# Mitigation of Short Lived Climate Pollutants from APG – flaring – Arctic Zone RF

Husamuddin Ahmadzai, Tekn Dr.

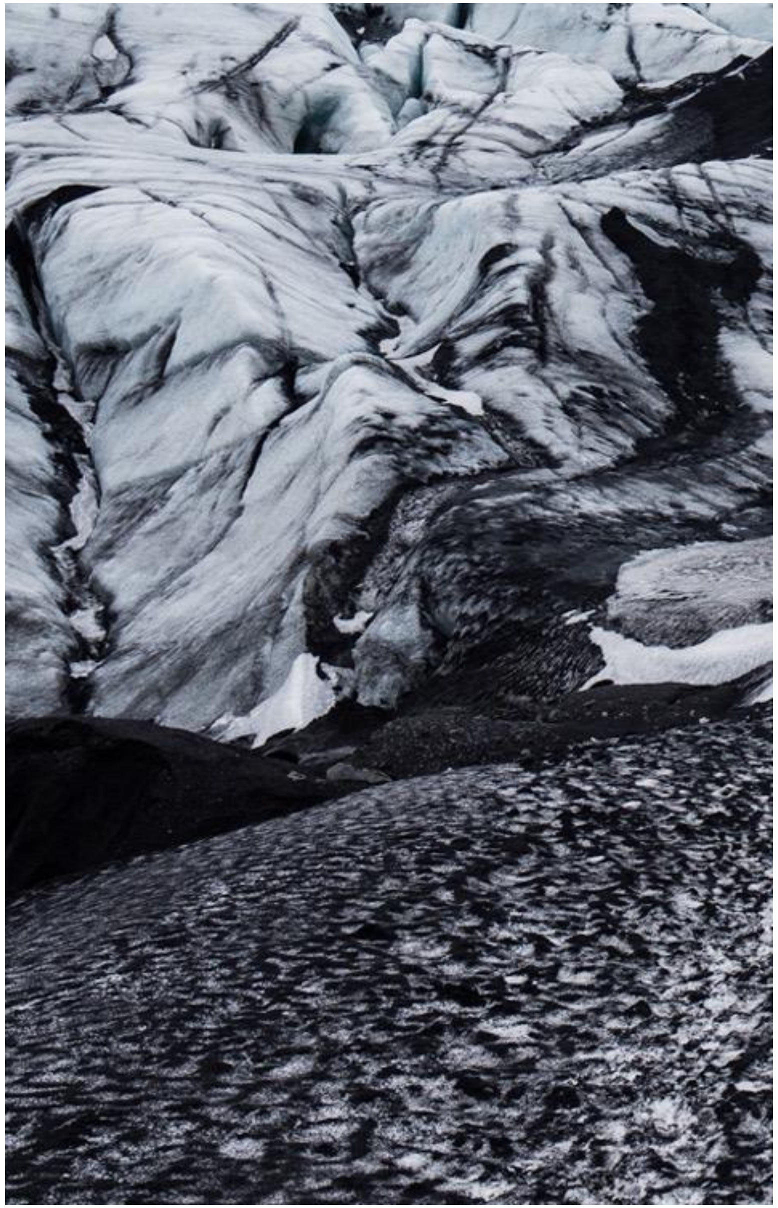
CEng, CE (E), FIMMM, FAusIMM

Technology Innovations in Oil and Gas

The 2017 Arctic Energy Summit

19 September 2017
Helsinki, Finland

NEFCO | NORDIC ENVIRONMENT FINANCE CORPORATION

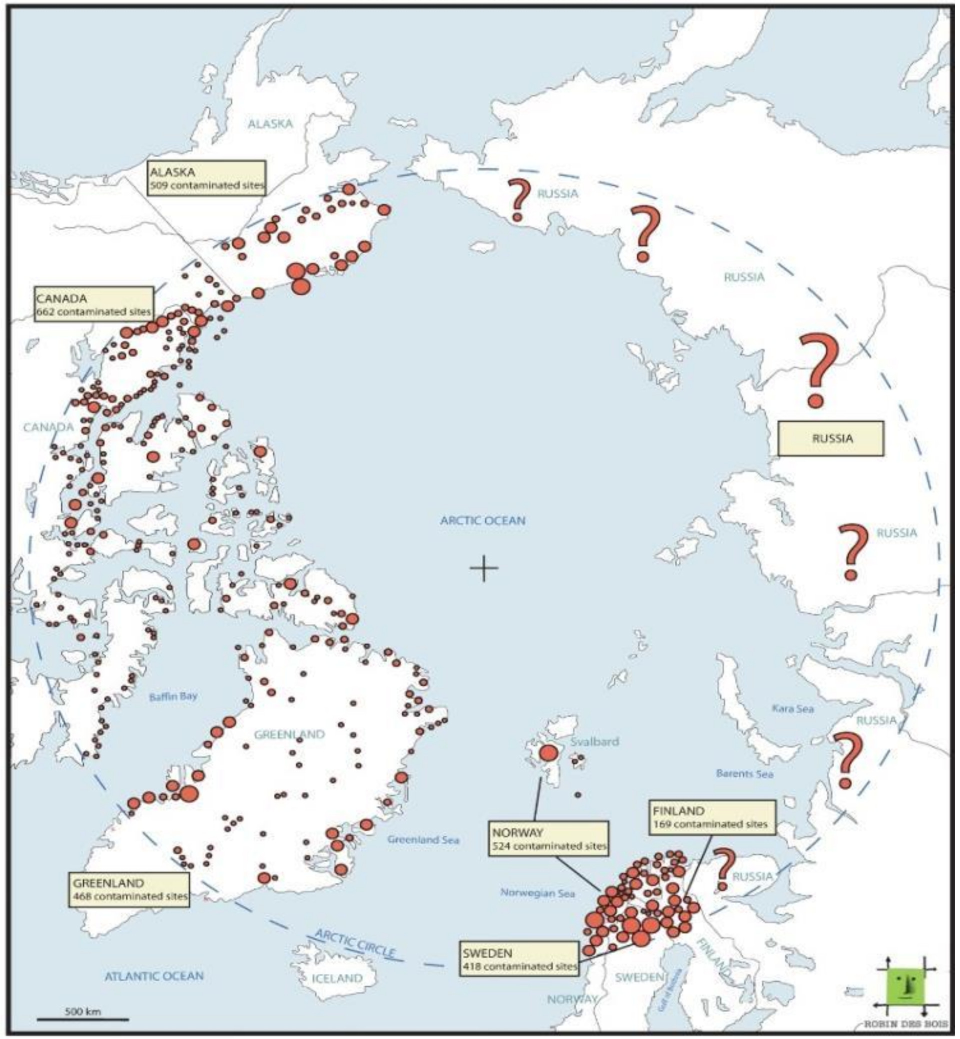


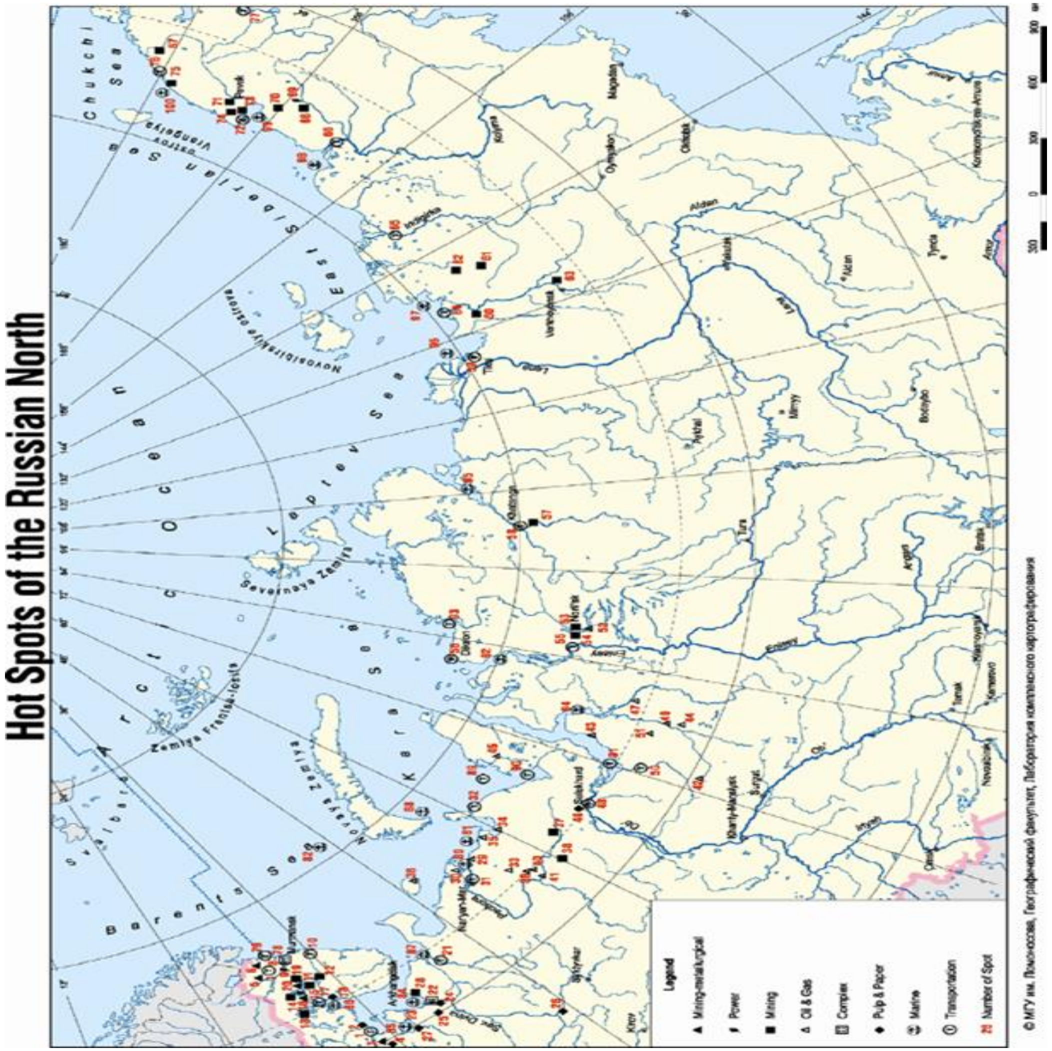
# Backdrop

- Short lived climate pollutants (SLCP) include black carbon (BC), hydrofluorocarbons (HFC), methane ($CH_4$) and tropospheric ozone ($O_3$)
