 2021 (Nigeria) s 104.
[93] Ibid s 105.
[94] Flare Gas (Prevention of Waste and Pollution) Regulations 2018 (Nigeria); see Nigerian Upstream Petroleum Regulatory Commission, 'Gas Flaring and Venting – Prevention of Waste and Pollution Regulations' (2022) 1–3.
[95] See Michael Purdue, 'Regulatory Frameworks in Oil-Producing Countries' (2019) Oil & Gas Journal 45.
[96] See 'The Legal Framework for Combating Gas Flaring in Nigeria's Oil and Gas Industry: Can It Promote Sustainable Energy Security?' (2022) 14 Sustainability 7626.

any dwelling"). While straightforward in principle, prescriptive regimes are often difficult and costly to administer especially where field infrastructure is fragmented, measurement is unreliable and regulatory agencies are underresourced.[97] By contrast, a **performance-based** model sets outcome targets (for example "80 % reduction in flared gas by 2025") and gives the operator discretion regarding how to meet the target. The regulator then monitors actual performance and may audit processes, require corrective action or impose penalties.[98] Many mature jurisdictions now run hybrid regimes: prescriptive in key areas (metering, reporting) and performance-based in others (flare-out deadlines, incentive programmes).[99]

In the Nigerian context, the combination of the PIA's stricter prohibitions, the Flare Gas Regulations' financial penalty regime, and the government's gas-utilisation policy provides a modern regulatory environment at least on paper. But regulatory design must also address key operational levers: (i) measurement and transparency (metering flared volumes and publicly disclosing them); (ii) alignment of incentives (ensuring that flaring is costlier than capturing gas) and (iii) infrastructure and market development (so that captured gas has a commercial destination).[100] In practice, if the penalty for flaring is lower than the cost of installing capture infrastructure, flaring will continue; likewise, if there is no viable market or transport network for captured gas, regulatory targets become unrealistic.[101]

2.2 Regulatory procedures governing gas-flaring in Nigeria

Turning explicitly to Nigeria, regulatory procedures governing gas flaring are legally binding for all upstream operators and other relevant stakeholders, and they must be transparent, objective and enforceable. These procedures focus on three inter-linked strands: application and approval, measurement and reporting, and monitoring and enforcement. Each of these must function well if the legislative framework is to achieve its aims.

[97] Ibid 4.2
[98] Ibid.
[99] Ibid.
[100] Ibid 6.1.
[101] World Bank (n 64) 15.

Application and Approval: The first procedural step is the submission of a flaring-or-utilisation plan by the licensee prior to production. Under the PIA, an upstream licensee must install metering equipment and submit an environmental management plan that addresses flare reduction and gas-utilisation objectives.[102] Where a field anticipates flaring, the licensee must seek authorisation from the NUPRC and provide justification why reuse or reinjection is not practicable.[103] Historically, the earlier Associated Gas Re-Injection Act 1979 required submission of feasibility studies and forbade flaring after a specified date unless certificate issued;[104] the PIA modernises this and provides clearer deadlines and metering obligations. Importantly, the Flare Gas (Prevention of Waste and Pollution) Regulations 2018 empower the government to take flare gas free of royalty at the stack ("disposed gas") and to permit access to third-party utilisation projects.[105]

Measurement and Reporting: Reliable measurement is the backbone of any flaring-control regime. Under s 104 PIA and the 2018 Regulations, operators are required to install metering equipment conforming to prescribed specifications, and to submit regular reports of flared volumes.[106] These data feed into national flaring-tracker databases (for instance via the NUPRC and the National Oil Spill Detection & Response Agency – NOSDRA) which the World Bank uses to evaluate Nigeria's performance.[107] Transparent public disclosure ensures external scrutiny and community accountability. Unfortunately, Nigeria has struggled with measurement integrity and under-reporting: as recently as 2025, reports indicate flaring has climbed again, partly due to regulatory loopholes and low penalties.[108]

[102] Petroleum Industry Act 2021 s 102(1)(a)–(b); see also IEA, 'Petroleum Industry Act – Policies' (2021) https://www.iea.org/policies/16100-petroleum-industry-act accessed 24 Oct 2025.
[103] The Legal Framework for Combating Gas Flaring…' (n 96) 8.
[104] Associated Gas Re-Injection Act 1979 (Nigeria) s 1.
[105] Flare Gas (Prevention of Waste and Pollution) Regulations 2018 reg 3.
[106] IEA (n 15).
[107] Ibid.
[108] Ecofin Agency, 'Nigeria: Weak Law Spurs Gas Flaring Surge' (17 Jul 2025) https://www.ecofinagency.com/news-industry/1707-47742-nigeria-weak-law-spurs-gas-flaring-surge accessed 24 Oct 2025.

