


Estimation of flared gas volumes at oil & gas fields using VIIRS data

VIIRS Users meeting, June 2022

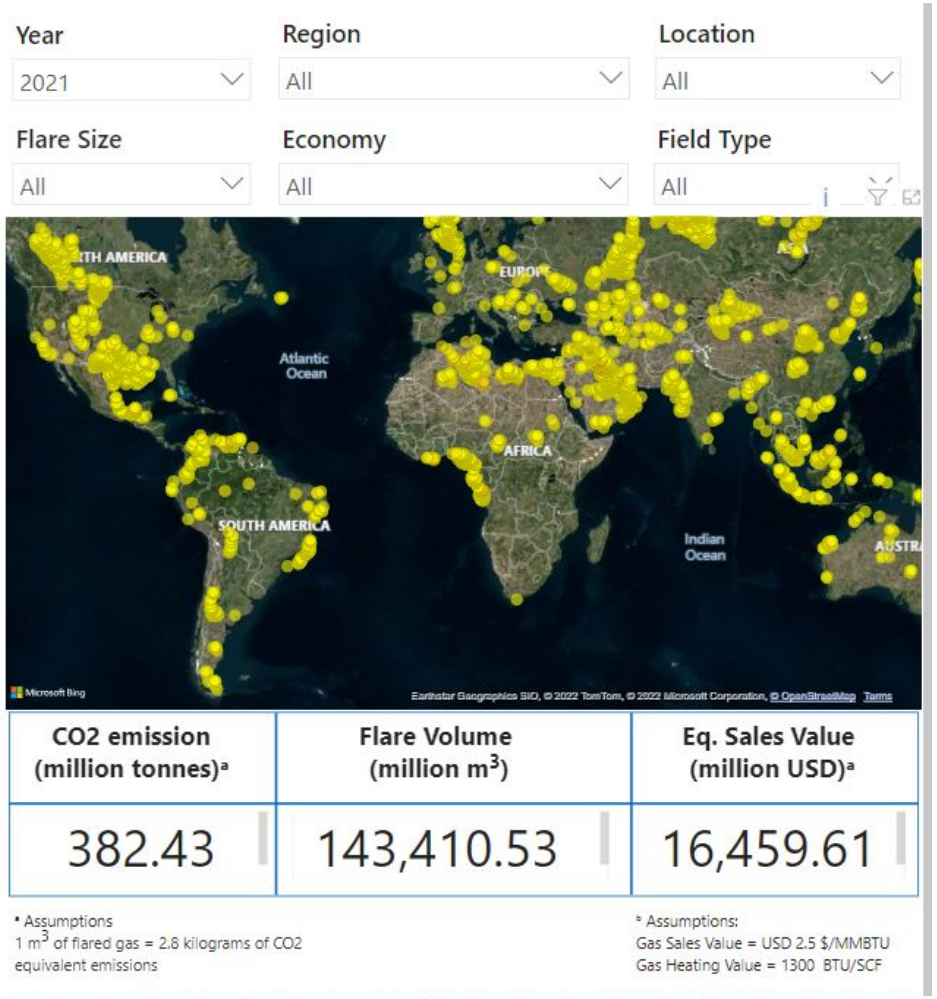
WORLD BANK GROUP

GGFR
Global Gas Flaring Reduction Partnership

Zero Routine Flaring by 2030

Topics Covered

- What is GGFR
- VIIRS interpretation methodology
- Global flare volume estimates
- Imported Flare Gas Index



What is GGFR

The Global Gas Flaring Reduction Partnership (GGFR), initiated in 2003 and hosted by the World Bank, is a multi-donor trust fund of governments, oil companies, and multilateral organizations **committed to ending routine gas flaring at oil and gas production sites across the world.**

GGFR uses VIIRS satellite data to estimate gas flare volumes at oil & gas production sites around the world to monitor progress in its reduction.

Why is reducing flaring at oil and gas facilities important?

1. Flaring itself is an unacceptable, wasteful activity

Flaring is environmentally damaging, emitting around 400 million tonnes of CO2 equivalent each year in the form of carbon dioxide and methane – carbon dioxide from the combusted gas, and methane in the gas that remains un-combusted due to combustion inefficiency of the flares