- Tropospheric $O_3$ is formed by oxidation of other ozone precursors, in particular methane ($CH_4$), non-methane volatile organic compounds (NMVOCs), carbon monoxide (CO), and nitrogen oxides ($NO_x$).

# Arctic "Hot Spots" - Circumpolar

2750 Arctic Contaminated sites




NORDIC
ENVIRONMENT
FINANCE
CORPORATION

# The issue

- Regarding SLCP, Oil and gas industry is responsible for a large share of soot ("black carbon"), and methane emissions in the Arctic.
- Preliminary estimates is that emissions in the Russian Arctic Zone  are of the order of 105 000 t/y $CH_4$ (methane) and 45 000 t/y Black Carbon (BC).
- Corresponding $CO_2$-eq is estimated to range from about 12 M tonne to 70 M tonne. (range reflects the uncertainty with the GWP value of BC).

# The issue

- Current emissions of SLCP from APG is estimated to be up to 3 percent of the total GHG emissions of the RF (2016),
- By 2020 APG production in the Russian Arctic Zone may increase 15-fold (excluding Rosneft's Vankor field in the north of Krasnoyarsk Krai) which, in case of flaring, may result in substantial pressure on environment.
- Among the effective measures to mitigate soot and methane emissions in the Russian Arctic zone the following points can be identified:

NEFCO NORDIC ENVIRONMENT FINANCE CORPORATION

# Key solutions

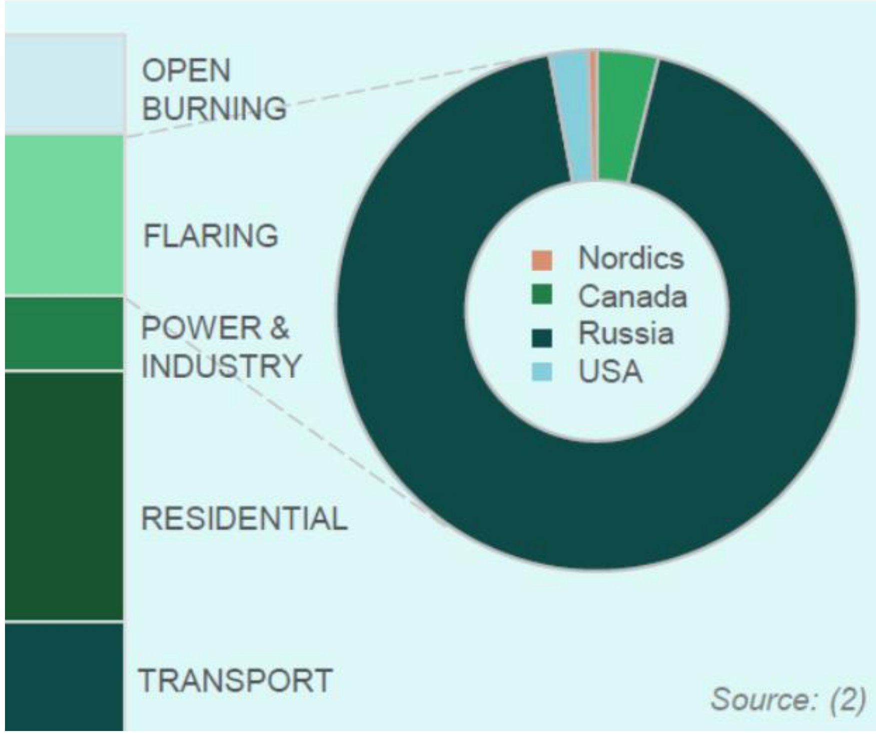
- reduction of APG flaring;
- reduction of natural gas liquids in APG flaring;
- improvement of flare facility to ensure "soot-free" APG flaring (zero soot emissions and reducing of methane emissions by 20-30 times);
- reduction of methane losses during production and transportation of natural gas

