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flare.IQ

José Domínguez
Flow Product Specialist Europe
09/10/2024

Do you know your flares?

#methaneemissions
#combustionefficiency
#emissionabatement
#oversteaming

Flare methane emission monitoring and reporting

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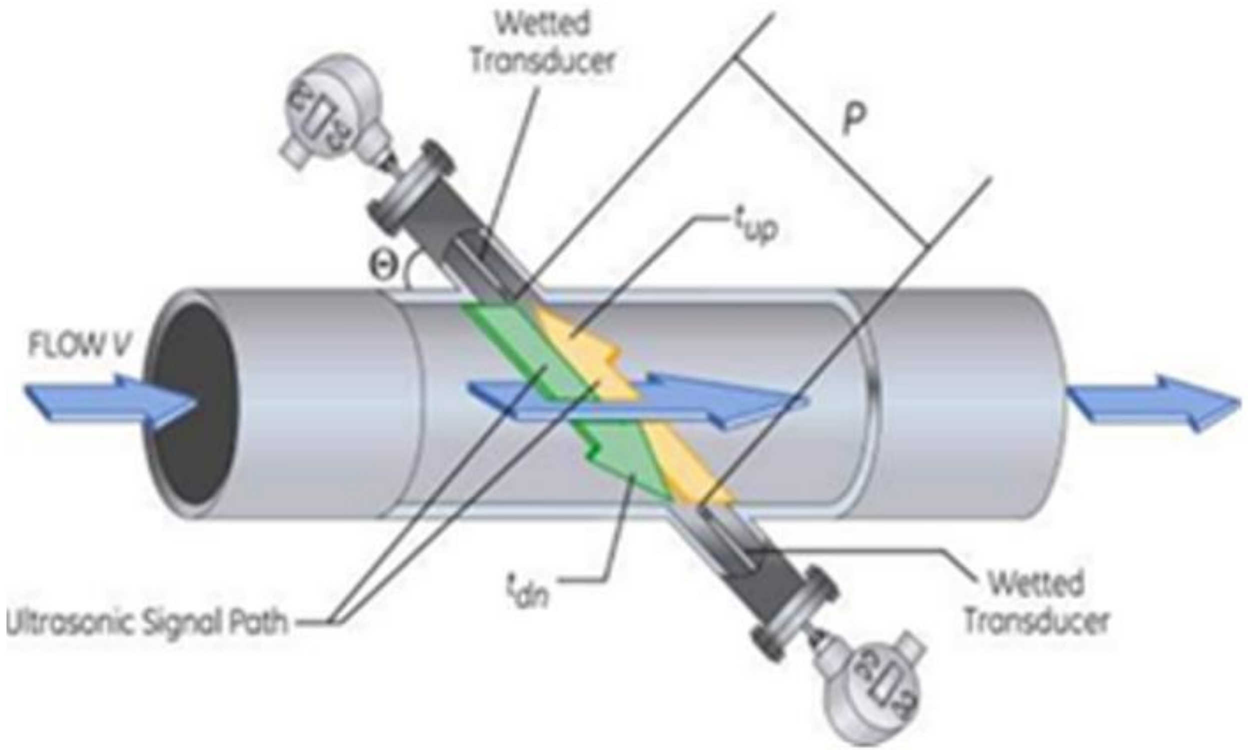
What do we know?



Distance
t_up + t_down → Speed of Sound

Distance
t_up - t_down → Volumetric Flow
Area

What is incomplete combustion: Methane example

100% Combustion Efficiency

$$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$$

$$CH_4 + O_2 \rightarrow 0.5\,CH_4 + 0.5CO_2 + H_2O$$

50% Combustion Efficiency

How to compare?

But what is CO2eq?

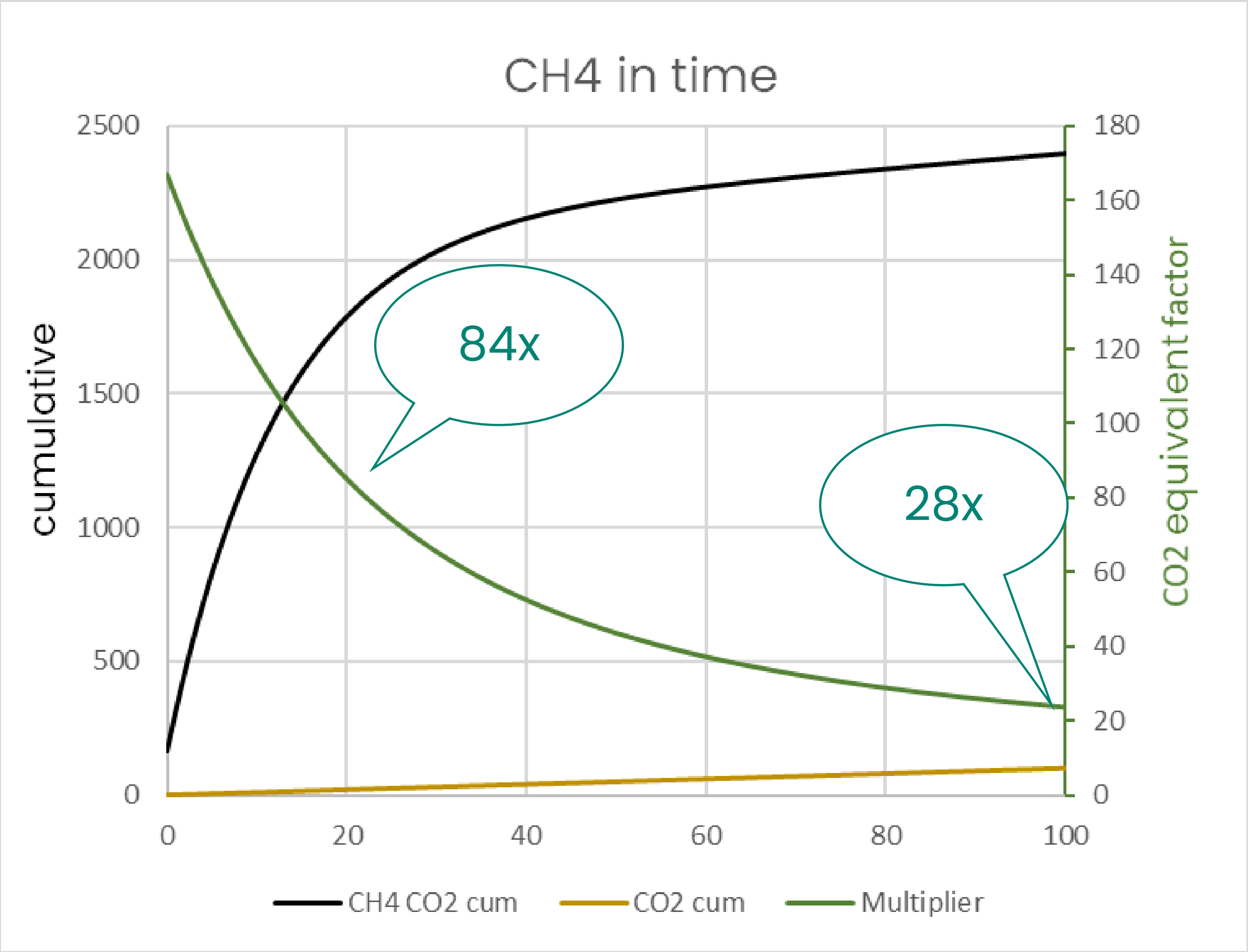
- Environmental Protection Agency definition:

- Carbon dioxide equivalent or CO_2e means the number of metric tons of CO2 emissions with the same global warming potential as one metric ton of another greenhouse gas, and is calculated using Equation A-1 in 40 CFR Part 98.