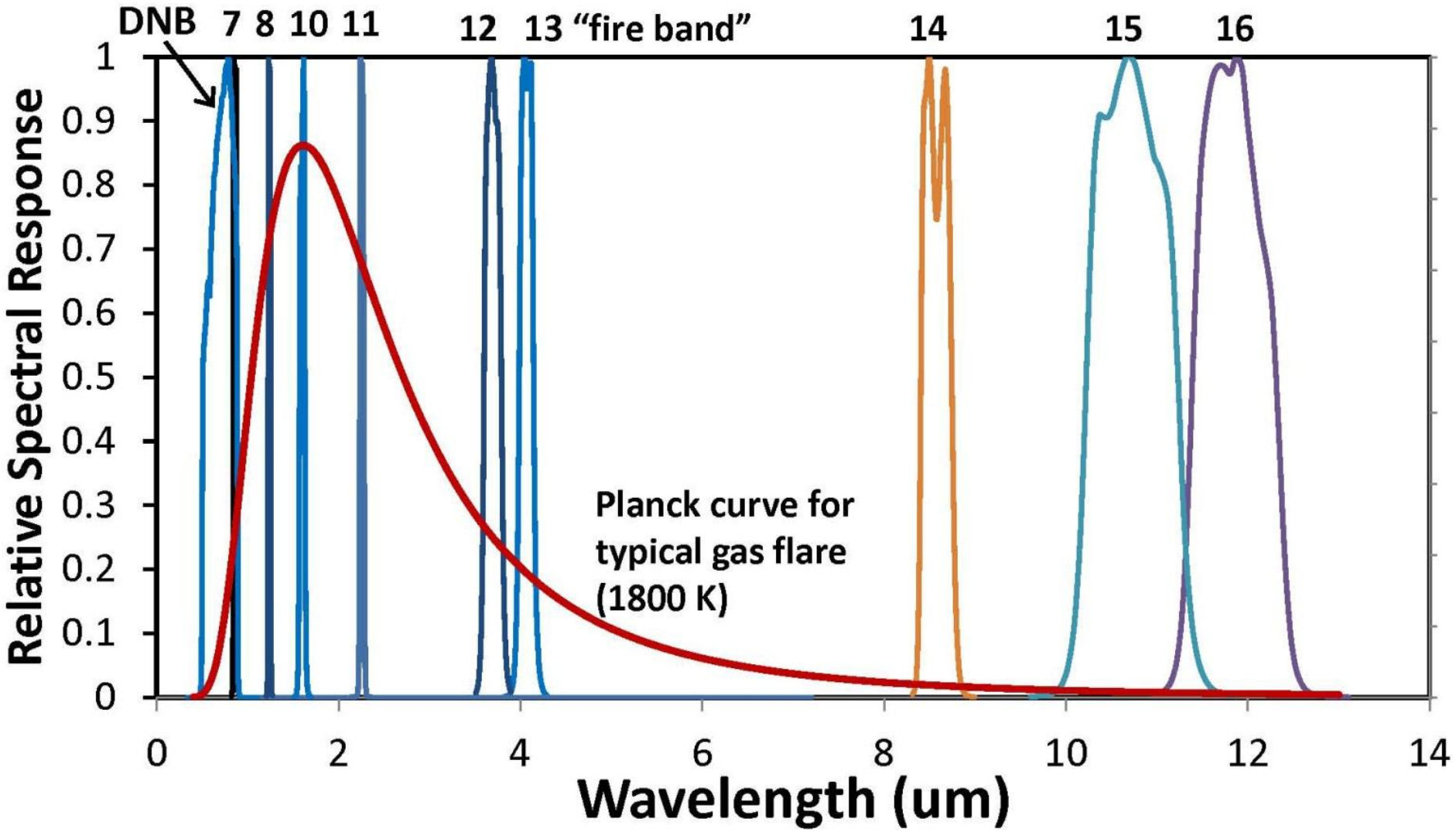
It is also a waste of a valuable resource. Assuming a value of US$ 2/mmbtu, flaring wastes gas that has a value of over US$ 10 billion a year

2. Reducing flaring is essential to maximize the benefit of reducing methane leakage

Reduction in methane emissions (leakage and fugitives) from oil and gas operations is a major climate change mitigation activity. If an oil or gas field is routinely flaring gas, any methane emissions mitigated will not be used, but will just increase the volume of gas being flared.

VIIRS interpretation methodology

VIIRS spectral bands collected at night



Source: NOAA, Payne Institute/Colorado School of Mines

Typical gas flare detection with dual Planck curves

Combustion parameters:

ID=VNF_npp_d20141111_t0227520_e0229162_b15744_x0032398E_y329372N_l0382_s2756_v21

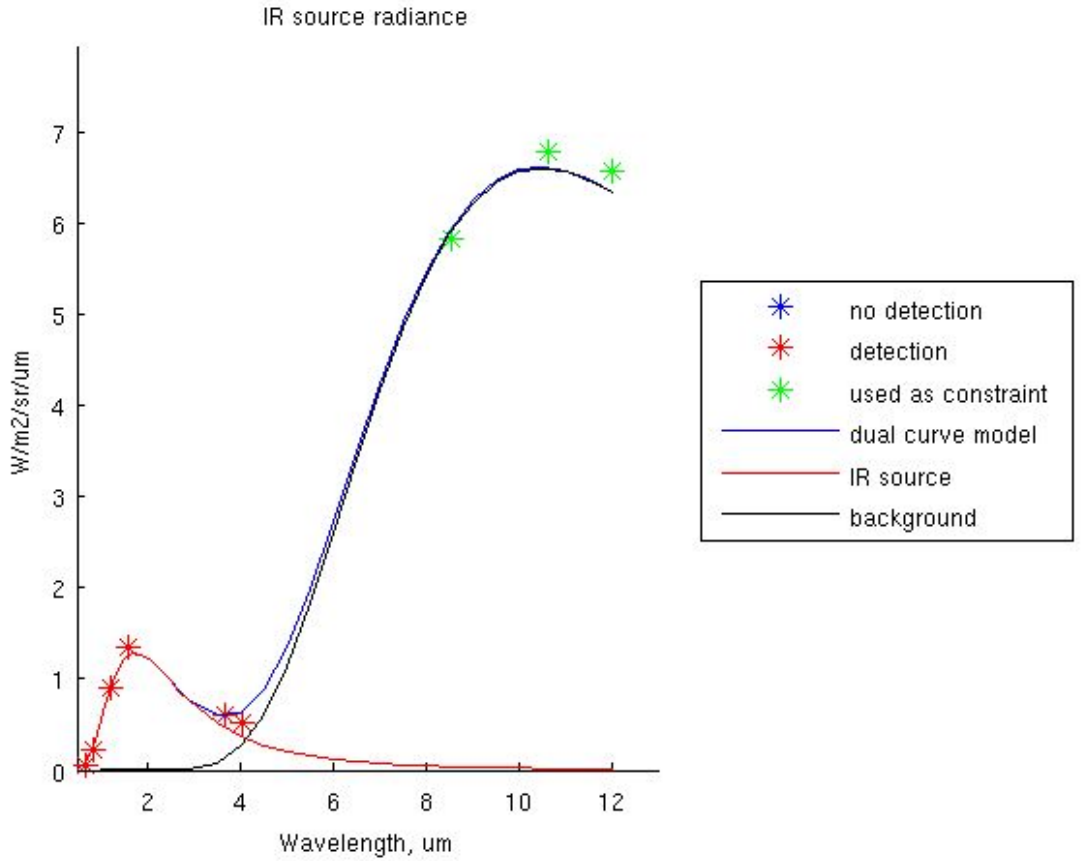
Lat=32.937229 Lon=3.239845 deg. Time=2014/11/11 02:29:08

