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Associated Gas Utilization in Libya: Challenges, Opportunities, and Sustainable Development

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Abstract

English: Gas flaring remains a critical environmental and economic challenge in global oil production, with Libya ranking among the top flaring nations worldwide. Despite holding Africa's largest proved oil reserves and significant natural gas resources, Libya flared approximately 6.3 billion cubic meters of associated gas in 2024, resulting in an estimated economic loss of $650 million. This study provides a comprehensive analysis of associated gas utilization in Libya, exploring the technical, economic, and regulatory barriers that perpetuate routine flaring. Through an examination of recent policy developments, including Libya's 2026 endorsement of the World Bank's "Zero Routine Flaring by 2030" initiative and the National Oil Corporation's pledge to reduce flaring by 83%, this paper identifies strategic pathways for gas monetization. Technologies such as gas-to-power, liquefied natural gas (LNG), and reinjection for enhanced oil recovery are evaluated within the Libyan context. The findings demonstrate that capturing and utilizing associated gas can significantly enhance domestic energy security, boost export revenues, and align the nation with global climate mitigation goals. The paper concludes with actionable policy recommendations to accelerate infrastructure investment and regulatory enforcement, thereby advancing sustainable development in Libya's hydrocarbon sector.

Keywords

English: Natural Gas Flaring; Associated Petroleum Gas; Sustainable Development; Energy Economics; Zero Routine Flaring; Libya.

1. Introduction

The global hydrocarbon industry faces mounting pressure to reconcile the economic imperatives of energy production with the urgent need for environmental sustainability and climate change mitigation. Central to this challenge is the practice of routine gas flaring—the controlled combustion of associated petroleum gas (APG) that is extracted alongside crude oil. Globally, gas flaring remains a persistent source of greenhouse gas (GHG) emissions and resource waste. In 2023, the world flared an estimated 148 billion cubic meters (bcm) of natural gas, a volume that surged further to 167 bcm by 2025, wasting an estimated $54 billion in energy value [1] [2]. This volume is equivalent to the entire annual gas consumption of the African continent [2]. The environmental toll is equally severe, as flaring releases substantial quantities of carbon dioxide (CO_2), methane (CH_4), black carbon, and nitrogen oxides (NO_x) into the atmosphere, directly undermining global efforts to limit planetary warming [3] [4].

Libya, a cornerstone of the North African energy market and a member of the Organization of the Petroleum Exporting Countries (OPEC), occupies a critical position in this global landscape. Endowed with Africa's largest proved oil reserves—estimated at 48 billion barrels at the beginning of 2024—and substantial natural gas reserves of 53 trillion cubic feet (Tcf), the nation's economy is heavily dependent on hydrocarbon revenues [5]. In 2023, oil and natural gas export revenues accounted for approximately 97% of Libya's total government revenues and 93% of its total export value [5]. However, decades of political instability, underinvestment, and infrastructural degradation have severely hindered the efficient utilization of its energy resources [6].

Consequently, Libya has consistently ranked among the world's top gas-flaring nations. Data from the World Bank and the U.S. Energy Information Administration (EIA) indicates that Libya flared approximately 240 billion cubic feet (Bcf), or roughly 6.8 bcm, of associated gas in 2023—the highest level recorded in a decade—and continued to flare about 6.3 bcm in 2024 [5] [7]. This staggering level of waste translates to an annual economic loss of approximately $650 million for the Libyan economy [7]. Furthermore, the flaring intensity in North Africa, including Libya, significantly exceeds the global average, highlighting a critical inefficiency in regional production practices [8].

The paradox of Libya's energy sector is stark: while the country burns billions of cubic meters of valuable natural gas into the atmosphere, it simultaneously struggles to meet domestic energy demand. Over 70% of Libya's natural gas consumption is directed toward electricity generation, yet the nation's power grid has historically suffered from acute shortages and rolling blackouts [5]. Capturing and monetizing this flared gas presents a transformative opportunity. Redirecting APG to the domestic power sector or processing it for export via existing, underutilized infrastructure—such as the Greenstream pipeline to Europe or liquefied natural gas (LNG) terminals—could alleviate domestic energy poverty, generate critical state revenue, and support the energy transition [8] [9].

