Technology Leadership Board – Accelerate Deployment Workstream

Aim – Accelerate Deployment seeks to speed up the use of proven technologies that offer a value proposition for offshore energy, initially targeting those which have had support from the NZTC (**Focus Area 1**), then reaching out to the wider oil and gas supply chain and innovations already deployed in other industries (**Focus Area 2**).

Technology Promotion – Promote these technologies through TLB members' influence, Technology Managers' Network meetings and TLB website publications e.g. today's session, where we have invited 4 technologies that were selected from the Energy Transition Zone pitch session on the 12th January, along with two others.

Future topics-1 – seek out and share Operating companies challenges and new technology deployments, including how they have adapted their internal processes and standards to enable success

Future topics-2 – explore promotion of Non Intrusive Inspection technologies as part of a wider push to accelerate their development and uptake across the industry.

Future topics-3 – ……happy to take ideas from this forum

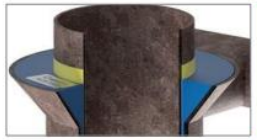
Accelerate Deployment

Accelerate Deployment Workstream – Focus Area 1

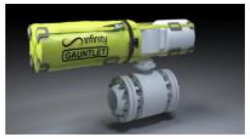
The TLB in partnership with the Net Zero Technology Centre (NZTC) reviewed 50+ portfolio technologies as an initial phase.

Screening drove selection of 6 technologies for promotion based on a criteria including: TRL 7/8, trial success, value potential, etc.

The Technology Companies prepared case studies, for publication and presentation at the Technology Managers' Network [PowerPoint Presentation (the-tlb.com)]



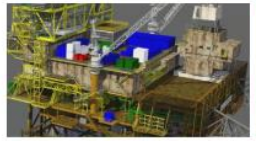
AquaShim
Aquaterra



Infinity Gauntlet
Infinity

Offshore Methane Emissions Measurement
Flylogix

Digital Worker Platform
Kite



Laser Scanning Digital Twin
GDi

Focused Stress Concentration Tomography
Oceaneering & Speir Hunter

Accelerate Deployment Workstream – Focus Area 2

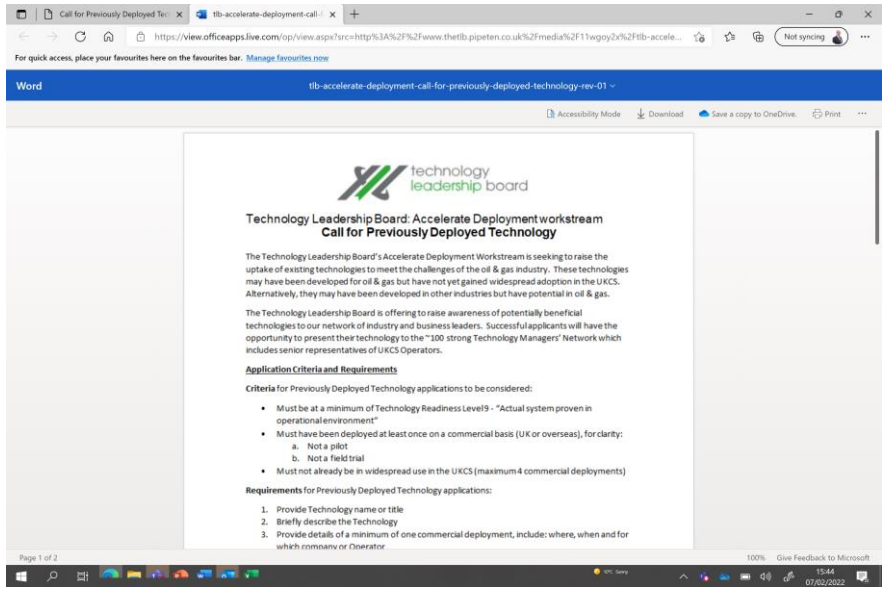
The Technology Leadership Board: Home (the-tlb.com)
Temporary site: www.thetlb.pipeten.co.uk/ http://www.thetlb.pipeten.co.uk/workstreams/workstreams/accelerate-deployment/call-for-previously-deployed-technology/

We would like to hear about technologies which have been successfully deployed, not necessarily in our sector, that offer track record or value proposition ideally suited toward Offshore Energy.

The Technology Leadership Board is offering to raise awareness of potentially beneficial technologies to our network of industry and business leaders. Successful applicants will have the opportunity to present their technology to the ~100 strong Technology Managers' Network which includes senior representatives of UKCS Operators.

- **Call open now, closes noon 28th February 2022.**
- **Applicant screening and selection in March 2022.**
- **Presentations to TMN Meetings Q2/3 2022**

Apply here



Technology Leadership Board: Accelerate Deployment workstream
Call for Previously Deployed Technology

The Technology Leadership Board's Accelerate Deployment Workstream is seeking to raise the uptake of existing technologies to meet the challenges of the oil & gas industry. These technologies may have been developed for oil & gas but have not yet gained widespread adoption in the UKCS. Alternatively, they may have been developed in other industries but have potential in oil & gas.

The Technology Leadership Board is offering to raise awareness of potentially beneficial technologies to our network of industry and business leaders. Successful applicants will have the opportunity to present their technology to the ~100 strong Technology Managers' Network which includes senior representatives of UKCS Operators.

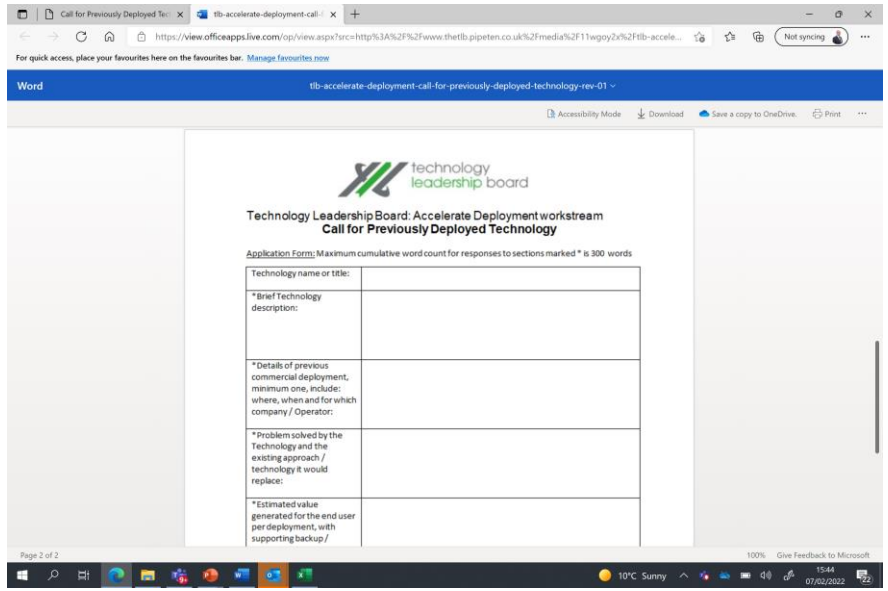
Application Criteria and Requirements

Criteria for Previously Deployed Technology applications to be considered:

- Must be at a minimum of Technology Readiness Level 9 - "Actual system proven in operational environment"
- Must have been deployed at least once on a commercial basis (UK or overseas), for clarity:
  a. Not a pilot
  b. Not a field trial
- Must not already be in widespread use in the UKCS (maximum 4 commercial deployments)

Requirements for Previously Deployed Technology applications:

1. Provide Technology name or title
2. Briefly describe the Technology
3. Provide details of a minimum of one commercial deployment, include: where, when and for which company or Operator



Technology Leadership Board: Accelerate Deployment workstream
Call for Previously Deployed Technology

Application Form: Maximum cumulative word count for responses to sections marked * is 300 words

Technology name or title:	
*Brief Technology description:	
*Details of previous commercial deployment, minimum one, include: where, when and for which company / Operator:	
*Problem solved by the Technology and the existing approach / technology it would replace:	
*Estimated value generated for the end user per deployment, with supporting backup /	

Accelerate Deployment

technology leadership board

Accelerate Deployment

Accelerate Deployment Workstream – Technology Promotion

Continue to promote technologies through Technology Managers Network forums and material, e.g.

Today we have invited 4 technologies that were selected from the Energy Transition Zone pitch session on the 12th January to present along with two others.

Future topics-1 – seek out and share Operating companies challenges and new technology deployments, including how they have adapted their internal processes and standards to enable success

Future topics-2 – explore promotion of Non Intrusive Inspection technologies as part of a wider push to accelerate their development and uptake across the industry.

Request for Operators to nominate themselves to present at future forums on either topic 1 or topic 2.

Future topics-3 – …… ***any ideas from this forum?***

Oil & Gas Authority

Flaring & Venting – OGA's view

Technologies for Flaring & Venting Monitoring and Reduction - Webinar

Douglas Griffin
Head of Measurement, OGA UK

15 February 2022

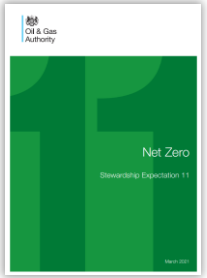
Context

Oil & Gas Authority

- OGA established 2015, with strong emphasis on ‘Maximising Economic Recovery’ – the ‘OGA Strategy’.
- New OGA Strategy came into force February 2021. Net Zero obligations are now part of the ‘Central Obligation’ on Operators.

> “Economic recovery of oil and gas need not be in conflict with the transition to net zero, and the oil and gas industry has the skills, technology and capital to help unlock solutions required to help the UK achieve the net zero target.
> However, the OGA takes the view that industry should go considerably faster and farther in reducing its own carbon footprint, or risk losing its social licence to operate.”

- Stewardship Expectation 11.



Stewardship Expectation 11

Oil & Gas Authority

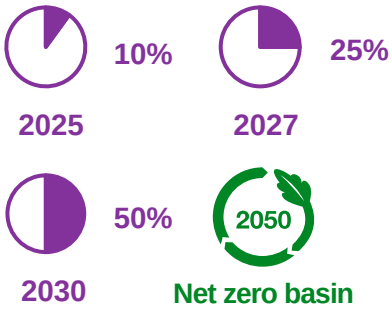
Active flare reduction strategy:

- Flare measurement including tracking of ‘unlit’ periods & composition analysis
- Monitoring of flare combustion efficiency

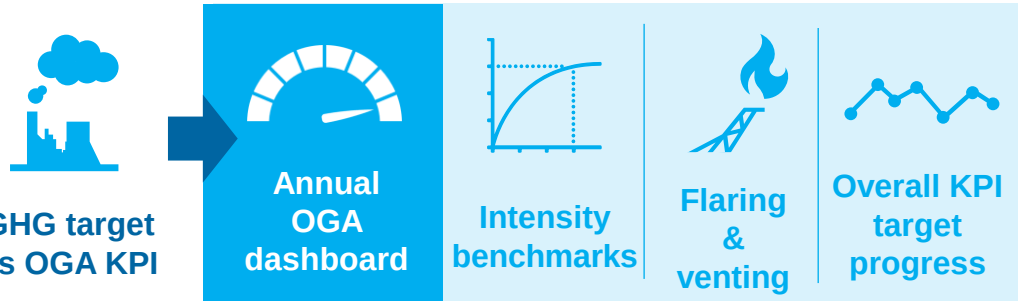
Active vent reduction strategy.

Invest in & deploy appropriate GHG emissions measurement technologies.

North Sea Transition Deal Commitments



OGA tracking and monitoring progress



Flare & Vent – OGA Policy

Oil & Gas Authority

OGA published updated Flare & Vent policy June 2021

Consenting
- Drive to continually reduce flare & vent
- ‘Cold flare’ now reported as vent

Stewardship
- Regular engagement with Operators
- Emissions Reduction Action Plans (ERAPs)

Data – Benchmarking of flaring & venting data

All of this is underpinned by the ability to satisfactorily quantify emissions.

New developments to plan on basis of no routine flaring and venting
Zero routine flaring and venting for all by 2030 at the latest

Emissions Reduction Action Plans

Oil & Gas Authority

Current estimate of GHG emissions, with uncertainty of determined quantities (measured / calculated)

- Flares, vents & any other GHG sources
- Fugitive emissions

ERAP should be **fully embedded into Operators' key processes** (targets, KPIs)

Regularly refreshed / re-prioritised project hopper containing potential emissions reduction actions / projects, with costs & estimated GHG-reduction potential

Demonstrate that Field / Terminal **business plans include sanctioned GHG reduction actions / projects**. These must be fully funded & resourced, with realistic delivery timelines.

Track-record of GHG-reduction actions / projects delivered to date, detailing subsequent reviews

- Measured emissions reduction v. planned
- Execution timeline v. planned

Measurement Challenges - Flare

Oil & Gas Authority

- Measurement (metering) of quantity delivered to flare tip (consented by OGA)
- Quantification of resultant emissions (reporting to ETS, EEMs, ERAPs etc.)

Metering

- Installation effects - lack of representative flow calibration
- Use of CFD to correct – but how traceable is this?

Emissions

- Combustion efficiency
- Composition of flare gas

Measurement Challenges - Vent

Oil & Gas Authority

- Measurement (metering) of quantity vented (consented by OGA – quantification now required)
- Quantification of resultant emissions (reporting to EEMs, ERAPs etc. *note: not ETS!*)

Metering

- Installation effects - lack of representative flow calibration
- Low flow sensitivity

Emissions

- Composition of vent gas
- How representative are models for fugitive emissions?
- If fugitive emissions directly measured, how representative?

Future Trends?

Oil & Gas Authority

2050

- Regulation of fugitive emissions?
- Consenting of emissions rather than amount of gas flared or vented?
- ETS to include Methane?

Recap

- **OGA Strategy**
- **SE11**
- **OGA Flare & Vent Policy**
- **ERAPs**
- **Flare & Vent Measurement Challenges**