Temperature source=1665 deg. K Temperature background=276 deg. K

Radiant heat intensity=10.74 W/m2 Radiant heat=10.52 MW

Source footprint=24.14 m2

Cloud state=cloudy Atmosphere corrected=no



Source: NOAA, Payne Institute/Colorado School of Mines

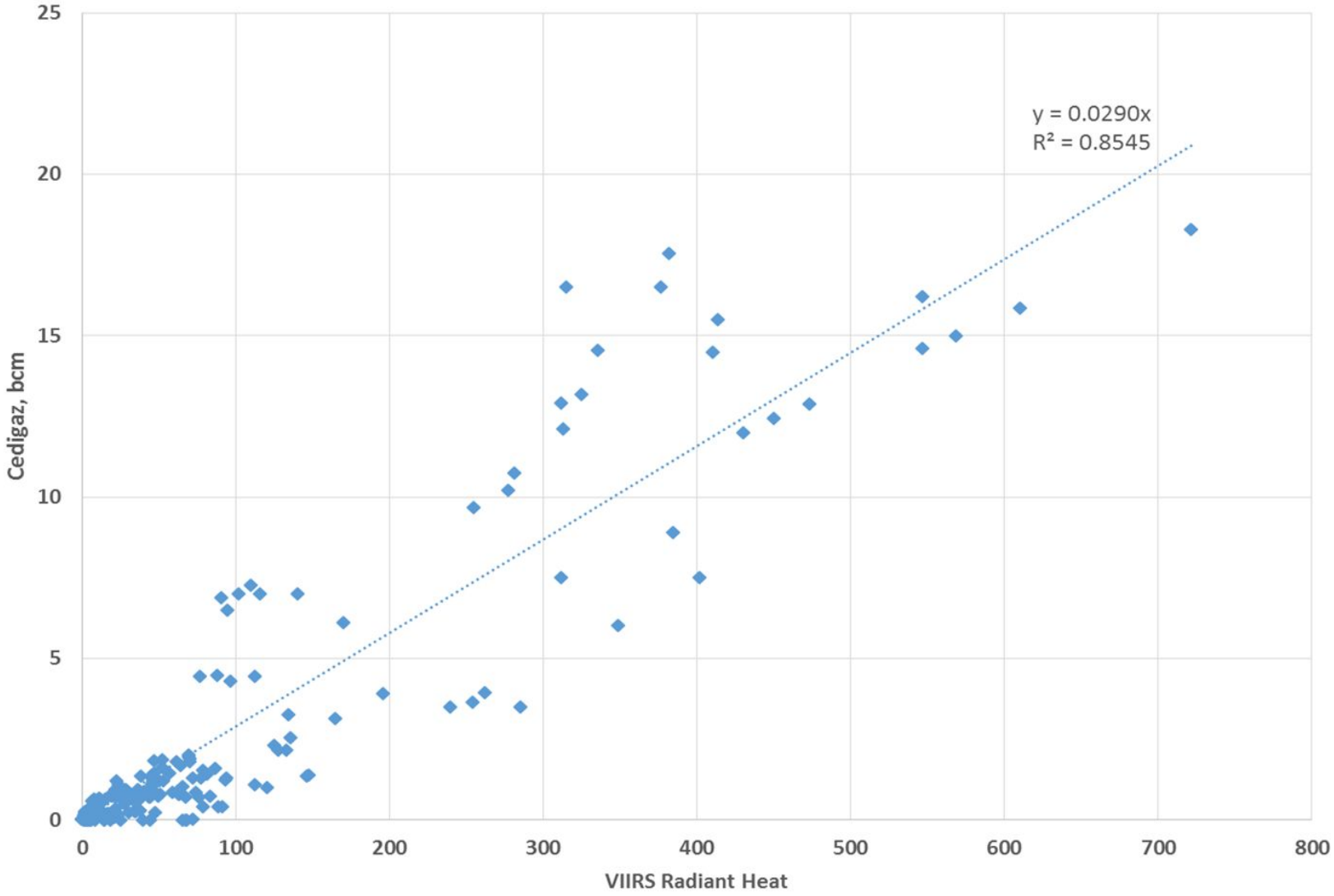
Planck curve analysis to estimate a flare's radiant heat

- Planck curves are fitted to the signals from detectors 7-13 and 14-16 respectively to represent the emissions from a small hot source and the large cooler background
- The wavelength with peak radiant emission for each Planck curve is used to calculate the source temperature using Wien's Law ($T = c/\lambda_{max}$)
- The radiant heat per unit area (W/m2) is calculated from this temperature using the Stefan-Boltzmann Law ($W/m2=\sigma T^4$)
- The emission scaling factor (ESF) is the ratio between the observed radiance and the radiance of an object at the same temperature that fills the field-of-view
- Multiplying the pixel footprint size by the ESF gives an estimate of the source area
- Total radiant output (Watts) is calculated as the product of the radiant heat per unit area and the source area

