Analytical Report

Flare Gas Estimation and Environmental Impact Assessment in Petroleum Production

1. Overview

This analytical report summarizes insights and recommendations derived from four integrated dashboards covering:
Oil Production & Flaring, **Air Quality (PM)**, **Climate Impact (Methane & CO_2)**, and **Health Implications** for communities near oil production areas.

The analysis highlights the relationships between production levels, flaring practices, environmental performance, and human health outcomes across multiple countries.

2. Dashboard Analysis

2.1 Oil Production & Flaring Dashboard

Key Insights

- **Higher production leads to higher flaring:**
  Countries with large oil output typically exhibit higher flaring due to limited gas-handling infrastructure.
- **Significant energy loss:**
  Flaring results in substantial waste of usable energy that could be converted into electricity, fuel, or chemical products.
- **Large efficiency gaps:**
  Technology, operational practices, and regulatory strength create wide differences in flare intensity between countries.
- **High-production, low-flaring countries exist:**
  Demonstrating that effective gas management can significantly reduce routine flaring even at high production levels.

Recommendations

- flaring and utilize associated gas efficiently.
- **Re-inject gas into reservoirs** to enhance oil recovery and minimize emissions instead of burning it.
- **Deploy mini-LNG units** to liquefy and transport flared gas for export or local industrial use.
- **Generate electricity on-site** using recovered gas to power operations and reduce reliance on external energy sources.
- **Develop small-scale Methanol/Ammonia plants** to convert flare gas into valuable chemical products.
- **Partner with energy companies** to supply recovered gas to nearby residential and industrial areas.
- **Expand temporary gas storage capacity** to store excess gas and use it during peak demand periods.
- **Invest in pipelines, gas processing units, and storage infrastructure** to support long-term gas recovery and utilization.
- **Upgrade flare systems with high-efficiency burners** to improve Destruction Efficiency (DE) and reduce methane slip.
- **Set annual flare-reduction KPIs** at both operator and national levels to track progress and drive accountability.

2.2 Air Quality (PM) Dashboard

Key Insights

- **PM does not directly correlate with flaring:**
  Some high-flaring countries show low PM due to efficient combustion or favorable atmospheric conditions.
- **Air pollution is multi-source:**
  Transport, industry, power plants, and dust contribute heavily to PM, often outweighing the impact of flaring.
- **Single-year PM trends are misleading:**
  multi-year averages provide a clearer picture of long-term air-quality performance.
- **Localized flaring still matters:**
  Even when national PM values are low, communities near production sites may face elevated exposure.

Recommendations

- Base air-quality assessments on **multi-year PM averages**.
- Deploy **real-time PM monitoring systems** around oil fields.
- Target **non-flaring pollution sources** in high-PM countries.
- Maintain high combustion efficiency even in areas with low PM to avoid future air-quality deterioration.

2.3 Climate Impact Dashboard (Methane, CO_2, DE)

Key Insights

- **Methane slip greatly increases climate impact:**
  Poor combustion efficiency or outdated flares release more methane, which is far more potent than CO_2.
- **Reducing flaring delivers fast climate benefits:**
  Gas capture significantly cuts greenhouse gas emissions with relatively low implementation time.
- **Destruction Efficiency varies widely across countries:**
  Operational performance and technology strongly affect methane and CO_2 emissions.
- **Climate burden depends on both flare volume and combustion quality:**
  High volumes + low DE = severe environmental impact.

Recommendations

1. Expand Gas Utilization & Recovery Projects

- Develop **Gas-to-Power** projects to convert flared gas into electricity.
- Scale up **Gas Reinjection** programs to enhance oil recovery and reduce routine flaring.
- Deploy **methane capture and mini-LNG technologies** to utilize associated gas instead of wasting it.

2. Improve Combustion Efficiency & Flare Performance

- Adopt **advanced combustion-efficiency technologies** to increase Destruction Efficiency (DE).
- Upgrade flare systems (burners, tips, ignition reliability) to minimize methane slip and adjusted emissions.

3. Strengthen Economic and Strategic Planning

- Conduct **comprehensive cost–benefit studies** comparing flaring vs. gas recovery, considering both financial and environmental impacts.
- Integrate gas recovery and methane reduction into **national climate and energy strategies**.

4. Establish Clear Policy Targets & Governance Frameworks

- Set **country-level KPIs** based on current emission baselines, including:
    - **Flare Reduction %** (annual reduction in flare volume)
    - **CH_4 Capture %** (percentage of methane recovered and utilized)
    - **DE Improvement %** (annual enhancements in combustion efficiency)
- Align flare-reduction plans with **global climate commitments and reporting frameworks**.

2.4 Health Impact Dashboard

Key Insights

- **Flaring emits pollutants harmful to human health:**
  PM, NOx, SOx, VOCs, and methane all increase health risks.
- **Long-term exposure causes chronic diseases:**
  Higher rates of asthma, bronchitis, COPD, and cardiovascular issues are linked to proximity to flaring sites.
- **Vulnerable communities face greater risk:**
  Populations living near oil fields — often rural or low-income — have limited access to healthcare.

- **Health risks are underreported:**
  Lack of adequate monitoring leads to underestimation of real exposure levels.

Recommendations

- Install **real-time emission and air-quality monitors** at and around oil fields.
- Conduct **targeted health assessments** for high-risk communities.
- Reduce emissions through **gas recovery and high-DE flare systems**.
- Include **health impact assessments** in environmental and operational planning.

3. Cross-Cutting Conclusions

- Routine flaring remains a **major source of wasted energy**, climate emissions, and localized pollution.
- Countries with strong policies, adequate infrastructure, and modern flare systems perform significantly better.
- Air quality and health outcomes depend on **multiple pollution sources**, not flaring alone.
- Gas recovery presents a **high-value, low-hanging opportunity** for emission reduction, energy utilization, and community protection.

4. Strategic Recommendations (Overall)

- Prioritize **gas recovery and utilization** projects to turn flaring into economic value.
- Strengthen **national regulations and annual KPIs** for flare and methane reduction.
- Improve **air-quality and health monitoring systems** around production zones.
- Embed **climate and health considerations** into all oil and gas operational decisions.