Or in simple words:

- A way to compare apples to oranges

CO2 vs CH4



- CH4 = 167x CO2 at release (GWP)
- Decays overtime (reacts with Ozone)
- But cumulative GW effects remain

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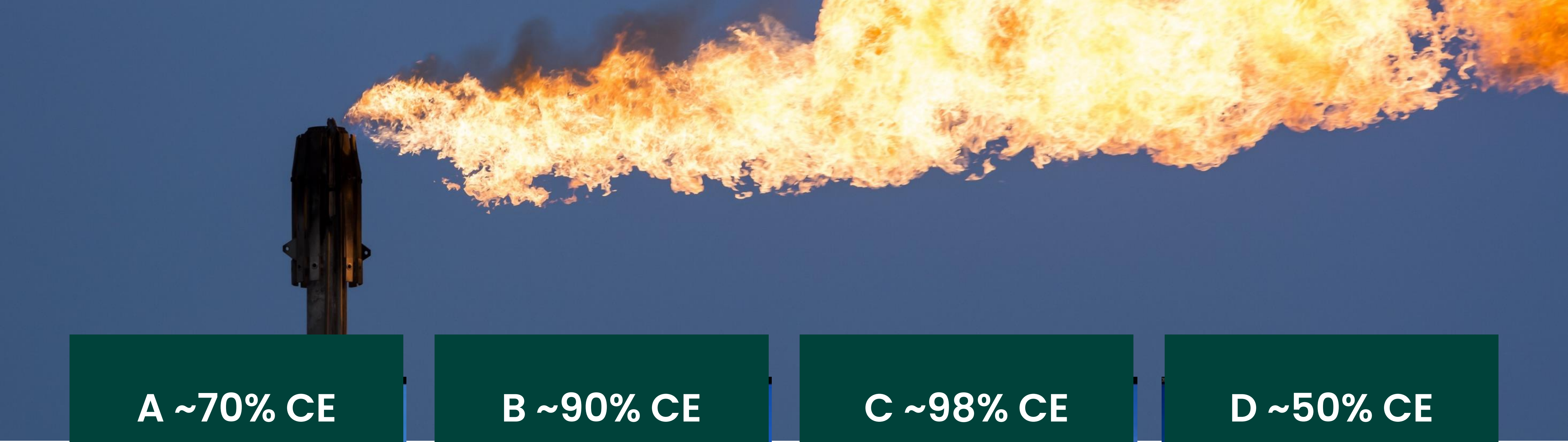
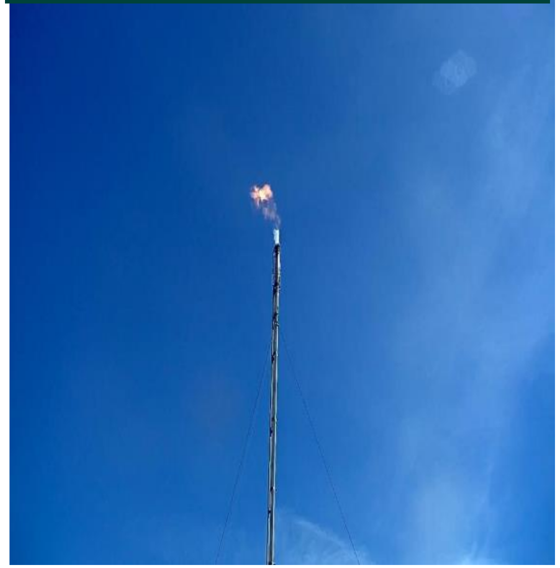


A ~70% CE



B ~90% CE

C ~98% CE

D ~50% CE

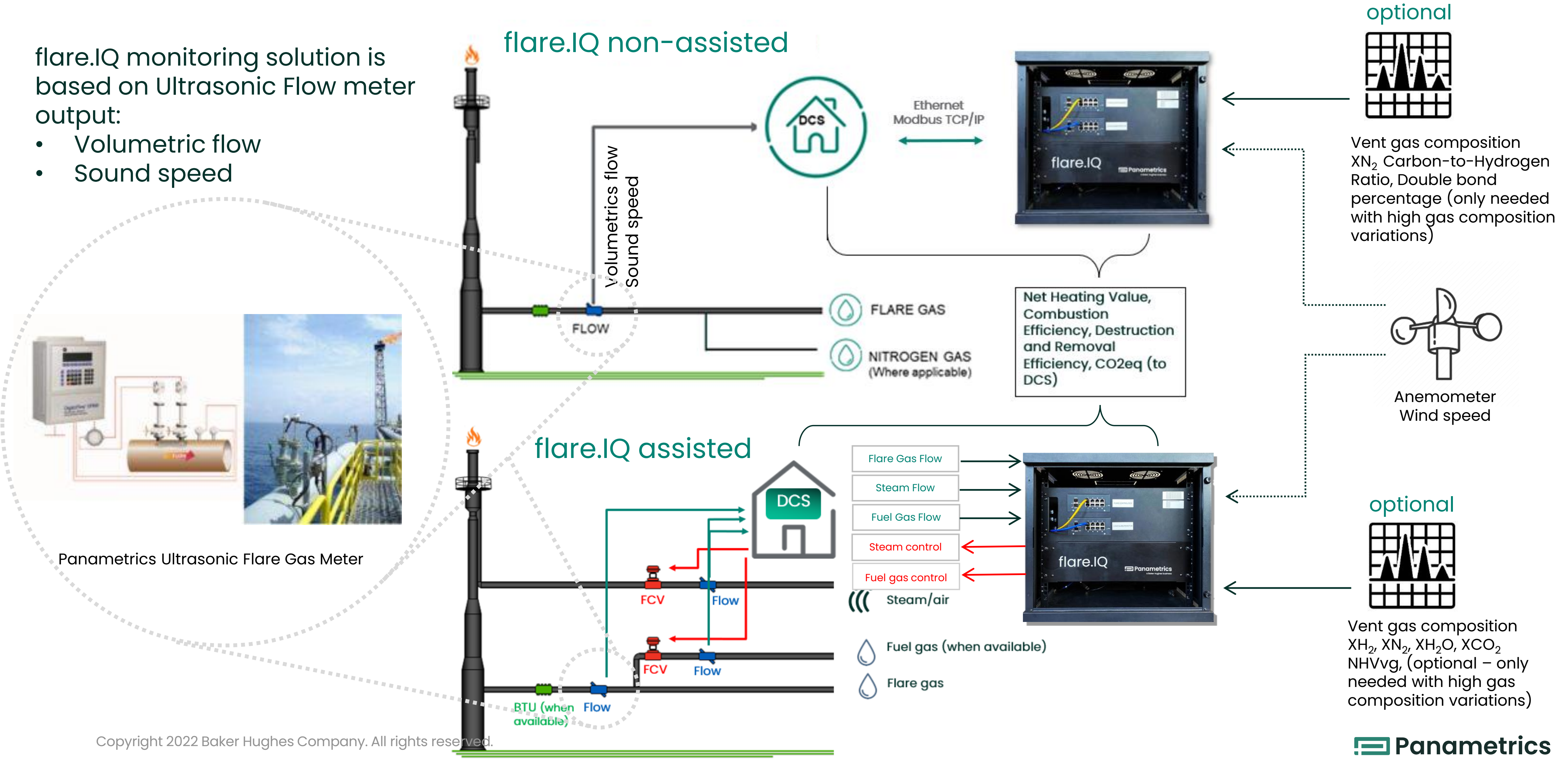
Solution:

flare.IQ optimizes flare operations, reduces emissions and saves costs

flare.IQ - how does it work?

flare.IQ monitoring solution is based on Ultrasonic Flow meter output:

- Volumetric flow
- Sound speed



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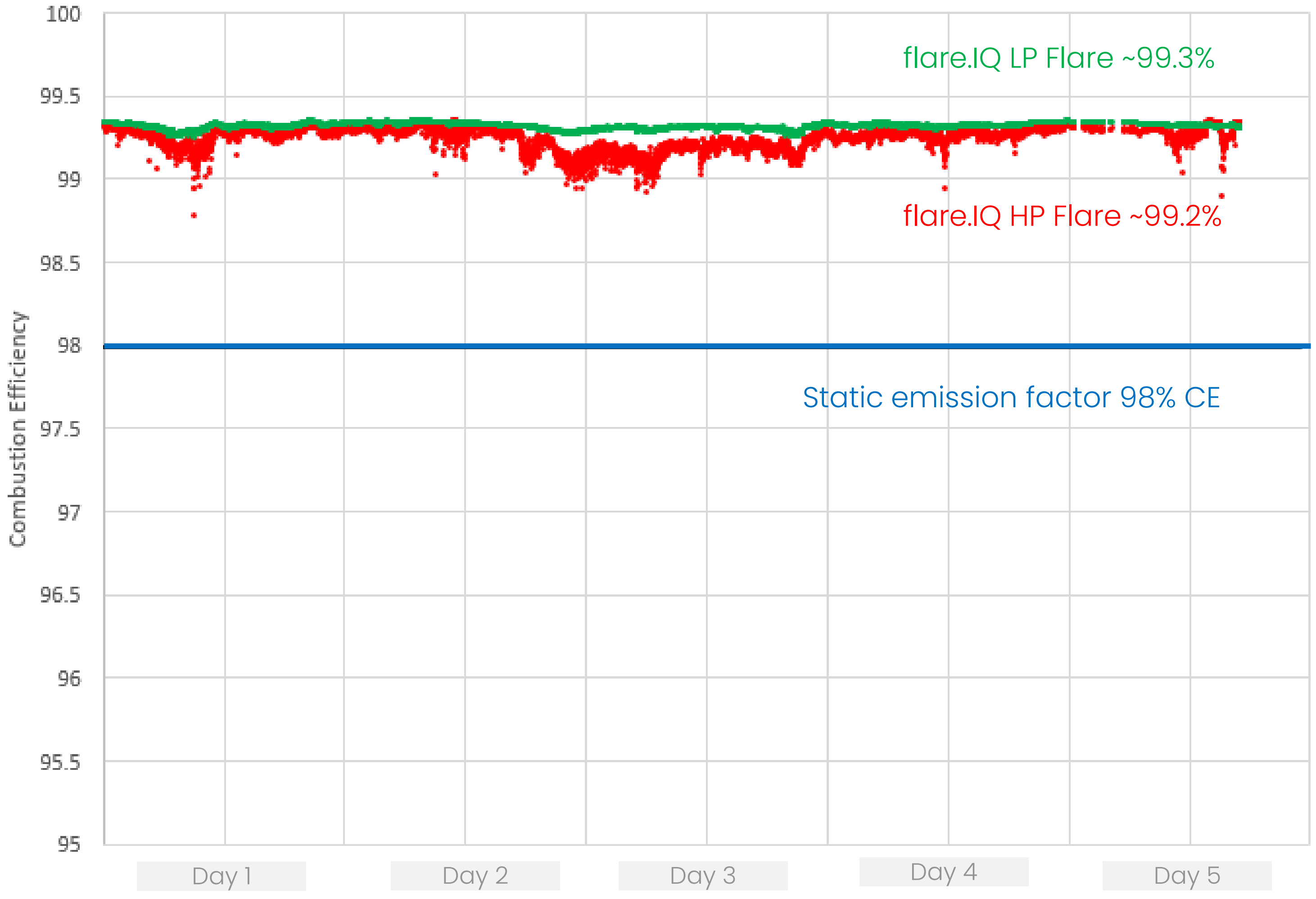
flare.IQ – Unassisted flare(offshore monitoring)