Source: NOAA, Payne Institute /Colorado School of Mines

VIIRS radiant heat (RH) estimates vs Reported flare volumes

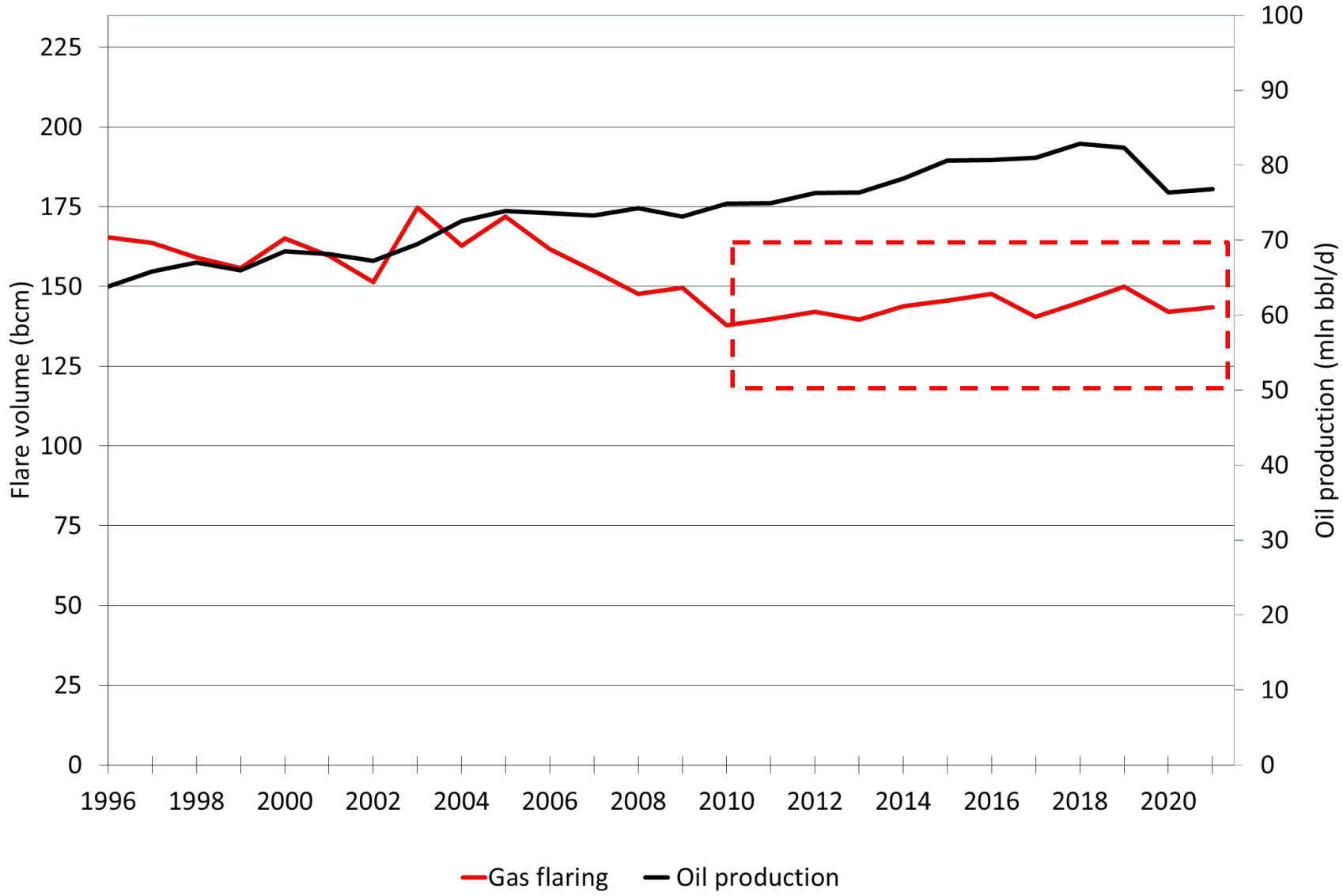
VIIRS correlation: Cedigaz reported flare volumes vs. VIIRS radiant heat estimate
2012 - 2016



Source: NOAA, Payne Institute/Colorado School of Mines, Cedigaz

Global flare volume estimates

1996-2021 gas flare volumes and oil production



+20% since 1996
(+1% since 2012)

-13% since 1996
(+1% since 2012)