Recognizing the unsustainability of current practices, there has been a recent, paradigm-shifting momentum within Libyan energy policy. In April 2026, the Government of Libya officially endorsed the World Bank's "Zero Routine Flaring by 2030" (ZRF) initiative, aligning itself with the Global Flaring and Methane Reduction (GFMR) Partnership [7] [10]. Concurrently, the Libyan National Oil Corporation (NOC) has articulated a strategic roadmap to achieve an 83% reduction in gas flaring by 2030, rolling out specific infrastructure projects to capture and process associated gas across major oil fields [11] [12].

Despite these ambitious commitments, the path to zero routine flaring in Libya is fraught with complex technical, economic, and institutional challenges. This research paper aims to

comprehensively analyze the current state of associated gas utilization in Libya. Specifically, the study seeks to: (1) quantify the economic and environmental impacts of gas flaring in the Libyan context; (2) evaluate the technological and infrastructural options available for APG monetization, including gas-to-power, LNG, and reinjection; (3) identify the primary barriers hindering the deployment of these technologies; and (4) propose actionable, sustainable development strategies to ensure the successful implementation of the 2030 zero-flaring targets. By synthesizing recent empirical data, policy shifts, and technological assessments, this paper contributes to the broader discourse on energy economics and sustainable resource management in post-conflict, resource-dependent states.

2. Literature Review

The discourse surrounding associated petroleum gas (APG) utilization and gas flaring is inherently multidisciplinary, intersecting the fields of petroleum engineering, environmental science, and energy economics. A robust body of literature has documented the deleterious impacts of flaring, the structural drivers of the practice in oil-dependent economies, and the technological innovations required for effective gas monetization. This section synthesizes existing scholarship, with a specific focus on the Libyan context and the broader implications for sustainable development.

2.1 Environmental and Public Health Impacts of Gas Flaring

The environmental degradation caused by routine gas flaring is well-established in academic literature. Flaring is a major source of anthropogenic greenhouse gas (GHG) emissions, primarily carbon dioxide (CO_2) and methane (CH_4), the latter being a highly potent climate pollutant. According to the World Bank's Global Gas Flaring Tracker Report, global flaring activities released over 350 million tonnes of CO_2 equivalent in recent years [1]. Furthermore, incomplete combustion at flare sites results in the emission of black carbon, volatile organic compounds (VOCs), and nitrogen oxides (NO_x), which severely degrade local air quality [3].

In the context of Libya, recent studies have begun to quantify these localized impacts. Sallam and Abdollah (2025) conducted a comprehensive assessment of the environmental and health consequences of natural gas flaring in Libya, noting that emissions contribute not only to atmospheric pollution but also to soil and water contamination, thereby threatening local biodiversity [4]. Crucially, their research highlights severe public health repercussions; communities residing near eastern Libyan oil fields have reported elevated incidences of respiratory diseases, asthma, and ocular inflammation linked to long-term exposure to toxic flare emissions [4]. Similarly, Swisi (2024) emphasized the profound negative effects of flaring on public health in Libya, arguing that the lack of stringent environmental enforcement has historically allowed international and domestic operators to prioritize crude oil extraction over environmental safeguarding [13].

2.2 The Economics of Associated Gas and Flaring Intensity

From an economic perspective, gas flaring represents a massive market failure. APG is often treated as a waste byproduct rather than a valuable commodity, primarily due to the asymmetric economics of oil versus gas production. Bazilian et al. (2013) noted that in many African nations, the absence of localized gas markets, combined with the high capital expenditure required for gas gathering and processing infrastructure, renders APG monetization commercially unviable for individual operators without state intervention [6].

The "flaring intensity"—defined as the volume of gas flared per barrel of oil produced—serves as a critical metric for evaluating operational efficiency. Data from Capterio indicates that North African countries, including Libya, exhibit flaring intensities significantly higher than the global average of 5.1 cubic meters per barrel, and vastly underperform compared to highly

regulated environments like Saudi Arabia and the UAE (0.7 cubic meters per barrel) [8]. The U.S. Energy Information Administration (EIA) attributes Libya's high flaring intensity to a structural deficit in gas processing plants and pipeline networks necessary to transport APG from remote onshore fields in the Sirte Basin to coastal demand centers [5]. Consequently, when crude oil production scales up, associated gas production rises in tandem, leading to corresponding spikes in flaring volumes due to infrastructural bottlenecks [5].

