Gas flaring as a source of black carbon in the Arctic

December 2019

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Flaring is a technique that the oil and gas industry uses for getting rid of unwanted flammable gases by burning them.[1]

When the hydrocarbons are burned, they release greenhouse gases, such as carbon dioxide and methane, as well as other gases and particles, including black carbon. The amount of black carbon that is released depends on the composition of the gas and on the specific conditions under which they are burned.[2]

Gas flaring takes place either on a routine basis or as an emergency measure, for example for releasing pressure. Routine flaring can be defined as flaring during normal oil production operations in the absence of sufficient facilities or amenable geology to re-inject the produced gas, utilize it on-site, or dispatch it to a market.[3] Globally, it results in more than 350 million tons of CO_2 equivalent emissions every year and wastes a valuable resource, with harmful impacts to the environment from un-combusted hydrocarbons. If this amount of gas could be used for power generation, it would be enough energy to provide more electricity than the annual consumption of the African continent. While associated gas cannot always be used to produce power, it can often be utilized in other productive ways or re-injected into an underground formation.[4]

For the past decade, there has been a declining trend in gas flaring. However, in 2018, an increase was noted, mainly related to extraction of shale gas and in countries involved in conflicts.[5] In the Arctic, the main area of flaring activity is in northwest Russia.[6] A study based on satellite imagery indicates black carbon emission from gas flaring in the Russian Arctic increased in the early 2000s.[7]

Black carbon from flaring

Estimates of emissions of black carbon from flaring are uncertain, and are dependent on the methods and models that are used for making the estimate.[8] In a global perspective gas flaring is considered a minor source of black carbon (about 3% of emission). In the Arctic, one study based on model simulations estimated that flaring accounts for 42% of the black carbon in the air, as an annual average. The simulation also showed that in the month of March, over half of the black carbon near the surface might be from flaring.[9] Another study, which estimated black carbon emissions from satellite imagery, suggests that gas flaring could potentially explain a significant fraction of Arctic warming.[10] In areas near the Russian oil and gas fields, the impact is large enough to trigger melting of sea ice, in turn resulting in feedback mechanisms that amplify the warming.[11]

Actions to reduce flaring

Routine flaring can be reduced in ways that make business sense because they are economically beneficial. One important strategy is to use the gas that would otherwise be burned as a local energy source for heating and electricity. Another option is to capture it in ways that make it possible to sell or to store for future use. A report that Carbon Limits has produced as part of the EU Action on Black Carbon in the Arctic (EUA-BCA) provides an overview of so-called Best Available Techniques Economically Achievable (BATEA) that are particularly relevant towards demonstration and feasibility projects in the Arctic.[12] Many of them have been available for some time and implemented in some location. The report

highlights the following options for managing associated petroleum gas (APG) in ways that minimize emissions of black carbon and other atmospheric pollutants:

1. Using all, or part of, APG to fuel on-site oil extraction activities requiring heat and/or power.
2. Reinjecting gas into existing wells for enhanced oil recovery or underground storage.
3. Exporting natural gas. Technologies are available for treating the APG to produce natural gas that is sold on the market.
4. Exporting Liquid hydrogen Products. This option would involve further processing of the captured natural gas to high-value fuels that could be exported from the site.
5. Exporting electricity. This option would involve using local gas production for producing electricity that could be sold to consumers elsewhere.
6. Stripping the heavier natural gas liquids from APG prior to flaring. As a stand-alone option, such techniques can be used when other BATEA are deemed economically unfeasible.
7. Optimizing combustion conditions at the flare. This option is applicable on its own, both in relation to emergency flaring and for routine flaring that has not been possible to eliminated through implementation of other BATEA.

The choice of technology will depend on the specific conditions at each production facility. The report from Carbon Limits - *Best Available Techniques Economically Achievable to address black carbon from gas flaring* - presents a detailed assessment of each of these options, intended as a knowledge base for both businesses and national administrations that regulate the industry.[13]

Policy initiatives

The World Bank has taken a leadership role in gas flaring reduction through the Global Gas Flaring Reduction Partnership (GGFR). It is a public-private initiative comprising international and national oil companies, national and regional governments, and international institutions. GGFR works to remove technical and regulatory barriers to flaring reduction, conducting research, disseminating best practices, and developing country-specific gas flaring reduction programs.[14] Activities include the initiative 'Zero Routine Flaring by 2030' (ZRF 2030).[15] Countries and companies who have signed on to ZRF 2030 are obliged to publicly report their flaring and progress towards the goals on this initiative on an annual basis. All the oil and gas producing countries in the Arctic (Canada, Denmark, Norway, the Russian Federation, and the United States) have endorsed ZRF 2030.[16]

In the Arctic, the *Arctic Council Expert Group on Black Carbon and Methane* summarizes policy activities within the Arctic countries and issues recommendations. Its 2019 report included the following recommendations related the oil and gas industry, covering emissions of black carbon and methane: 1) adopt and implement oil and gas methane emissions reduction strategies; 2) encourage the adoption of best practices in reducing routine flaring and in improving gas capture; 3) encourage the adoption of best practices in reducing routine flaring and in improving gas capture; 4) urge firms to engage in international and domestic voluntary emissions reduction activities for both black carbon and methane; and 5) promote targeted and cost-effective measures at large methane emission sources, where relevant.[17]

The Arctic Council Work Group Arctic Action Contaminants Programme (ACAP) supports the on-going project 'Mitigation of short-lived

climate pollutants from APG flaring' through its Project Support Instrument. The project works with the Russian government and Russian companies together with consultancies to identify options for reducing emission from flaring and to demonstrate best available technologies and practices (BAT-BEP).[18]

There are also national regulations in place that limit the amount of flaring that is permitted.