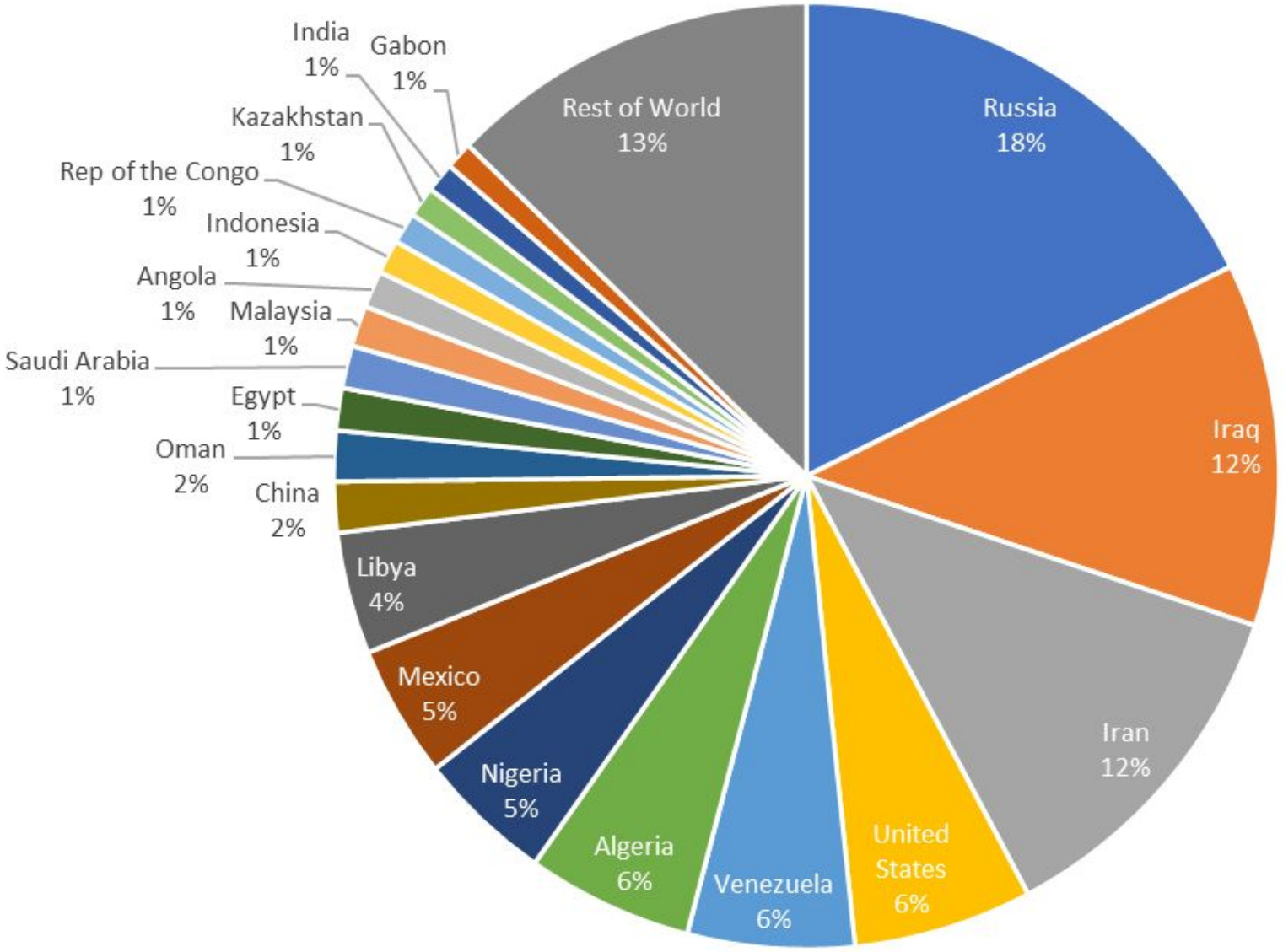
	Flare (bcm)	Oil (mln bbl/d)
2019	150	82
2020	141	76
2021	144	77

Source: NOAA, Payne Institute and Colorado School of Mines, EIA, GGFR

Global individual flare volumes: 2021

Source: NOAA, Payne Institute and Colorado School of Mines, GGFR

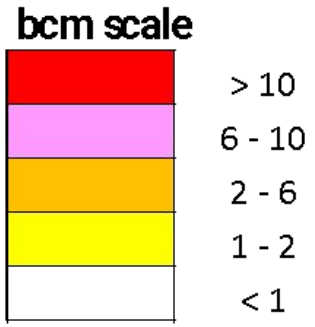
Percentage share of global flaring in 2021