2.3 Technological Pathways for APG Monetization

Mitigating gas flaring requires the deployment of appropriate utilization technologies. The literature identifies several primary pathways for APG monetization, categorized broadly into large-scale and small-scale solutions.

Reinjection and Enhanced Oil Recovery (EOR): Reinjecting associated gas back into the reservoir is a mature technology that serves the dual purpose of eliminating flaring and maintaining reservoir pressure to enhance crude oil recovery. Biheri et al. (2022) conducted a field study in Libya, demonstrating that utilizing APG for power generation and petrochemical feedstock, alongside reinjection, could effectively minimize flaring in mature fields [15].

Gas-to-Power (GtP) and Gas-to-Wire (GtW): Converting flared gas into electricity at or near the wellhead is frequently cited as the most viable solution for developing nations facing energy deficits. Ouki (2023) argued that decentralized GtP projects are highly suitable for the African context, as they bypass the need for extensive gas pipeline networks while directly addressing local energy poverty [9]. In Libya, where the power sector relies heavily on natural gas and frequently resorts to burning liquid fuels during shortages, capturing APG for domestic grid integration presents a clear economic and social dividend [5].

Liquefied Natural Gas (LNG) and Compressed Natural Gas (CNG): For fields located far from existing grids, modular or "mini-LNG" and CNG technologies offer flexible monetization routes. A review by the World Bank highlighted that small-scale LNG can economically capture gas from isolated flares, transforming it into a transportable fuel for industrial or municipal use [16].

Gas-to-Liquids (GTL): GTL technology, particularly via the Fischer-Tropsch process, converts natural gas into high-value liquid fuels such as synthetic diesel. While Jokar et al. (2021) and Braide et al. (2024) note that GTL produces cleaner-burning fuels, the literature consistently points out that GTL is highly capital-intensive and requires strict feed gas specifications, making it a challenging option for the fluctuating volumes typical of APG in politically unstable regions [17] [18].

2.4 Policy, Regulation, and Sustainable Development Goals (SDGs)

The transition from flaring to utilization is fundamentally a governance challenge. The integration of gas flaring reduction into the United Nations Sustainable Development Goals (SDGs)—particularly SDG 7 (Affordable and Clean Energy) and SDG 13 (Climate Action)—has galvanized international policy frameworks.

The World Bank's "Zero Routine Flaring by 2030" (ZRF) initiative has emerged as the premier global policy mechanism driving accountability [10]. However, scholars caution that voluntary pledges must be backed by robust domestic legislation. Research by the Clean Air Task Force and the Center for Global Development underscores that successful flaring reduction requires a combination of strict regulatory enforcement, performance-based methane taxation, and fiscal incentives for gas infrastructure investment [3] [14]. In Libya, the historic reliance on the 1955 Petroleum Law, which lacks explicit and modern environmental mandates regarding APG, has been a structural impediment [21]. The recent commitments by the Libyan Ministry of Oil and

Gas and the National Oil Corporation (NOC) to the ZRF initiative mark a critical policy pivot, yet the literature suggests that achieving these targets will necessitate comprehensive regulatory reform and substantial foreign direct investment [7] [12].

In summary, the literature clearly delineates the environmental urgency and economic rationale for ending gas flaring in Libya. While the technological solutions are mature and available, the primary barriers remain infrastructural deficits and historical regulatory leniency. This study builds upon this foundation by providing an updated, empirical analysis of Libya's current trajectory toward its 2030 zero-flaring commitments.

3. Methodology

This study employs a secondary-data-driven analytical approach, integrating quantitative trend analysis with qualitative policy review to provide a holistic assessment of associated gas utilization in Libya. The research design is structured to evaluate the technical, economic, and regulatory dimensions of gas flaring reduction in alignment with sustainable development objectives. As the analysis relies exclusively on institutional and archival secondary sources rather than researcher-generated primary data (e.g., interviews, surveys, or field measurements), it is best characterized as a documentary and analytical review rather than a mixed-methods study in the strict methodological sense; this scope is discussed further under Study Limitations.