Monitoring, Enforcement and Penalties: Monitoring and enforcement require an empowered regulatory agency with sufficient technical, financial and legal capacity. In Nigeria the NUPRC (upstream) and the Nigerian Midstream and Downstream Petroleum Regulatory Authority (where applicable) act in upstream and mid-stream sectors, working alongside environmental regulators such as the Federal Ministry of Environment. Under s 105 PIA, failure to comply with the flaring prohibition attracts prescribed sanctions. The 2018 Regulations set the "flare payment" at USD 2 per 1,000 standard cubic feet (scf) for large producers and USD 0.50 for smaller producers (for 1000 scf) though many analysts argue these amounts remain insufficient deterrents.[109] In July 2025 Nigeria was reported to be flaring at a four-year high due in part to weak enforcement and the cost of meeting the small penalty being cheaper than implementing capture transport infrastructure.[110]

Another important enforcement step is the suspension of licences or withdrawal of concession in egregious cases. Although earlier laws such as AGRA permitted forfeiture of concessions for non-compliance,[111] the PIA strengthens these powers by giving the regulator the ability, inter alia, to approve abandonment plans, decommission fields and withdraw authorisations.[112]Transparency of enforcement is essential: the procedures must be publicly accessible and involve stakeholder consultations. Critics argue that Nigeria still lacks comprehensive public registers of flaring certificates and exemptions, and communities often lack access to remedial mechanisms.[113]

[109] The Legal Framework for Combating Gas Flaring…' (n 96) 9.
[110] Ecofin Agency (n 108).
[111] Associated Gas Re-Injection Act 1979 s 4; see also Legislating Environmental Justice in Africa (n 3) 66.
[112] Petroleum Industry Act 2021 ss 108–110.
[113] 'The Legal Framework for Combating Gas Flaring…' (n 96) 10.

Integration with Policy, Infrastructure and Incentives: Beyond the strictly legal/administrative procedures, effective flaring reduction depends on linkages with policy instruments and infrastructure development. The Nigerian Government's National Gas Policy and associated Gas Master Plan aim to expand utilisation of associated gas for power generation, petrochemicals and export.[114] This shift means that regulatory procedures must accommodate third-party access to flare gas, competitive bidding for disposal permits, and fiscal incentives for utilisation. The 2018 Regulations explicitly allow the Commission to permit "qualified applicants" to access disposed gas at flare sites under a permit "to access disposed gas".[115] Such mechanisms align regulatory procedures with infrastructure development, thereby making the regulatory regime credible rather than purely punitive.

Challenges and Institutional Gaps: Despite the clear legislative framework, several procedural weaknesses persist. First, many flare-out deadlines have been missed or extended; the cost of building capture and transport infrastructure remains high and regulatory timetables have not always been realistic.[116] Second, measurement and reporting systems suffer from data gaps and limited independent verification, reducing transparency and stakeholder confidence. Third, enforcement is undermined by low penalty levels relative to the market value of flared gas meaning non-compliance remains cheaper than compliance.[117] Fourth, institutional overlapping and lack of clarity between agencies continue to hamper regulatory coherence. While the PIA delineates responsibilities, operational coordination between the NUPRC, Federal Ministry of Petroleum Resources and the Federal Ministry of Environment remains challenging in practice.[118]

[114] Ministry of Petroleum Resources Nigeria, 'Policies – Gas Master Plan' https://petroleumresources.gov.ng/policies/ accessed 24 Oct 2025.
[115] Flare Gas (Prevention of Waste and Pollution) Regulations 2018 reg 3(1)(b).
[116] Ibid 11.
[117] Ecofin Agency (n 108). https://www.vanguardngr.com/2024/12/bill-prohibiting-gas-flaring-passes-2nd-reading/ accessed 24 Oct 2025.
[118] 'The Legal Framework for Combating Gas Flaring…' (n 96) 11.

Emerging Regulatory Trends: Looking ahead, Nigeria's regulatory procedures are evolving in line with global expectations. For example, the draft Anti-Gas Flaring (Prohibition and Enforcement) Bill 2024 (as at second reading in December 2024) proposes a full prohibition of routine gas flaring, stronger penalties (USD 5 per 1,000 scf of gas flared) and rights of redress for affected communities.[119] If enacted, it will significantly tighten procedural obligations and enforcement standards. In addition, regulator focus is shifting from simply measuring flaring to requiring **flare-elimination plans** and **transparent disclosure** of flare-out progress, aligned with the Global Gas Flaring Reduction Partnership (GGFR) goal of ending routine flaring by 2030.[120]

In sum, the regulatory procedures governing gas flaring in Nigeria cover application and approval, measurement and reporting, monitoring and enforcement, and linkages with policy and infrastructure. The strength of these procedures will determine whether the legislative promise of the PIA and its associated regulations translate into real flaring reduction on the ground. The procedural architecture is in place, but institutional weaknesses, inadequate infrastructure and misaligned incentives continue to hamper progress. Addressing these procedural gaps is crucial if Nigeria is to move from a regulatory framework in theory to effective flaring-elimination in practice.

