Algeria
Associated Gas Utilization Study

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with thanks to Tom Mitro for his review.

Columbia Center
on Sustainable Investment
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Summary of Findings

Tough stance on gas flaring with a strong legal framework made of tax and penalty

GGFR award and CCS project

Increasing flaring due to aging fields and lack of investment in infrastructure.

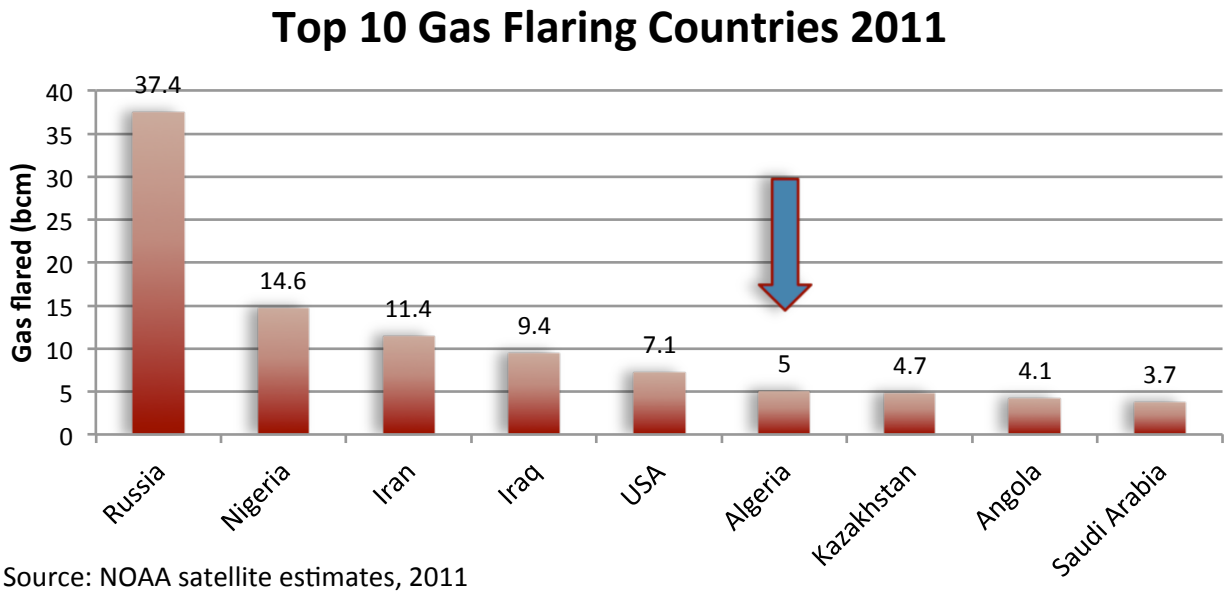
- Algeria appears to have taken a tough stance on gas flaring within the last decade. It has legally prohibited flaring since 1966 but only started penalizing it in 2005. It is one of only three countries (along with Nigeria and Norway) that taxes flaring. The current level of flaring tax is similar to that levied in Norway.
- Until 2012, the reduction of flaring was drastic, which led to the Algerian national oil and gas company Sonatrach receiving the World Banks's Global Gas Flaring Reduction (GGFR) award. Sonatrach was in particular rewarded for its unique Carbon Capture and Storage, injecting CO2 removed during sweetening into a saline formation (In Salah Gas).
- Since then, however, flaring has been on an upward trend, in particular from Sonatrach fields, suggesting that the enforcement of the strong legal framework is challenged by 1) a lack of investment in adequate infrastructure, which is hampered by a combination of fuel subsidies and low oil prices hurting the state finance; 2) the aging of oil fields generating more associated petroleum gas (APG); and 3) the lack of foreign investment.

The statistics of APG flaring in Algeria: How bad is it?