Impact of real time measurement: (vs. static factor)

Combustion Efficiency Difference:

- Static 98.0%
  - 2% Methane slip
- Flare.IQ Real-time 99.3%
  - > 0.7% Methane slip

This is a ~65% reduction on reported methane emissions

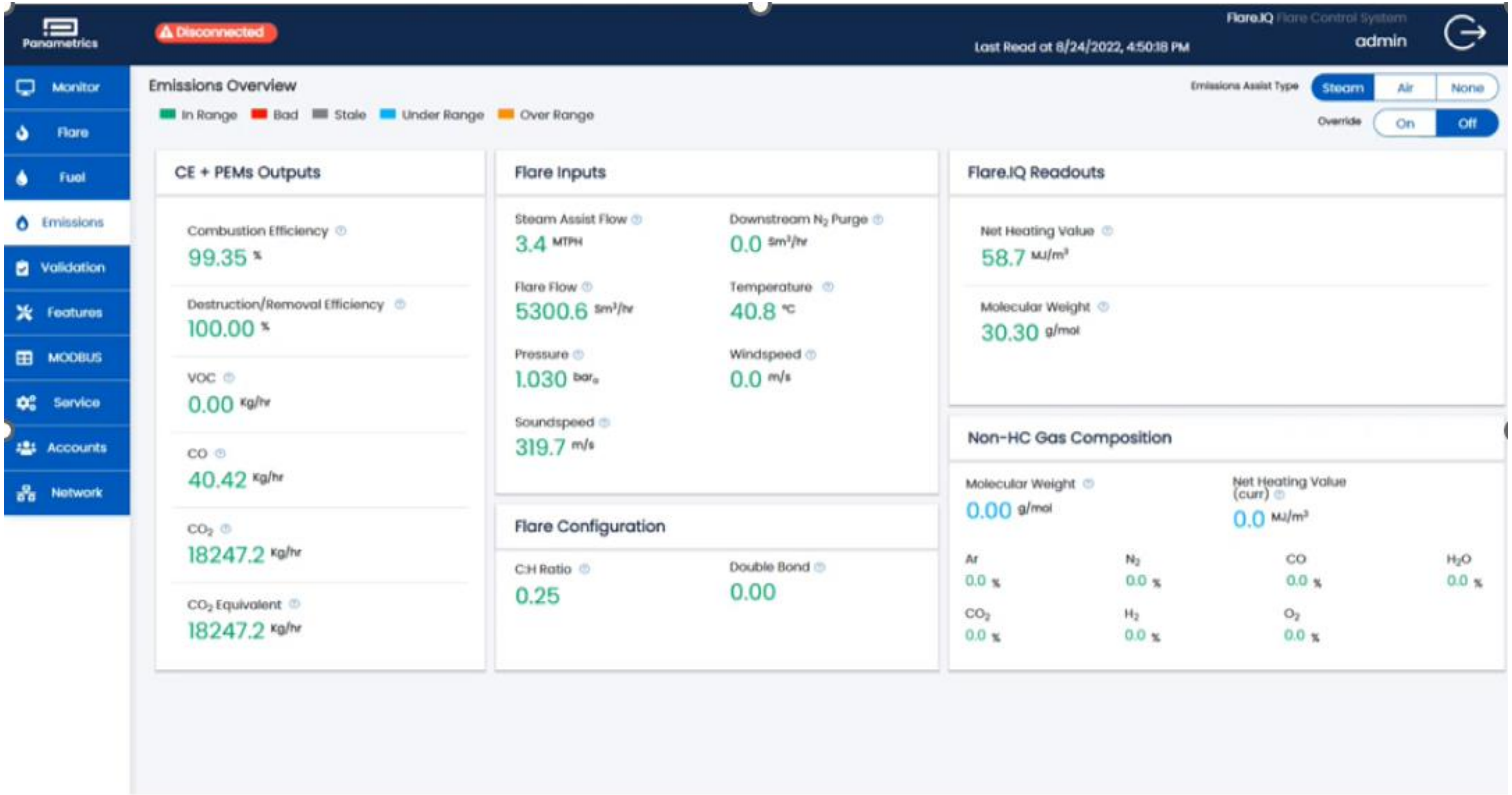
Typical customer benefit :**200k$** savings in taxes per year

flare.IQ – Assisted flare(Control)

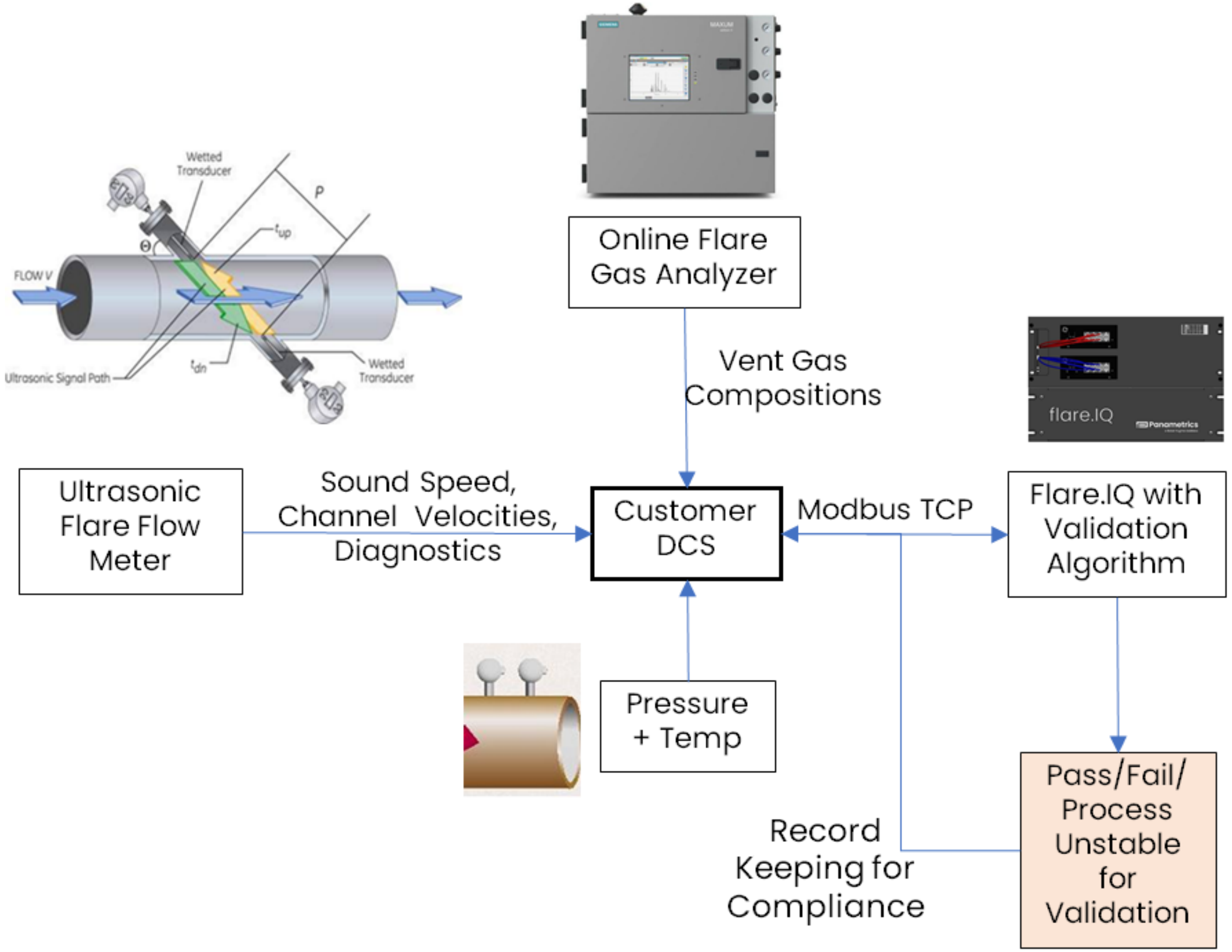
	Refinery 1 (large)	Refinery 2 (small)	Refinery 3 (medium)	
Flare flow	5663	481	453	m3/hr
Steam before f.IQ	3360	1362	917	kg/hr
Steam after f.IQ	354	127	114	kg/hr
Saving %	90	91	87	%
Steam	23	23	23	Euro/mT
Annual steam savings	**605.544**	**248.804**	**161.905**	**Euro**
CE before f.IQ	86%	63%	84%	
CE after f.IQ	~98%	~98%	~98%	
Carbon Credit	80	80	80	Euro/mT
Annual Methane emission savings	26.944	4.474	14.715	mT CO2 eq
Cars removed from the road	5857	972	3198	Cars
Annual Carbon credits	**2.155.520**	**357.920**	**1.177.200**	**Euro**