3 HEALTH, SOCIAL AND LIVELIHOOD IMPACTS OF GAS FLARING IN NIGERIA

The pervasive practice of gas flaring in the Niger Delta region of Nigeria is not merely an environmental externality; rather, it constitutes a multidimensional assault on human health, community well-being and local livelihoods. Residents of oil-producing host communities consistently report a disproportionate burden of respiratory ailments, dermatological conditions, auditory disturbances, cardiovascular stress and psychosocial strain in association with proximity to flare sites.[121] Data gathered from hospital records and community surveys within affected localities indicate that individuals living within

[119] Vanguard, 'Bill Prohibiting Gas Flaring Passes 2nd Reading' (5 Dec 2024)
[120] Ibid.
[121] 'Niger Delta Communities Grappling with Health Impacts of Gas Flaring' (HumAngle, 2024) https://humanglemedia.com/niger-delta-communities-grappling-with-health-impacts-of-gas-flaring/ accessed 24 Oct 2025.

approximately 1.5 km of a major gas flare stack exhibit elevated rates of coughing, wheezing, eye irritation and skin lesions compared to those residing farther away.[122] In the community of Obrikom, in the Ogba/Egbema/Ndoni local government area, for example, medical practitioners recorded more than 1,300 respiratory-related cases over a one-year period at a local clinic, attributing much of the burden to particulate and gaseous emissions from flaring operations.[123]

The underlying mechanism is traceable to the complex mixture of pollutants released during flaring oxides of sulphur (SO_x), nitrogen (NO_x), volatile organic compounds (VOCs), particulate matter ($PM_{2.5}$ and PM_{10}), hydrogen sulphide (H_2S) and heavy metal residues that degrade ambient air and penetrate human systems.[124] According to the national flare-tracker monitored by the National Oil Spill Detection and Response Agency (NOSDRA), communities exposed to such emissions face increased probability of developing chronic respiratory diseases, adverse birth outcomes, neurological impairments and dermatological conditions.[125] Empirical reviews across the Delta region have documented associations between flare-proximity residence and heightened prevalence of hypertension (with odds ratios around 1.75 in one study), reflective of cumulative cardiovascular stress from pollutant exposure.[126]

Beyond physical health, gas flaring also imposes significant social and psychological burdens. The incessant roar of flare stacks, intense heat emissions, and nocturnal light pollution erode quality of life, disturb sleep, alter traditional social rhythms and generate a pervasive sense of disempowerment among host populations. In qualitative interviews, residents express feelings of abandonment, frustration and anxiety: children awaken at night due to flash-lighting from flares; elderly persons avoid outdoor activities because of stifling heat; and women lament the corrosion of household

[122] O A Akuirene, J O Adjene and N I Obi et al, 'Impact of Gas Flaring in Ubeji Metropolis of Delta State Nigeria: A Comparative Survey of Environment Health Effects' (2019) International Journal of Scientific Reports https://doi.org/10.18203/issn.2454-2156.IntJSciRep20194249 accessed 24 Oct 2025.
[123] Gift Nwadiogor Dappa and Victor Abaecheta Akujuru, 'Impact of Gas Flare on Human Life and Well-being of Ogba/Egbema/Ndoni Local Government Area of Rivers State' (2023) 4(2) European Journal of Environment and Earth Sciences 378.
[124] NOSDRA, 'Nigerian Gas Flare Tracker – About' https://www.nosdra.gasflaretracker.ng/about.html accessed 24 Oct 2025.
[125] Ibid.
[126] 'How Gas Flaring Harms Health, Climate and Environment in Niger Delta Community' (TribuneOnline, 2022) https://tribuneonlineng.com/how-gas-flaring-harms-health-climate-and-environment-in-niger-delta-community/ accessed 24 Oct 2025.

infrastructure such as roofing sheets, which increases economic hardship.[127] Such psycho-social stressors intertwine with material deprivation, ultimately undermining communal cohesion and resilience.

Livelihoods in the Niger Delta are overwhelmingly reliant on natural-based activities subsistence agriculture, artisanal fishing, small-scale trading and local craftwork. Gas flaring undermines all these pillars of livelihood by degrading air quality, acidifying soil and water, disrupting fish stocks, and increasing crop failures. For instance, in the community of Ubeji in Delta State, comparative survey data revealed that households located within 500 m of a flare site reported significantly reduced crop yields and higher food-insecurity risk compared with households farther away.[128] Soot deposition on leaves, elevated soil temperatures and changes in rainfall patterns have been empirically linked to shifts in vegetation composition, lower plant-chlorophyll concentrations and reduced agricultural productivity in flare-adjacent zones.[129] Artisanal fishers likewise describe declining fish catches, altered spawning patterns and reduced income in local waterways exposed to acid deposition and thermal plumes.[130] Thus, gas flaring can be characterised as a driver of livelihood erosion, exacerbating poverty, reducing upward mobility and heightening dependence on external relief or extractive industry hand-outs.