Oil & Gas Authority

Thank you

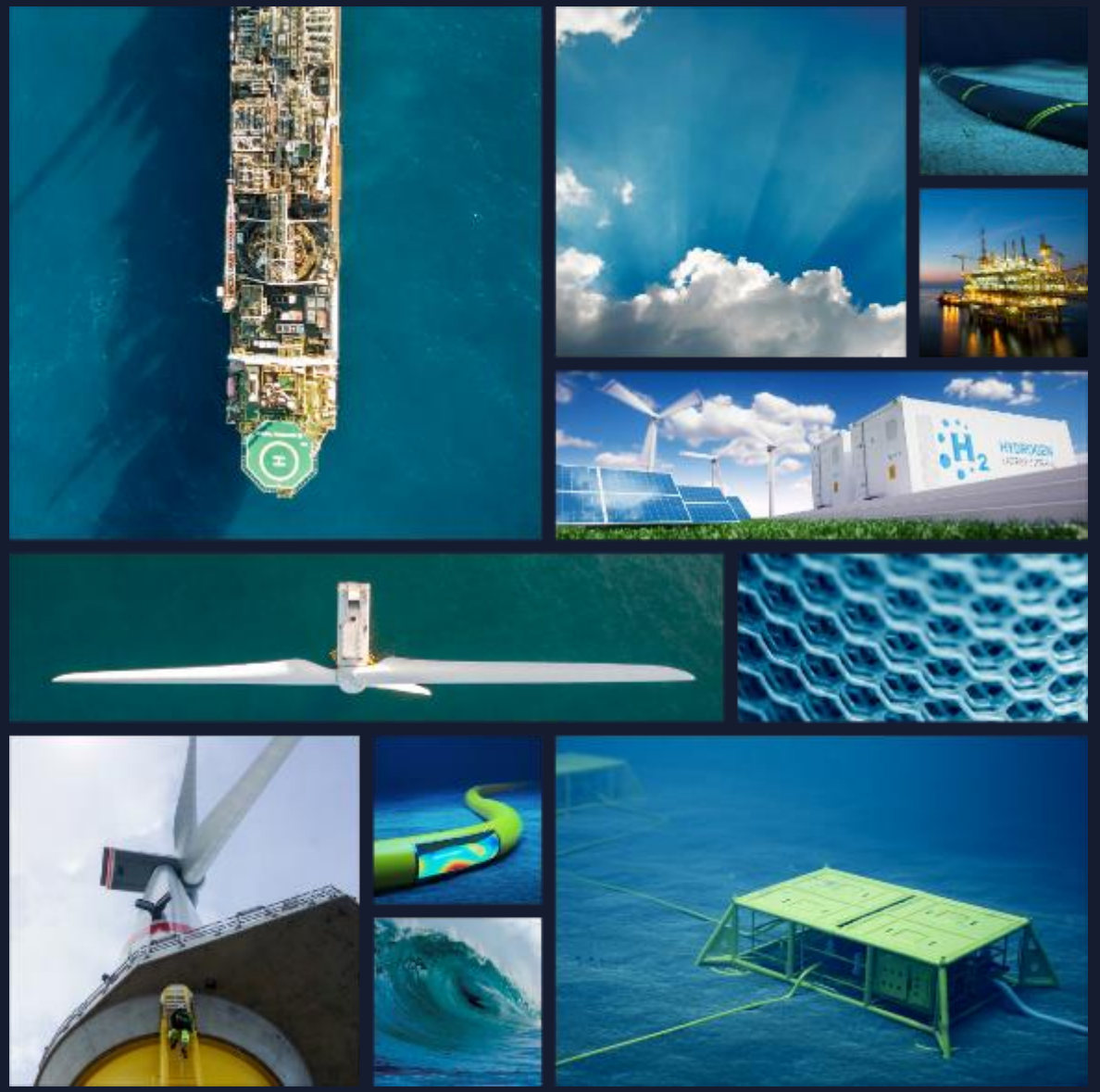
Introduction to Virtual Metering

OGA Technology Leadership Board

15th February 2022

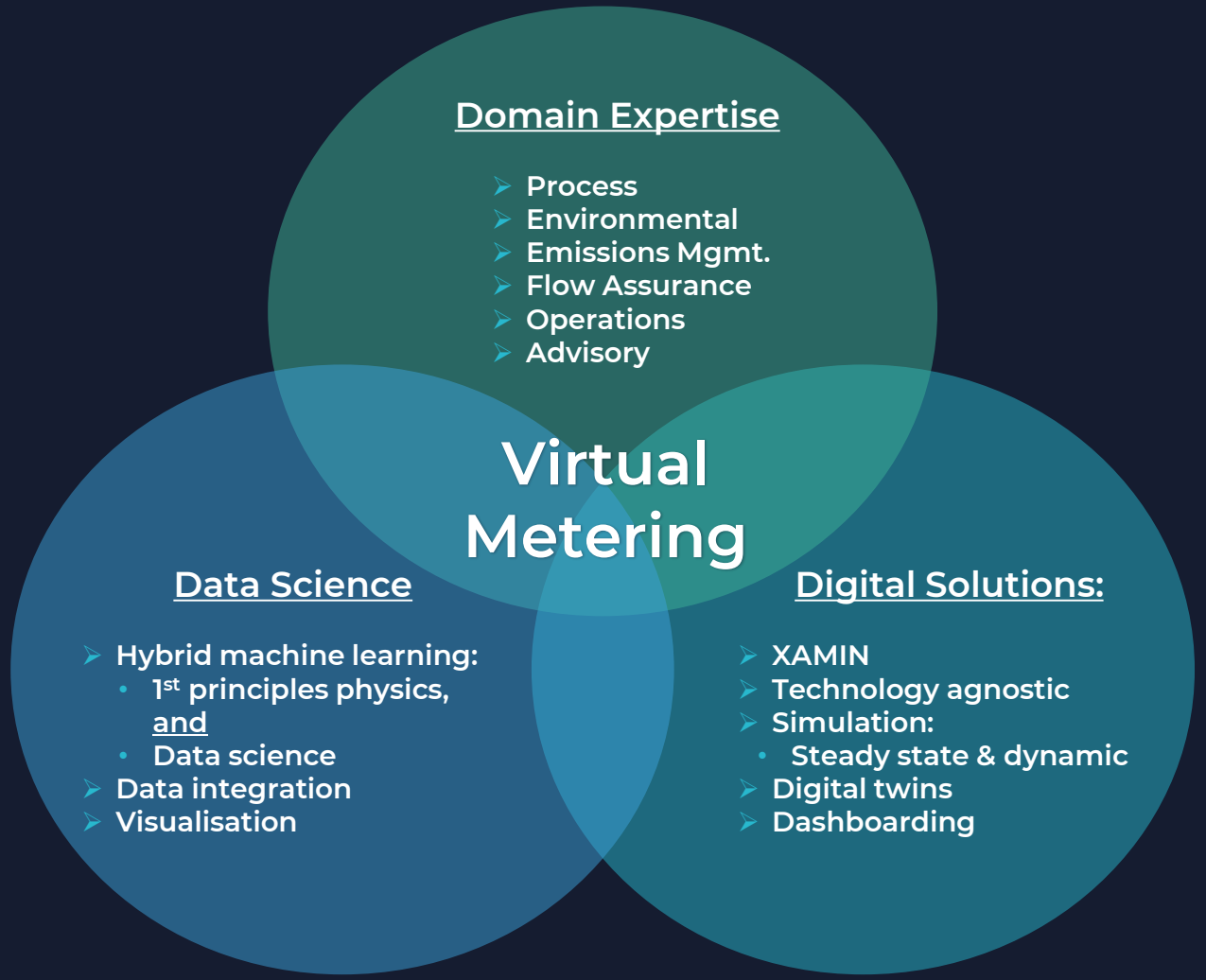
Craig.Dougary@xodusgroup.com

WWW.XODUSGROUP.COM

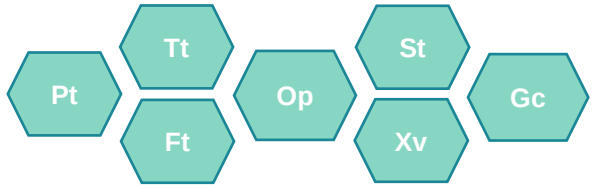


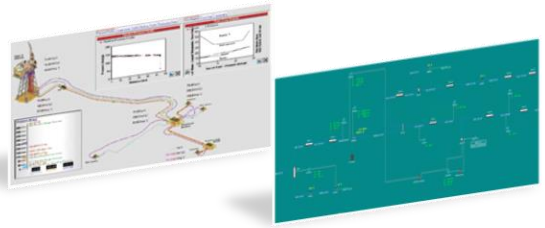
Combining Xodus Group's engineering domain expertise with digital capabilities to extract maximum value from your data.

- Integrated & multi-discipline
- Innovative solutions to modernise and optimise operations support
- Contextualise and visualise data, throughout the organisation
- Extensive experience
- Proven track record
- "Cradle to grave" capabilities



Virtual Metering: <u>leveraging existing data to derive measurements</u> which are not monitored by physical sensors or where an existing meter fails to operate reliably.





Instrumentation

Simulation

RO Size

Valve CV

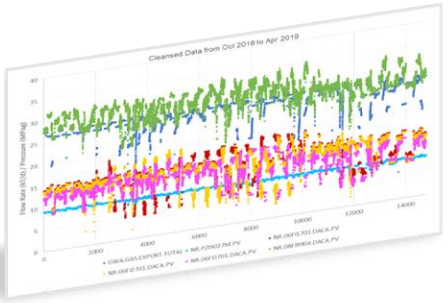
Composition

Valve Char. Curve

System Volumes

Configuration

Historical Data



Virtual Metering

- Virtual metering typically uses one, or a combination of methods:
  - First principles engineering calculations,
  - Data regression and correlation based on historical operating data,
  - Simulation based, either standalone or supported by historical operating data.
- "Hybrid" approach: guided but not limited to existing historical performance and is constrained by 1st principles physics
- Can be applied to any system where sufficient data is available to develop and drive the meter
- Xodus have developed a virtual flare meter for a major UK operator which was accepted by BEIS as a suitable replacement to the existing, faulty flare meter
- Vital to understand, monitor, optimise and report accurate emissions data

Flare and Vent Systems:

- Purge & pilot flows,
- Emergency blowdowns,
- Maintenance depressurisation,
- Pressure control to flare,
- Tank vapour outflow.

Fuel Gas Users:

- Individual turbines,
- Glycol regeneration,
- Seawater deaeration,
- Blanket gas,
- Fired heaters.

Other Applications:

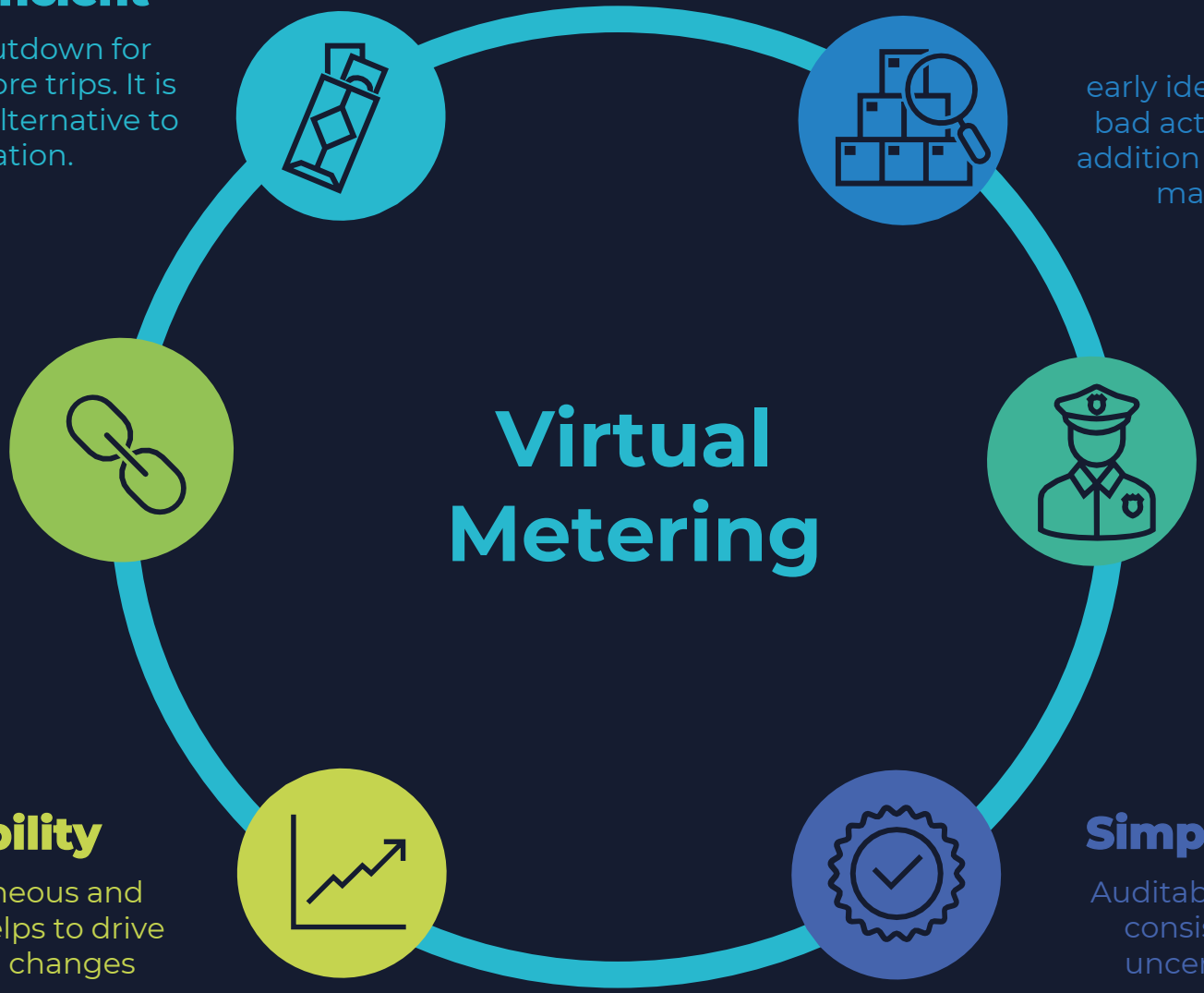
- Flare tip combustion efficiency,
- Turbine performance emissions,
- Well flows,
- Export system flows,
- LCV outflow calculation.

Economically Efficient

does not require plant shutdown for installation or regular offshore trips. It is a feasible and economical alternative to physical instrumentation.

Integrated Data Management

early identification of potential issues, bad actors or low / high flowrates, in addition to instrument calibration and maintenance requirements



Bespoke

Customisable to meet your specific facility needs and is not tied in
to specific software or providers

Removes Legacy Issues

which can result in costly fines, increased person hours and potential reputational damage from mismeasurement filing

Improved Visibility

Dashboards give instantaneous and cumulative values which helps to drive accountability for making changes

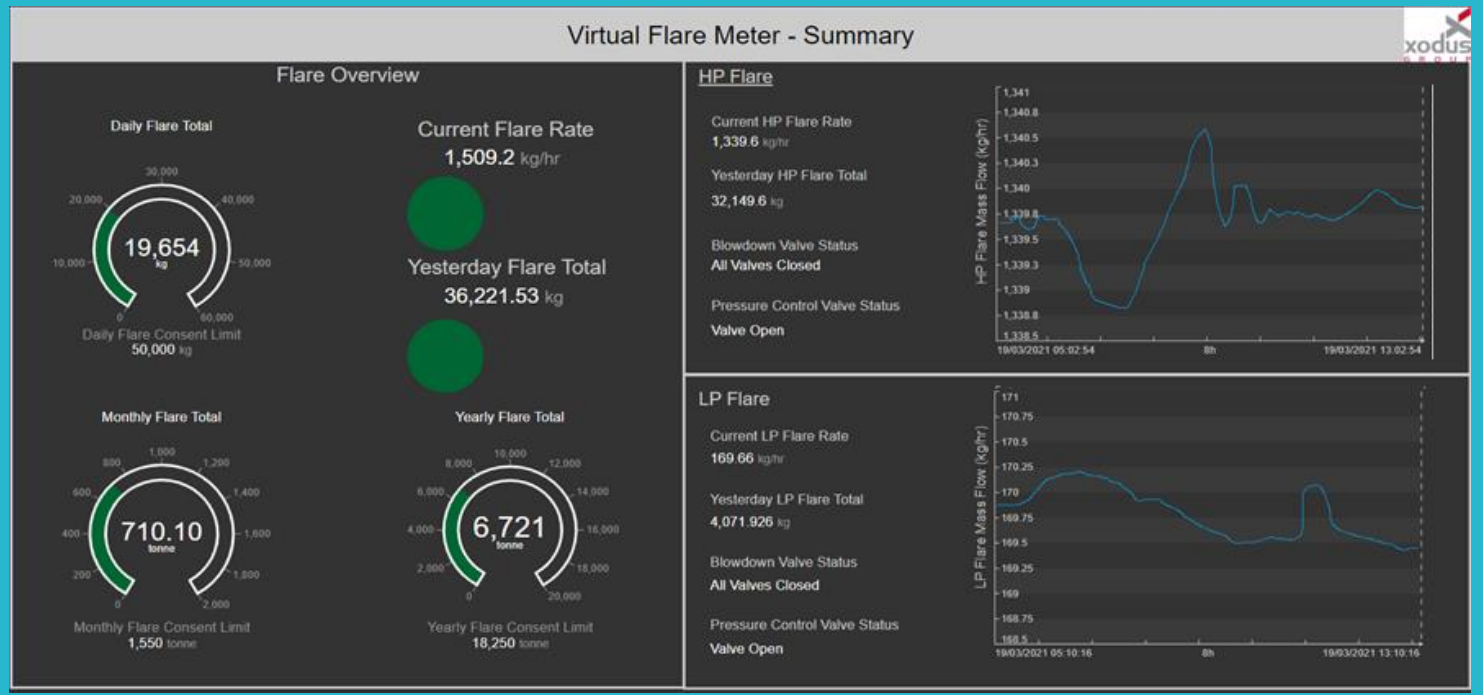
Simplified Verification

Auditable (internal or external) and consistent basis, removing the uncertainty and inefficiency of manual calculations

Case Study – Std. Calculation Basis

Problem: Asset had significant issues with their HP flare metering; at times of high flaring flowrate it would cut out or breakdown completely.

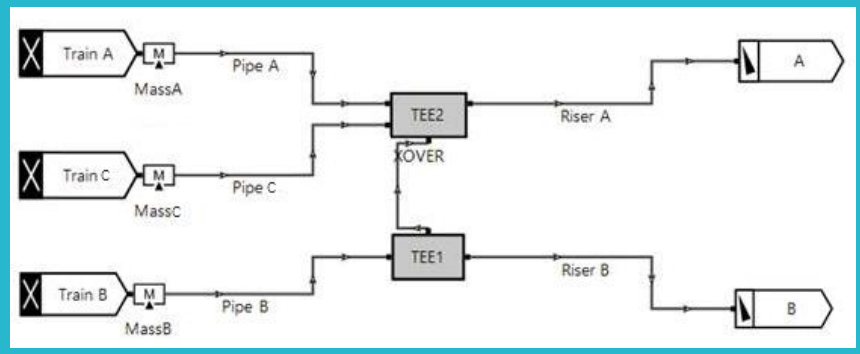
Solution: Xodus developed and deployed a virtual meter which continuously monitored and recorded the flaring from the HP flare. This resulted **in increased visibility of the real-time flare baseload**, allowing day to day **optimisation, identification of bad actors** and leading to a **standardised approach** and **significant reduction in person-hours** required to calculate and submit mismeasurement reports.