- Massive steam savings
- Massive CE improvement
- From 600k to 2.7M€ savings per year

flare.IQ – PEMS/CEMS Tool



flare.IQ – Digital Validation



- Fulfills need for **regulatory compliance** of flare meter
- Digital verification to realize **periodic/on-demand** flare meter validation in situ
- Minimize customer down time and **O&M costs**
- No service visit or process interruption to access flow meter

flare.IQ testing

Objective

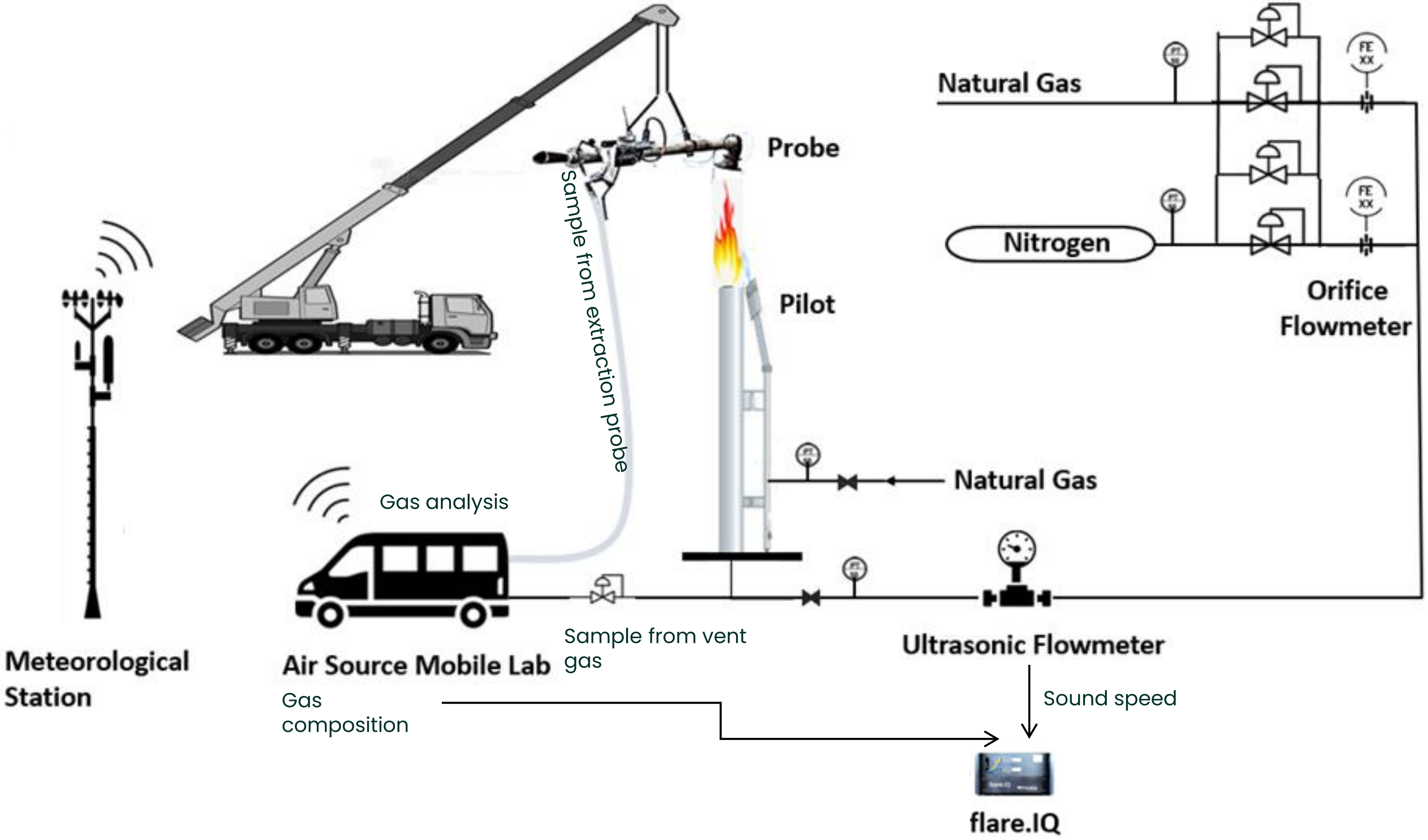
- Verify flare.IQ algorithm of upstream flare CE/DRE calculation with experimental testing carried out at a combustion testing facility

What's done

- Various flare tips and sizes
- Test matrix covering 80 cases
  - high / medium / low BTU
  - high / medium / low flow
- Gas composition:
  - Natural Gas 17% - 100%
  - Nitrogen: 83% - 0%
- Flow Rates: 1050 - 39000 SCFH / 30 – 1100 m3/h
- BTU Content: 200 - 920 BTU/SCF / 7.4 – 34 MJ/m3
- Wind Speed: 0 - 14 MPH / 0 – 24 km/h
- Pilot on/off

flare.IQ testing with extractive sampling in full swing

Flare combustion efficiency test systems



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Scientific support

- Paper about the experimental results of the John Zink facility testing and conclusions + CE and DRE results

  https://www.mdpi.com/2073-4433/15/3/333

- Paper about new method for monitoring flare CE and DRE

  https://www.mdpi.com/2073-4433/15/3/356

- Paper about CFD simulation of CE Upstream

  https://www.mdpi.com/2073-4433/15/7/800

Open Access Article

Full-Size Experimental Measurement of Combustion and Destruction Efficiency in Upstream Flares and the Implications for Control of Methane Emissions from Oil and Gas Production

by Peter Evans [1,*], David Newman [1], Raj Venuturumilli [1], Johan Liekens [1], Jon Lowe [1], Chong Tao [2], Jon Chow [2], Anan Wang [2], Lei Sui [2] and Gerard Bottino [2]

1 bp, Sunbury on Thames, London TW16 7LN, UK
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Atmosphere **2024**, *15*(3), 333; https://doi.org/10.3390/atmos15030333

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(This article belongs to the Section **Air Pollution Control**)

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Open Access Article

Validation of a New Method for Continuous Flare Combustion Efficiency Monitoring

by Chong Tao [1,*], Jon Chow [1], Lei Sui [1], Anan Wang [1], Gerard Bottino [1], Peter Evans [2], David Newman [2], Raj Venuturumilli [2], Jon Lowe [2] and Johan Liekens [2]

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* Author to whom correspondence should be addressed.