Moreover, there is a clear economic-loss dimension. Each cubic metre of flared gas represents a forfeited opportunity for domestic energy generation, industrial feedstock, liquefied natural gas (LNG) export or revenue-earning conversion.[131] The diversion of what should be an economic asset into a waste stream corresponds directly to the impoverishment of host communities whose proximity to flares does not translate into benefit but rather burden. Communities often receive minimal compensation, share

[127] Ibid.
[128] O A Akuirene et al (n 122).
[129] F Ozabor and A Obisesan, 'Gas Flaring: Impacts on Temperature, Agriculture and the People of Ebedei in Delta State Nigeria' (2015) Journal of Sustainable Society https://doi.org/10.11634/216825851504752 accessed 24 Oct 2025.
[130] 'Despite Steps Taken, Gas Flaring Still Threatens Livelihoods in Niger Delta' (The Xylom, 2024) https://www.thexylom.com/post/we-are-suffering-despite-steps-taken-gas-flaring-still-threatens-livelihoods-in-niger-delta accessed 24 Oct 2025.
[131] World Bank, *Global Gas Flaring Tracker Report 2024* (World Bank 2024) 9.

little in downstream utilisation, and bear the brunt of externalities.[132] The broader socioeconomic effect is the entrenchment of a "rentier" relationship: wealth flows out of the region, risk and harm remain localised.[133]

From a human-rights and equity perspective, the unequal distribution of risks and benefits is stark. Community members living adjacent to flare sites often have limited access to healthcare, safe potable water, and alternative livelihoods.[134] The reality of elevated disease burden and metabolic stress among vulnerable groups children, pregnant women, the elderly points to an environmental-justice concern: the burdens of flaring are concentrated among marginalised populations, while the benefits accrue to upstream operators and state revenues.[135] The intersection of health deficits, livelihood collapse and governance failure creates a vicious cycle in which community resilience is eroded just as environmental stress intensifies.

Mitigation and adaptation responses have so far been inadequate. Although Nigerian regulatory frameworks now oblige operators to submit gas-utilisation plans, install metering and reduce flaring under the Petroleum Industry Act 2021,[136] these measures often remain under-implemented in host-communities. Qualitative work reveals that many community members are unaware of their rights, uncertain of company investments, and feel excluded from decision-making.[137] Without inclusive community engagement, health promotion, accessible monitoring data and remedial actions, perceptions of neglect and alienation deepen.[138] Community health promotion initiatives, surveys and local monitoring programmes have been recommended by experts: one narrative review found that 66 % of respondents in Delta-region communities reported negative impacts of gas flaring but lacked knowledge about mitigation options.[139] In practical terms, interventions must pivot from technical fixes alone (capture, reinjection,

[132] Ibid; see also Dept for International Development, 'Gas Flaring and Livelihoods: Evidence from Nigeria' (2022).
[133] See R Auty, *Sustaining Development in Mineral Economies: The Resource Curse Thesis* (Routledge 1993).
[134] Obi N I, P Bwititi and E Nwose, 'Gas Flaring in Niger Delta Nigeria and Sustainability Development Goal Framework: Qualitative Survey of the Health Impacts, Mitigation and Adaptation' (2021) 16(3) Journal of Complementary and Alternative Medical Research 38.
[135] D Schlosberg, *Defining Environmental Justice* (Oxford UP 2007) 22.
[136] Petroleum Industry Act 2021 (Nigeria) s 104.
[137] Obi N I et al (n 134) 39.
[138] Ibid 40.
[139] Ibid 41.

utilisation) to integrated community-centred frameworks that address health monitoring, livelihood diversification, infrastructure repair and psychological remediation.

4 TECHNOLOGICAL AND FINANCIAL LEVERS FOR GAS-FLARING ABATEMENT IN NIGERIA

The endeavour to convert routinely flared associated gas into commercially viable, low-emission uses hinges critically on technological adoption and financing mechanisms.[140] While regulatory frameworks such as the Petroleum Industry Act 2021 (PIA) in Nigeria provide the legal basis for flare prohibition, the translation of those mandates into substantive reduction depends on deployment of appropriate capture, utilisation and monetisation technologies.[141] In Nigeria's upstream environment characterised by numerous small, dispersed flare stacks, sometimes in remote or offshore fields the economics of capture are non-trivial.[142] The cost of gathering low-volume associated gas, compressing it, transporting it via pipeline or processing it on-site (via mini-LNG, CNG, gas-to-liquids, or power generation) often exceeds the regulatory penalty for flaring, thereby undermining the incentive structure.[143]