Overview stats on APG flaring

Flaring trend over time

On the companies involved



Source: NOAA satellite estimates, 2011

- Algeria is the third largest oil producer in Africa, after Nigeria and Libya, and the largest natural gas producer in Africa. According to the EIA, Algeria's crude oil production will gradually decline at least in the short and medium term given that the big oil fields are mature and only small oil fields are planned to come on line.
- The APG comes from the fields in the southern and southeastern regions of the country.
- According to the flaring data collected by GGFR, Algeria flared 9.1 billion cubic meters (bcm) of APG as of 2015.

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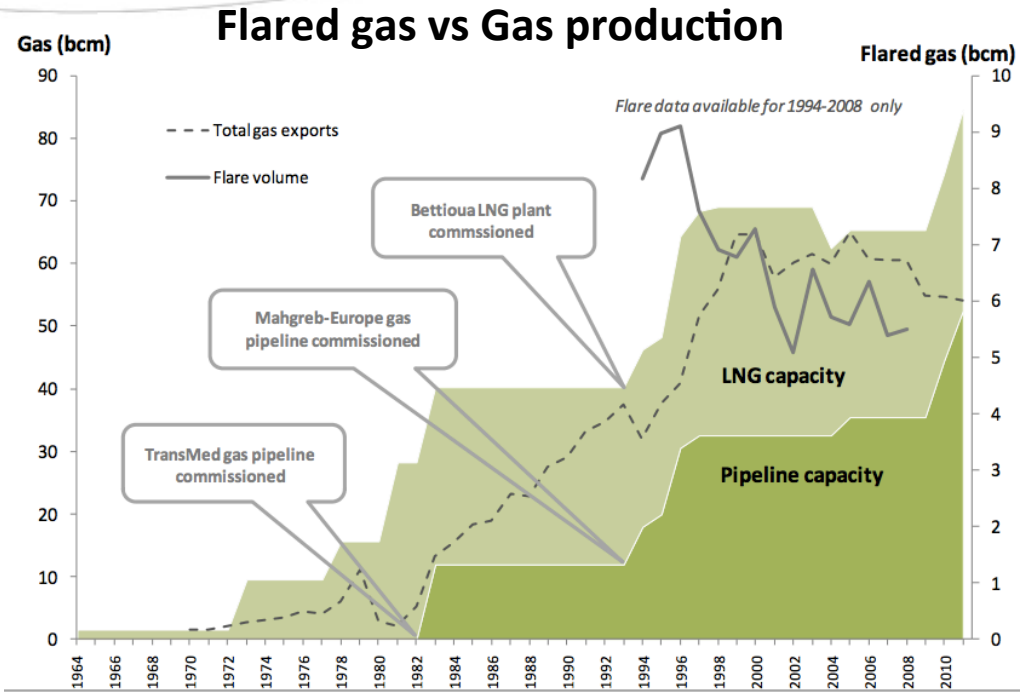

Source: GGFR, 2011

- Algeria developed a stringent program that brought down APG flaring from 33% of the gross natural gas produced in 1995 to less than 2% today, according to the EIA.
- This program leveraged the construction of gas pipeline infrastructure and liquefied natural gas (LNG) infrastructure which gave a market outlet to the APG produced.

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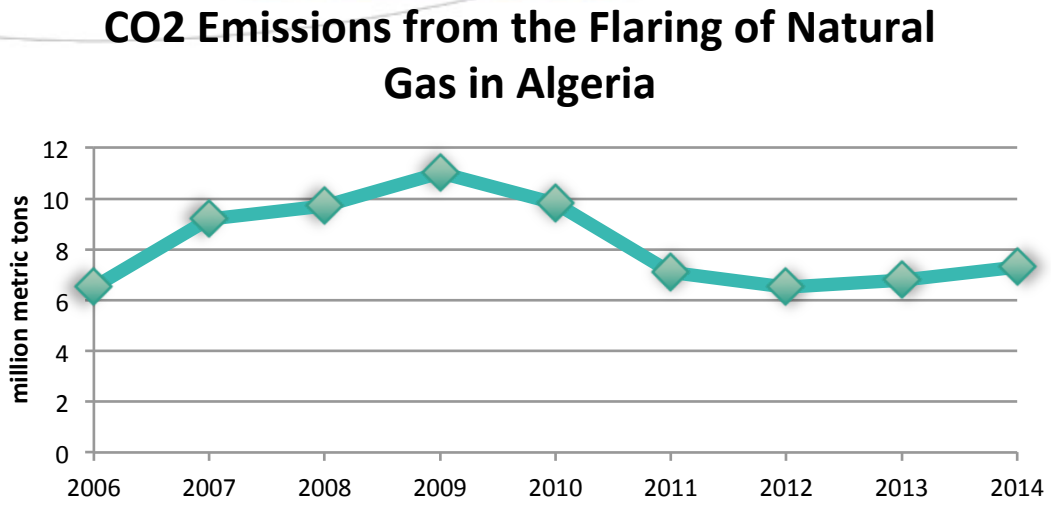