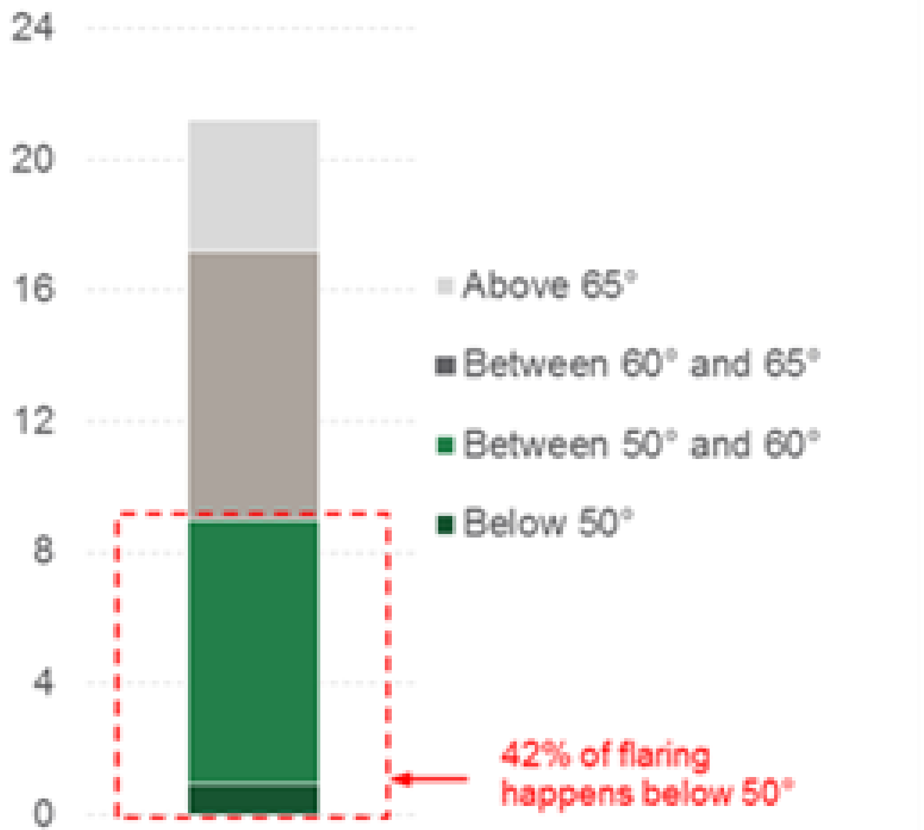
# Global Estimate and Costs

| Sector | 0 $/tCO_{2eq}$ | 10 $/tCO_{2eq}$ | 20 $/tCO_{2eq}$ | Max potential |
|---|---|---|---|---|
| Oil and gas | -31% | -39% | -42% | -56% |
| Agriculture | -4% | -6% | -8% | -23% |
| Waste | -3% | -13% | -16% | -37% |
| Coal mining | -8% | -40% | -46% | -52% |

Oil and gas sector emission reduction potential by 2030 (USEPA 2012)

# Potential from Flaring - Region




Based on 2015 NOAA satellite data:
https://www.ngdc.noaa.gov/eog/viirs/download_global_flare.html

Source Carbon Limits (2016, 2017)

# Energy – PSI SLCP Work in Progress

| Project | Budget EUR | PSI Funding EUR | Duration Months | Expected Results Emission Reduction |
|---|---|---|---|---|
| Valday Cluster BC/Diesel | 4.2 M | 1,12 M | WIP | 8 projects; 2000 t $CO_2$ |
| AIA Community BC-Health | 0,137 k | 0.137 k | WIP | Study No emission reduction |
| SLCP Mitigation Oil and Gas, APG Flaring | 609 M | 0.85 k | WIP | Feasibility studies + investment 6 – 35 M $CO_2$-e |
| Phase out of SLCP-HFC | 11.4 M | 0.18 k | WIP | Feasibility Study 400 000 t $CO_2$-e |
| TOTAL | 624 M | 2.3 M | | 6-35 million ton $CO_2$-e |

# The tasks – Russian Federation

- Key barriers to SLCP reduction from APG flaring in Russian Arctic Zone may be removed by:
  - enhancing authorities awareness of emissions level and reduction potential;
  - new incentives for investments in APG utilization for Arctic projects;
  - enhancing awareness of best available techniques (BAT);
  - introducing new gas monetization/value addition options in the Arctic with high costs from curtailed oil production;
  - raising public awareness of black carbon and methane effect on climate.

# BAT-BEP – Flaring ratios

Flaring activity according to annual maintenance programme

| | | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 |
|---|---|---|---|---|---|---|---|---|---|
| **Crude input** | (Mt/yr) | 3.08 | 3.42 | 3.40 | 3.43 | 3.53 | 3.41 | 3.35 | 2.53 |
| **Flare output** | (t/yr) | 704 | 201 | 560 | 1 003 | 390 | 753 | 165 | 6 155 |
| **Flaring ratio** | (‰) | **0.23** | **0.06** | **0.16** | **0.29** | **0.11** | **0.22** | **0.05** | **2.43** |

*Source:* [ 28, Tebert et al.2009 ]

Example of flaring ratio of two plants in Sweden

| | Flaring ratio (‰) | |
|---|---|---|
| | 2008 | 2009 |
| **Preem Gothenburg refinery** | 0.6 | 0.6 |
| **Preem Lysekil refinery** | 0.8 | 1.0 |

NEFCO
NORDIC ENVIRONMENT FINANCE CORPORATION

# BAT-BEP - Flaring

| Pollutant | Elevated flare | | Ground flare | |
|---|---|---|---|---|
| | **Abatement efficiency (1) (%)** | **Emission level (2) ($mg/Nm^3$)** | **Abatement efficiency (1) (%)** | **Emission level (2) ($mg/Nm^3$)** |
| VOCs (including $CH_4$) | > 98 (3, 4, 5) | NI | > 99 (3, 5) | NI |
| $NO_X$ | NI | 400 (200 ppm) | NI | 400 (200 ppm) |
| | NI | 108 (6) | NI | 108 (6) |
| CO | NI | 588 (6) | NI | 588 (6) |