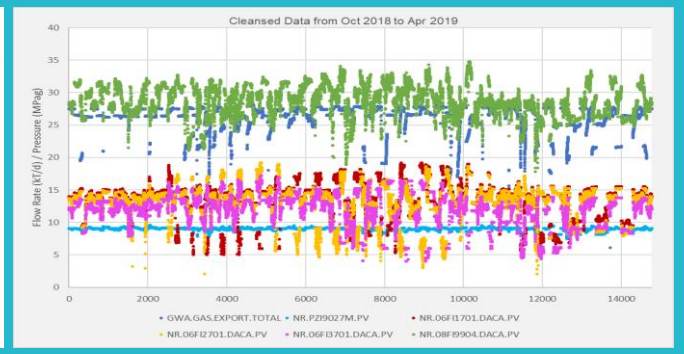


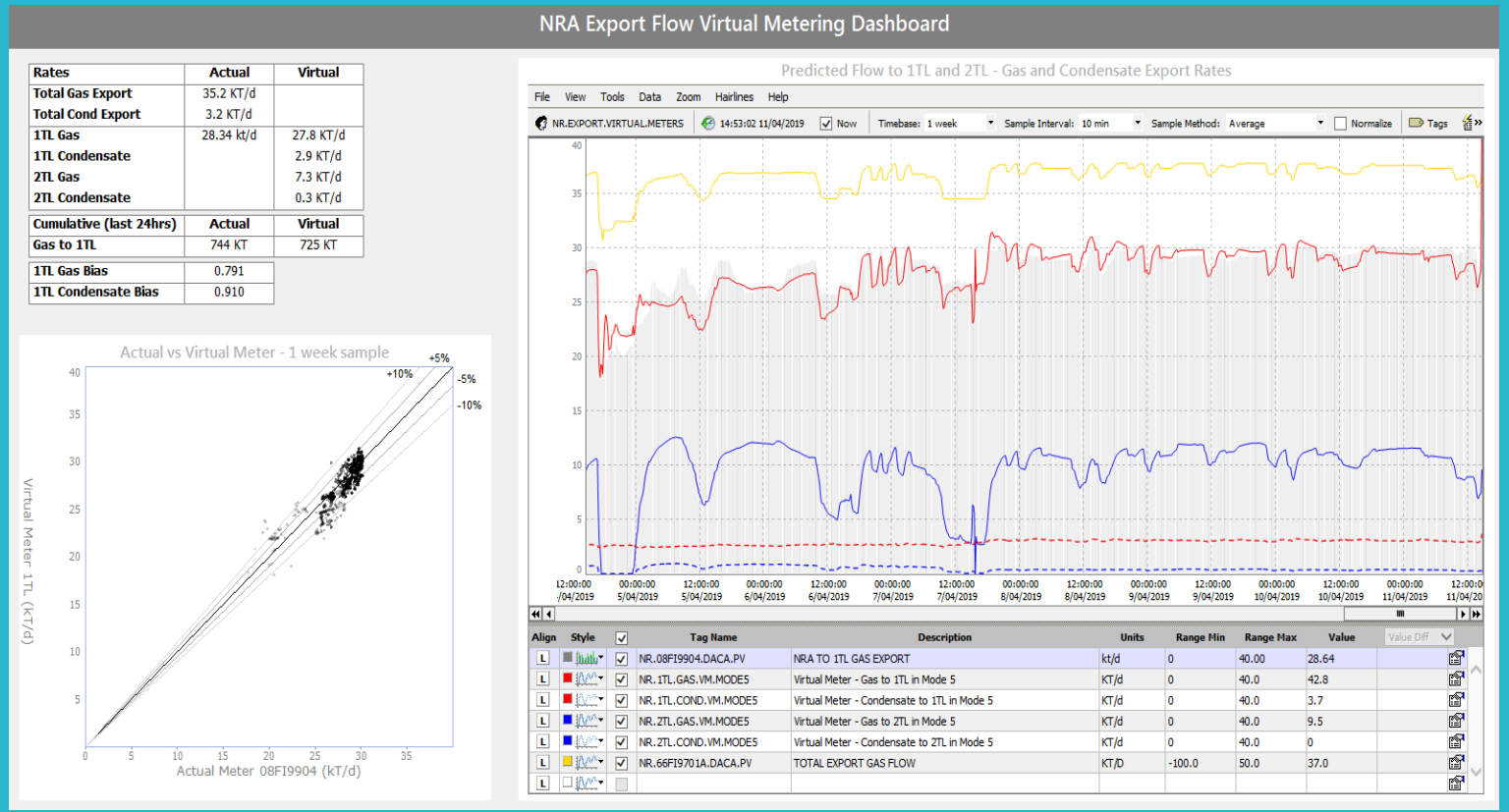
Case Study – Data Regression Basis

Problem: Export flow meter produced erratic readings at normal export rates, particularly during operation where the crossover is open and flow operates on a pressure balance

Solution: Xodus **extracted, analysed, cleansed and performed regression on thousands of data points** in order to be able to predict system performance. Historical data was **combined with thousands of simulations** to develop an **overall virtual metering solution** for gas and condensate flows.







= INSPIRING . UNIQUE . IMAGINATIVE

Flare, vent monitoring and reduction Powered by flare.IQ

OGA February 2022
Panametrics, a Baker Hughes business

Panametrics
a Baker Hughes business

Summary

Recent publications on Methane reduction

- COP 26 Presidency-Outcomes
- OGA Flaring-and-venting-guidance
- Ipieca Flare management guide

What we believe will happen

- Increased legislation on monitoring, reporting & Combustion Efficiency next years;

What IQ can bring to you

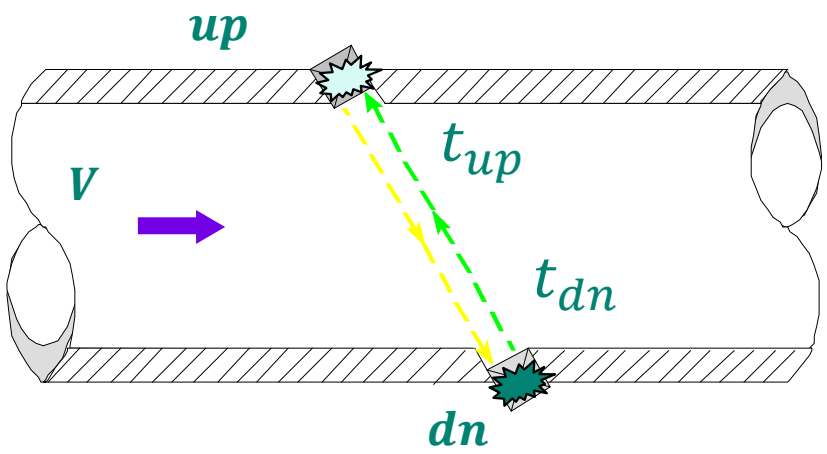
- An easy implementable solution for reporting;
- Avoids CE underreporting and CO2 overreporting;

Flare gas measurement

- How measure flow

Panametrics
a Baker Hughes business

Transit time



$$t_{up} > t_{dn}$$

$$V = f(t_{up}, t_{dn})$$

$$Q = V * A$$

$$SOS = f(t_{up}, t_{dn})$$

= Transducer is both the transmitter and receiver

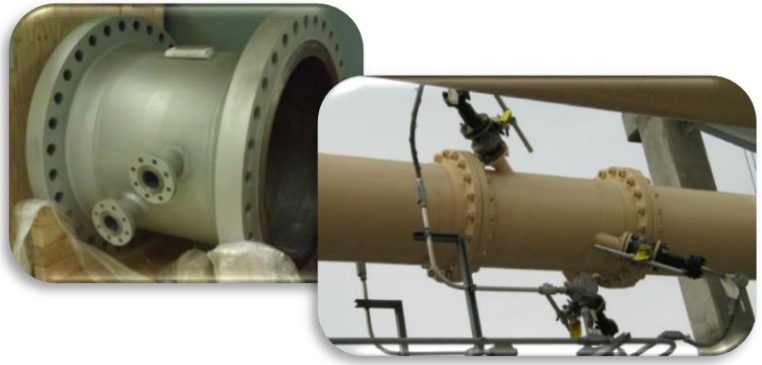
t = Transit time

- t_{dn} = Downstream direction signal *accelerated* by Flow
- t_{up} = Upstream direction, signal *decelerated* by flow
- V = Fluid velocity
- SOS = Fluid Sound Speed

Panametrics
a Baker Hughes business

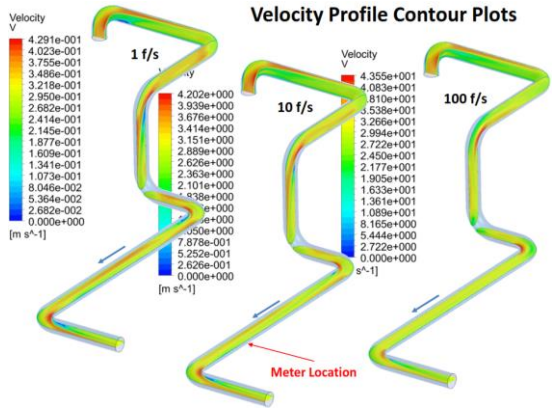
Flare Gas Flowmeter exists in Multiple Configurations

Spool-piece

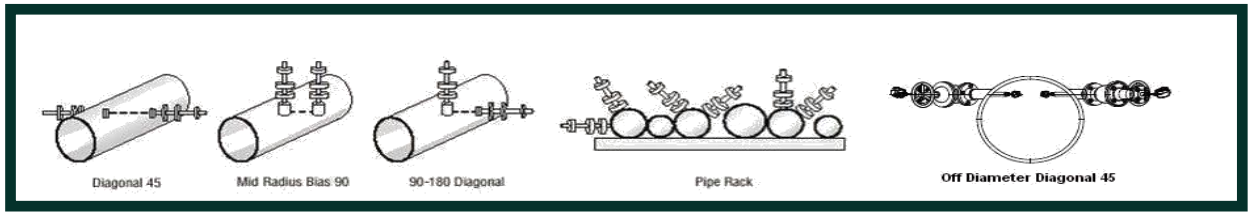


Hot-tap (or cold-tap)

CFD capabilty



Configurations to accommodate all piping set up



Capabilities to handle:

- 4000:1 turndown ratio
- Up to 100% CO2 content
- Extended temp. range (-190°C to 300°C or -310°F to 572°F)
- Local Field Service validation for compliance & reporting

Panametrics
a Baker Hughes business

Incomplete combustion

Baker Hughes

Flare Combustion: Methane

100% Combustion Efficiency

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

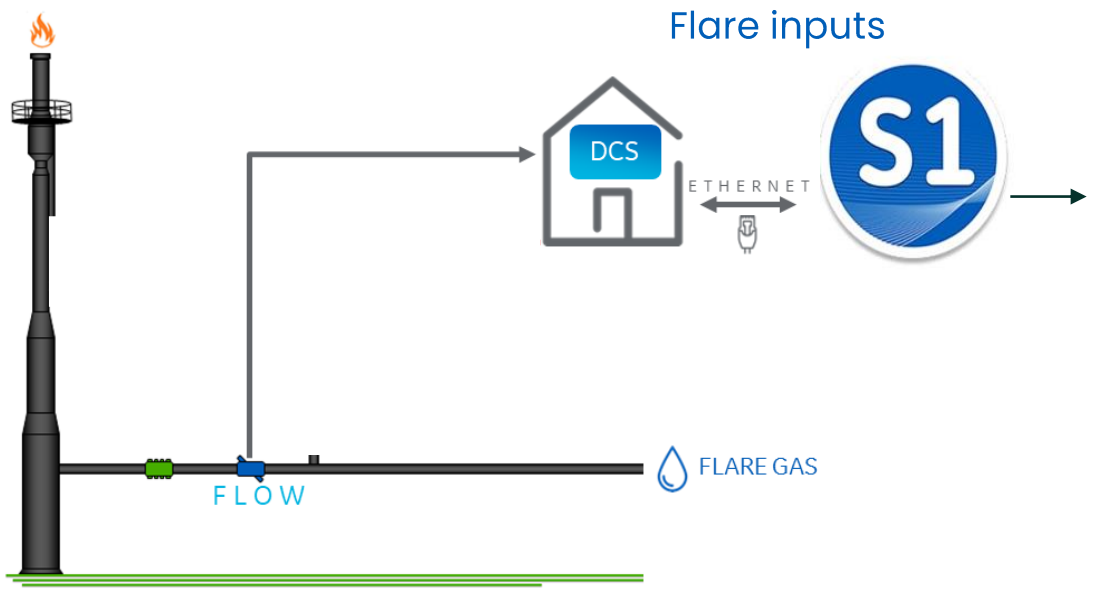
$$CH_4 + O_2 \rightarrow 0.5\,CH_4 + 0.5CO_2 + H_2O$$

50% Combustion Efficiency, approx. 7 to 16 times larger $CO2_{eq}$

Panametrics
a Baker Hughes business

What can flare.IQ do for upstream (unassisted) flares?

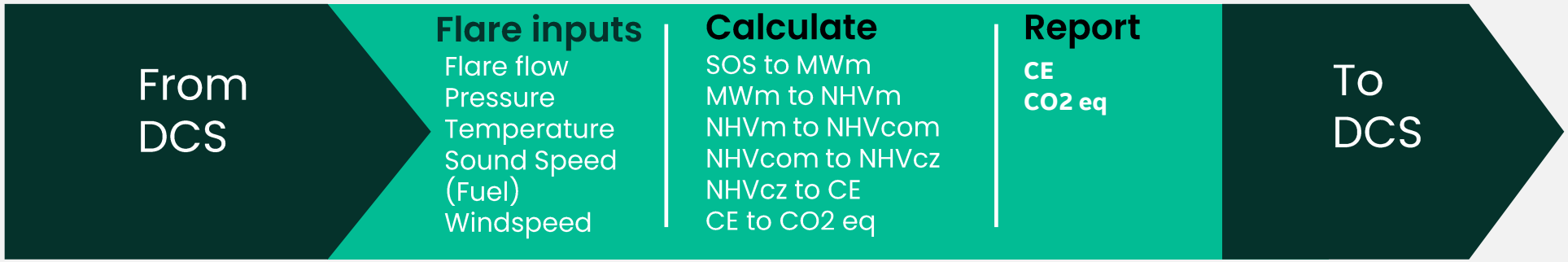
flare.IQ upstream solution



- Increase transparency
  Continuous online monitoring
- Simple to install on any DCS
  Unified approach
- Use real time CE% and Total Hydrocarbon (THC) DE
  Replace emissions factors with continuous analytics
- Realistic Methane reporting

Panametrics
a Baker Hughes business

flare.IQ logic overview



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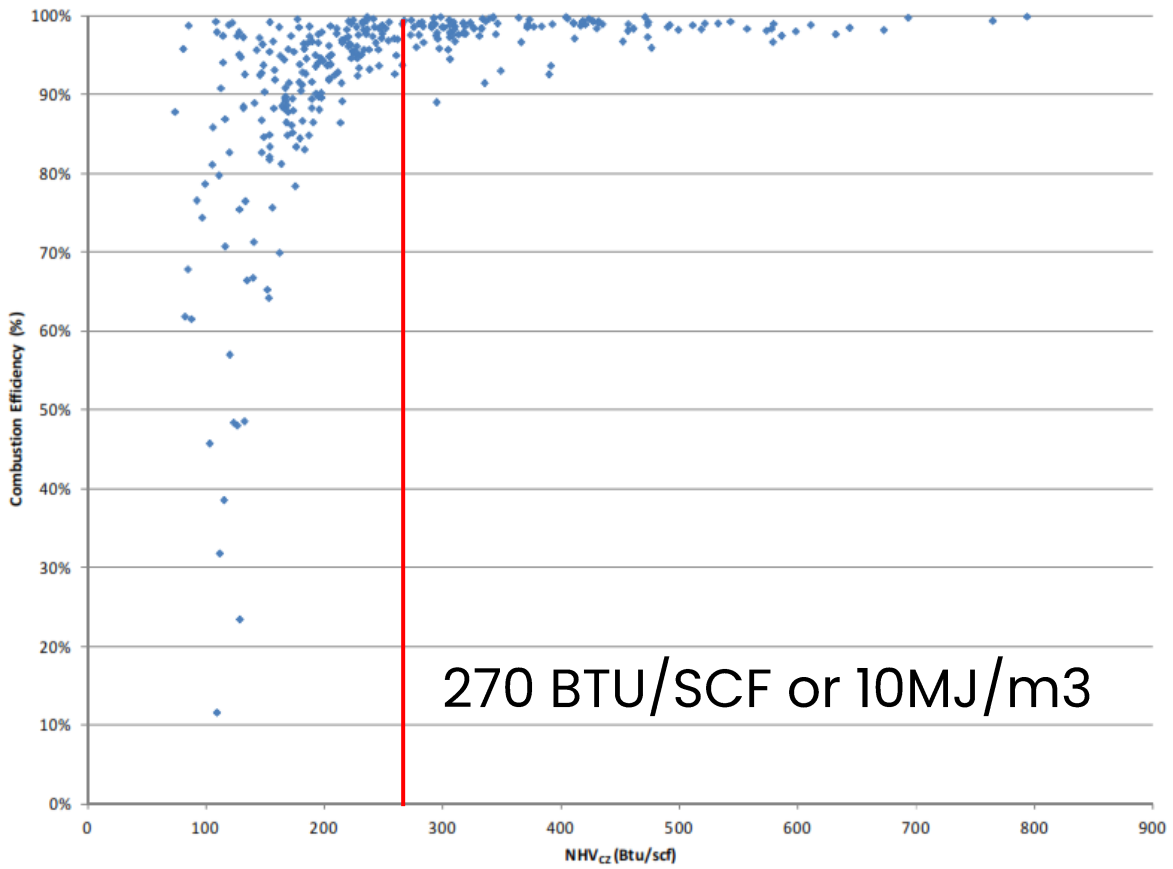
a Baker Hughes business