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(This article belongs to the Section **Air Pollution Control**)

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Open Access Article

Computational Fluid Dynamics Simulation of Combustion Efficiency for Full-Size Upstream Flare Experiments

by Anan Wang [1,*], Isaac Sadovnik [1], Chong Tao [1], Jon Chow [1], Lei Sui [1], Gerard Bottino [1], Raj Venuturumilli [2], Peter Evans [2], David Newman [2], Jon Lowe [2] and Johan Liekens [2]

1 Baker Hughes, 1100 Technology Park Dr, Billerica, MA 01821, USA
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(This article belongs to the Section **Air Pollution Control**)

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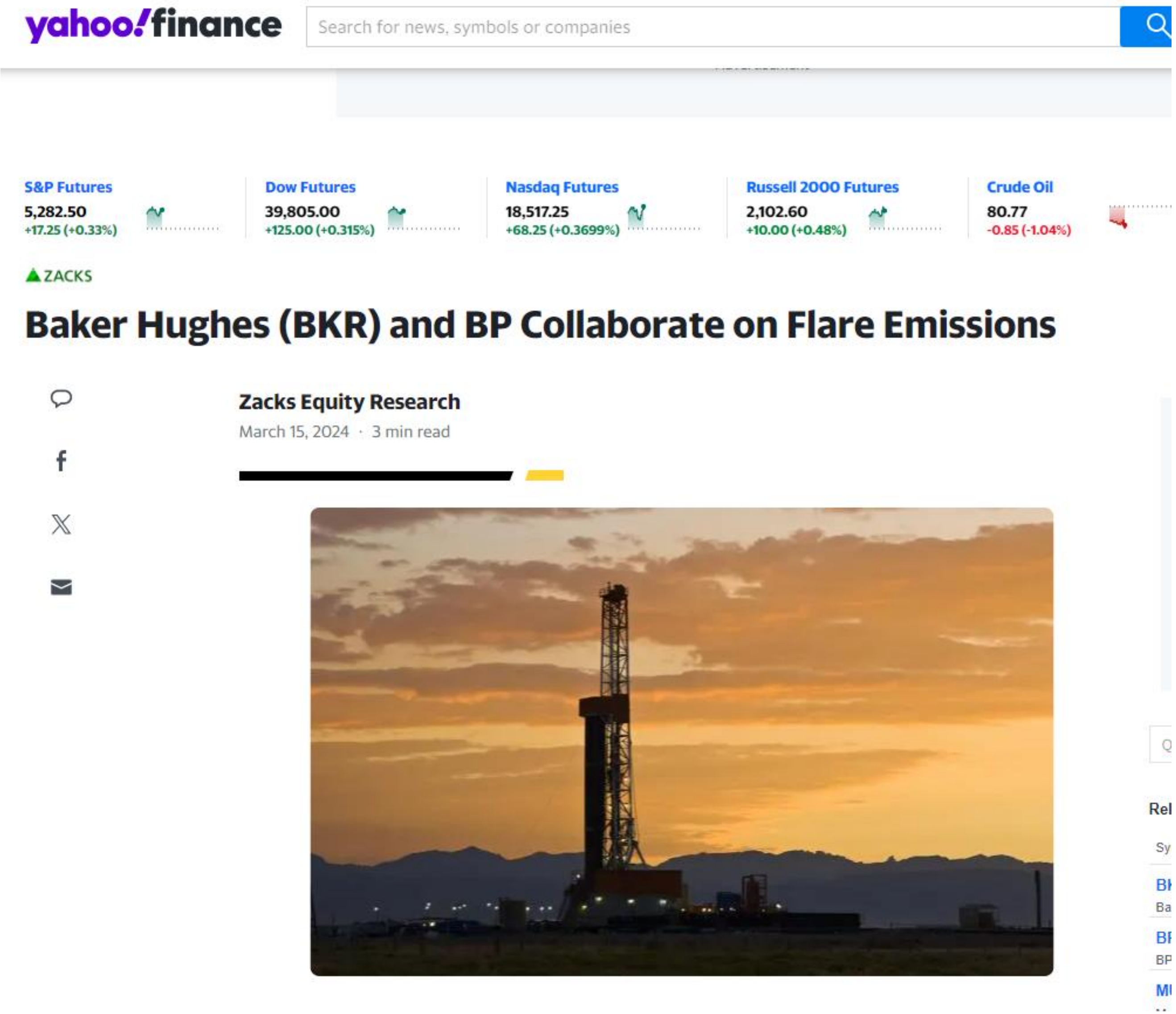
- https://finance.yahoo.com/news/baker-hughes-bkr-bp-collaborate-125400727.html



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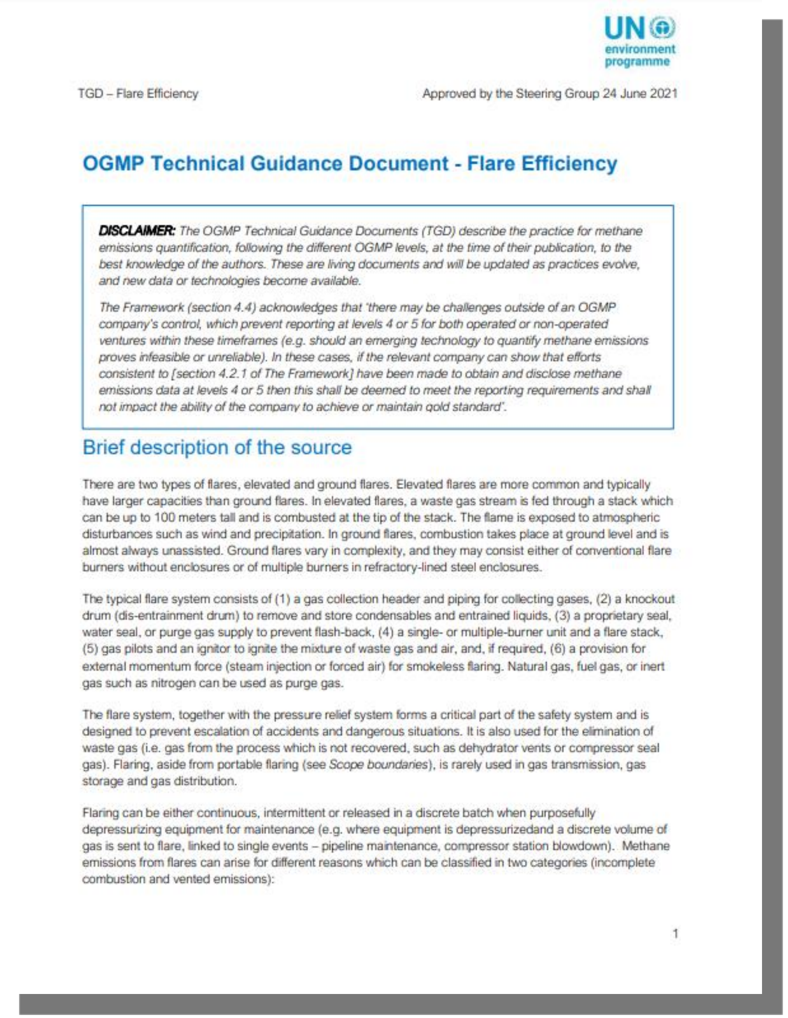
Oil & Gas Methane Partnership 2.0

What is it?

- The Oil & Gas Methane Partnership 2.0 (OGMP 2.0) is a multi-stakeholder initiative launched by UNEP and the Climate and Clean Air Coalition.
- The OGMP 2.0 is the only comprehensive, measurement-based reporting framework for the oil and gas industry that improves the accuracy and transparency of methane emissions reporting in the oil and gas sector.
- Already 80 companies joined the partnership
  - with assets on five continents
  - representing 50% of the world's oil and gas production
  - 20% of global natural gas transmission and distribution pipelines
  - over 10% of global storage capacity
  - 15% of global LNG terminals


UN environment programme

TGD – Flare Efficiency   Approved by the Steering Group 24 June 2021

OGMP Technical Guidance Document - Flare Efficiency

DISCLAIMER: *The OGMP Technical Guidance Documents (TGD) describe the practice for methane emissions quantification, following the different OGMP levels, at the time of their publication, to the best knowledge of the authors. These are living documents and will be updated as practices evolve, and new data or technologies become available.*

The Framework (section 4.4) acknowledges that 'there may be challenges outside of an OGMP company's control, which prevent reporting at levels 4 or 5 for both operated or non-operated ventures within these timeframes (e.g. should an emerging technology to quantify methane emissions proves infeasible or unreliable). In these cases, if the relevant company can show that efforts consistent to [section 4.2.1 of The Framework] have been made to obtain and disclose methane emissions data at levels 4 or 5 then this shall be deemed to meet the reporting requirements and shall not impact the ability of the company to achieve or maintain gold standard'.

Brief description of the source

There are two types of flares, elevated and ground flares. Elevated flares are more common and typically have larger capacities than ground flares. In elevated flares, a waste gas stream is fed through a stack which can be up to 100 meters tall and is combusted at the tip of the stack. The flame is exposed to atmospheric disturbances such as wind and precipitation. In ground flares, combustion takes place at ground level and is almost always unassisted. Ground flares vary in complexity, and they may consist either of conventional flare burners without enclosures or of multiple burners in refractory-lined steel enclosures.