Source: NOAA, Payne Institute and Colorado School of Mines, GGFR

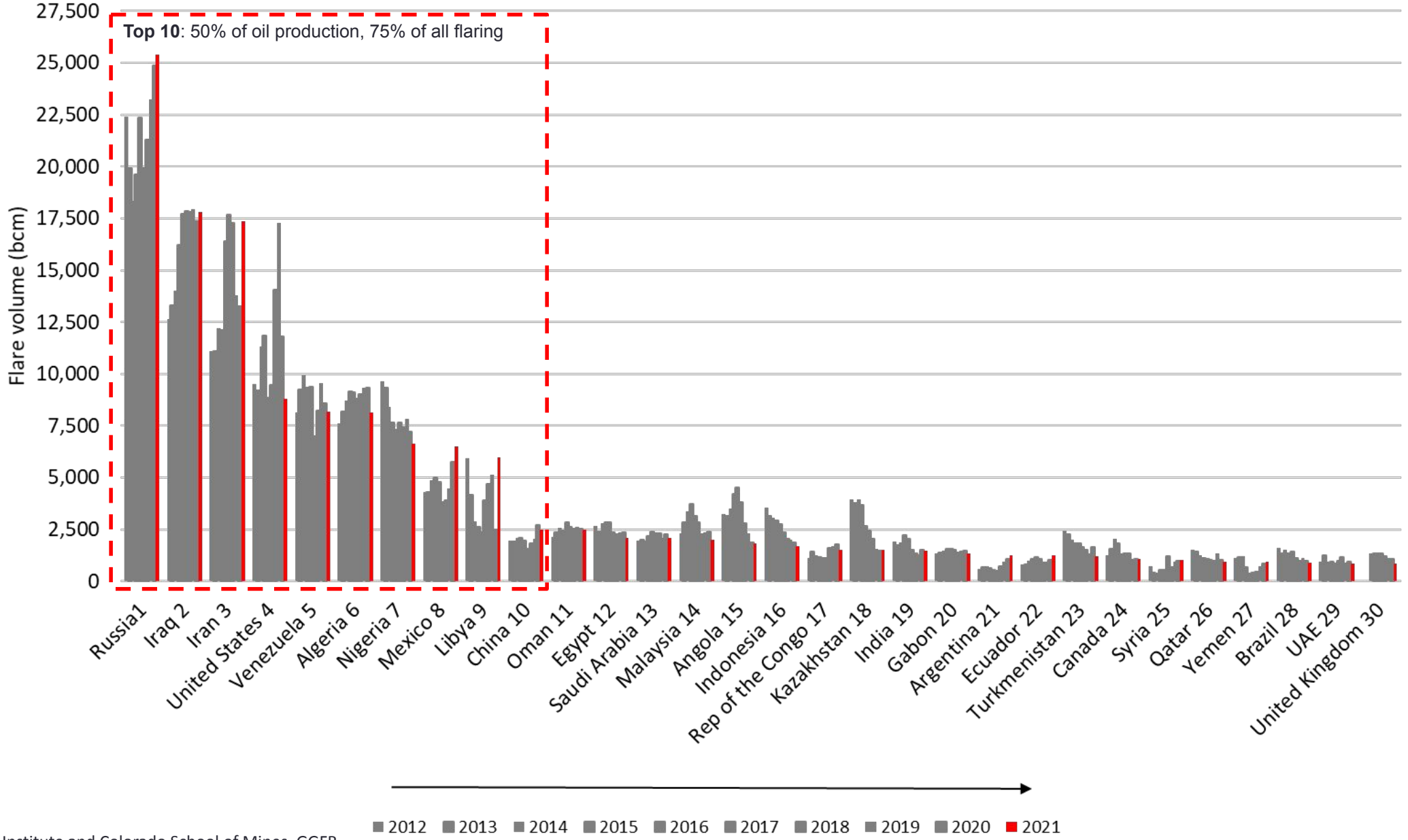
Top 20 flaring countries – ranked by 2021 flare volumes

bcm	2017	2018	2019	2020	2021
Russia	19.92	21.28	23.21	24.13	25.41
Iraq	17.84	17.82	17.91	17.37	17.80
Iran	17.67	17.28	13.78	13.26	17.38
United States	9.48	14.07	17.29	11.81	8.78
Venezuela	7.00	8.22	9.54	8.59	8.19
Algeria	8.80	9.01	9.34	9.32	8.16
Nigeria	7.65	7.44	7.83	7.20	6.63
Mexico	3.79	3.89	4.48	5.77	6.51
Libya	3.91	4.67	5.12	2.47	5.97
China	1.56	1.82	2.02	2.72	2.49
Oman	2.60	2.54	2.63	2.52	2.48
Egypt	2.34	2.26	2.34	2.36	2.08
Saudi Arabia	2.32	2.29	2.10	2.26	2.08
Malaysia	2.83	2.25	2.37	2.41	2.00
Angola	3.80	2.79	2.33	1.87	1.80
Indonesia	2.33	2.06	2.00	1.88	1.67
Rep of the Congo	1.14	1.58	1.67	1.79	1.52
Kazakhstan	2.42	2.05	1.57	1.48	1.51
India	1.50	1.34	1.31	1.49	1.46
Gabon	1.50	1.38	1.46	1.47	1.34
Rest of the world	20.2	19.0	19.7	19.2	18.2
Total	141	145	150	141	144