Net heating value in the combustion zone



EPA Report

- EPA report compares tests with a wide range of compositions at different sites
- 270 BTU/SCF triggers Combustion Efficiency at 96.5%

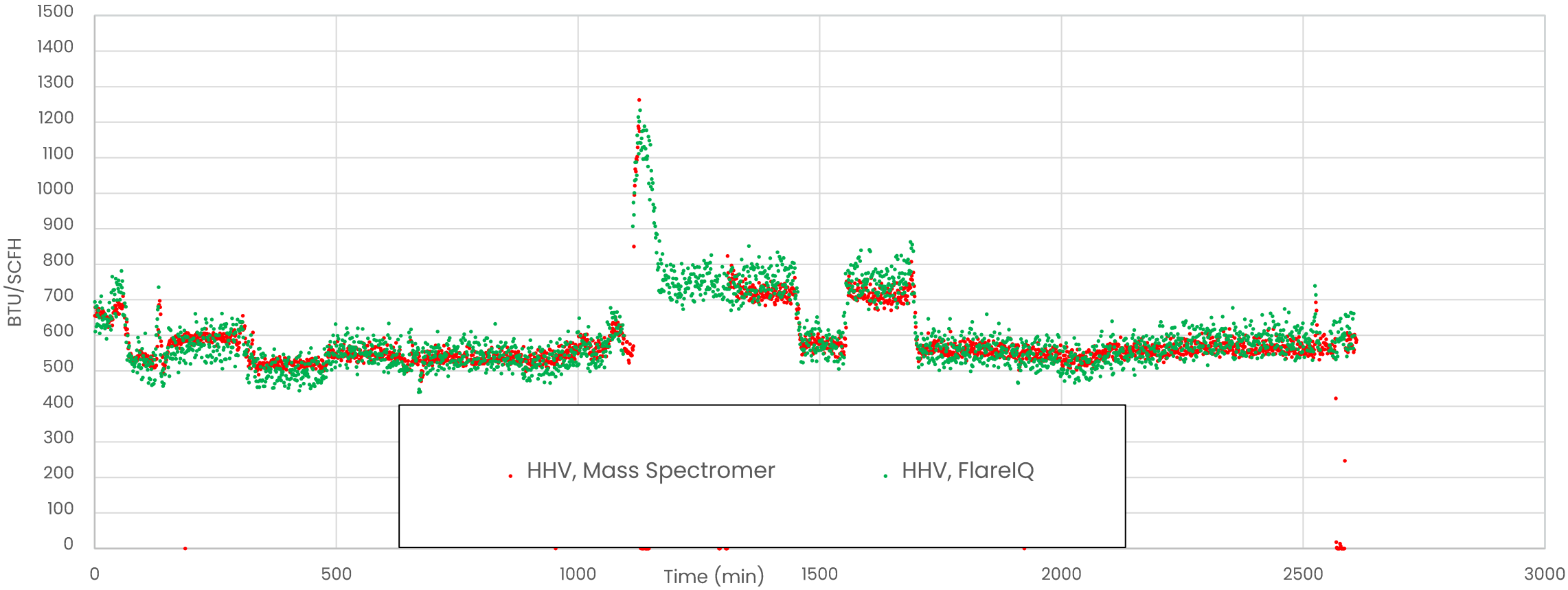
EPA 2012 flaretechreport.pdf

* "Parameters for Properly Designed and Operated Flares" prepared by the U.S. Environmental Protection Agency's (EPA's) Office of Air Quality Planning and Standards (OAQPS) dated April 2012 ("EPA Draft Report")

Panametrics
a Baker Hughes business

flare.IQ Field Validation Testing

DEMONSTRATED ACCURACY: **3-5%** against Mass Spectrometer Reference



Panametrics
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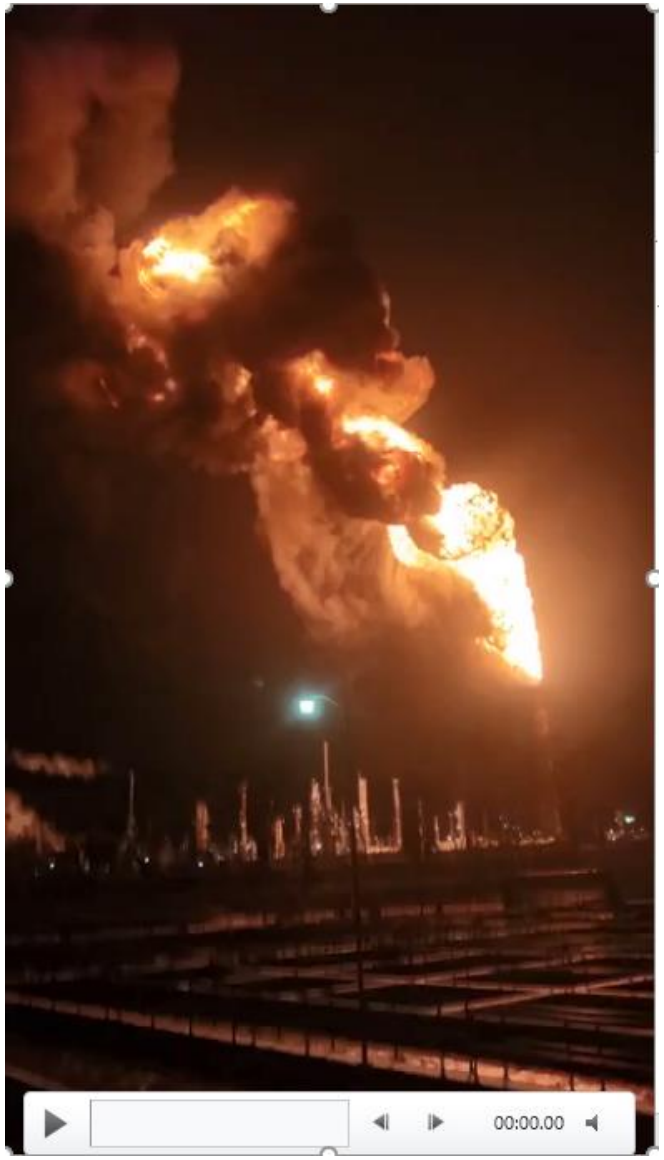
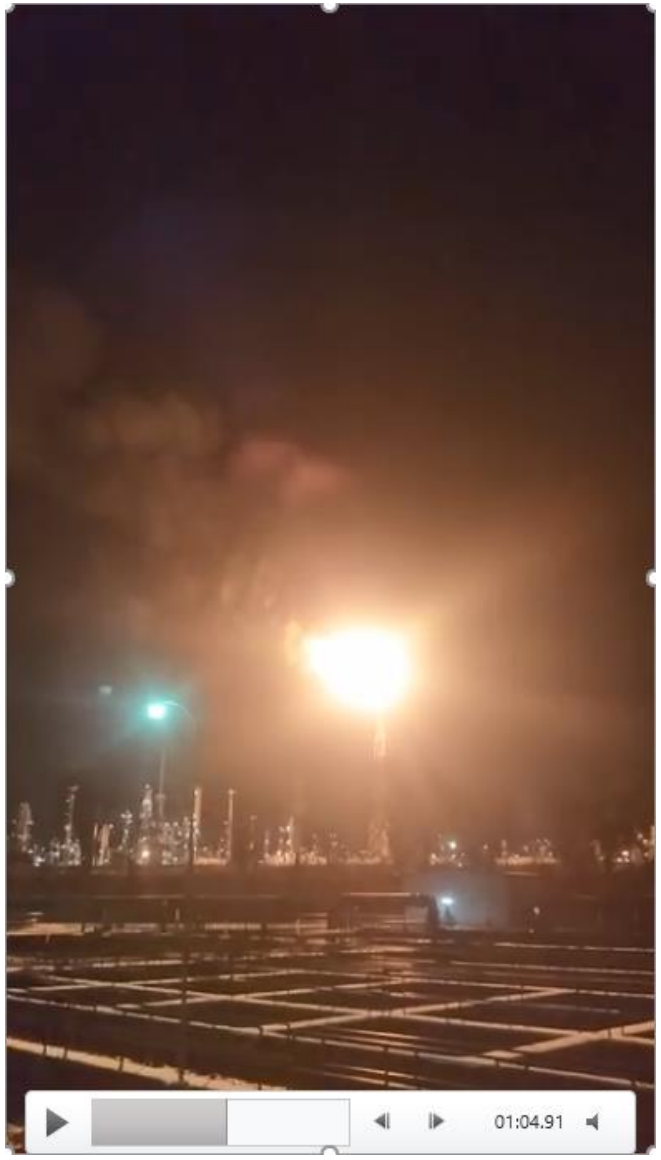




Emergency shutdown on the Diesel Hydrotreater, IQ is activated after 35 seconds

Shots [Youtube Video Lima, Ohio Husky flare]

Alternative options for reporting

Fixed CE of 98%

- The heat content plays an important roll and is not considered this way. Could work if composition were constant.

Gas Chromatograph

- NHV can be computed with high accuracy, but the system would be to slow to respond. Requires maintenance and calibration.

Camera with spectrum analysis

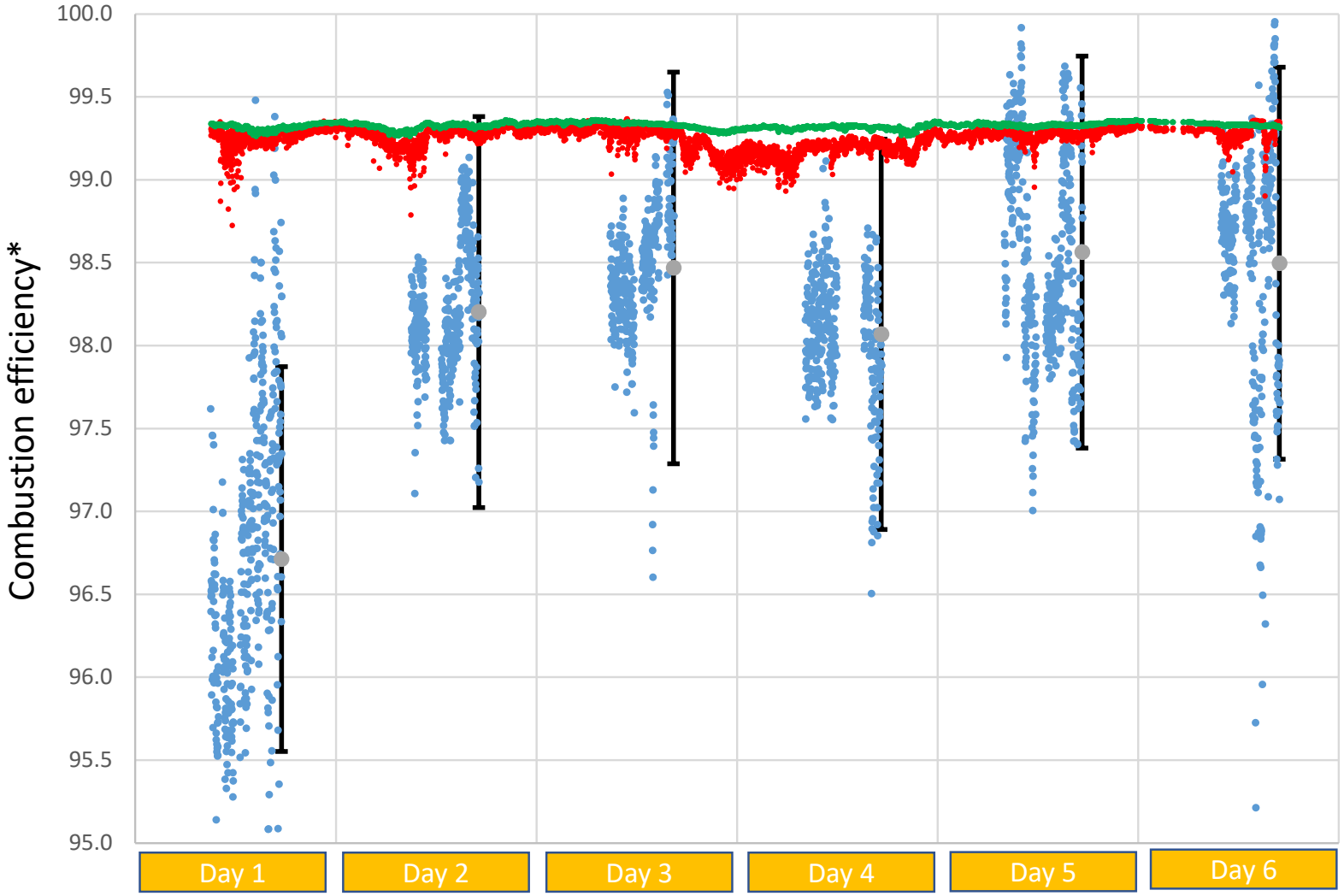
- Potentially works. Requires a position + cabling nearby the flare in the safe zone that is not always possible. Impacted by weather conditions like fog, rain, sun.

None of the above option can quantify the amount of CO2 equivalent.

IQ can and is ready to comply future reporting on emissions.

Panametrics
a Baker Hughes business

flare.IQ and Reference measurements on Glen Lyon in 2020



Camera with spectral analysis

Glen Lyon LP flare

Glen Lyon HP flare

Reference method and uncertainty

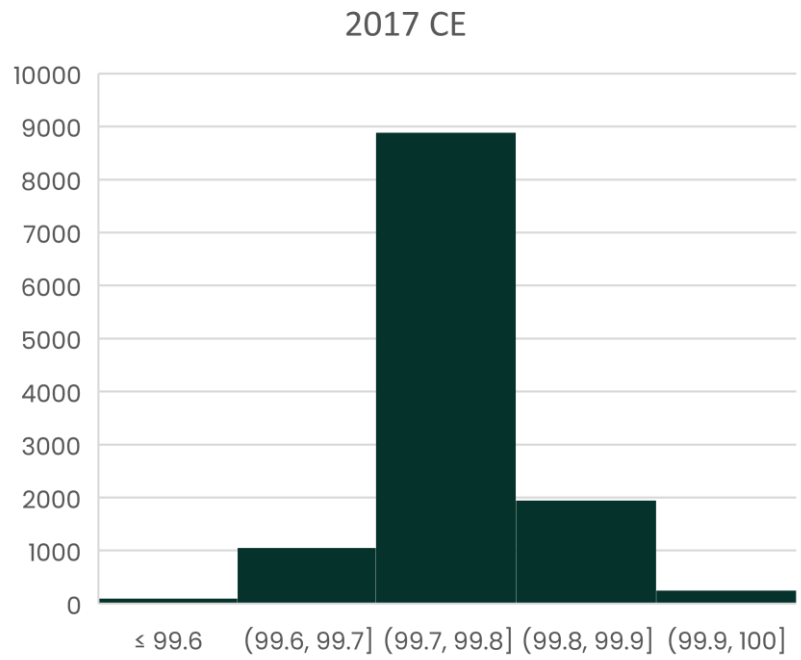
* Reported emissions are based upon destruction efficiency, including incomplete combustion components such as CO and soot