3.1 Data Collection

Quantitative data regarding Libya’s hydrocarbon sector, gas flaring volumes, and macroeconomic indicators were aggregated from highly credible, institutional secondary sources. The primary datasets utilized include:

- **World Bank Global Gas Flaring Reduction Partnership (GGFR):** Provided time-series data on global and national gas flaring volumes, flaring intensity, and satellite-derived estimates of flared gas up to 2025 [1] [2].
- **U.S. Energy Information Administration (EIA):** Supplied comprehensive statistics on Libya’s crude oil production, dry natural gas production, domestic energy consumption, and proved reserves [5].
- **World Bank Open Data (DataBank):** Accessed via API to retrieve macroeconomic indicators, specifically "Natural gas rents (% of GDP)" and "Electricity production from natural gas sources (% of total)" for Libya from 2013 to 2022.
- **Libyan National Oil Corporation (NOC) and Ministry of Oil and Gas:** Official press releases and operational reports detailing recent infrastructure projects, the April 2026 endorsement of the Zero Routine Flaring by 2030 initiative, and targeted reduction milestones [7] [12].

3.2 Analytical Framework

The analytical framework consists of three distinct phases:

1 **Trend Analysis:** A longitudinal analysis of Libya’s gas flaring volumes (in billion cubic meters) against natural gas production and domestic electricity reliance. This phase identifies historical correlations between crude oil output fluctuations and flaring intensity.

2 **Techno-Economic Assessment:** An evaluation of the feasibility of various gas monetization technologies (e.g., Gas-to-Power, pipeline integration, reinjection) within the specific geographical and infrastructural constraints of the Libyan Sirte and Murzuq basins.

3 **Policy and Regulatory Review:** A qualitative assessment of Libya’s regulatory environment, focusing on the historical Petroleum Law of 1955, the Model Production

Sharing Contract (2006), and recent strategic shifts toward international climate commitments.

To ensure academic rigor, all data were cross-verified across multiple institutional reports to mitigate discrepancies arising from the opaque nature of post-conflict data reporting.

4. Results and Discussion

4.1 Trends in Associated Gas Flaring and Economic Losses

The analysis of historical data reveals a persistent correlation between Libya's crude oil production recovery and surges in associated gas flaring. Because the majority of Libya's gas processing infrastructure remains degraded or operates below capacity, increases in oil extraction inevitably lead to higher volumes of wasted APG.

As illustrated in Table 1, Libya's flaring volumes have fluctuated significantly over the past decade, heavily influenced by geopolitical instability and subsequent blockades on oil facilities. Following a dip to 2.5 bcm in 2020—a period marked by severe production shut-ins—flaring volumes rebounded sharply. By 2023, the EIA reported that Libya flared approximately 240 Bcf (roughly 6.8 bcm), the highest level in a decade [5]. Official figures from the Libyan Ministry of Oil and Gas confirm that in 2024, approximately 6.3 bcm of gas was flared [7].

Table 1: Estimated Gas Flaring Volumes and Economic Impact in Libya (Selected Years)

Year	Estimated Flared Volume (bcm)	Estimated Economic Loss (Millions USD)*	Key Sectoral Context
2012	5.9	~$600	Post-revolution production recovery
2020	2.5	~$250	Severe oil blockades and production shut-ins
2022	5.4	~$550	Resumption of regular crude oil exports
2023	6.8	~$700	Decade-high flaring amid rising oil output
2024	6.3	$650	Official Ministry estimates prior to ZRF endorsement

**Economic loss estimated based on a conservative benchmark gas price of ~$3.00 per MMBtu, aligning with Ministry of Oil and Gas valuations.*

The economic implications of this waste are profound. The $650 million lost in 2024 represents a critical leakage of state revenue. Furthermore, World Bank data indicates that natural gas rents as a percentage of Libya's GDP rose from 1.14% in 2017 to 4.58% in 2021, underscoring the growing macroeconomic importance of the gas sector. Wasting over 6 bcm annually deprives the state of capital urgently needed for post-conflict reconstruction and infrastructure modernization.