[1] James D.N. McEwen and Matthew R. Johnson, "Black Carbon Particulate Matter Emission Factors for Buoyancy-Driven Associated Gas Flares," *Journal of the Air & Waste Management Association* 62, no. 3 (March 2012): 307–21, https://doi.org/10.1080/10473289.2011.650040.

[2] Stephanie Saunier, Marc-Alexander Bergauer, and Irina Isakova, "Best Available Techniques Economically Achievable to Address Black Carbon from Gas Flaring" (Oslo, Norway: Carbon Limits, 2019).

[3] Michael Stanley, "Gas Flaring: An Industry Practice Faces Increasing Global Attention" (2018).

[4] The World Bank, "Zero Routine Flaring by 2030," Text/HTML, World Bank, accessed September 9, 2019, https://www.worldbank.org/en/programs/zero-routine-flaring-by-2030.

[5] World Bank Global Gas Flaring Reduction Partnership (GGFR), "Increased Shale Oil Production and Political Conflict Contribute to Increase in Global Gas Flaring. Press Release No: 2019/EEX/200/" (The World Bank, June 12, 2019), https://www.worldbank.org/en/news/press-release/2019/06/12/increased-shale-oil-production-and-political-conflict-contribute-to-increase-in-global-gas-flaring.

[6] Z. Klimont, "Developing Emission Scenarios within the EU Action on Black Carbon" (2018), https://www.amap.no/documents/download/3391/inline.

[7] Mee-Hyun Cho et al., "A Missing Component of Arctic Warming: Black Carbon from Gas Flaring," *Environmental Research Letters* 14, no. 9 (September 6, 2019): 094011, https://doi.org/10.1088/1748-9326/ab374d.

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[9] A. Stohl et al., "Black Carbon in the Arctic: The Underestimated Role of Gas Flaring and Residential Combustion Emissions," *Atmospheric Chemistry and Physics* 13, no. 17 (September 5, 2013): 8833–55, https://doi.org/10.5194/acp-13-8833-2013.

[10] Cho et al., "A Missing Component of Arctic Warming."

[11] Cho et al.

[12] Saunier, Bergauer, and Isakova, "Best Available Techniques Economically Achievable to Address Black Carbon from Gas Flaring."

[13] Saunier, Bergauer, and Isakova.

[14] The World Bank, "Global Gas Flaring Reduction Partnership (GGFR)," Text/HTML, World Bank, accessed September 9, 2019, https://www.worldbank.org/en/programs/gasflaringreduction.

[15] The World Bank, "Zero Routine Flaring by 2030."

[16] The World Bank.

[17] Arctic Council, "Expert Group on Black Carbon and Methane. Summary of Progress and Recommendations 2019" (Tromsø, Norway: Arctic Council Secretariat, 2019), http://hdl.handle.net/11374/2411.

[18] Vygon Consulting, "Mitigation of Short-Lived Climate Pollutants from APG - Flaring. Phase 1B. Demonstration of Best Available Technologies and Environmental Proactices (BAT-BEP) to Reduce SLCP Emission from Flaring of ABP - Analysis of BAT-BEP and Business Cases for SLCP Mitigation in the Russian Arctic. Final Report" (Vygon Consulting, June 2019), [to be added].

Why is black carbon a concern in the Arctic?

What is the European Union action on black carbon in the arctic?

The European Union (EU) Action, which runs from 2018–2020, will contribute to efforts to reduce black carbon emissions in the Arctic by:

- Supporting the development of commitments and targets to limit production of Arctic black carbon, with a focus on the three regionally important human sources from Arctic nations (gas flaring from oil and gas fields, residential heating—including heating stoves and diesel fuel use—and maritime shipping); and
- Enhancing international cooperation on black carbon policy in the Arctic region.

The action has four major work components:

- Improving the knowledge base on black carbon emissions,
- Increasing awareness and sharing knowledge,
- Preparing technical advice documents and scenario analyses, and
- Supporting development of a roadmap for international cooperation on black carbon.

Why is the EU interested in taking action on black carbon in the Arctic?

The Arctic is a strategically important region and is experiencing dramatic, transformative impacts from climate change. The EU recognizes the importance of taking action now on black carbon to reduce its warming effect on the Arctic, improve air quality, and protect human health. Cost-effective technologies to reduce black carbon emissions already exist and can be implemented now.

This document has been produced with the financial assistance of the European Union. The contents of this document are the sole responsibility of the authors and can under no circumstances be regarded as reflecting the position of the European Union.

For further information, visit https://eua-bca.amap.no/gas-flaring