Source: International Energy Data, 2015

- After a sharp reduction in flaring between 2009 and 2012, sanctioned by the GGFR award in 2012 (see next slide), Algeria's flaring is on an upward trend again.
- GGFR data shows 8.1 bcm of APG flared in 2013, 8.6 bcm in 2014 and 9.1 bcm in 2015. This increasing trend is most probably explained by the decline of the big oil fields where the gas/oil ratio typically rises, reflecting declining overall well pressure, with the reinjected gas coming to the surface and displacing some of the liquids being produced; this leads to more APG being produced and then flared if no additional measure is taken to monetize it.
- While the domestic energy consumption has risen and APG could serve this demand, it seems that low oil market prices and fuel subsidies have drained the state finance and hampered the development of adequate investment in infrastructure to absorb this APG.

The statistics of APG flaring in Algeria: Who is involved?

Overview stats on APG flaring

Flaring trend over time

On the companies involved

- Most of the majors are present in Algeria but they all operate in joint venture with Sonatrach, the Algerian national oil and gas company.
- Most of the flaring can be traced back to the aging giant fields that Sonatrach has operated: Hassi Messaoud, which typically produces around 500,000 barrels/day of crude (40% of total Algeria's oil output), and smaller ones such as the fields of Zarzaitine, Haoud Berkaoui, and Ait Kheir.
- In 2012, Sonatrach won the World Bank GGFR award. This award recognizes the efforts and resources of Sonatrach for the reduction of gas flaring for the protection of the environment. These projects led to the recovery of 260 bcm of APG.
- Anadarko is the biggest international oil company operating in Algeria. It signed production-sharing agreements with Sonatrach in the late 1980s and since then has produced oil from three mega projects located in the Sahara Desert (Ourhoud, HBNS and El Merk – Blocks 404 and 208). The El Merk facility (described in slide 12) minimizes flaring at block 208.
- International investment has sagged since 2002 due to an unfavorable investment climate.

What is the legal and fiscal framework in place to stop flaring and incentivize APG use?

Regulation: Agencies and analysis

Regulation: Legal framework and analysis

Government institutions involved in regulation of oil production/flaring	Description
Ministry of Energy and Mines	In charge of developing policy and strategy for the exploration, production and valorization of petroleum, mining and energy resources, and their related industries.
National Agency for the Valorization of Hydrocarbon Reserves (ALNAFT)	Created by the Hydrocarbons Law of 2005 and effectively in function since 2008. Promotes investment in hydrocarbon exploration and production. It manages and monitors the contractual aspects of upstream activities, from the development plan to the collection of royalties. This function includes the granting of permits for exceptional flaring, as well as the collection of penalties on gas flaring.
Hydrocarbons Regulating Authority (ARH)	Created by the Hydrocarbons Law of 2005. Implements and enforces regulations pertaining to hydrocarbon activities, including technical and transportation tariffs and free access regulation. It also oversees the implementation of environmental regulations including those related to carbon dioxide emissions.
Sonatrach	National company in charge of the exploration, exploitation, transport, processing, and marketing of hydrocarbons. Before the establishment of ALNAFT, Sonatrach was also the regulator.