(1) Efficiency depends on the specific plant configuration and operational conditions; the performances indicated are based upon half-hourly averages [ 176, Schenk et al. 2009 ].
(2) The emission levels reported are indicative of what is being achieved at some industrial installations under normal operating conditions; because emission levels strongly depend on the specific plant configuration and operating conditions, the values given should be used with extreme caution for permitting.
(3) Under optimum conditions, i.e. heat content of waste gas > 8–11 $MJ/Nm^3$; low flows and low heat content achieve lower combustion efficiencies (as low as 65 %) [ 142, Akerodolu and Sonibare 2004 ].
(4) [ 52, US EPA 1995 ] [ 142, Akerodolu and Sonibare 2004 ].
(5) [ 24, InfoMil 2000 ].
(6) [ 52, US EPA 1995 ].
NB: NI = no information provided.

# BAT-BEP - Flaring

BAT is to use flaring only for safety reasons or non-routine operational conditions (e.g. start-ups, shutdowns) by using one or both of the techniques given below

| | Technique | Description | Applicability |
|---|---|---|---|
| a | Correct plant design | This includes the provision of a gas recovery system with sufficient capacity and the use of high-integrity relief valves. | Generally applicable to new plants. Gas recovery systems may be retrofitted in existing plants. |
| b | Plant management | This includes balancing the fuel gas system and using advanced process control. | Generally applicable. |

# BAT-BEP

**When flaring is unavoidable, BAT is to use one or both of the techniques given below**by using one or both of the techniques given below

| | Technique | Description | Applicability |
|---|---|---|---|
| a | Correct design of flaring devices | Optimisation of height, pressure, assistance by steam, air or gas, type of flare tips (either enclosed or shielded), etc., aimed to enable smokeless and reliable operation and to ensure the efficient combustion of excess gases. | Applicable to new flares. In existing plants, applicability may be restricted due to e.g. maintenance time availability during the turnaround of the plant. |
| b | Monitoring and recording as part of flare management | Continuous monitoring of the gas sent to flaring, measurements of gas flow and estimations of other parameters (e.g. composition, heat content, ratio of assistance, velocity, purge gas flow rate, pollutant emissions (e.g. NOX, CO, hydrocarbons, noise)). The recording of flaring events usually includes the estimated/measured flare gas composition, the estimated/measured flare gas quantity and the duration of operation. The recording allows for the quantification of emissions and the potential prevention of future flaring events. | Generally applicable. |

# BAT-BEP VOC (Common WWC 2016)

In order to prevent or, where that is not practicable, to reduce diffuse VOC emissions to air, BAT is to use a combination of the techniques given below.

| | Technique | Applicability |
|---|---|---|
| *Techniques related to plant design* | | |
| a | Limit the number of potential emission sources | Applicability may be restricted in the case of existing plants due to operability requirements. |
| b | Maximise process-inherent containment features | |
| c | Select high-integrity equipment (see the description in Section 4.6.2) | |
| d | Facilitate maintenance activities by ensuring access to potentially leaky equipment | |
| *Techniques related to plant/equipment construction, assembly and commissioning* | | |
| e | Ensure well-defined and comprehensive procedures for plant/equipment construction and assembly. This includes using the designed gasket stress for flanged joint assembly (see the description in Section 4.6.2) | Generally applicable. |
| f | Ensure robust plant/equipment commissioning and handover procedures in line with the design requirements | |
| *Techniques related to plant operation* | | |
| g | Ensure good maintenance and timely replacement of equipment | Generally applicable. |
| h | Use a risk-based leak detection and repair (LDAR) programme (see the description in Section 4.6.2) | |
| i | As far as it is reasonable, prevent diffuse VOC emissions, collect them at source, and treat them | |

NEFCO NORDIC ENVIRONMENT FINANCE CORPORATION

# Challenges

- Regulation
- Remote locations
- Monitoring and standards
- Definitions and methodology (including estimating the $CO_2$-equivalents associated with of BC (e.g. from flaring, bio-fuel, heavy transportation), non-methane VOC (e.g. from the oil and gas industry) and tropospheric Ozone ($O_3$).
- Cross media issues (mercury, arsenic etc.) water, waste
- Maintenance and capacity building
- Information dissemination

# Thank You!

19 September 2017
Helsinki, Finland

NEFCO NORDIC ENVIRONMENT FINANCE CORPORATION