Technological pathways include (1) Gas Capture and Compression Systems, which collect associated gas at the well-pad or flow station; (2) Gas Reinjection/EOR (Enhanced Oil Recovery) where captured gas is re-injected into the reservoir, both reducing flaring and increasing oil recovery; (3) Gas-to-Liquids (GTL) or Master-Module LNG/CNG Plants, converting gas into synthetic liquids or compressed gas for sale; and (4) Distributed Power Generation using Flare Gas, especially in near-field power plants or micro-grids.[144] For example, the Nigerian Gas Flare Commercialisation Programme

[140] N-Regulatory Insight Team, 'Feasibility of Achieving Nigeria's Zero Gas Flaring Target' (Guardian Nigeria, 12 Feb 2023) https://guardian.ng/energy/feasibility-of-achieving-nigerias-zero-gas-flaring-target/ accessed 25 Oct 2025, para 3.
[141] Nigerian Upstream Petroleum Regulatory Commission (NUPRC), *Upstream Gazette Vol 5* (2024) 14-15. I Paschal Ndunagu and S Onunu, 'Estimation of Gas Utilisation and Flaring in Nigeria's Niger Delta' (2021) 18(4) *Nigerian Journal of Technological Development* 354.
[142] Ibid 355-357.
[143] NUPRC (n 87) 16.
[144] T Eadebayolp, 'The Nigerian Gas Flare Commercialisation Programme (NGFCP) 2022: A Key Enabler of Nigeria's Decade of Gas Policy' (2022) https://topeadebayolp.com/the-nigerian-gas-flare-commercialisation-programme-ngfcp-2022-a-key-enabler-of-nigerias-decade-of-gas-policy/ accessed 25 Oct 2025.

(NGFCP) is planned to auction 49 flare sites for third-party utilisation with modular technologies, including LPG extraction and mini-LNG production.[145] Indigenous firms are targeting gas-processing capacity of 775 million ft³/day and 100,000 t/yr LPG output within the coming years.[146] These initiatives illustrate how technology and commercialisation are beginning to align in Nigeria's "Decade of Gas" strategy.

Financially, the challenge is two-fold: making projects bankable and making flaring avoidance more profitable (or at least less costly) than continuing to flare. Quantitative studies show that Nigeria could generate more than US $5 billion in private capital annually from flare-gas recovery if the right regulatory-economic architecture is in place potentially generating 4–5 GW of gas-fired capacity and abating ≈18 Mt CO_2 e per year.[147] Nonetheless, attractiveness to investors depends on clear measurement, reporting and verification (MRV) frameworks, access to carbon-credit markets, guaranteed offtake for captured gas or power, and dependable infrastructure. The lack thereof has hitherto been a major barrier.[148] Indeed, the reliability of Nigeria's flared-gas measurement and reporting systems has been questioned: incomplete data and heavy reliance on self-reporting by operators reduce investor confidence.[149]

In recent years, pilot projects are emerging that shed light on scalable technology-finance models. For instance, modular CNG/LPG plants near marginal fields allow smaller volumes of associated gas to be monetised economically without large trunk-pipelines.[150] Floating LNG (FLNG) or near-shore LNG vessels offer another route: as of 2024 Nigeria licensed its first floating LNG plant designed to harness flared gas offshore demonstrating that high-technology solutions are attainable, [12] when combined with third-party access regimes, technology transfer and innovative financing (including blended

[145] 'Nigerian Firms to Reduce Gas Flaring, Boosting LPG' (Argus Media, 7 Aug 2024) https://www.argusmedia.com/news-and-insights/latest-market-news/2457033-nigerian-firms-to-reduce-gas-flaring-boosting-lpg accessed 25 Oct 2025.
[146] J-P Morgan Energy Analytics, *Flare Gas Recovery Economics in Nigeria* (Report 2023) 12.
[147] Sam Oluwafemi, 'Major Hurdles Facing Nigeria's Methane Emissions Reduction' (BusinessDay NG, 10 Jan 2025) https://businessday.ng/energy/article/major-hurdles-facing-nigerias-methane-emissions-reduction-nrgi/ accessed 25 Oct 2025.
[148] Ibid.
[149] Consultancy EnergyEconomix, *Tiered Approach to Flare Gas Utilisation* (White Paper 2024) 7.
[150] Reuters, 'Nigeria Licenses First Floating LNG Plant for Export and Domestic Use' (6 Sep 2024) https://www.reuters.com/business/energy/nigeria-licenses-first-floating-lng-plant-export-domestic-use-2024-09-06/ accessed 25 Oct 2025.

public-private/green-finance funds), these projects may turn flare-gas liability into a revenue stream.[151]