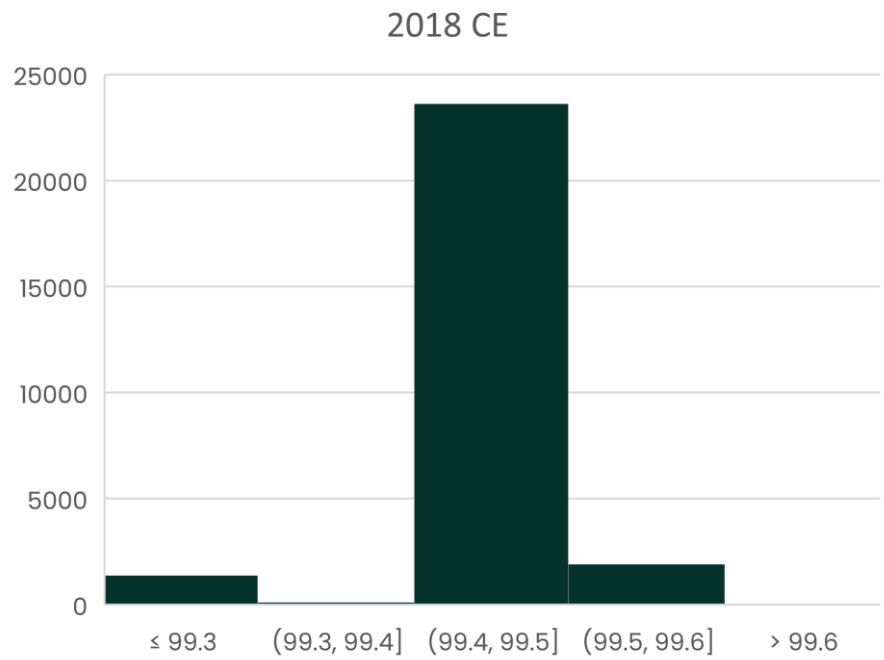
Panametrics
a Baker Hughes business

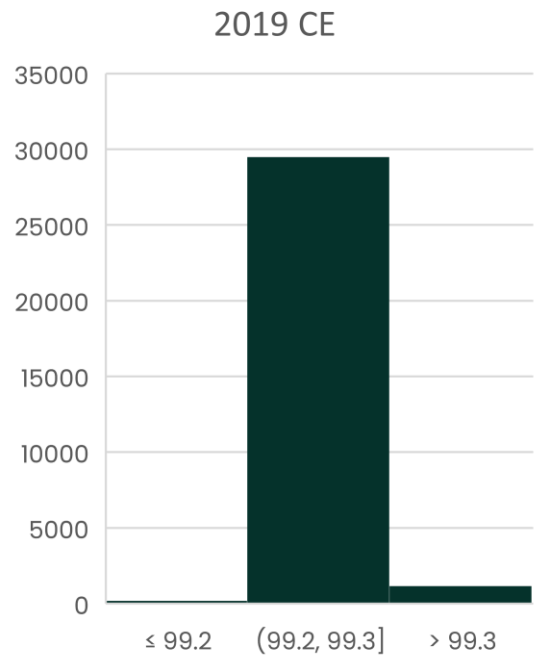
Analysis based on offshore real data

- Flare flow
- N2 and CO2%
- Fuel gas flow
- Assumed windspeed 8m/s

- Consistent data, low dispersion
- Systematically >> 98%







Panametrics
a Baker Hughes business

Summary

What IQ can bring to you

- An easy implementable solution for reporting;
- Avoids CE underreporting and CO2 overreporting;

Panametrics
a Baker Hughes business

Questions

Contact

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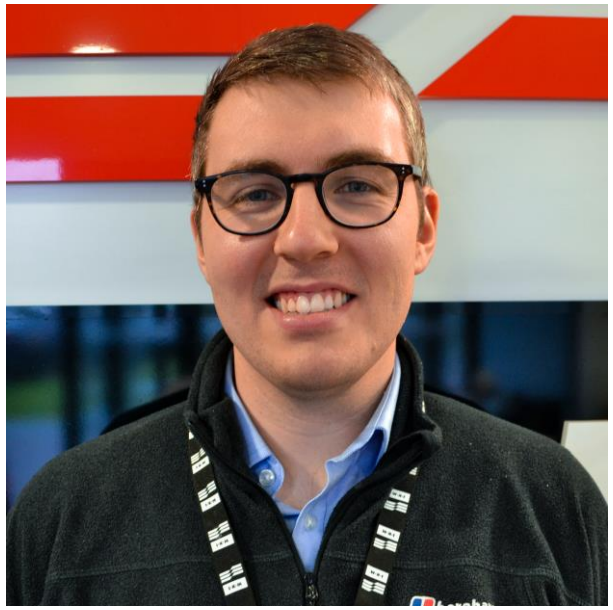
Regional Sales Manager
dorus.bertels@bakerhughes.comm
Ultrasonic flow specialist –Europe

Baker Hughes

Flaring & Venting Methane Emissions

IKM Methane Emissions Quantification (MEQ) Service

Introductions



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Decom, Renewables & Technical Manager

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Email - MEQ.IKMTesting@uk.ikm.com

IKM's Vision

Future emission quantification will be completed by a combination of shore-based UAVs & satellite emissions data .

Achieved by:

- IKM's methane emissions model – a combination of precise direct and aerial measurements.
- Correlation between model and emissions recorded during aerial surveys.

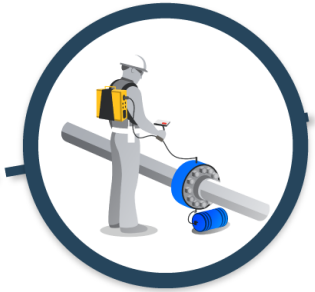
IKM's MEQ Service

Generation / Validation of Emissions Model

Macro Quantification

Quickly identifies and quantifies biggest emitters.

Sensitivity >0.0183g/hr (8.76scf/yr)



Micro Quantification

Utilises Patent Pending survey technique, enhancing sensitivity and accuracy.

Sensitivity >0.91 µg/hr (0.000427scf/yr)

Aerial Quantification

Used for flaring, venting and holistic quantitative emissions measurement of entire asset.

Sensitivity >24g/hr (11,388 scf/yr)

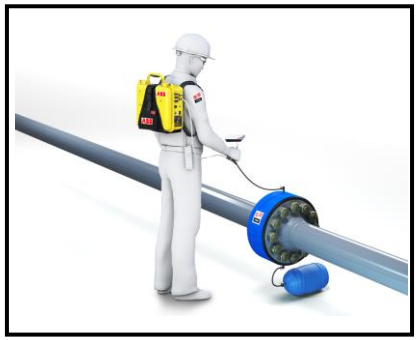
Supporting OGMP 2.0 Compliance

Supporting Yearly Reductions of Methane Emissions

Macro & Micro Quantification

- IKM's emissions specialists conduct field verification survey of selected connections to verify accuracy of source-specific emission factors used in the emissions model.
- MiQ - isolates the joint from the elements providing a highly accurate reading
- QR barcode tags used to identify & track source elements.

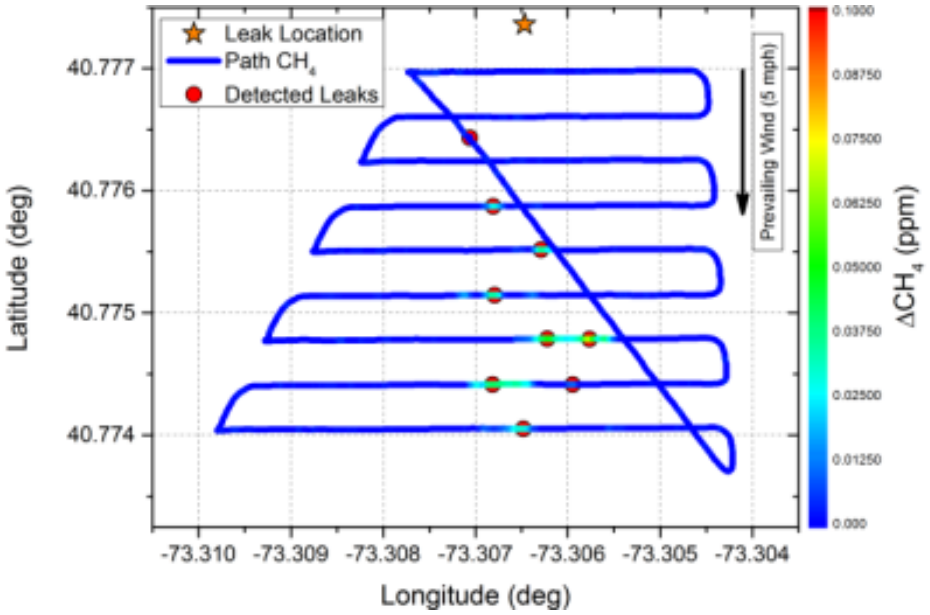
Macro Quantification using Sample Wand
Quickly identifies, locates and quantifies methane leaks, characterising leaks using traffic light system.
Sensitivity >0.0183g/hr *(8.76scf/yr)*



Micro Quantification using Probe
Incorporates IKM patent pending survey technology, providing highly accurate and precise measurements.
Sensitivity >0.91µg/hr *(0.000427scf/yr)*

Aerial Quantification

- Enhanced accuracy and reliability of source identification using integrated sonic anemometer to correlate sensor data with wind direction.
- Analyser provides best in class sensitivity & accuracy.
  - **24g/hr** or **210Kg/year** (11,388scf/yr) with high precision
  - Accuracy removes the need for conservative estimation of emissions, compared to less accurate instruments.
- Provides accurate picture of flare and vent methane emissions values



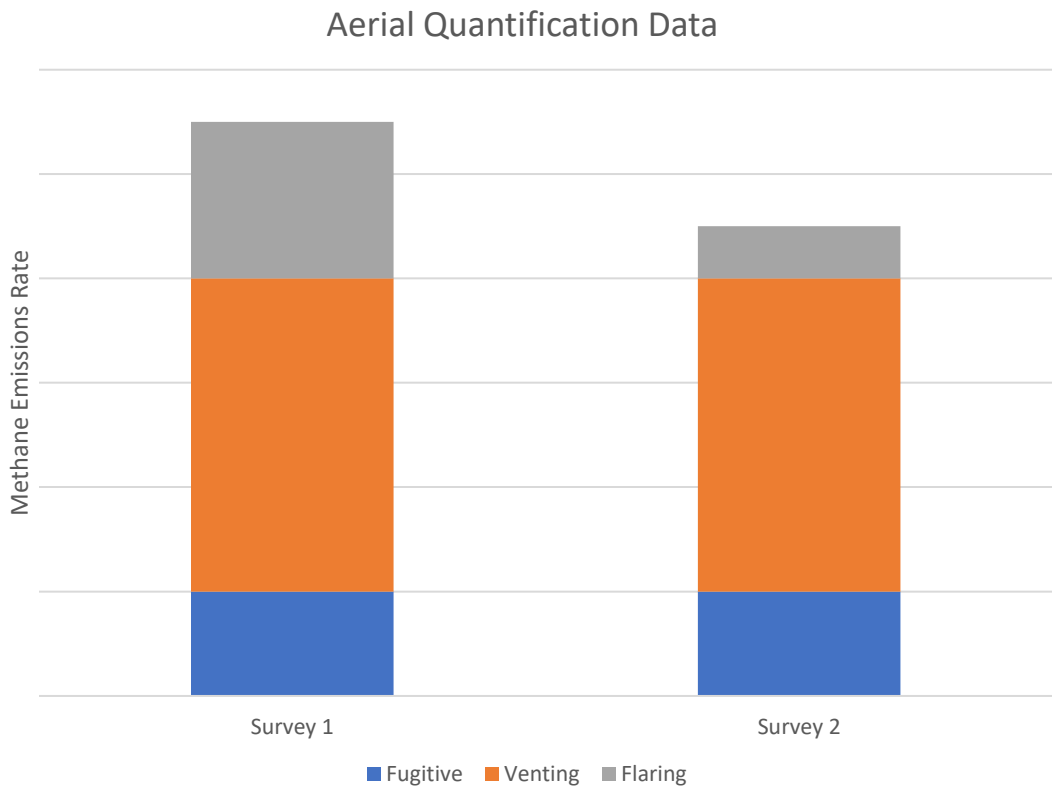
Aerial Quantification Methodology

Method for analysing flare emissions/efficiency

- Two surveys conducted at varied asset flaring rates.
- Platform provided flaring rates used in conjunction with survey results to calculate combustion efficiency.

Asset emissions breakdown enhanced using MiQ & MaQ.

- Provides granularity of emission sources.
- Verifies site specific Emission Factors (EFs).

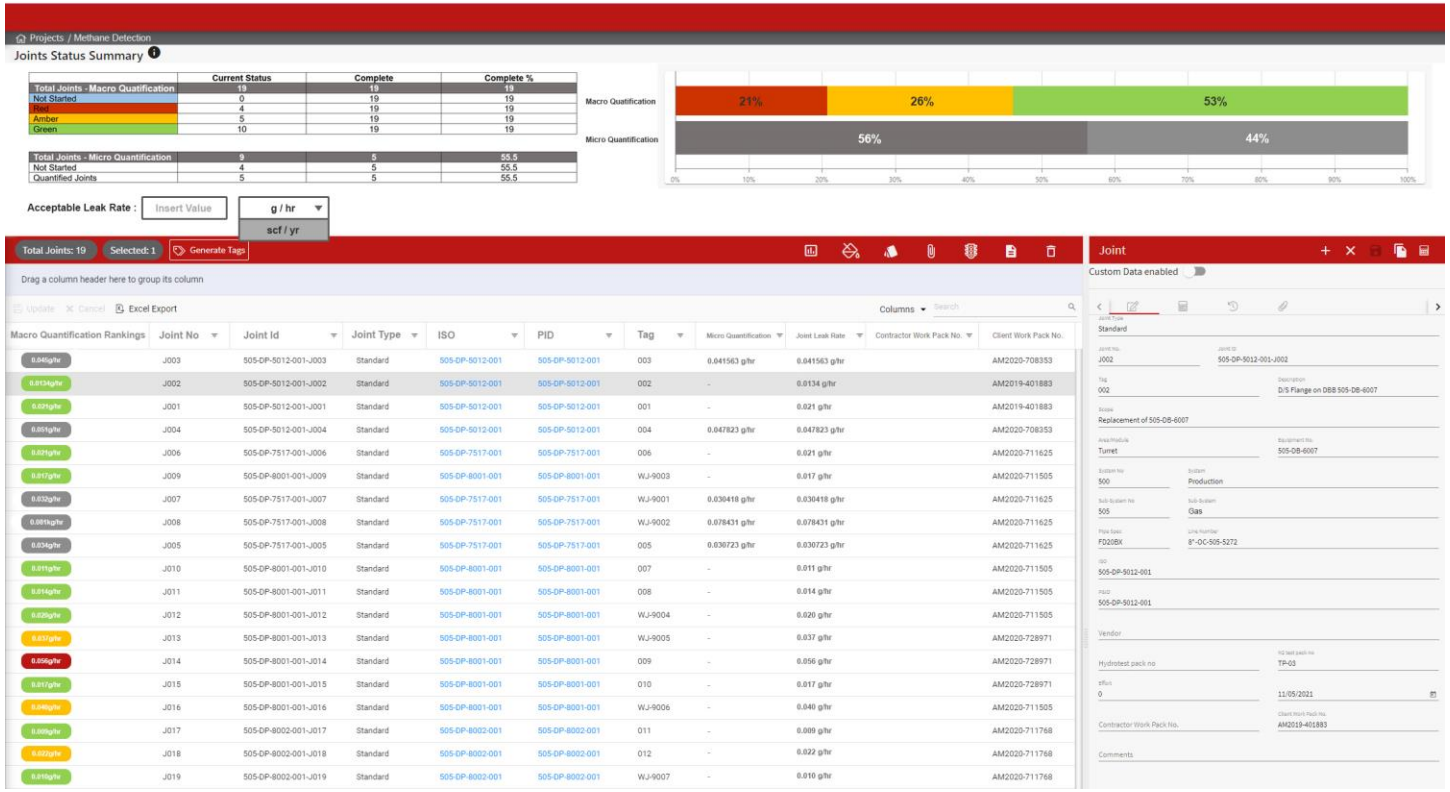


Vent Quantification Methodology

- Variety of methods available to correspond with varying vent types and compressor exhausts.
  - Bagging of vents for accessible discharge points.
  - Stack sampling using ABB analyser & probe.
  - Use of drone measurement of individual vent exhausts.
- Provide correlation between measured values and identifiable process parameters.