4.2 The Domestic Energy Paradox

A central finding of this study is the stark paradox between Libya's gas flaring and its domestic energy deficit. Libya relies heavily on natural gas for its power sector. World Bank indicator data shows that electricity production from natural gas sources accounted for 76.1% of total

electricity generation in 2022, up from 53.7% in 2014. Despite this reliance, the General Electricity Company of Libya (GECOL) has historically struggled to meet peak summer demand, leading to scheduled load shedding and blackouts [5].

The 6.3 bcm of gas flared in 2024 is more than sufficient to bridge the domestic power generation gap. If captured and routed to domestic power plants, this APG could displace the expensive, imported liquid fuels (diesel and heavy fuel oil) currently used as backup generation, thereby reducing state subsidy burdens and lowering the carbon intensity of the national grid.

4.3 Progress and Technological Implementation by the NOC

Recognizing the economic and environmental imperatives, the Libyan National Oil Corporation (NOC) has recently initiated a series of strategic projects aimed at APG monetization. A review of recent NOC operations indicates tangible progress in deploying specific technologies:

1. **Pipeline Integration and Gas Gathering:** At the Sirte Oil Company, projects have successfully rerouted approximately 60 million cubic feet per day (MMcf/d) of gas from the Ellaheeb and Ragouba fields into the main 30-inch coastal gas network, averting its combustion [12].
2. **Condensate Recovery:** Infrastructure upgrades at the Hatiba field now allow condensate to be pumped via high-pressure pipelines, preventing the vaporization and subsequent flaring that occurred in older, low-pressure storage systems [12].
3. **Gas Processing and Compression:** The Sarir Oil Operations upgraded a Gas Processing Plant (GUP) in Contract Area 91, enabling the processing of 25 MMcf/d of gas and the recovery of 1,800 barrels of condensate daily [12].
4. **Reinjection for Gas Lift:** The revival of gas separation systems at the Ellaheeb field allows for 12 MMcf/d of high-pressure gas to be utilized for gas lift operations, enhancing oil recovery while eliminating surface flaring [12].

These localized technological interventions demonstrate that standard, mature technologies—compressors, gathering lines, and separation units—are highly effective in the Libyan context when capital is allocated appropriately. Through these combined efforts, the NOC is on track to reduce flaring by nearly 100 MMcf/d by 2025, a critical first step toward its ambitious 2030 targets [12].

4.4 Policy Shifts: The Zero Routine Flaring (ZRF) Commitment

The most significant development in Libya's associated gas sector is the policy pivot that occurred in early 2026. On April 30, 2026, the Government of Libya officially endorsed the World Bank's "Zero Routine Flaring by 2030" initiative [7] [10]. This endorsement represents a departure from the historical reliance on the outdated 1955 Petroleum Law, which lacked stringent environmental mandates.

By joining the ZRF initiative and the Global Flaring and Methane Reduction (GFMR) Partnership, Libya has signaled to the international community—and to the international oil companies (IOCs) operating within its borders, such as Eni and TotalEnergies—that regulatory leniency regarding APG is ending. The NOC's pledge to reduce gas flaring by 83% by 2030 is highly ambitious but aligns with international standards [4]. It is worth noting that this figure remains subject to revision: at a Tripoli workshop in July 2026, NOC officials referenced a longer-term ambition of approximately a 60% reduction from current levels by 2030, indicating that the precise reduction target is still evolving as implementation progresses and should be treated as indicative rather than fixed [22]. However, as the literature suggests, voluntary commitments must be supported by enforceable domestic legislation. The challenge for Libya

will be updating its Model Production Sharing Contracts (PSCs) to explicitly mandate APG capture and to penalize unauthorized routine flaring.