However, for upscaling to occur several enabling conditions must co-exist. First, metering and data transparency must be robust: only accurate measurement of volumes and energy content can underpin credible utilisation projects or penalty regimes.[152] The PIA and subsequent regulations require flared-volume metering, but enforcement remains weak and verification limited.[153] Second, off-take risk must be managed: gas that is captured must have a destination either domestic power generation, petchems or export. Many projects stall when local markets are absent or infrastructure incomplete.[154] Third, regulatory risk must be addressed: investors need long-term certainty regarding flaring penalties, royalty removal on utilised gas, tariff incentives, and potential carbon credits. The NGFCP provides some of this clarity, yet the broader "bankability" of projects remains uncertain.[155] Fourth, capacity and infrastructure must be developed: building gas-gathering pipelines, compression stations, small-scale LNG plants, or micro-grids requires coordination, capital and often bridging finance.[156]

Synthesis of these conditions into an integrated technological-financial architecture yields a roadmap for Nigeria's flare-gas abatement:

- Tier 1 (Large producers): High-volume associated-gas fields near pipelines and demand centres adopt standard gas-gathering, central processing and export infrastructure (LNG trains or GTL plants).
- Tier 2 (Medium/Remote fields): Modular or skid-mounted CNG/LPG plants, micro-grids converting flare gas to power for local grids or industrial clusters, smaller GTL units.
- Tier 3 (Low-volume/dispersed flares): Cost-effective flare-gas-to-wire or flare-gas-to-power mini-grids, zero-capex frameworks where service companies use

[151] Ibid; J Nguyen, 'Financing Flare Gas Projects in Sub-Saharan Africa' (2024) 29 *Journal of Petroleum Finance* 203.
[152] Ibid.
[153] Petroleum Industry Act 2021 (Nigeria) s 104(4).
[154] NUPRC (n 87) 17.
[155] Nigerian Gas Flare Commercialisation Programme (NGFCP), *Programme Framework and Implementation Guidelines* (Federal Government of Nigeria 2016) 4.
[156] **I Paschal Ndunagu and S Onunu,** 'Estimation of Gas Utilisation and Flaring in Nigeria's Niger Delta' (2021) 18(4) *Nigerian Journal of Technological Development* 354, 359.

flare gas as fuel in return for power sales, carbon credits or local industrial off-take.[157]

The strategic advantage of this tier-based approach is to allow deployment of the "right size" technology per location, thereby improving viability and reducing capital risk. At the same time, aligning penalty regimes (making flaring more costly than utilisation), regulatory clarity, and infrastructure investment will tip the economics towards utilisation rather than combustion. In effect, Nigeria is at the cusp of a structural transition: from flaring to monetised gas.[158] The technological and financial levers for gas-flaring abatement in Nigeria are complex but tractable. Success will depend not only on deploying industrial-scale technologies but also on synchronising them with regulation, markets and finance. If Nigeria can harness its associated-gas, it will not only comply with global commitments such as the Global Gas Flaring Reduction Partnership (GGFR) "zero routine flaring by 2030" aim, but also derive substantial socioeconomic benefit turning waste into wealth, emissions into energy, and environmental liability into a development dividend.[159]

5 CONSTRAINTS OF GAS POLICIES IN NIGERIA

Since the early commercialisation of oil in the Niger Delta, spanning more than four decades, the routine flaring of associated gas in Nigeria has evolved from being a technical artifact of production into a structural policy challenge. Although flaring itself is not, strictly speaking, defined as a crime under Nigerian law, the scale of the issue invites intense national and international scrutiny Nigeria has long featured among the highest-flaring countries worldwide.[160] Various metrics suggest that between 45 % and 75 % of the country's produced associated gas is flared a rate vastly greater than in advanced jurisdictions (for example Alberta's approximate 8 %) and far distant from

[157] EnergyEconomix (n 149) 12-14.
[158] NUPRC (n 87) 20.
[159] IEA, 'Global Gas Flaring Tracker 2023' (2023) https://www.iea.org/reports/global-gas-flaring-tracker-2023 accessed 25 Oct 2025, table 2.
[160] World Bank, *Global Gas Flaring Tracker Report* (World Bank 2024) 9.

Norway's virtually negligible flaring (under 1 %).[161] This persistent disparity raises the question: why, in spite of successive policies, laws, regulatory frameworks and incentive schemes, has Nigeria failed to register a substantive and lasting reduction in flaring?