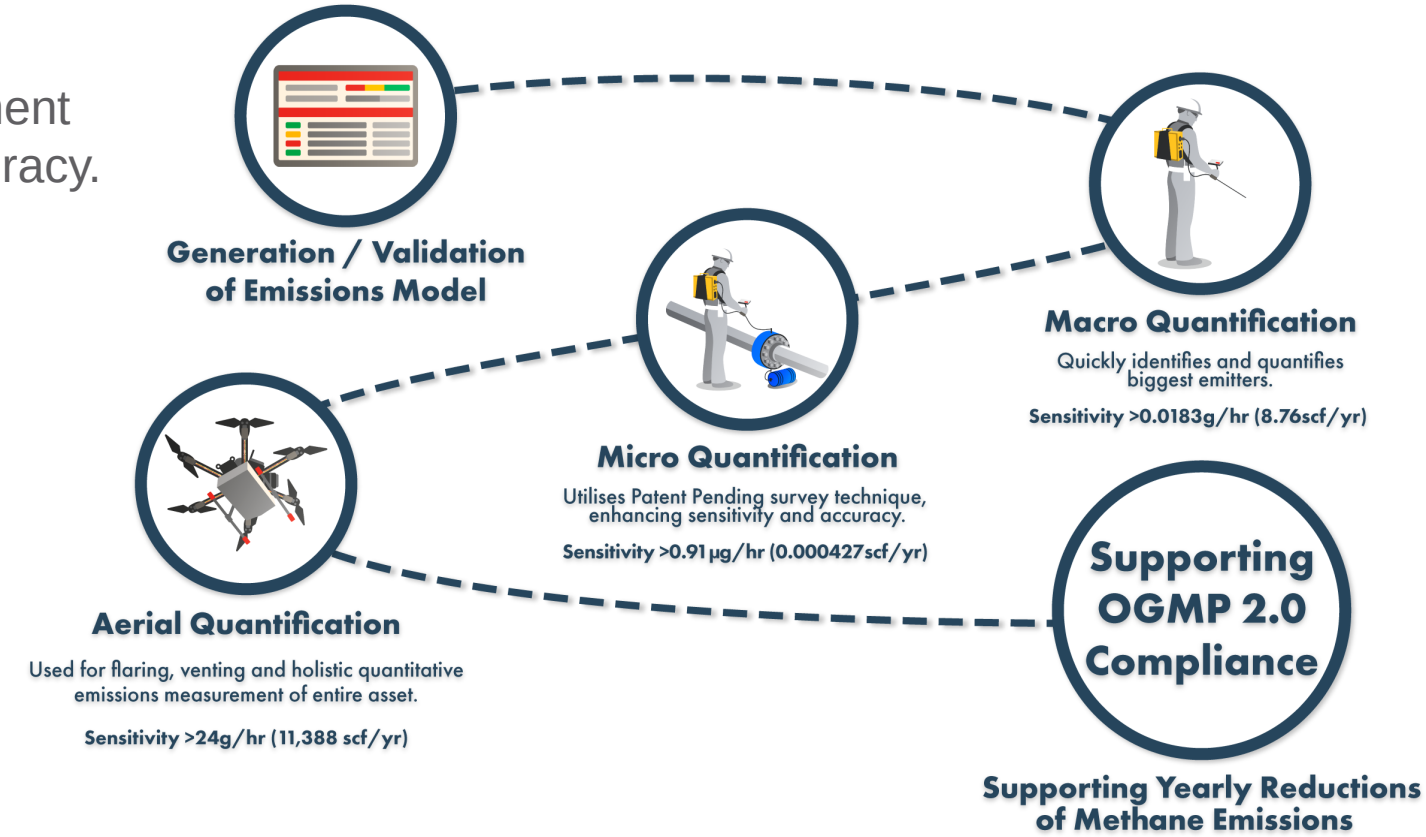
Data Management Software (I-OPS)

- Real time analytical platform providing correlation between all measurement methods.
  - Ability to incorporate survey data from other sources.
- Solution for capturing, trending, and tracking emissions data.
- Development of methane emissions model.
- Highly customisable platform
  - Output can be tailored to client system/software
  - Bespoke dashboards



Summary

- Flare & vent methane emission measurement providing unparalleled sensitivity and accuracy.
- IKM's MEQ Service enables OGMP 2.0 compliance.
- Public assurance that methane is being responsibly managed through credible emissions model.
- Expansion of service to meet the ultimate industry goal - no additional POB.



We are looking for industry leaders to deliver our vision.

1st Step – Site Survey

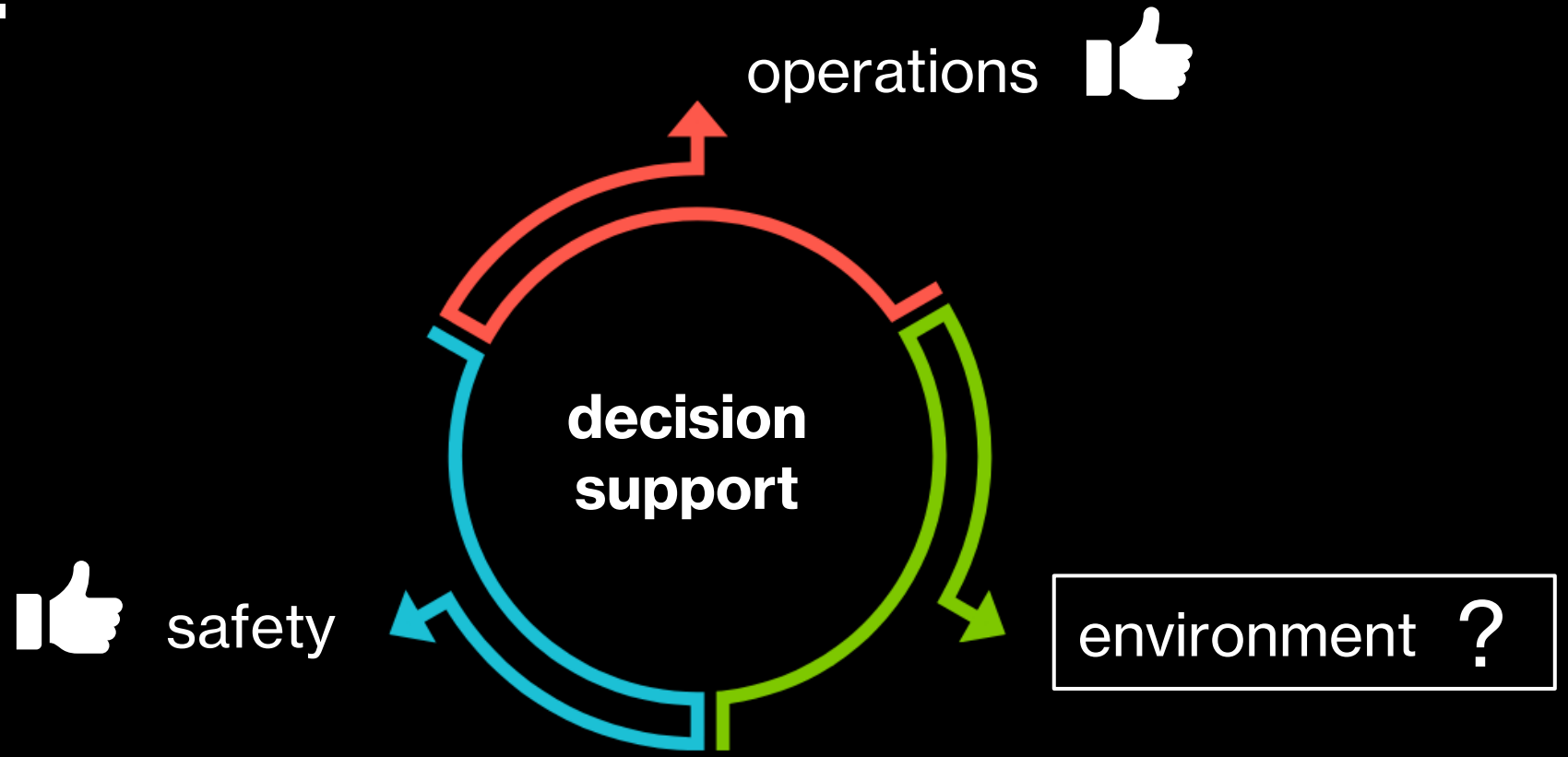
Questions?

Email - MEQ.IKMTesting@uk.ikm.com


OPEX
an ERM Group company
We make AI work
for complex assets.
HELPING CARBON INTENSIVE
INDUSTRIES REDUCE EMISSIONS.

The pressure to cut emissions is mounting by the day.

OPEX
an ERM Group company



OPEX
an ERM Group company

Artificial Intelligence solutions that help carbon intensive industries achieve cleaner, more efficient and lower cost operations.

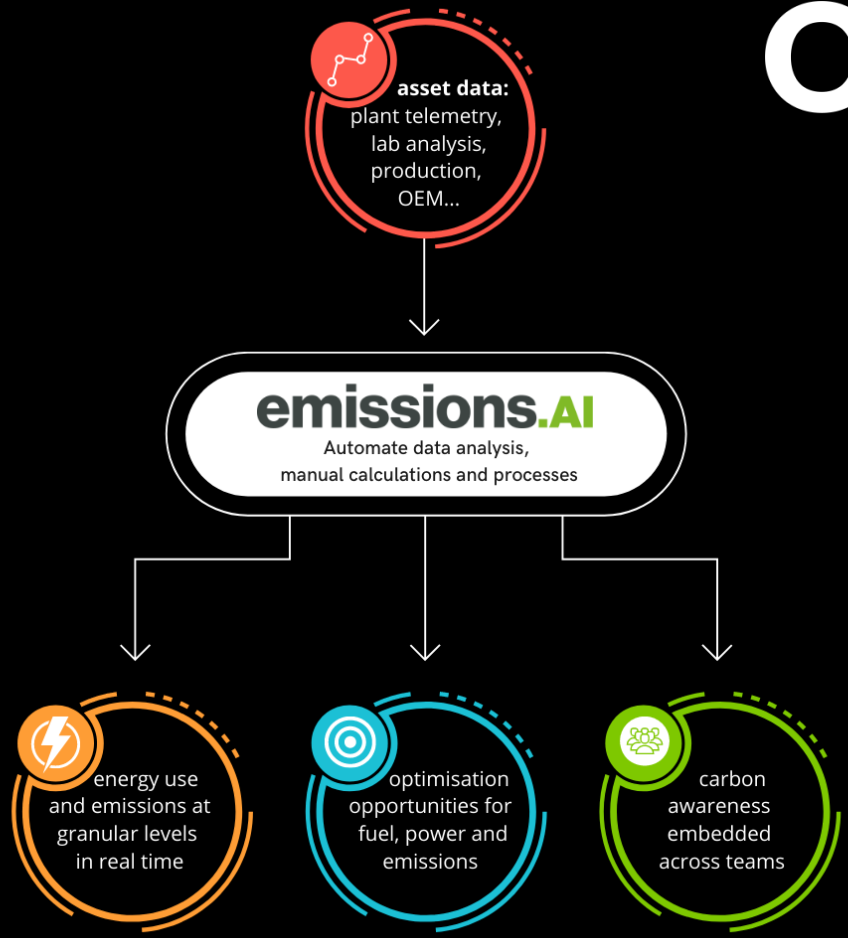
Harbour Energy
bp
Canadian Natural
cnooc
px
SERICAENERGY
dana PETROLEUM
Chevron
INEOS

emissions.AI

OPEX
an ERM Group company

Actionable
Emissions Intelligence

A cloud-based AI solution to help companies optimise facilities for lower carbon emissions.



Pre-Built Modules

- ENERGY EFFICIENCY
- OIL IN WATER TOOL
- FLARING & VENTING
- METHANE

emissions.AI

OPEX
an ERM Group company

Flaring & Venting Module

emissions.AI

OPEX
an ERM Group company

Flaring & Venting Module

- Categorise flaring volumes - CAT 1, 2 & 3
- Granular data to identify process improvement opportunities
- High level snapshot of current flaring rates and 12-month trends
- Drill down capability to interrogate real time and historic data

emissions.AI

emissions.AI

OPEX
an ERM Group company

Emissions savings unlocked...

Score Group

Proven Technologies to Reduce Flaring and Venting Emissions

15th February, 2022

Score Group

Some Perspective on flaring reduction…

$2.5m	Capex Planned
62off	Valves Targeted “JICM”
$20k	Monitoring Survey
615T	Emissions / Annum
8off	Leaking Valves Repaired
54off	Valve Repairs Avoided
$343k	Annual Gas Recovery
$3m	Net Gain in Year 1

Fastest and most reliable pathway to “Net Zero”

Single source provider
(Breadth & Depth of Services)

Criticality Driven Focus, Risk Management

Innovative Monitoring Solutions & Engineering Support

Quantification (For top-down approach, and repair prioritisation)

Permanent and temporary maintenance capabilities

Close the loop :–
find it, fix it AND improve!

EMISSIONS ELIMINATION PROGRAM FROM SCORE GROUP

The single source solution, supporting your journey towards zero leaks and emissions

Timeline to “Net Zero”

SHORT TERM (< 1YEAR)
Compliance & Beyond

- 4-step GHG Emissions Elimination Program (EEP)
- Prioritisation – Surveys – Analysis – Quantification – Rectification – Continuous improvement

MEDIUM TERM (Year 1-3)
Enhanced Emissions Elimination

- Improved accuracy and cost-effective methods
- Support services to generate and deliver Net Present Value (NPV) positive solutions to reduce (eliminate) flaring/venting/fugitive emissions
- Broader approach to reduce environmental losses

LONG-TERM (Year 3+)
Optimised Emissions Elimination

- Macro solutions for flaring and emissions
- Permanently installed sensors/systems enhancing remote monitoring capabilities, no survey requirement
- Continuous improvement of plant assets and systems, valve performance etc.
- Thinking beyond - supporting the transition journey to green energy
  - Valve recycling
  - Engineering support
  - Materials engineering – Hydrogen/CCUS

Target Leaks and Emissions Sources - A holistic approach

LEAKS TO ATMOSPHERE

From plant & equipment

LOSSES TO FLARE AND VENTING

ISOLATING VALVES POINTING TO FLARE

LOSSES TO VENTS/DRAINS

ISOLATING VALVES POINTING TO FLARE

SYSTEM INEFFICIENCIES

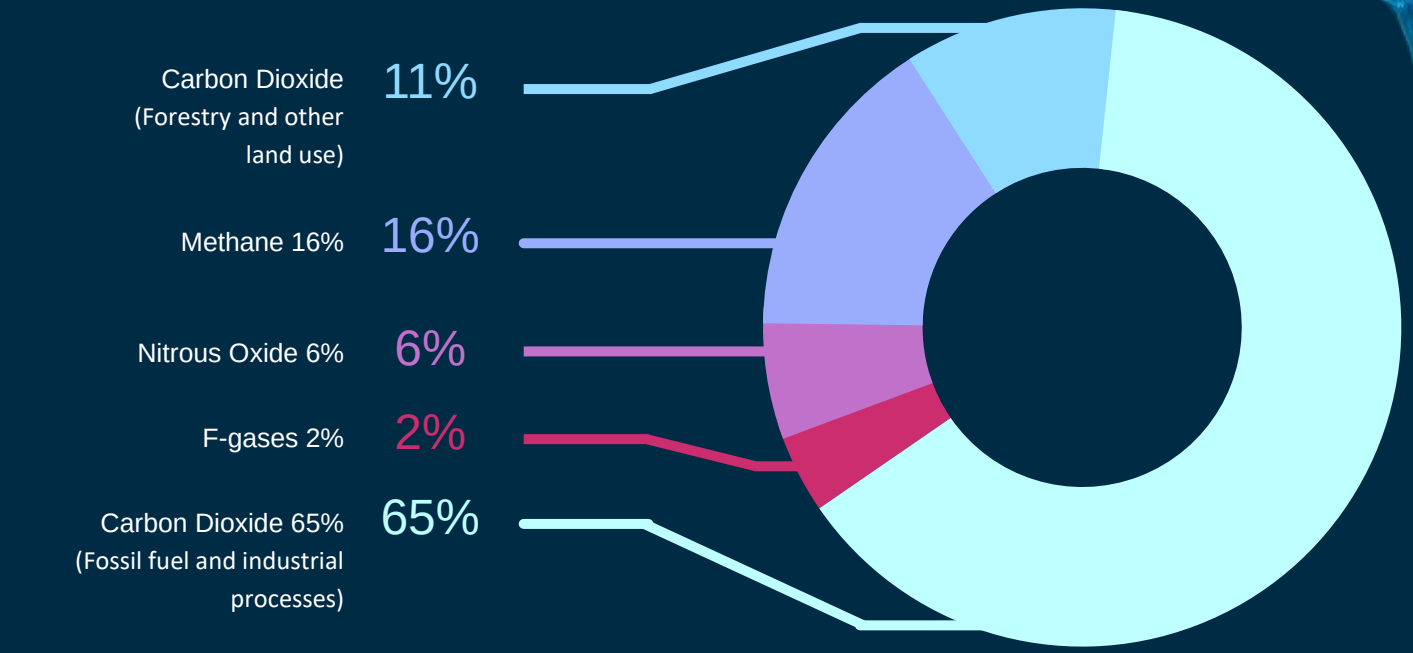
GENERATING CO2 AS A BI-PRODUCT

NON-FUGITIVE EMISSIONS

CORROSION CRACKS IN PIPEWORK ETC.

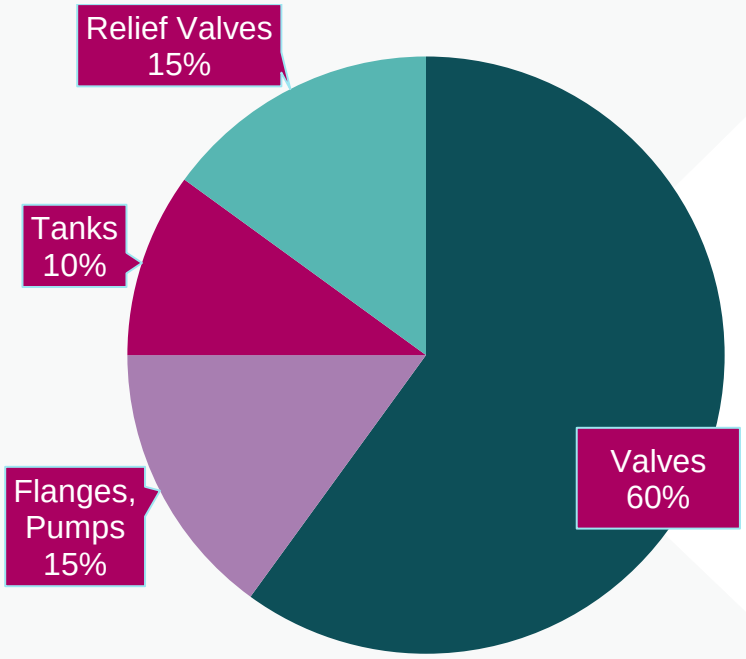
Global Greenhouse Gas Emissions by Gas

Plus all other 'non-Greenhouse Gas' process leaks and emissions.