What is the legal and fiscal framework in place to stop flaring and incentivize APG use?

Regulation: Agencies

- 1966: Algerian Government prohibits flaring of gas.
- 2005 Hydrocarbon Law and 2006 Ordinance:
  - Prohibits flaring, but ALNAFT (National Agency for the Development of Hydrocarbon Resources) may, exceptionally and for limited periods, grant authorization for flaring at an operator's request.
  - Actually, Executive Decree 13-400 relating to flaring states that ALNAFT must grant temporary authorization in specific circumstances such as in the case of "the assessment of the productivity of wells during the pilot phase for unconventional hydrocarbons" or in the case of "the first exploratory use of a production well" or for maintenance.
  - Any application for such authorization must contain a well location report describing the provisional date, duration and estimated volumes to be flared. In addition, a detailed technical program for testing the well laying out the required safety measures must be submitted.
  - Authorizations to flare are limited to durations not exceeding 90 days.
  - Permitted flaring is subject to a tax of 8,000 DZD (~US$110) per thousand normal cubic meters, modified each year at a fixed rate; this is a flaring tax similar to that levied in Norway.
  - For remote or isolated areas, where the gas infrastructure is limited or lacking, specific pricing conditions are determined.

Regulation: Legal framework and analysis

- According to GGFR, gas flare taxes could potentially cost operators more than US$600 million annually. We didn't find evidence that these were actually paid.
- Sonatrach had set objectives of recovering 94% of associated gas by 2008-2009 and 100% by 2010, but these were seemingly not achieved.
- Since Sonatrach was also the regulator for years, passing on the regulatory power to ALNAFT has taken some time and might have also delayed the enforcement of the flaring measures.

What needs could the flared gas satisfy?

- Power generation
- Liquefied Natural Gas (LNG)
- Liquid Petroleum Gas (LPG)
- Condensates
- Reinjection

- It seems APG will not be used for power generation.
- According to the IEA, natural gas already accounted for 93% of power generation in Algeria in 2013 and the Algerian government is aiming at reducing this dependence by increasing the share of electricity generated by renewable energy. The goal of the Algerian Energy Ministry of Energy and Mines is to generate 40% of Algeria's electricity from renewable sources by 2030.
- The APG could, however, feed LNG facilities and the liquid petroleum gas (LPG) expansion project as explained in the next slide.

What needs could the flared gas satisfy?

- Power generation
- **Liquefied Natural Gas (LNG)**
- Liquid Petroleum Gas (LPG)
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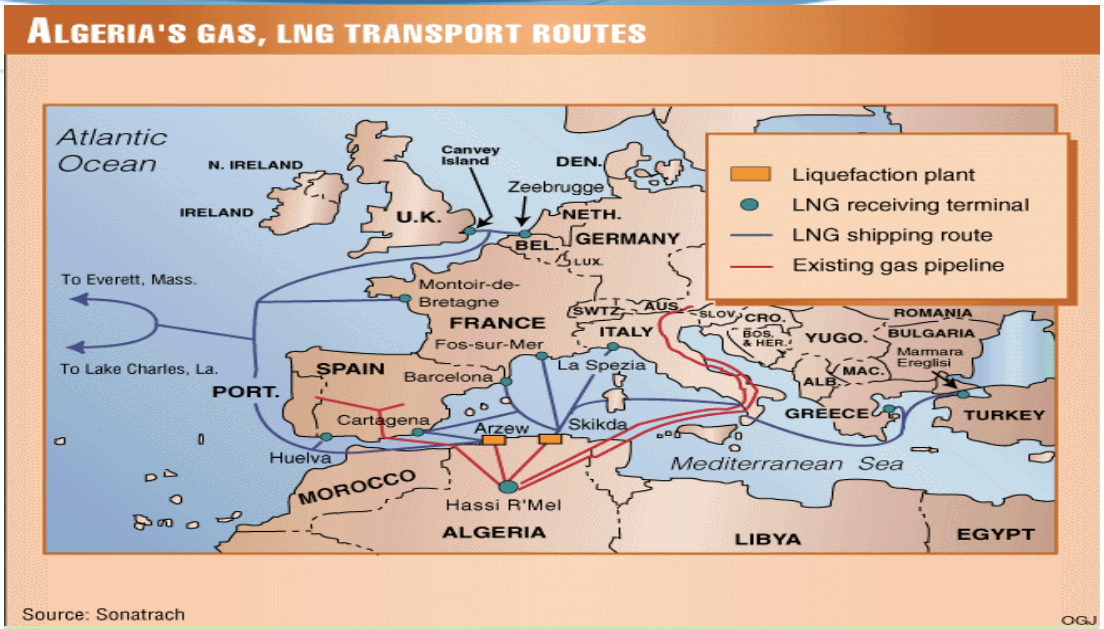