The typical flare system consists of (1) a gas collection header and piping for collecting gases, (2) a knockout drum (dis-entrainment drum) to remove and store condensables and entrained liquids, (3) a proprietary seal, water seal, or purge gas supply to prevent flash-back, (4) a single- or multiple-burner unit and a flare stack, (5) gas pilots and an ignitor to ignite the mixture of waste gas and air, and, if required, (6) a provision for external momentum force (steam injection or forced air) for smokeless flaring. Natural gas, fuel gas, or inert gas such as nitrogen can be used as purge gas.

The flare system, together with the pressure relief system forms a critical part of the safety system and is designed to prevent escalation of accidents and dangerous situations. It is also used for the elimination of waste gas (i.e. gas from the process which is not recovered, such as dehydrator vents or compressor seal gas). Flaring, aside from portable flaring (see *Scope boundaries*), is rarely used in gas transmission, gas storage and gas distribution.

Flaring can be either continuous, intermittent or released in a discrete batch when purposefully depressurizing equipment for maintenance (e.g. where equipment is depressurizedand a discrete volume of gas is sent to flare, linked to single events – pipeline maintenance, compressor station blowdown). Methane emissions from flares can arise for different reasons which can be classified in two categories (incomplete combustion and vented emissions):

1

flare.IQ and OGMP 2.0 level 4 compliance

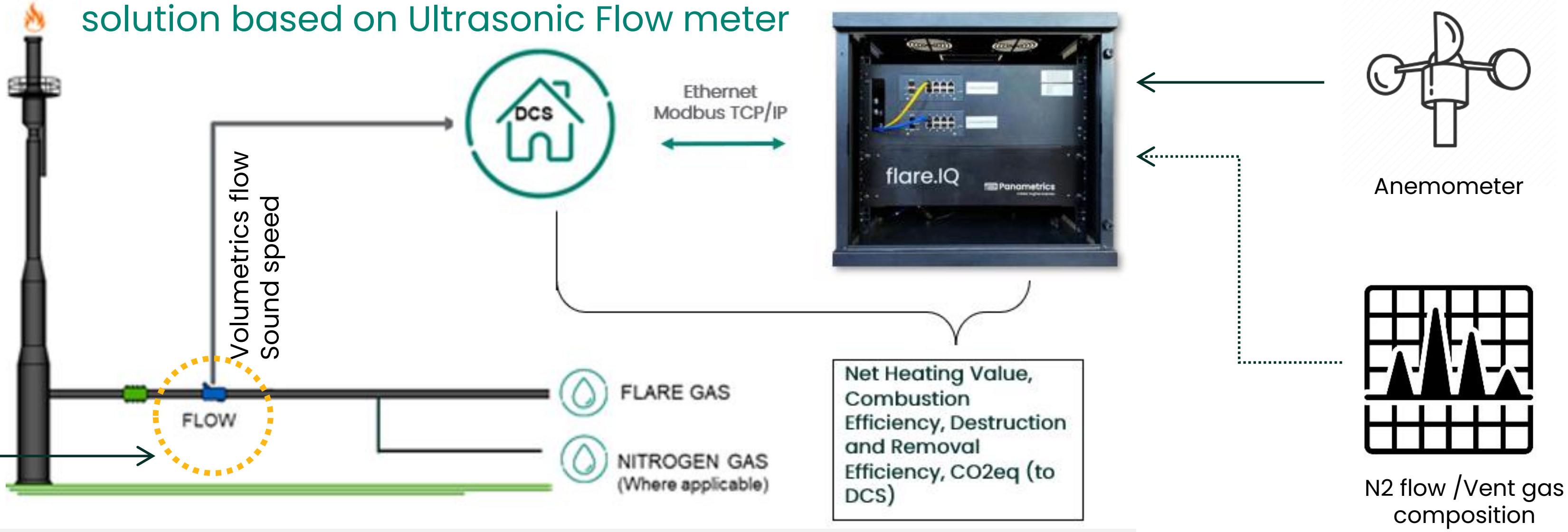
OGMP 2.0 statement:
Process simulation models based on representative flare systems and operating/environmental conditions, validated by direct measurements and engineering calculations based on studies relevant to the flare condition can also be used to determine the destruction efficiency of the flare.

=

Flare.IQ statement
Flare.IQ implements in situ flare combustion efficiency (CE) and destruction and removal efficiency (DRE) monitoring based on a parametric model derived from flare CE experimental data and computational fluid dynamics calculations. This method can be deployed on upstream flares to achieve maintenance-free, real-time monitoring of CE/DRE based on process and environmental conditions from ultrasonic flow meter and wind speed measurement.

Flare.IQ real time CE & DRE monitoring solution based on Ultrasonic Flow meter

Panametrics Ultrasonic Flare Gas Meter



CE / DRE = f(NHV, flare flow, tip diameter, exit velocity, wind speed, gas composition)

Realtime flare emission monitoring technology - conclusions

1 24 / 7 quantification

Replace static emissions factors with real-time CE / DRE measurement

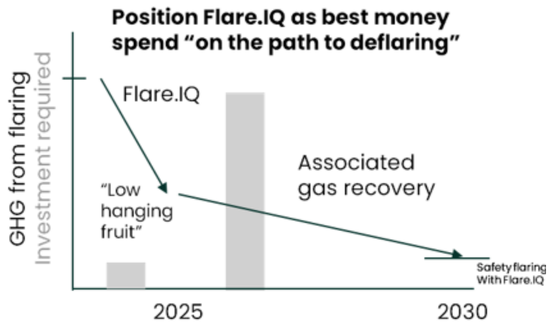
2 Techn. Fit for purpose

Ultrasonic flow measurement technology for flares is best in class, on which flare.IQ has been built

3 In situ

CE / DRE measurement is not dependent on weather conditions such as mist, clouds and rain

4 Abatement solution



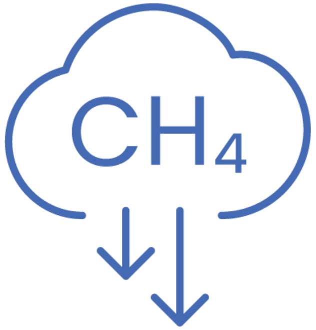
‘Low hanging fruit’: best money spent ‘on the path to de-flaring’

5 OGMP 2.0 level 4

OGMP Oil And Gas Methane Partnership 2.0

OGMP 2.0 level 4 Compliance to methane emission reduction guidelines for CE / DRE monitoring and reporting

6 Emission reduction



Realtime measurement enables improving & controlling processes better, which may result in significant emission reductions

7 Easy to deploy

Making use of existing Ultrasonic Flare meter installed base - ease of installation