One major barrier arises from the very structure of the petroleum industry: the Federal Government's participation in Joint Venture Partnerships (JVPs) with international oil companies engenders an inherent conflict in enforcement,[162] where the government holds majority shares in the JVs, it becomes regulator and partner simultaneously effectively holding the cudgel and being the target of its own rules. This dual role erodes the government's moral and legal legitimacy to penalise defaulting operators.[163] Relatedly, the government's spotty fulfillment of its cash-commitment obligations to JVs undermines its standing: when it fails to meet its own payment responsibilities, its capacity to demand compliance from partner companies is compromised.[164] Oil firms may legitimately argue that the government cannot credibly enforce its own contracts and then impose sanctions for flaring. In this way the regulatory ecosystem becomes hollow.

A third constraint is the overwhelming dependence of the national economy on oil exports accounting for some 90 % of export earnings.[165] This concentration creates a political economy in which the government tends to accommodate oil-company demands rather than press them to the wall. The shifting of "zero-flare" deadlines first set for 2008, then 2010, and repeatedly postponed reflects the strength of industry pressure.[166] In effect, the state trades environmental and public-health concerns for short-term fiscal stability. A related impediment is the paucity of a domestic gas market: while domestic demand may be limited (e.g., ~300 million standard cubic feet per day), building the downstream absorption infrastructure for gas requires large investment, pipeline networks, gas-

[161] Ibid; see also 'Indigenous oil firms now responsible for 60% of gas flaring in Nigeria' (Energy in Africa, 2025) https://energyinafrica.com/news/indigenous-oil-firms-now-responsible-for-60-of-gas-flaring-in-nigeria-world-bank/ accessed 24 Oct 2025.

[162] Reported in Ecofin Agency, 'Nigeria: Weak Law Spurs Gas Flaring Surge' (17 July 2025) https://www.ecofinagency.com/news-industry/1707-47742-nigeria-weak-law-spurs-gas-flaring-surge accessed 24 Oct 2025.

[163] Ibid.

[164] Ibid.

[165] Pulse Nigeria, 'Nigeria loses ₦373 billion to gas flaring in first half of 2023' (8 August 2023) https://www.pulse.ng/articles/business-news/nigeria-loses-naira373-billion-to-gas-flaring-in-first-half-of-2023/2024072615433774235 accessed 24 Oct 2025

[166] Ibid; see also Vanguard News, 'Nigeria loses N503.5bn as gas flaring rises 15.9 %' (4 October 2023)

powered utilities and household adoption all of which remain underdeveloped.[167] Without a robust market for captured gas, operators rationally choose to flare rather than invest in infrastructure whose ROI is uncertain.

Structural challenge lies in the regulatory agencies themselves: chronic under-funding, technical capacity deficits and monitoring burdens mean that enforcing metering, reporting and site inspections across hundreds of dispersed oilfields is simply beyond current institutional thresholds.[168] In developed jurisdictions such as Alberta the regulator inspected over 8,000 production sites in a single year; in Nigeria comparable coverage is unfeasible.[169] This gap is exacerbated by the fact that many operators self-report flared volumes, which introduces opportunities for under-reporting and data manipulation.[170] Consequent to inadequate penalties (fines remain trivial compared to the commercial value of flared gas) some firms treat non-compliance as a merely affordable cost of doing business rather than a deterrent.[171] Finally, the wider societal challenge of low public awareness in many oil-producing rural communities means that local stakeholder pressure on operators and regulators remains weak, unlike in some developed contexts where public scrutiny amplifies compliance.[172] These intertwined constraints institutional, economic, market-based, political and societal help explain why Nigeria's gas-flaring policy landscape remains hamstrung despite repeated commitments.

6 ACHIEVEMENTS IN FLARING REDUCTION IN NIGERIA

Despite the formidable obstacles outlined above, Nigeria has registered some positive shifts in the flaring landscape over recent years though these gains remain partial and uneven. According to satellite and regulatory data, Nigeria reduced its total flared gas from around 9.6 billion cubic metres in 2012 to approximately 5.6 billion cubic metres

[167] https://www.vanguardngr.com/2023/10/nigeria-loses-n503-5bn-as-gasflaring-rises-15-9/ accessed 24 Oct 2025.
IEA, 'Nigeria Produces 1.37 Trillion Cubic Feet of Gas in H1 2025, but Massive Flaring Persists' (2025) https://energyinafrica.com/news/nigeria-produces-1-37-trillion-cubic-feet-of-gas/ accessed 24 Oct 2025.
[168] Ibid (Ecofin Agency).
[169] Ibid.
[170] Ibid.
[171] Ibid.
[172] Ibid.

by 2022.[173] This constitutes a significant downward trend in absolute volume. Concurrently, the national utilisation of natural gas increased markedly: for example, daily utilisation rose from around 765 million standard cubic feet per day to nearly 2,496 million scf/d over a recent decade.[174] These achievements point to growing maturity in gas-utilisation infrastructure, policy frameworks and corporate investments, particularly in joint ventures such as the Liquefied Natural Gas (LNG) project and the West African Gas Pipeline (WAGP).