- Algeria's favorable geographical positioning adjacent to the Mediterranean Sea makes it a privileged candidate for the development of LNG.
- As of 2016, Algeria was the seventh largest exporter of LNG in the world. Currently, Algeria has four liquefaction LNG units along the Mediterranean Sea with a total design capacity to process 44 mt/year of natural gas.
- This infrastructure could be leveraged from APG use. However Sonatrach had plans for two large scale facilities in 2009 that have since been scrapped, and aging trains at existing facilities must be upgraded.

What needs could the flared gas satisfy?

- Power generation
- Liquefied Natural Gas (LNG)
- **Liquid Petroleum Gas (LPG)**
- Condensates
- Reinjection

Source: Gazeo, 2015

- Already the largest LPG producer in Africa and the 9th largest LPG producer in the world, Algeria has embarked on an aggressive plan to switch from conventional fuels to LPG in domestic passenger cars and light-duty vehicles.
- Currently only 3% of vehicles in Algeria run on LPG, but the government has set a goal to integrate 100,000 LPG-based vehicles into the transportation sector by 2030.
- Similarly, the government aims at 11,000 new compressed natural gas (CNG)-powered buses by 2030. To this end, a conversion center and CNG service stations will be set up.
- The motivation is to enhance energy efficiency and reduce pollution. Road transport constitutes 41% of all energy use, producing about 14 million tons of CO2 annually. By 2030, if the plan described above is in place, energy consumption is projected to drop by 9%, bringing a national budget savings of 42 billion dollars in 2030—which could help compensate for a loss in revenues brought about by low prices and fuel subsidies.
- This project could help channel more APG to domestic utilization.

APG use company case study: the El Merk facilities

Power Generation

Liquefied Natural Gas (LNG)

Liquid Petroleum Gas (LPG)

Condensates

Reinjection

- **Project Participants**
  - Operated by Groupement Berkine, a joint venture of Sonatrach and the Anadarko Association (comprising Anadarko, Maersk Oil and Eni) on behalf of themselves and the other El Merk partners ConocoPhillips and Talisman (Algeria).
- **Project Description and Motivation**
  - The project is designed around a Central Processing Facility (CPF) to process and export reservoir liquids from four primary sources – the El Merk North, El Merk East and El Kheit Et Tesseka fields in Block 208 and the unitized El Merk field in Block 208 and Block 405a. It also accommodates liquids from the Sonatrach/Anadarko and Sonatrach/Eni Association on Block 403a/404a, situated approximately 80 km north of the El Merk development.
  - The project was completed in 2013.
  - El Merk processes an estimated:
    - 98,000 barrels of oil per day
    - 29,000 barrels of condensate per day
    - 31,000 barrels of LPG per day
    - 500 million standard cubic feet of residue and reinjection gas compression and
    - About 80,000 barrels per day of produced water treatment and reinjection facilities.
- **Project Location**
  - The El Merk Fields are located 300 km southeast of Hassi Messaoud, a remote desert location in the Berkine Basin, approximately 160 km southeast of the town of Hassi Messaoud, close to both Tunisia and Libya.
- **Associated Gas Use**
  - The CPF consists of three trains – two oil/condensate and one NGL – to process, store, meter, and export the hydrocarbon liquids. The export products include: Sahara blend crude, light condensate and a mixed LPG stream of propane and butane which are extracted from the APG of these fields.
  - The dry component of the APG is reinjected.