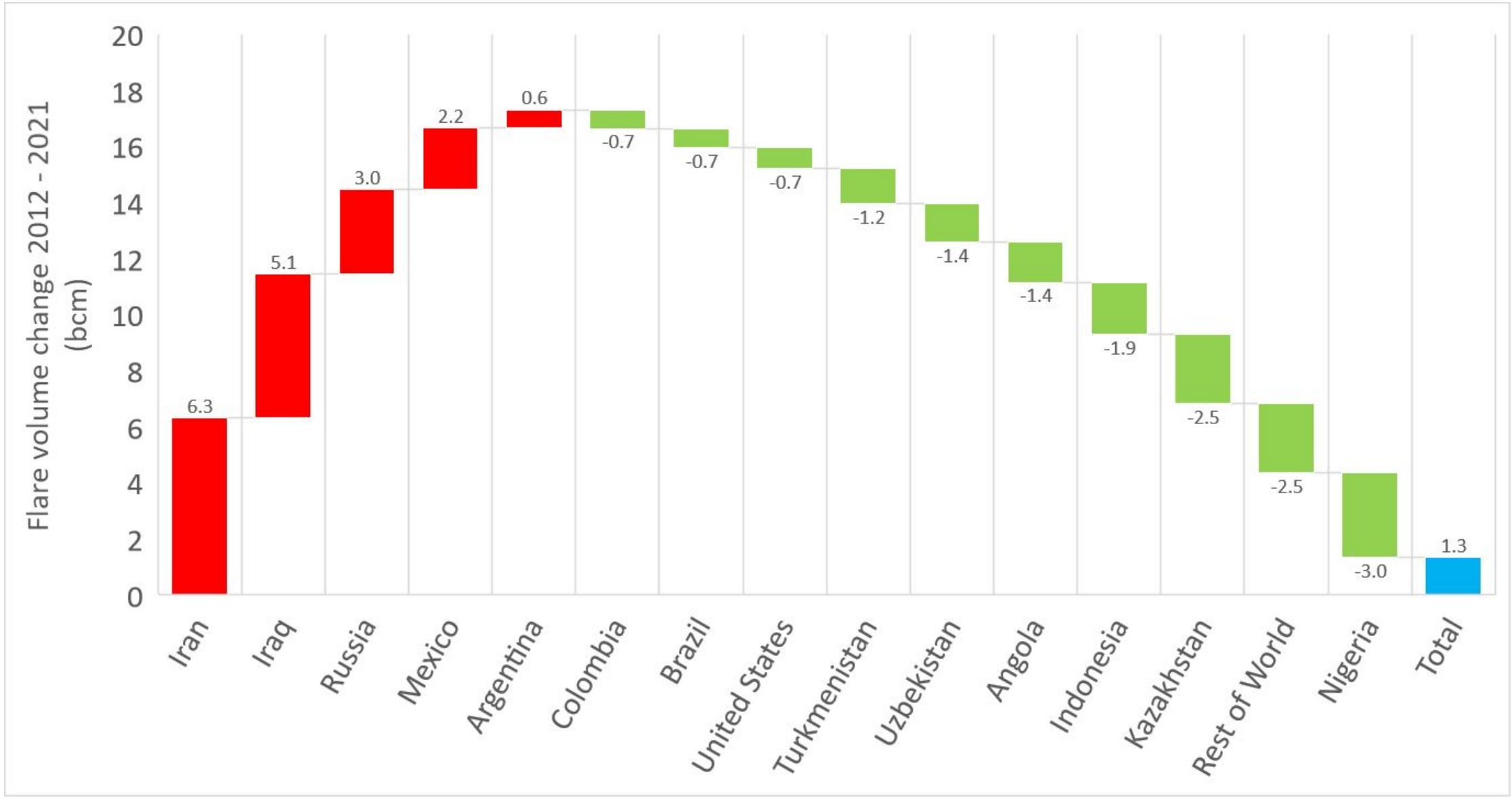
Source: NOAA, Colorado School of Mines, GGFR

Top 30 flaring countries, ranked by 2021 flare volume



Source: NOAA, Payne Institute and Colorado School of Mines, GGFR

Progress by some countries since 2012 eroded by increases in others



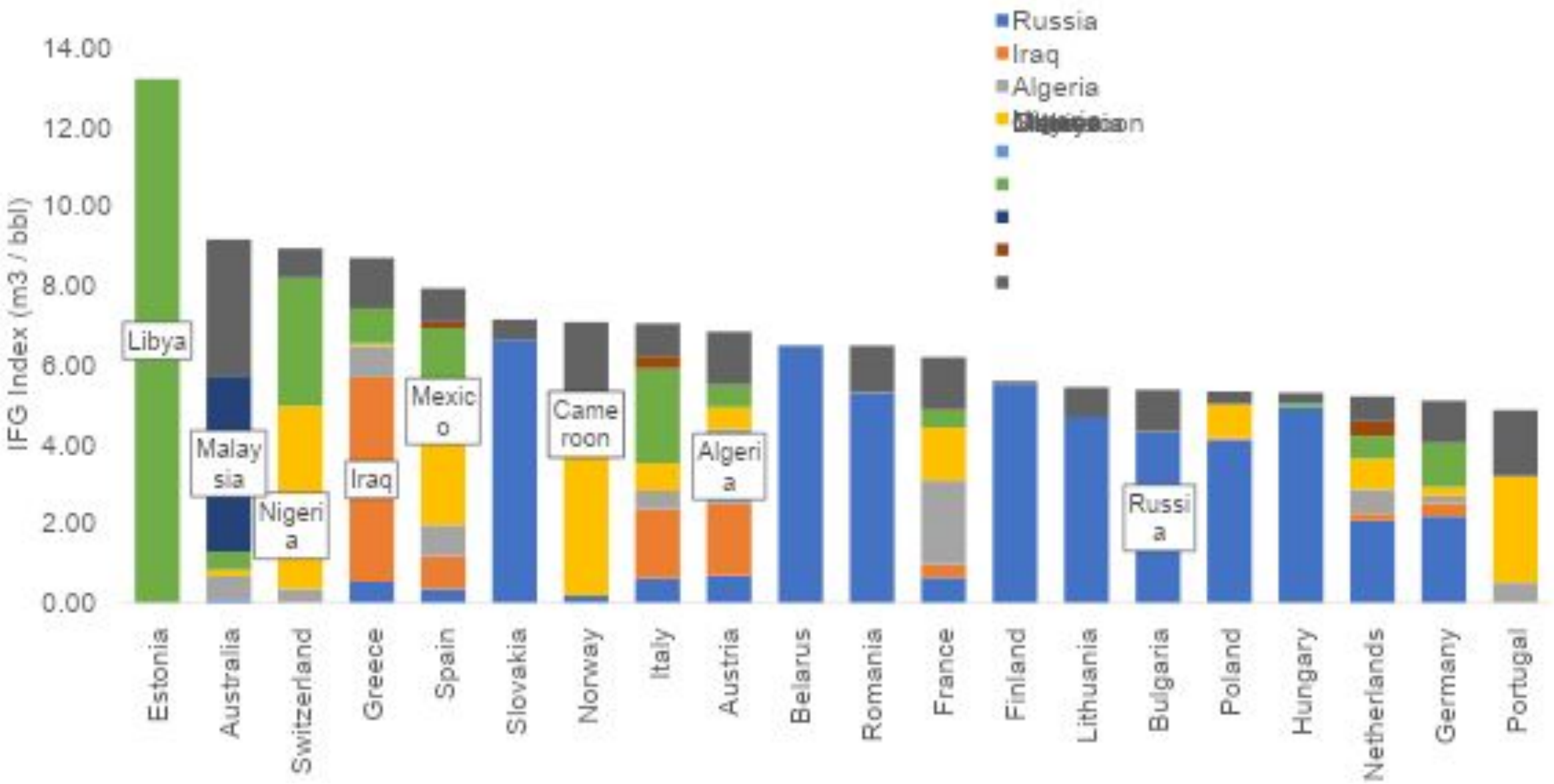
Source: NOAA, Payne Institute and Colorado School of Mines, GGFR