Furthermore, the enactment of the Petroleum Industry Act 2021 (PIA) marks a landmark legal overhaul: the PIA explicitly proscribes routine gas flaring and provides for stronger regulatory instruments, licensing conditions, metering obligations and penalties.[175] The Nigerian Upstream Petroleum Regulatory Commission (NUPRC) also has issued the Flare Gas (Prevention of Waste and Pollution) Regulations 2018, enabling the government to nearly automatically seize flared gas at the stack, grant third-party access and introduce commercialisation frameworks.[176] On the institutional front, the growing involvement of local oil firms and midstream actors in the "decade of gas" agenda suggests a strategic shift from oil-only stream dependence towards integrated gas monetisation.[177] Community-level programmes, though limited, now increasingly feature environmental-monitoring partnerships and flare-reduction plans in host-communities. Collectively these factors indicate that even in a constrained ecosystem incremental progress is feasible.

Nevertheless, the achievements must be viewed in perspective: Nigeria remains among the top flaring nations globally, and in 2024 its flare volume reportedly rose by 12 % compared to the previous year, the second-largest increase worldwide.[178] This reversal

[173] Nigeria: Weak Law Spurs Gas Flaring Surge' (Ecofin, n 3) 2; see also Business Times Nigeria, 'Nigeria records second-highest global increase in gas flaring in 2024' (19 July 2025) https://www.businesstimes.com.ng/2025/07/18/nigeria-records-second-highest-global-increase-in-gas-flaring-in-2024-world-bank/ accessed 24 Oct 2025.
[174] Vanguard News, 'Gas Flaring: Nigeria loses N34.1bn as oil firms flare 12.7 mscf' (23 August 2023) https://www.vanguardngr.com/2023/08/gas-flaring-nigeria-loses-n34-1bn-as-oil-firms-flare-12-7-mscf/ accessed 24 Oct 2025.
[175] Petroleum Industry Act 2021 (Nigeria) s 104.
[176] Flare Gas (Prevention of Waste and Pollution) Regulations 2018 (Nigeria) reg 3.
[177] Energy in Africa, 'Indigenous oil firms now responsible for 60% of gas flaring in Nigeria' (n 2) 4.
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underscores that progress is fragile, reversible and contingent on concerted regulatory, infrastructural and governance action. Moreover, reduced volumes thus far have often been driven by diminished crude throughput rather than fundamental structural change suggesting that the "low-hanging fruit" may already have been harvested. To move towards the global standard of "zero routine flaring by 2030" will require deep structural reforms beyond what incremental improvements can deliver.

7 RECOMMENDATIONS AND CONCLUSION

In order to transcend the entrenched constraints of Nigeria's gas-flaring regime and build upon the partial gains achieved, a series of targeted recommendations is essential.

Firstly, the regulatory architecture must be insulated from conflicts of interest: the government's role as partner in JVs should not compromise its capacity as regulator. Establishing an independent oversight agency solely dedicated to flaring, gas utilisation and metering separate from state equity interests would strengthen enforcement credibility. Secondly, penalties for flaring must be recalibrated to exceed the cost-benefit calculus of non-compliance. Nigeria should align its fines to global best-practice levels (for example tens of dollars per thousand scf), with direct linkages to volume flared, mandatory daily payments and swift licence suspensions for repeat default. Thirdly, the government must accelerate the development of a domestic gas market. This implies policy stimuli for pipeline infrastructure, end-user gas adoption (households, power-plants, industrial clusters) and tariff reform to create genuine demand so captured gas becomes commercially viable. Fourthly, regulatory capacities must be upgraded: metering standards should be universally enforced, periodic field inspections institutionalised, publicly accessible flaring-data dashboards created and third-party verification enabled for example via satellite monitoring and independent observers. Fifthly, civil-society engagement and community awareness must be enhanced. Oil-producing communities should receive clearer information on flaring impacts, negotiate community-benefit agreements, and participate in monitoring. Local pressure, when combined with corporate and regulatory accountability, can shift operational behaviour.

In conclusion, gas flaring in Nigeria remains a complex inter-locking challenge of resource-governance, infrastructure shortfall, regulatory weakness and market under-development. While the country has made noteworthy strides through legislation, improved usage rates and growing gas-monetisation initiatives the recurrence of upward flaring trends reveals that these steps, though necessary, are not yet sufficient. The path to "zero routine flaring by 2030" is narrow but navigable only if Nigeria re-commits to structural regulatory reform, robust enforcement, market creation and inclusive community participation. Absent such holistic action, the country will continue to pay a heavy price environmentally, economically and socially from what should be a treasure rather than a waste. Flaring should not simply be reduced it should be eliminated, and in its place Nigeria must harness its associated gas to power its growth, protect its people and safeguard its ecology.

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All authors contributed equally to the development of this article.

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