APG use company case study: Hassi Messaoud – ZCINA plant

Power Generation

Liquefied Natural Gas (LNG)

Liquid Petroleum Gas (LPG)

Condensates

Reinjection

- **Project Participants**
  - Sonatrach and Engineering, Procurement and Construction contractor Saipem SpA
- **Project Description and Motivation**
  - The project is designed around the ZCINA processing zone separating LPG and condensates from the APG of the Hassi Messaoud North field.
  - It was completed in 2012.
  - The project is composed of three gas treatment plants that are modular and designed to accommodate future APG increases.
  - Average production of LPG: 4,600 t/day
  - Average production of on condensate: 300 t/day
- **Project Location**
  - Near the village of Hassi Messaoud
- **Associated Gas Use**
  - The project consists of three LPG trains with a capacity of 8 million cubic meters/day extendable to four.

CO2 reduction project at gas fields

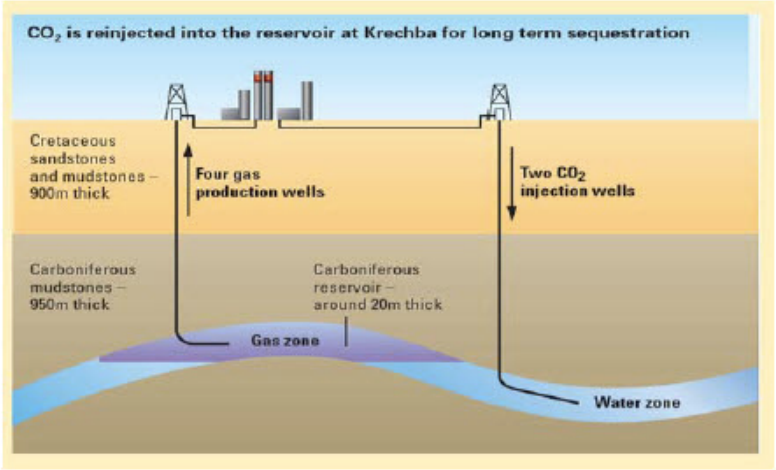
Power Generation

Liquefied Natural Gas (LNG)

Liquid Petroleum Gas (LPG)

Natural Gas Liquids (NGL)

Reinjection



Source: Global CSS Institute

- The In Salah field, located in the Algerian Sahara, is run as a joint venture between Sonatrach, BP and Statoil. Here, there is an industrial scale facility for reduction of CO2 emissions via reinjection into deep wells.
- In Salah involves the development of seven proven gas fields in the southern Sahara desert, about 1,200 km south of Algiers. The first phase of development started in 2004 and involves a production capacity of approximately nine billion cubic meters of gas per year at three fields. The gas is gathered at the main Krechba gas treatment plant, transported along a 500 km pipeline to the major gas collection point at Hassi R'Mel, and then exported to markets in Spain and Italy. The second phase will start in 2015.
- The gas produced has a CO2 content of between 5-10 per cent, which must be removed to meet sales gas export specifications of 0.3 per cent CO2. The Krechba gas treatment plant removes the CO2 and produces a CO2 stream of over 98% purity.
- Since the start of 2004, 3.8 million tons of CO2 gas has been stored below ground into the same geological saline formation that holds the natural gas. However, reinjection was stopped in 2011 as a safety measure.
- Alongside this CO2 Storage project, the In Salah CO2 Assurance Joint Industry Project was set up to monitor the CO2 storage process leveraging geochemical, geophysical and production techniques, including satellite imaging, well monitoring, seismic monitoring, and micro-seismic monitoring. It is supported by the JV partners as well as the US Department of Energy and the EU Directorate of Research.
- Currently, the movements of the injected CO2 are being studied and used to assess current reinjection strategy.

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