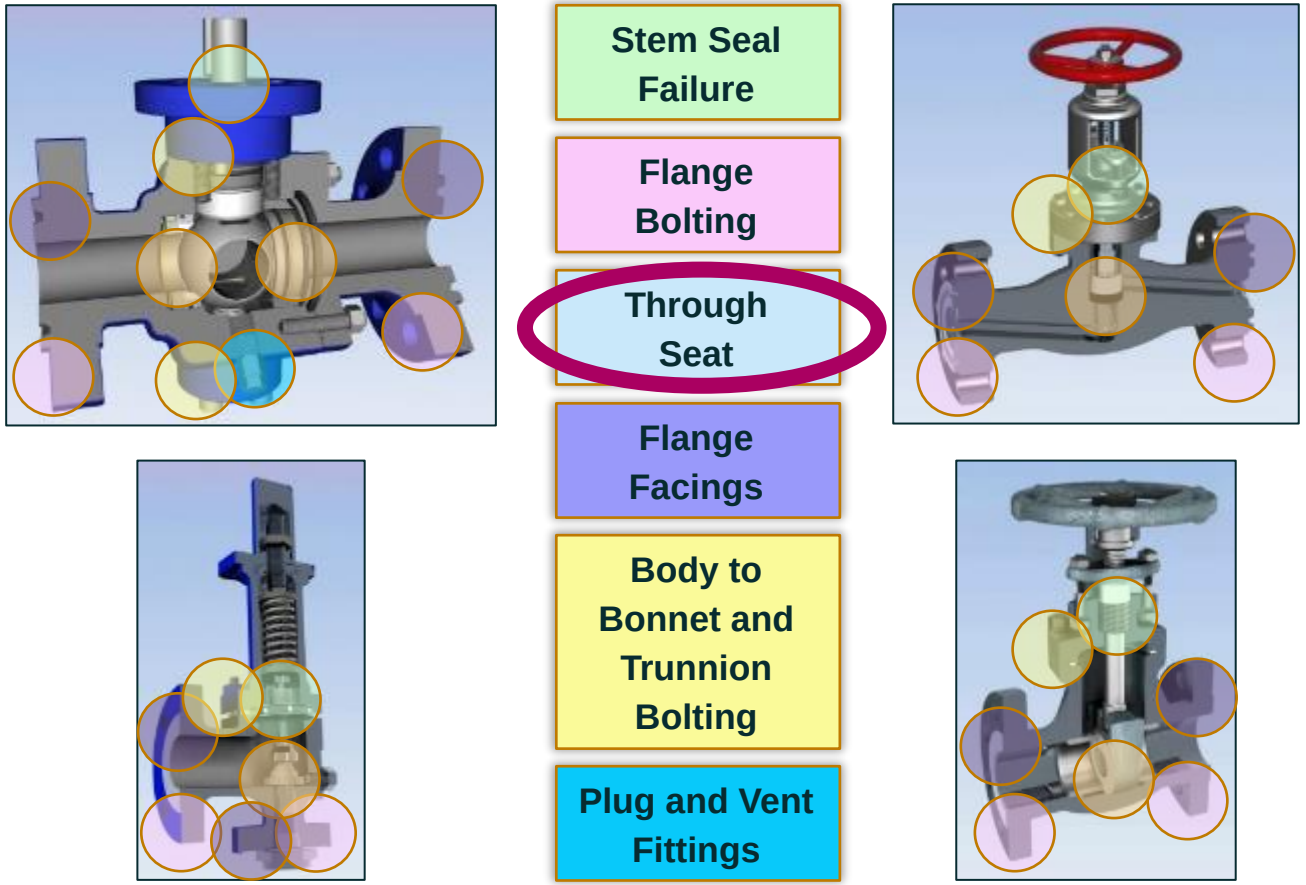


Why are valves a primary focus for “Net Zero” discussions?

Fugitive Emission Sources by Percentage



Source – Monitoring and containment of Fugitive Emissions from Valve Stems, University of British Columbia, Vancouver



Leak Paths on Ball, Globe, Relief and Gate Valves

EMISSIONS ELIMINATION PROGRAM

PROVIDING CROSS INDUSTRY SUPPORT TO ACHIEVE ZERO EMISSIONS

A single source solution, supporting your journey towards zero leaks and emissions.

TOOLS AND TECHNIQUES

- MIDAS Meter®, MIDAS® Sensor, V-MAP ®
- Optical gas imaging
- Thermal imaging
- VOC/FID Sniffers
- Ultrasound (airborne/structural)
- Non-Destructive Testing
- Complementary condition monitoring tooling
- Quantification tooling and software
- Software solutions (digital survey tablet)

SOURCES OF LEAKS & EMISSIONS

Leakages to atmosphere

Losses to flare

Losses to vents/drains

System inefficiencies

Non-fugitive emissions

SOURCES OF LEAKS AND EMISSIONS

EEP

- CO2
- METHANE
- OTHER PROCESS FLUIDS

LEAKAGES TO ATMOSPHERE
- Loss of Tightness from equipment/other connection issues

- **OPTICAL GAS IMAGING**
- **VOC/FID SNIFFER**
- **QUANTIFICATION TOOLING**

LOSSES TO FLARE AND VENTING
- Internal through-valve leakage on isolating valve populations pointing to flare

- **MIDAS METER®**
- **MIDAS SENSOR® ACOUSTIC EMISSIONS**

LOSSES TO VENTS/DRAINS/STACK
- Internal through-valve leakage from isolating areas

- **MIDAS METER®**
- **MIDAS SENSOR® ACOUSTIC EMISSIONS**

SOURCES OF LEAKS AND EMISSIONS

EEP

- CO2
- METHANE
- OTHER PROCESS FLUIDS

NON FUGITIVE EMISSIONS
- Loss or emission to atmosphere due to causes such as corrosion pinholes or cracks in process containment systems

- **NDT – ULTRASONIC THICKNESS TESTING**

SYSTEM INEFFICIENCIES
- Mitigating Generators of CO2

- **THERMAL IMAGING**
- **ULTRASOUND (AIRBORNE/STRUCTURAL)**
- **MIDAS METER® MIDAS® SENSOR ACOUSTIC EMISSIONS**
- **V-MAP®**
- **OTHER CONDITION MONITORING TOOLING**

MIDAS® VALVE DIAGNOSTICS RANGE

KEY QUANTIFICATION TOOLS FOR ONLINE MONITORING AND EVALUATING

Score's proprietary suite of monitoring equipment and systems include:-

- **Permanently deployed MIDAS® Sensor / V-MAP®**
  System for continuous, non-invasive valve condition and performance monitoring of critical valves and the process/systems in which they are operating. With almost 20 years of successful operation

- **Hand-held MIDAS Meter®**
  Non-Invasive Through-Seat Leak Testing tool. Delivers a proven valve monitoring technology. With a track record of more than 10 years.

Used globally by companies in the oil and gas, petrochemical, utility, energy and wider process industries

MIDAS® Sensor / V-MAP® - For continuous and automated leak detection, quantification and trending

BENEFITS

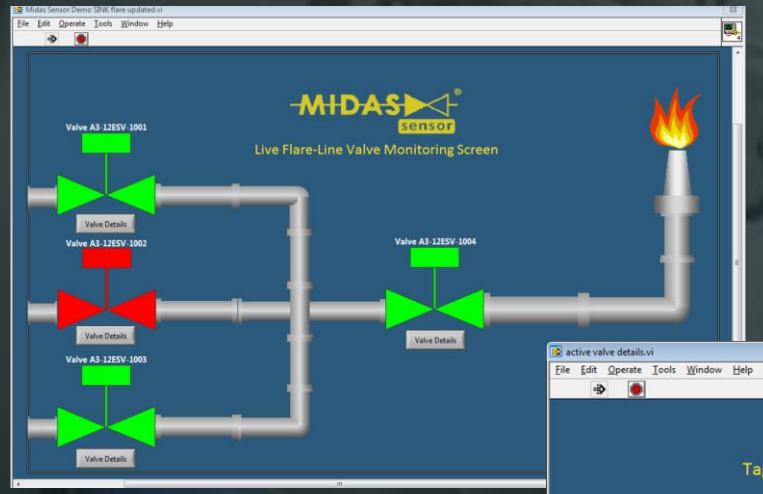
- Remote monitoring of all valve operations
- Margins monitoring supports predictive approach to maintenance
- Evidence to drive proactive and predictive maintenance activities
- Performance standards for all Safety Critical Elements
- Condition and performance reporting on every valve stroke
- Trending of valve, actuator and drive train over product life cycles
- Manages risk and reduces exposure to failures for personnel

FEATURES

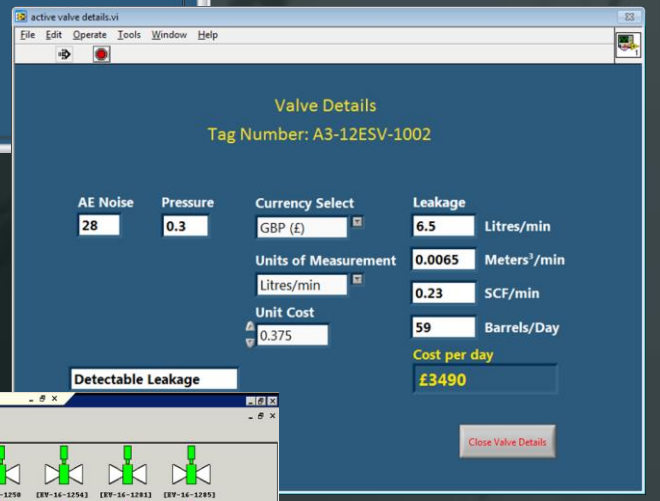
- Issues warning of any performance deterioration
- Remote access to data and analysis functions
- Provides trending, benchmark comparison, reports and audit records
- All ESV operations are recorded
- Monitors the actuator supply pressure and strain between valve operations
- Seamlessly integrates with customers' Site Automation Systems (SAS)

APPLICATIONS

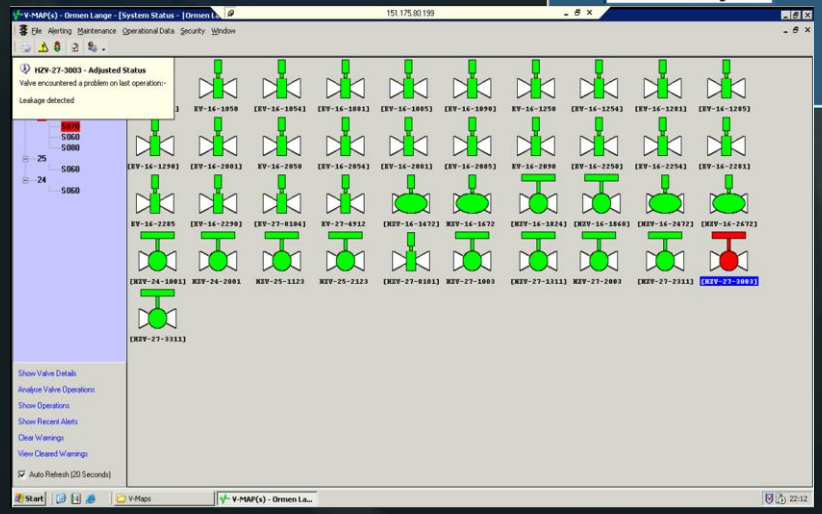
- Asset Integrity Management (AIM)
- Risk Based Inspection (RBI) programmes
- Pre-shutdown planning activities to maximise ROI
- Trouble shooting to avoid shutdowns
- Reliability data for confirmation of Safety Integrity Levels (SILs)



Detect

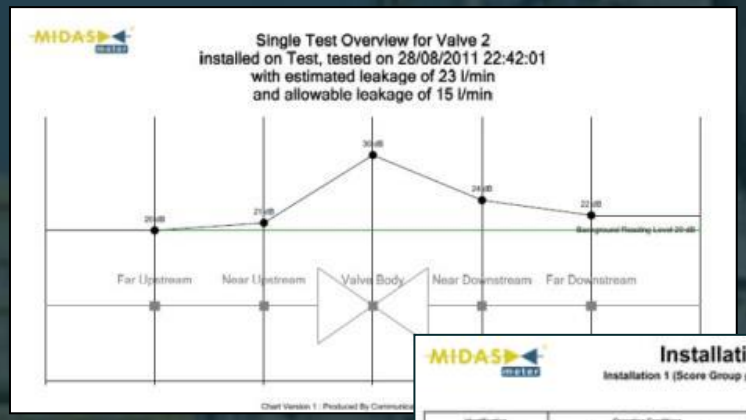


Quantify

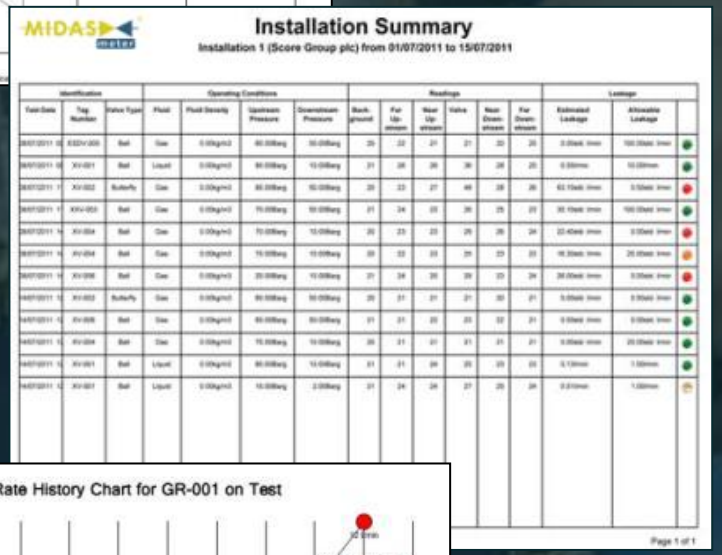


Trend

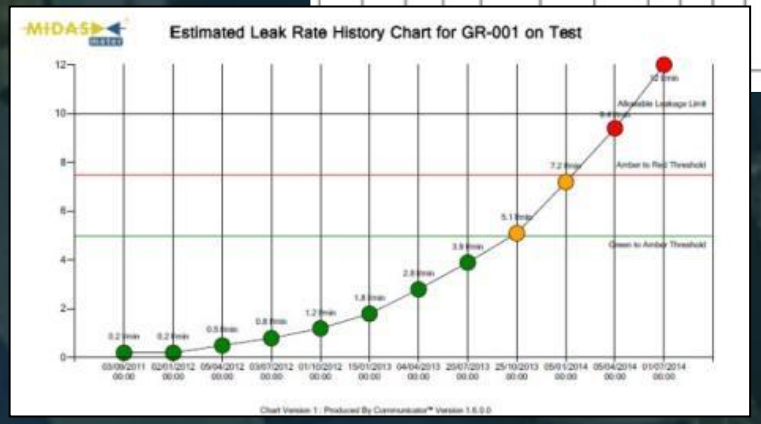
MIDAS Meter® - For hand-held leak detection, quantification and trending



Detect



Quantify



Trend

BENEFITS

- Reduced operating costs
- Maximised profitability
- Minimised losses
- Optimised process efficiency
- Optimised reliability and uptime
- Minimised safety and environmental risks

FEATURES

- Completely portable and easy-to-use
- Non-intrusive and safe for use in hydrocarbon environments
- Integral display for use stand alone
- Rechargeable battery
- Bluetooth from sensor to PDA for data logging/quantification analysis
- Data download and export capabilities

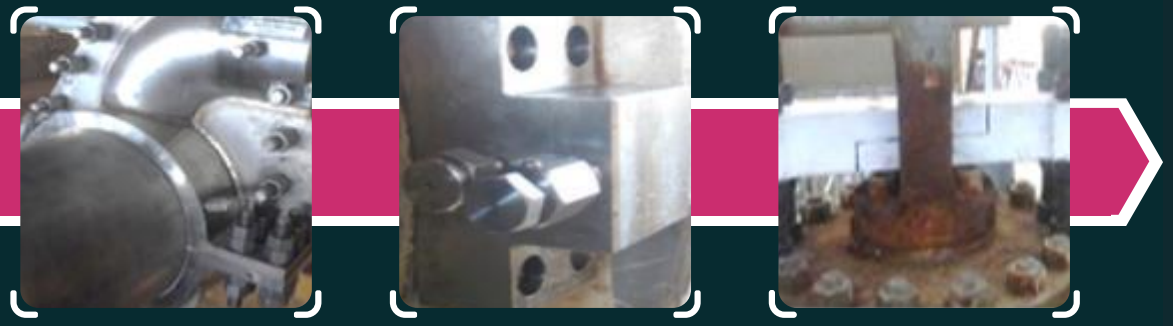
APPLICATIONS

- Asset Integrity Management (AIM)
- Risk Based Inspection (RBI) programmes
- Pre-shutdown planning activities to maximise ROI
- Trouble shooting to avoid shutdowns