8 Field proven and independently tested

Installed at various sites and tested for comparison

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Methane Regulation

José Domínguez

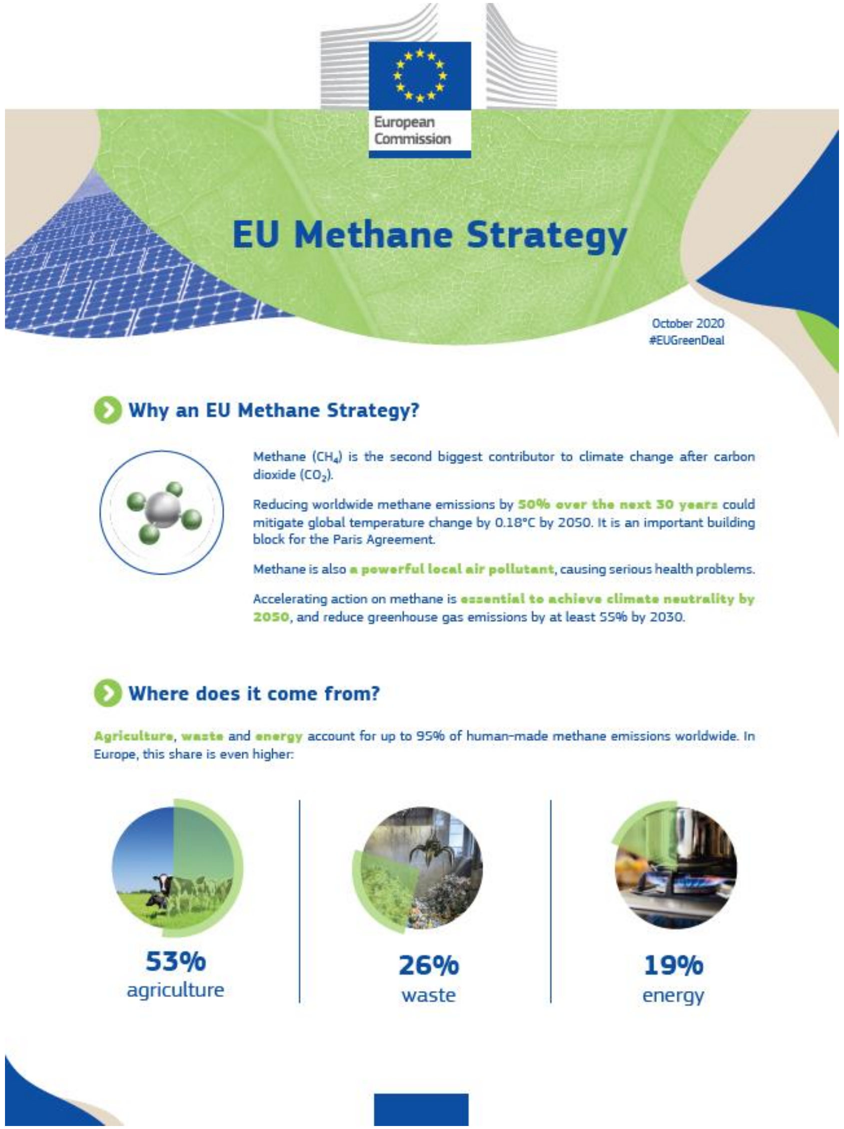
Agenda

Regulatory Framework in the EU

- The Precedents
- Regulatory Overview
- Up/Midstream
- Downstream
- Summary

The precedents

- **Regulation 2018/1999 : Governance of the Energy Union and Climate Action**
  - "Member States to establish national inventory systems to estimate anthropogenic emissions of greenhouse gases and to report those national projections" Uses IPCC guidelines and default emission factors, uncertainty about origin,frequency and magnitude of emissions.
- **Directive 2010/75/EU: Industrial Emissions Directive (under revision) → Applicable to refineries**
- Member States commit to control and reduce the impact of industrial emissions on the environment. Based on a "polluter pays" principle, supported by the BATS . Focus on NOx, CH4,CO2, etc.
- **(EC)166/2006 E-PRTR: European Polutant Release and Transfer Register**
- The PRTR regulation requires that each facility reports quantity of pollutants they released to air/water or transferred to another facility. (Including CH4 if emissions above 100,000 kg/year)
- **Regulation EU 2018/842: Effort Sharing Regulation**
  - Contains binding anual greenhouse gas emissions targets at country level for Member States from 2021 to 2030, includes CH4



Regulatory Overview(Europe)

- **Downstream**
  - Industrial Emissions Directive (Under revision ,ready in 2-3 years)
  - E-PRTR
  - Report above 100.000kg of CH_4
  - Report above 100.000.000kg of CO_2
  - “polluter pays principle”
  - Emissions into air / water / soil
  - Dust, SOx ,NOx…
  - BATS (Best Available Techniques)
  - Emissions Trading Scheme

- **Upstream + Midstream**
  - 2024/1787 approved June 2024
  - Upstream production and exploration
  - Transmission, distribution, LNG…
  - Penalties for flaring
  - Combustion efficiency systems required

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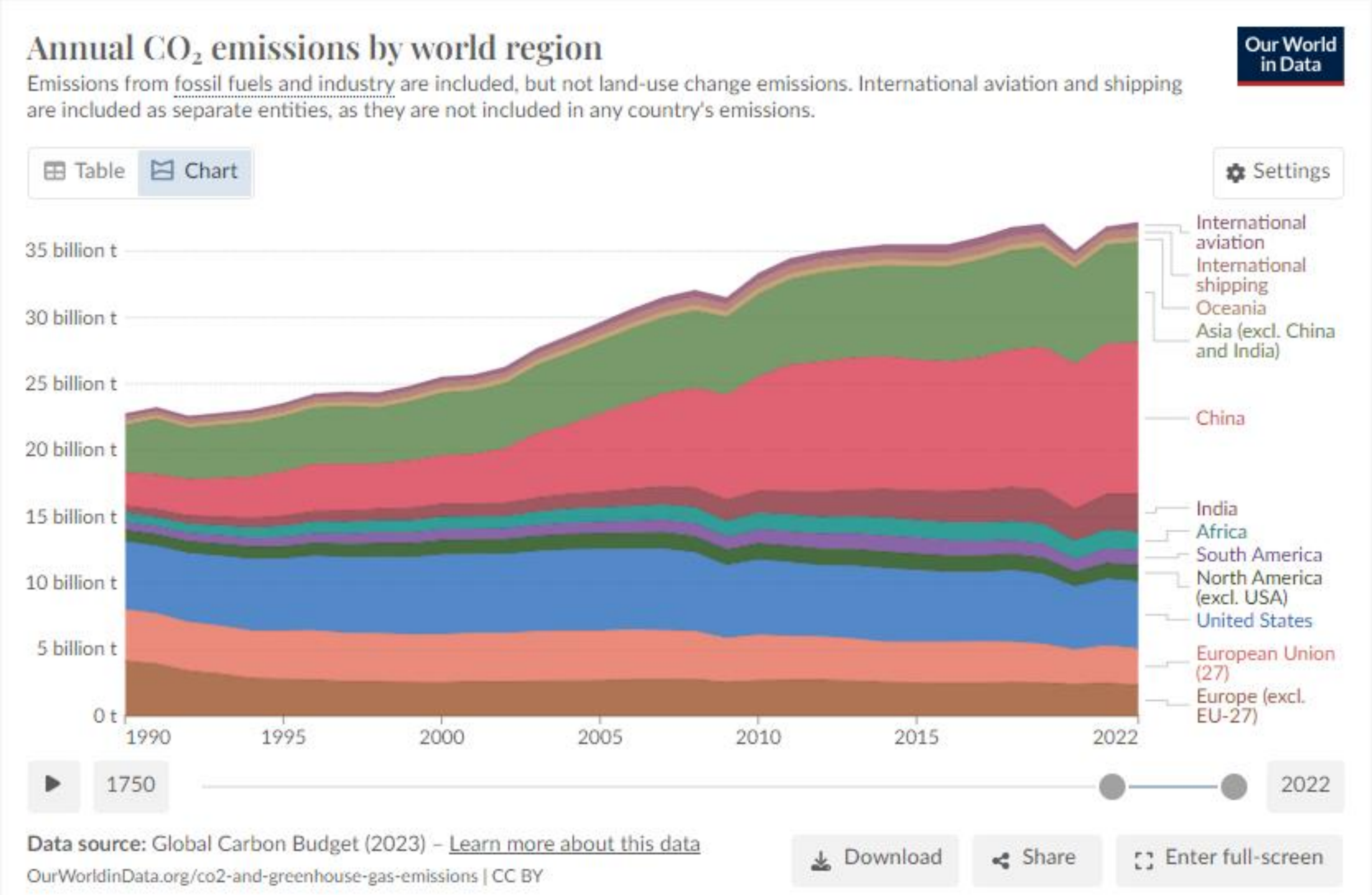
1990-2022



- EU(27) : 3,87 to 2,76
- USA: 5,12 to 5,06
- China: 2,48 to 11,40
- India: 0,57 to 2,83
- Africa: 0,66 to 1,42
- Rest of Asia: 3,55 to 7,55

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Up/Midstream

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2024/1787 Strategy

What will the EU do about it?

The EU will **lead the way globally to address methane emission reductions** in all relevant sectors and with all partner countries.

MORE ACCURATE MEASUREMENT AND REPORTING

- Proposing **EU legislation** on **compulsory measurement**, **reporting**, and **verification** for all energy-related methane emissions.
- **Improved measurement and reporting of methane emissions by companies**, including through sector-specific initiatives.
- **Satellite-based detection** of super-emitters through the EU's Copernicus programme.
- Support the creation of an **international methane emissions observatory** with the UN, including a methane supply index for international transparency.

MORE EFFECTIVE MITIGATION MEASURES

- Providing targeted support to accelerate the development of **the market for biogas** from sustainable sources, including pilot projects for rural and farming communities.
- Promotion of best practices and technologies, feed and breeding changes, and carbon farming to **reduce agricultural emissions**.
- An obligation to **improve leak detection and repair (LDAR) of leaks** on all fossil gas infrastructure, production, transport and use.
- Possible future **legislation on venting, flaring and standards** covering the full supply chain, and support to the World Bank 'Zero Flaring' initiative.
- **A review** of the Landfill Directive, Urban Waste Water Treatment Directive and Sewage Sludge Directive.