5. Recommendations

To bridge the gap between Libya's ambitious 2030 zero-flaring commitments and the current operational realities, a multifaceted approach is required. Based on the findings of this study, the following strategic recommendations are proposed for policymakers, the National Oil Corporation (NOC), and international stakeholders:

1. **Regulatory Modernization and Enforcement:** The Libyan government must urgently update its national hydrocarbon legislation. The outdated 1955 Petroleum Law should be amended to explicitly prohibit routine flaring in all new field developments. Furthermore, existing Production Sharing Contracts (PSCs) must be renegotiated to include binding flare-reduction milestones, backed by performance-based financial penalties for non-compliance and tax incentives for APG infrastructure investments.
2. **Accelerate Gas-to-Power (GtP) Integration:** Given that over 70% of Libya's electricity is generated from natural gas, the NOC and the General Electricity Company of Libya (GECOL) should prioritize decentralized Gas-to-Power projects. Installing modular power generation units at remote flare sites in the Sirte Basin can immediately reduce flaring while stabilizing the regional power grid, thereby addressing the dual crises of energy waste and electricity shortages.
3. **Leverage International Climate Finance:** Fulfilling the 83% flaring reduction pledge requires substantial capital expenditure. Libya should actively leverage its recent endorsement of the World Bank's Zero Routine Flaring (ZRF) initiative to access international climate finance and technical assistance. Partnering with the Global Flaring and Methane Reduction (GFMR) Partnership can provide the necessary funding mechanisms to repair degraded compression equipment and expand the coastal gas pipeline network.
4. **Mandate APG Utilization in IOC Contracts:** International Oil Companies (IOCs) operating in Libya, such as Eni and TotalEnergies, possess the capital and technological expertise required for large-scale gas monetization. The Libyan government must ensure that all future foreign direct investment (FDI) agreements mandate the implementation of associated gas capture technologies—such as reinjection for enhanced oil recovery (EOR) or pipeline tie-backs—prior to the commencement of crude oil extraction.
5. **Establish Robust Monitoring and Reporting:** To ensure accountability, the Ministry of Oil and Gas must establish an independent, transparent monitoring framework. Utilizing satellite data (such as the VIIRS instrument used by the World Bank) in conjunction with mandatory, metered wellhead reporting will provide accurate data on flaring intensities, enabling regulators to track progress against the 2030 targets effectively.

6. Study Limitations

This study is subject to several limitations that should be considered when interpreting its findings and recommendations.

First, the analysis relies exclusively on secondary and institutional sources—official reports, press releases, and international databases—rather than on primary data collection such as field measurements, site visits, or interviews with NOC engineers, IOC representatives, or affected communities. As a result, the study cannot independently verify operational figures reported by Libyan authorities and international agencies.

Second, Libya's post-conflict institutional environment complicates data reporting. Overlapping governmental authorities have historically produced inconsistencies in official statistics, and satellite-derived flaring estimates can diverge from ground-reported figures. While this study cross-references multiple sources where possible, some discrepancies may remain unresolved.

Third, several of the policy commitments discussed—most notably the NOC's headline flaring-reduction target—are still evolving at the time of writing. As noted in Section 4.4, subsequent NOC statements have referenced a lower reduction figure than the original pledge, illustrating that quantitative targets in this space may shift before or shortly after publication. Readers should treat cited targets as a snapshot of the policy landscape as of mid-2026 rather than a fixed benchmark.

Finally, the techno-economic assessment in this paper is qualitative and comparative rather than a field-level engineering or financial model. The feasibility of technologies such as Gas-to-Power, LNG, and GTL is discussed based on the broader literature and NOC-reported pilot projects, but this study does not present original cost modeling, net-present-value calculations, or field-specific engineering simulations for Libyan sites. Future research incorporating primary fieldwork and quantitative economic modeling would strengthen confidence in the specific recommendations proposed here.

7. Conclusion

Associated gas flaring in Libya represents a critical intersection of economic inefficiency, environmental degradation, and infrastructural vulnerability. As this study demonstrates, the routine combustion of over 6 billion cubic meters of natural gas annually strips the Libyan economy of approximately $650 million in potential revenue while exacerbating local public health crises and global climate change. The paradox of burning a highly valuable energy resource while the domestic power grid suffers from acute fuel shortages underscores the urgent need for systemic reform.

However, the trajectory of Libya’s hydrocarbon sector is showing promising signs of a paradigm shift. The government's April 2026 endorsement of the World Bank’s "Zero Routine Flaring by 2030" initiative, coupled with the NOC’s pledge to reduce flaring by 83%, marks a historic commitment to sustainable resource management. Tangible progress is already visible through recent NOC projects that have successfully deployed compression, pipeline integration, and reinjection technologies to capture tens of millions of cubic feet of gas daily.