Imported Flare Gas (IFG) Index

$$IFG\ Index\ of\ crude\ importing\ country, X\ (m3/bbl) =$$

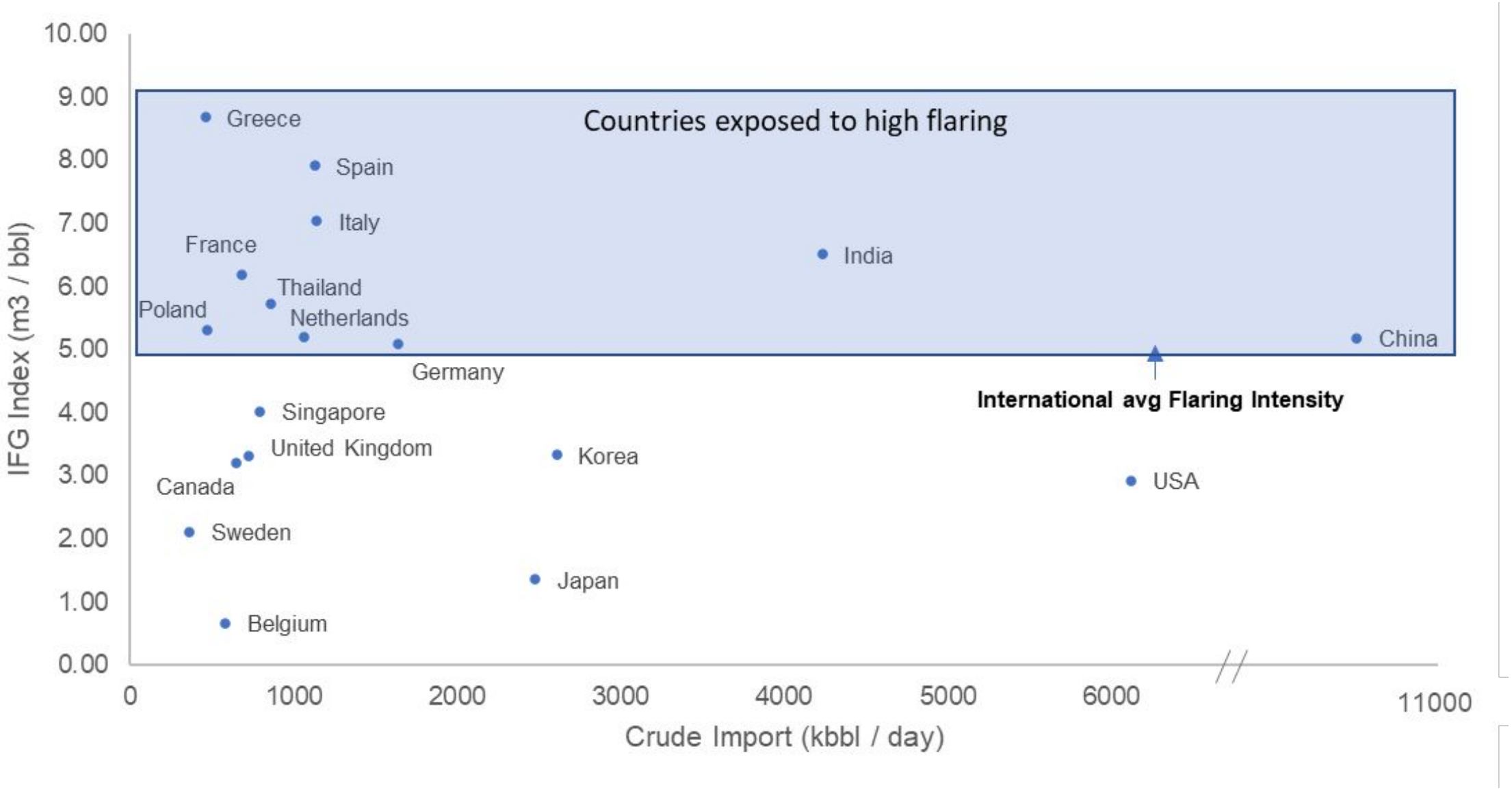
$$\frac{\sum Crude\ import\ from\ country\ Y * flare\ intensity\ of\ country\ Y}{Total\ crude\ imported\ by\ country\ X}$$

2021 IFG Index: Top 20 Annex 1 Countries



Source: NOAA, Payne Institute and Colorado School of Mines, EIA, UN Comtrade, GGFR,

IFG Index of largest Annex 1crude importing countries (>250 kbbl/d)



Source: NOAA, Payne Institute and Colorado School of Mines, EIA, UN Comtrade, GGFR,

In summary

The VIIRS satellite data enables us to monitor the flaring trend on a global basis, and to see in which countries there is good progress reducing flaring, and in which there is clearly a need for urgent action.

Thank you

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