Print ISBN 978-92-76-23028-1 doi:10.2833/962224 MJ-03-20-627-EN-C
PDF ISBN 978-92-76-23027-4 doi:10.2833/76951 MJ-03-20-627-EN-N

- **Policy Area 1**
  - "Improve the accuracy of measuring and reporting of methane emissions in the energy sector"
  - Preferred option:
    - "Impose detailed measuring and reporting obligation on methane emissions from oil, gas and coal in the EU energy sector"
- **Policy Area 2**
  - "Options for the mitigation of methane emissions in the EU"
  - Preferred option:
    - "Impose obligations to mitigate methane emissions from oil, gas and coal in the EU energy sector /…/ and to ban venting and flaring"
- **Policy Area 3**
  - "Reducing methane emissions related to imported fossil energy or EU fossil fuel consumption ocurring outside the EU" Carbon Border Adjustment Mechanism(CBAM)
  - Preferred option:
    - Improve the information on methane emission sources from companies exporting fossil energy to the EU and incentives to reduce methane emissions

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Regulation Highlights(Upstream)

- Article 1:
  - Applies to oil and fossil gas exploration production/fossil gas gathering and processing
- Article 12:
  - Source level quantification of methane emissions, measured whenever feasible
- Article 15:
  - Venting/flaring prohibited unless for emergency reasons
- Article 23:
  - Report all flaring/venting events with DRE<99%
- Article 33:
  - Dissuasive penalties set by Member states

Source:

https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32024R1787

(43) Using flaring as an alternative to venting requires that flaring devices are efficient at combusting methane. For that reason, a combustion efficiency requirement should also be included for the cases in which flaring is allowed.

Global efforts in similar direction

- EU Methane Strategy
- Global Gas Flaring Reduction initiative World Bank
- Methane Guiding Principles
- OGMP 2.0 level 4 compliance

Fines are real (Chevron example, USA)

BAY AREA AIR QUALITY MANAGEMENT DISTRICT

A HEALTHY BREATHING ENVIRONMENT FOR EVERY BAY AREA RESIDENT

popular searches: Refinery Rules, Climate, Asbestos

Public Data Center | Air Monitoring Data

ABOUT AIR QUALITY | RULES & COMPLIANCE | PERMITS | COMMUNITY HEALTH | PLANS & CLIMATE | FUNDING

Air District secures decisive victory: Chevron & MRC refineries drop lawsuits: Chevron to pay highest violation penalties in agency history

Air District / News & Events / Air District secures decisive victory: Chevron & MRC refineries drop lawsuits: Chevron to pay highest violation penalties in agency history

Date

Tuesday, February 13, 2024

The Air District announced today it has reached two separate agreements with Chevron and Martinez Refining Company resulting in an end to the litigation against the agency over its groundbreaking Regulation 6, Rule 5, major emissions reductions from both refineries, unprecedented penalties and other payments of up to $138 million, and a Richmond-area Community Air Quality Fund, among other benefits. The Air District estimates that the emission reductions achieved by the rule will result in tens of millions of dollars per year in health benefits by reducing early deaths and other health impacts of exposure to particulate matter.

- https://www.baaqmd.gov/news-and-events/page-resources/2024-news/021324-announcement

Chevron Agreement Highlights:

- Chevron drops its lawsuit and agrees to reduce PM emissions as required in the rule.
- Chevron pays unprecedented penalties for any delay in compliance past the regulation's July 2026 compliance deadline. Chevron has committed to compliance with Rule 6-5 pollution limits, with escalating, record-setting penalties for non-compliance:
  - $17M for year 1
  - $17M for year 2
  - $17M for year 3
  - $32M for year 4
- Chevron implements interim PM emission reductions at the FCCU to obtain early reductions even before the regulation's compliance deadline.
- Chevron pays into the Community Air Quality Fund, initiated with $20 million and supplemented annually by $3.5 million during the period needed for Chevron to construct air pollution controls. The fund will finance projects aimed at reducing PM exposures in the communities impacted by the refinery.
- Chevron pays a $20 million fine for 678 other violations at the refinery unrelated to Reg. 6-5 and commits to a series of measures designed to reduce persistent flaring.
- Chevron pays half the Air District's attorney fees, up to $500,000.

MRC Agreement Highlights:

Downstream

What about Downstream?

- Industrial Emissions Directive under revision at the moment.
  - Revision Started in December 2023
  - Preliminary text aligned with:
    - Global Methane Pledge
    - Fit for 55 Package

(29a) ***The Commission should review the need to control emissions from onshore and offshore exploration and production of mineral oil and gas and the need to revise the activity threshold in Annex I for the production of hydrogen by electrolysis of water […] The review shall take into account the existing EU legislative framework, including the Regulation on methane emissions reduction in the energy sector [OJ: insert reference to the methane regulation] and Directive 2013/30/EU of the European Parliament and of the Council of 12 June 2013 on safety of offshore oil and gas operations.***

Source:

https://data.consilium.europa.eu/doc/document/ST-16939-2023-INIT/en/pdf

BRIEFING

EU Legislation in Progress

European Parliament

Review of the EU ETS

'Fit for 55' package

OVERVIEW

As part of the 'Fit for 55' package, the European Commission presented a legislative proposal to review the EU Emissions Trading System (ETS). The aim of the review is to align the EU ETS Directive with the EU targets set out in the European Climate Law. To this end, the amount of emission allowances would be reduced, fewer allowances would be allocated for free, and the ETS would be extended to maritime transport. A separate new emissions trading system would be established for fuel distribution for road transport and buildings.

In the European Parliament, the proposal was referred to the Committee on Environment, Public Health and Food Safety (ENVI), with Peter Liese (EPP, Germany) as rapporteur. The Parliament and the Council adopted their respective positions in June 2022 and reached a provisional trilogue agreement in December 2022. The file was subsequently split into two parts, with the monitoring, reporting and verification of maritime GHG emissions treated separately. The legal acts were published in the Official Journal on 16 May 2023 and enter into force on 5 June 2023.

Proposal for a directive amending Directive 2003/87/EC establishing a system for greenhouse gas emission allowance trading within the Union, Decision (EU) 2015/1814 concerning the establishment and operation of a market stability reserve for the Union greenhouse gas emission trading scheme and Regulation (EU) 2015/757

Committee responsible:	Environment, Public Health and Food Safety (ENVI)	COM(2021) 551
Rapporteur:	Peter Liese (EPP, Germany)	14.7.2021
Shadow rapporteurs:	Mohammed Chahim (S&D, the Netherlands) Emma Wiesner (Renew, Sweden) Michael Bloss (Greens/EFA, Germany) Alexandr Vondra (ECR, Czechia) Danilo Oscar Lancini (ID, Italy) Silvia Modig (The Left, Finland)	2021/0211A(COD) 2021/0211B(COD) Ordinary legislative procedure (COD) (Parliament and Council on equal footing – formerly 'co-decision')
Procedures completed.	Directive (EU) 2023/959 Regulation (EU) 2023/957 OJ L 130, 16.5.2023, pp. 105–114; 134–202	

Source:

https://www.europarl.europa.eu/RegData/etudes/BRIE/2022/698890/EPRS_BRI(2022)698890_EN.pdf

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Downstream Key Regulations

▶B REGULATION (EC) No 166/2006 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL

of 18 January 2006

concerning the establishment of a European Pollutant Release and Transfer Register and amending Council Directives 91/689/EEC and 96/61/EC

(Text with EEA relevance)

(OJ L 33, 4.2.2006, p. 1)

→

Report above 100.000 kg/year CH_4
Report above 100.000.000 kg/year CO_2
Tracked publicly in industry.eea.europa.eu

DECISIONS

COMMISSION IMPLEMENTING DECISION

of 9 October 2014

establishing best available techniques (BAT) conclusions, under Directive 2010/75/EU of the European Parliament and of the Council on industrial emissions, for the refining of mineral oil and gas

(notified under document C(2014) 7155)

(Text with EEA relevance)

(2014/738/EU)

→

1.20.7. *Other techniques*

Techniques to prevent or reduce emissions from flaring	**Correct plant design**: includes sufficient flare gas recovery system capacity, the use of high-integrity relief valves and other measures to use flaring only as a safety system for other than normal operations (start-up, shutdown, emergency). **Plant management**: includes organisational and control measures to reduce flaring events by balancing RFG system, using advanced process control, etc. **Flaring devices design**: includes height, pressure, assistance by steam, air or gas, type of flare tips, etc. It aims at enabling smokeless and reliable operations and ensuring an efficient combustion of excess gases when flaring from non-routine operations. **Monitoring and reporting**: Continuous monitoring (measurements of gas flow and estimations of other parameters) of gas sent to flaring and associated parameters of combustion (e.g. flow gas mixture and heat content, ratio of assistance, velocity, purge gas flow rate, pollutant emissions). Reporting of flaring events makes it possible to use flaring ratio as a requirement included in the EMS and to prevent future events.Visual remote monitoring of the flare can also be carried out by using colour TV monitors during flare events

Summary

- **Upstream**
  - New regulation in place
  - CE/DRE required by law
  - Affects:
    - Upstream
    - LNG
    - Transmission/Distribution
  - Alignment with
    - EU Methane Initiative
    - OGMP 2.0 level4
    - Flaring Reduction World Bank

- **Downstream**

https://industry.eea.europa.eu/

  - 100,000 kg/year for CH_4
  - 100,000,000 kg/year for CO_2
  - Use BATS for now.
  - Industrial Emissions Directive under revision(Ready 2026?)

Panametrics

a Baker Hughes business