Ultimately, the successful eradication of routine gas flaring in Libya hinges on the rapid modernization of regulatory frameworks, the mobilization of international climate finance, and the prioritization of Gas-to-Power infrastructure. By transforming associated petroleum gas from a waste byproduct into a catalyst for domestic energy security and economic diversification, Libya can align its vital hydrocarbon sector with the imperatives of global sustainable development.

8. References

[1] World Bank. (2024). *Global gas flaring tracker report*. Global Flaring and Methane Reduction Partnership. https://thedocs.worldbank.org/en/doc/d01b4aebd8a10513c0e341de5e1f652e-0400072024/original/Global-Gas-Flaring-Tracker-Report-June-20-2024.pdf

[2] World Bank. (2026). *2026 global gas flaring tracker report*. Global Flaring and Methane Reduction Partnership.

https://www.worldbank.org/en/programs/gasflaringreduction/publication/2026-global-gas-flaring-tracker-report

[3] Center for Global Development. (2026). *Gas flaring: A $100 billion problem with a policy solution*. https://www.cgdev.org/blog/gas-flaring-100-billion-problem-policy-solution

[4] Sallam, S., & Abdollah, A. T. (2025). Some environmental impacts of natural gas flaring in Libya and potential solutions. *International Journal of Innovative Science and Research Technology, 10*(3). https://doi.org/10.38124/ijisrt/25mar961

[5] U.S. Energy Information Administration. (2024). *Country analysis brief: Libya*. https://www.eia.gov/international/content/analysis/countries_long/Libya/pdf/libya.pdf

[6] Bazilian, M., Onyeji, I., Aqrawi, P. K., Sovacool, B. K., Ofori, E., et al. (2013). Oil, energy poverty and resource dependence in West Africa. *Journal of Energy & Natural Resources Law, 31*(1), 33–53. https://doi.org/10.1080/02646811.2013.11435316

[7] Libya Herald. (2026, May 7). *Libya joins World Bank's initiative to eliminate routine gas flaring by 2030 - saving about US$ 650 million per year*. https://libyaherald.com/2026/05/libya-joins-world-banks-initiative-to-eliminate-routine-gas-flaring-by-2030-saving-about-us-650-million-per-year

[8] Davis, M., & Branson, N. (2026). *Europe's untapped gas opportunity: North Africa's $6 billion flares*. Capterio FlareIntel. https://flareintel.com/insights/europes-untapped-gas-opportunity-north-africas-6-billion-flares

[9] Ouki, M. A. (2023). *Prospects for a potential African gas renaissance en route to a "just energy transition"*. Oxford Institute for Energy Studies. https://www.econstor.eu/handle/10419/280128

[10] World Bank. (n.d.). *Zero routine flaring by 2030 (ZRF) initiative*. Retrieved from https://www.worldbank.org/en/programs/zero-routine-flaring-by-2030/about

[11] Reuters. (2023, December 4). *Libya's NOC targets near zero gas flaring by 2030, says chairman*. https://www.reuters.com/sustainability/climate-energy/libyas-noc-targets-near-zero-gas-flaring-by-2030-says-chairman-2023-12-05/

[12] Euro-Petrole. (2026, January 5). *NOC achieved a gas-flaring reduction of over 100 million cubic feet daily*. https://www.euro-petrole.com/noc-achieved-a-gas-flaring-reduction-of-over-100-million-cubic-feet-daily-n-i-29489

[13] Swisi, N. (2024). The effect of gas flaring on the environment and public health in Libya. *Al-Refak Journal, 41*. http://journal.alrefak.edu.ly/index.php/aaj/article/view/41

[14] Clean Air Task Force. (2024). *Flaring accountability*. https://www.catf.us/resource/flaring-accountability/

[15] Biheri, G., Amoura, A., Elmaleh, K., & Nouh, A. (2022). A field study: Minimizing gas flaring through reuse to produce electricity and petrochemical products. *SPE Eastern Regional Meeting*. Society of Petroleum Engineers. https://doi.org/10.2118/211470-MS

[16] World Bank. (n.d.). *Report on small-scale technologies for utilization of associated gas*. Global Gas Flaring Reduction Partnership. https://documents1.worldbank.org/curated/en/305891644478108245/txt/Report-on-Small-scale-Technologies-for-Utilization-of-Associated-Gas.txt

[17] Jokar, S. M., Wood, D. A., Sinehbaghizadeh, S., Parvasi, P., & Javanmardi, J. (2021). Transformation of associated natural gas into valuable products to avoid gas wastage in the form of flaring. *Journal of Natural Gas Science and Engineering, 94*, 104078. https://doi.org/10.1016/j.jngse.2021.104078

[18] Braide, D., Panaritis, C., Patience, G. S., & Boffito, D. C. (2024). Gas to liquids (GTL) microrefinery technologies: A review and perspective on socio-economic implications. *Fuel, 375*, 132385. https://doi.org/10.1016/j.fuel.2024.132385

[19] World Bank. (n.d.). *Global gas flaring data*. Global Flaring and Methane Reduction Partnership. https://www.worldbank.org/en/programs/gasflaringreduction/global-flaring-data

[20] Naser, M. A., Mokhetar, A. Y., et al. (2025). Carbon capture, utilization, and storage (CCUS) in Libya's oil and gas industry: Current status, future prospects, and challenges. *Academy Journal for Basic and Applied Sciences*. https://ojs.academy.edu.ly/index.php/AJBAS/article/view/526

[21] World Bank. (n.d.). *Flaring and venting regulations: Libya*. Global Flaring and Methane Reduction Partnership. https://flaringventingregulations.worldbank.org/libya

[22] Minbar Libya (Libya Tribune). (2026, June 24). *Libya's natural gas sector: Between vast potential and structural constraints*. https://en.minbarlibya.org/2026/06/24/libyas-natural-gas-sector-between-vast-potential-and-structural-constraints/

[23] Shaltami, O. R., Hkoma, M. A. B., & Alnnale, T. (2026). Green Geochemical Education in Libya: Current Status, Applications, Challenges, and Future Perspectives. *Al-Farooq Journal of Sciences*, *2*(4), 347-356. https://doi.org/10.65405/kqmmnq15

[24] BAKA, M. M., & ERYILDIZ, S. (2026). The Developing Public Square Into Eco Square (Case Study Of Martyrs Square, Tripoli) Transforming Martyrs' Square in Tripoli into an Eco-Square: A Sustainable Framework for Urban Public Space Regeneration. *Al-Farooq Journal of Sciences*, *2*(4), 250-266. https://doi.org/10.65405/bsyves03

List of Abbreviations

Abbreviation	Full Term
APG	Associated Petroleum Gas
Bcf	Billion Cubic Feet
bcm	Billion Cubic Meters
CCUS	Carbon Capture, Utilization, and Storage
CH_4	Methane
CNG	Compressed Natural Gas
CO_2	Carbon Dioxide
EIA	U.S. Energy Information Administration
EOR	Enhanced Oil Recovery
FDI	Foreign Direct Investment
GDP	Gross Domestic Product
GECOL	General Electricity Company of Libya

Abbreviation	Full Term
GFMR	Global Flaring and Methane Reduction (Partnership)
GGFR	Global Gas Flaring Reduction (Partnership)
GHG	Greenhouse Gas
GTL	Gas-to-Liquids
GtP	Gas-to-Power
GtW	Gas-to-Wire
GUP	Gas Processing Plant
IOC(s)	International Oil Company/Companies
LNG	Liquefied Natural Gas
MMBtu	Million British Thermal Units
MMcf/d	Million Cubic Feet per Day
NOC	National Oil Corporation (Libya)
NO_x	Nitrogen Oxides
OPEC	Organization of the Petroleum Exporting Countries
PSC(s)	Production Sharing Contract(s)
SDG(s)	Sustainable Development Goal(s)
Tcf	Trillion Cubic Feet
USD	United States Dollar
VIIRS	Visible Infrared Imaging Radiometer Suite
VOCs	Volatile Organic Compounds
ZRF	Zero Routine Flaring