MAINTENANCE SOLUTIONS

NON-INTRUSIVE

- Valve Integrity clamps (stem, gland & plug)
- Pipe & flange integrity clamps
- Isolation barrier sealant injection
- Leak sealing solutions
- Gland packing adjustment
- Controlled bolting
- Composite techno-wrap



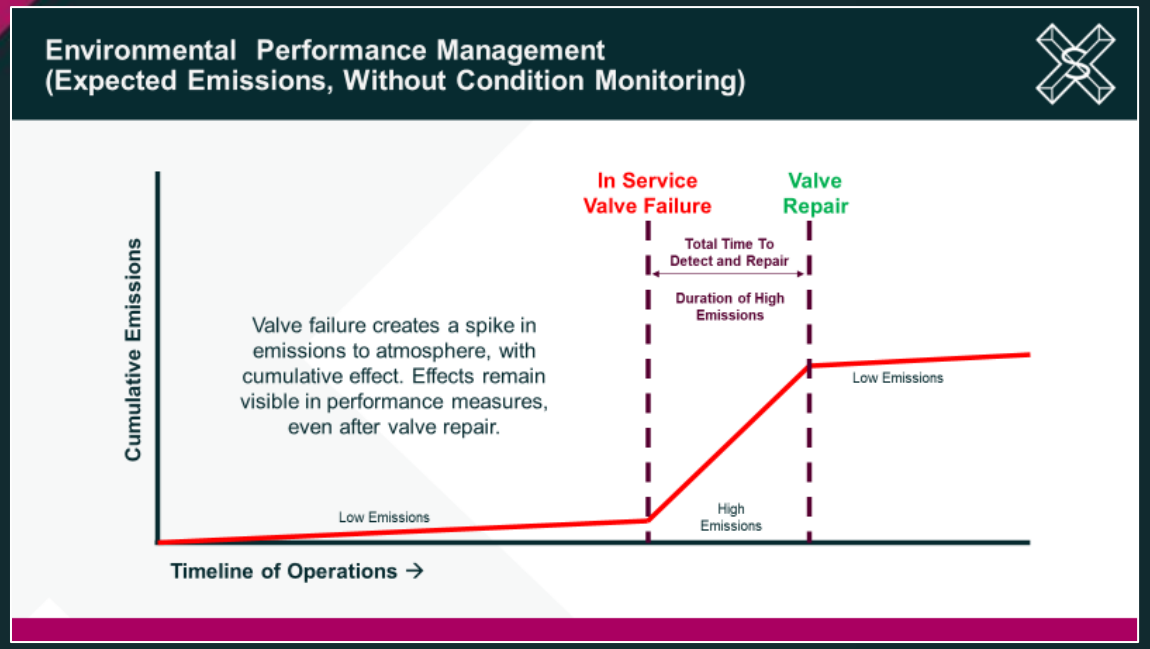
PLANNED

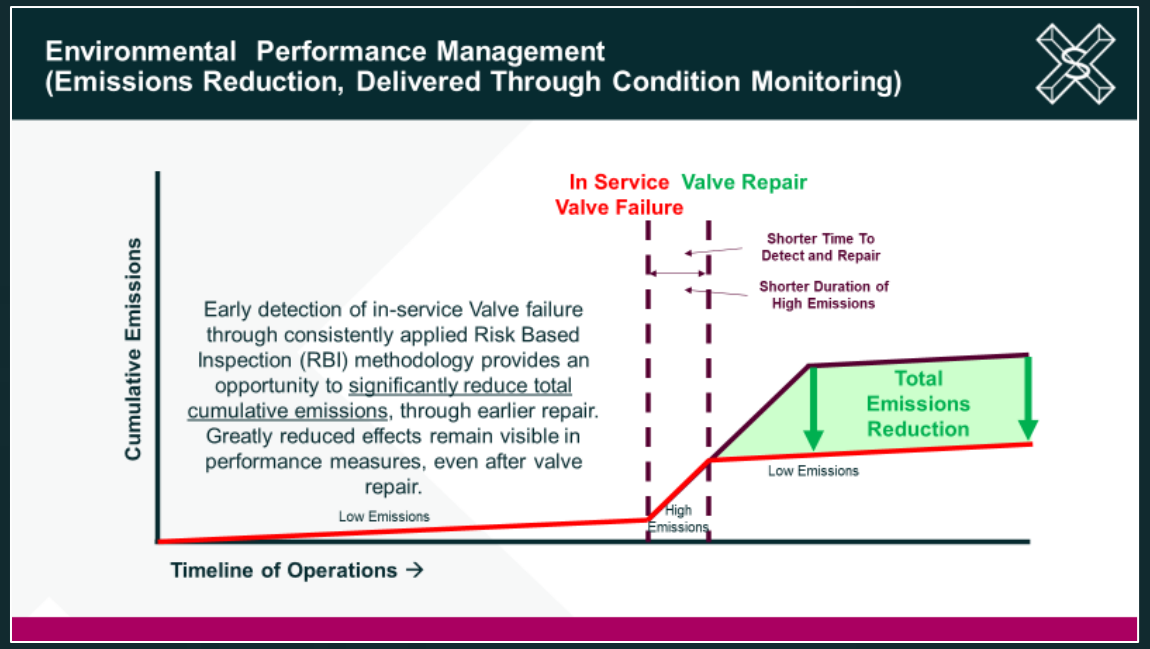
- New valve & actuator supply
- Joint integrity management
- Valve & Actuator overhaul & repair
- PSV inline testing & recertification
- Lagging inspection & repair
- Instrumentation/control systems inspection, repair, assembly & supply
- Hose manufacture & supply
- On-site machining & fabrication

Score **Group**

How to Reduce Process Emissions

With Valve Diagnostics Equipment / Systems and Targeted, Fast and Effective Repairs.





Case Study
Campaign undertaken at Processing Plant

01

Site Survey
Identified losses of 540 tonnes per annum

02

Data Analysis
Maintenance strategy developed

03

Mitigation
Mobilised to undertake non-intrusive maintenance

60% reduction achieved

04

Improvement
Mobilised to undertake intrusive maintenance

84% reduction achieved on total emissions

Identified & Repaired

- ✓ 178 On-line leaks repaired – valve glands, screwed fittings, instrument tubing and bolted joints
- ✓ 8 Isolation valves identified with through bore leakage – injected with isolation barrier solutions
- ✓ 700+ Valves overhauled
- ✓ 1086 Flanged joints assembled
- ✓ 221+ Flange faces re-machined to spec
- ✓ 142 New valves supplied

FLARING AND VENTING SOLUTIONS

BENEFITS OF PARTNERING WITH SCORE

- Safe, efficient and sustainable solutions
- Access, without complexity and compromise on quality
- More than 40 years of service in the UKCS
- Knowledge share and collaboration
- Specific Emissions Elimination Program (EEP) to reach net zero targets
- A significant contribution to Environmental, Social and Governance objectives and enhance overall business performance

Score **Group**

Working together and implementing our innovative technologies and proven program will help you eliminate emissions.

For consultation or further details, email: EEP@score-group.com

Thank You

kellas MIDSTREAM

Methane Emissions Monitoring

CATS Terminal (Teesside)

February 2022

Project Canary

Kellas (CATS Terminal) is the first installation of a Project Canary system outside the USA

- Project Canary is a for-profit Public Benefit Corporation, formed to deliver independent Environmental Social Governance (ESG) data; it employs a team of scientists and engineers and is recognised for uncompromising standards
  - The Project Canary advisory board includes members from the science, engineering and business world including, Lord John Browne, former CEO of BP.
- Kellas, supported by its owners Blackrock and GIC, explored the technology options available to continuously measure methane emissions at CATS
- The technology review identified only one product, Project Canary, that was ready for commercial operation and two others that were in the latter stages of development and field trials
- Kellas moved quickly to formalise a commercial agreement with Project Canary to install the first Project Canary system in the UK – and the first application, worldwide, outside of the US

Technology Overview - Project Canary (1)

Continuous real-time methane monitoring, leak detection, and alarms

- The CATS Terminal installed 12 x ‘Canary X’ methane sensors in December 2021
- Delivers **continuous methane monitoring**, with automated alarms to the operator
- The ‘Canary X’ sensor package includes:
  - Methane sensor – can measure methane gas fluctuations down to 250ppb
  - Wind sensor
  - GPS sensor
- The technology is being actively developed, tested, and optimised at Colorado State University’s METEC (Methane Emissions Technology Evaluation Centre
  - Integrate sensor data and cloud analytics to offer a complete IoT solution to detect and quantify methane emissions
  - Advanced filtering techniques to improve fidelity of sensor data, and enhance accuracy of the quantification model
  - The initial focus for quantification modelling is upstream facilities (eg well pads)
  - Midstream plants are not yet covered by the quantification algorithms

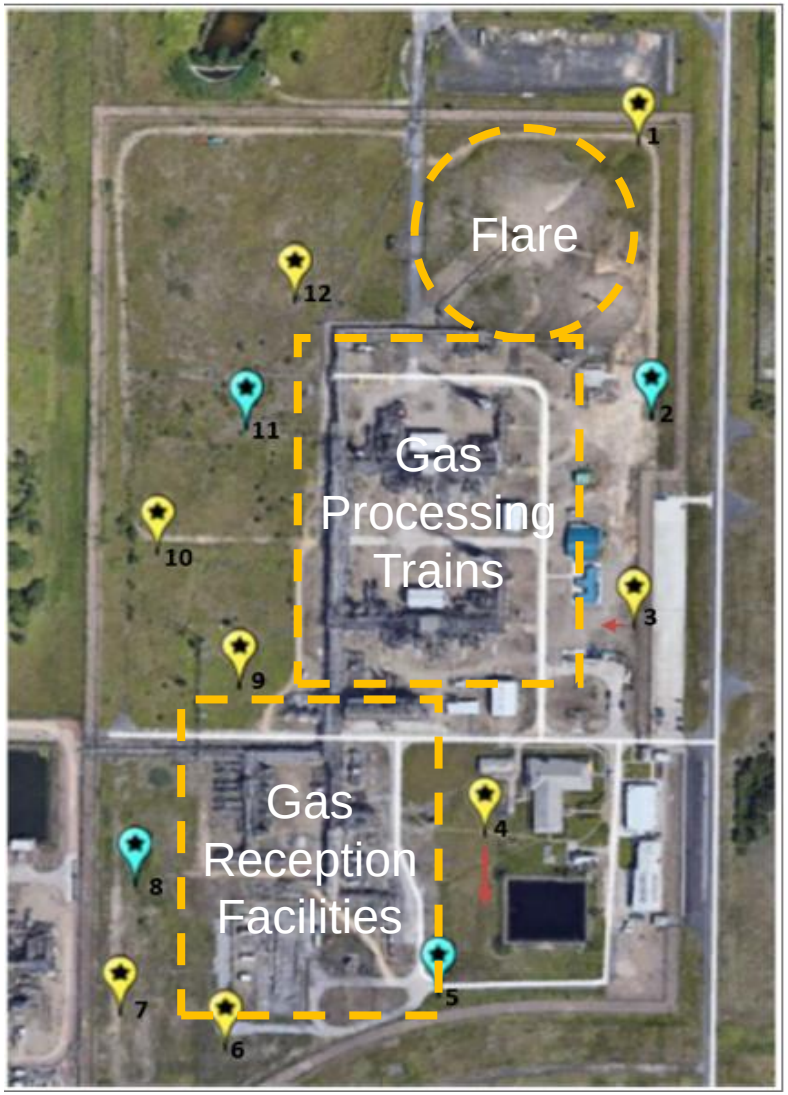
Technology Overview – Project Canary (2)

Detect, locate and quantify emission sources, allowing operators to quickly catch and remediate leaks

- The Canary X units are completely stand alone, and are solar powered/ charged
  - operate for upto 4 days on a single charge (should solar be compromised).
- Communication of data is via 4G cellular comms to the USA, with the data being sent and then presented via a web accessible dashboard
  - Via Vodafone 4G mobile phone network, with data encrypted
- Access to the dashboard is granted to individuals on a read only basis.
- Alerts are configured by agreement with the Project Canary Team and are sent to individuals by email and/or text message.
  - we have configured alerts each time a Canary measures 10ppm or above
  - the Ops Team then investigate via the dashboard and in the field as necessary

Continuous methane monitoring – CATS system

12 units strategically positioned around the perimeter of the CATS Terminal operational facilities

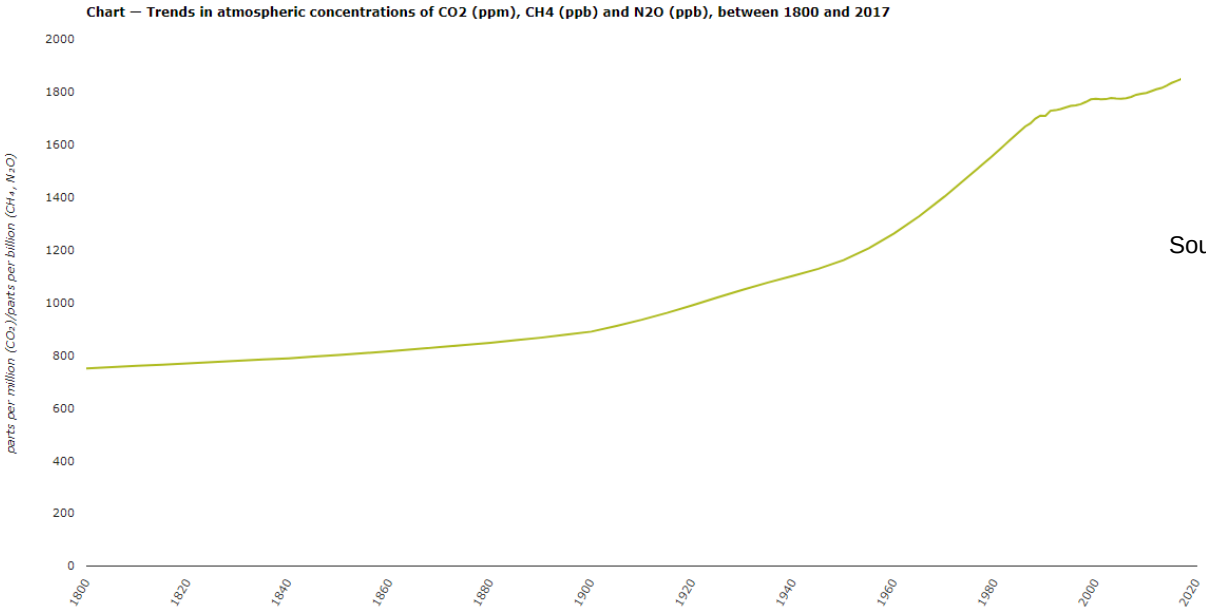


- The units we have installed are the ‘Canary X’ units solely to measure Methane, with the addition of wind speed and direction on four strategically placed units (marked blue on the aerial plot).

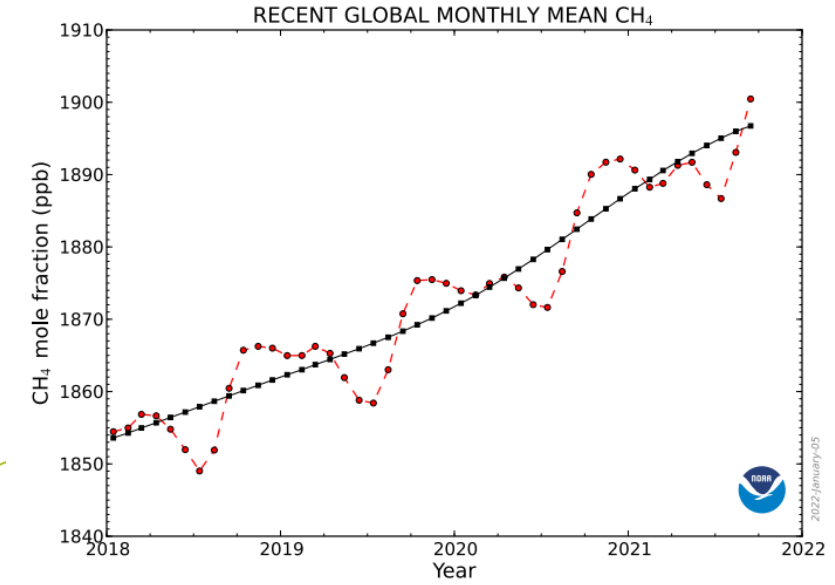
- Photo above: solar powered ‘Canary X’ (#4 on map)

Trends in Atmospheric ("Background") Concentration of Methane

Concentration of methane in the atmosphere has more than doubled since 1800; to 1.90ppm (1900ppb) in January 2022



Source: European Environment Agency https://www.eea.europa.eu



Source: NOAA Global Monitoring Laboratory, https://gml.noaa.gov/

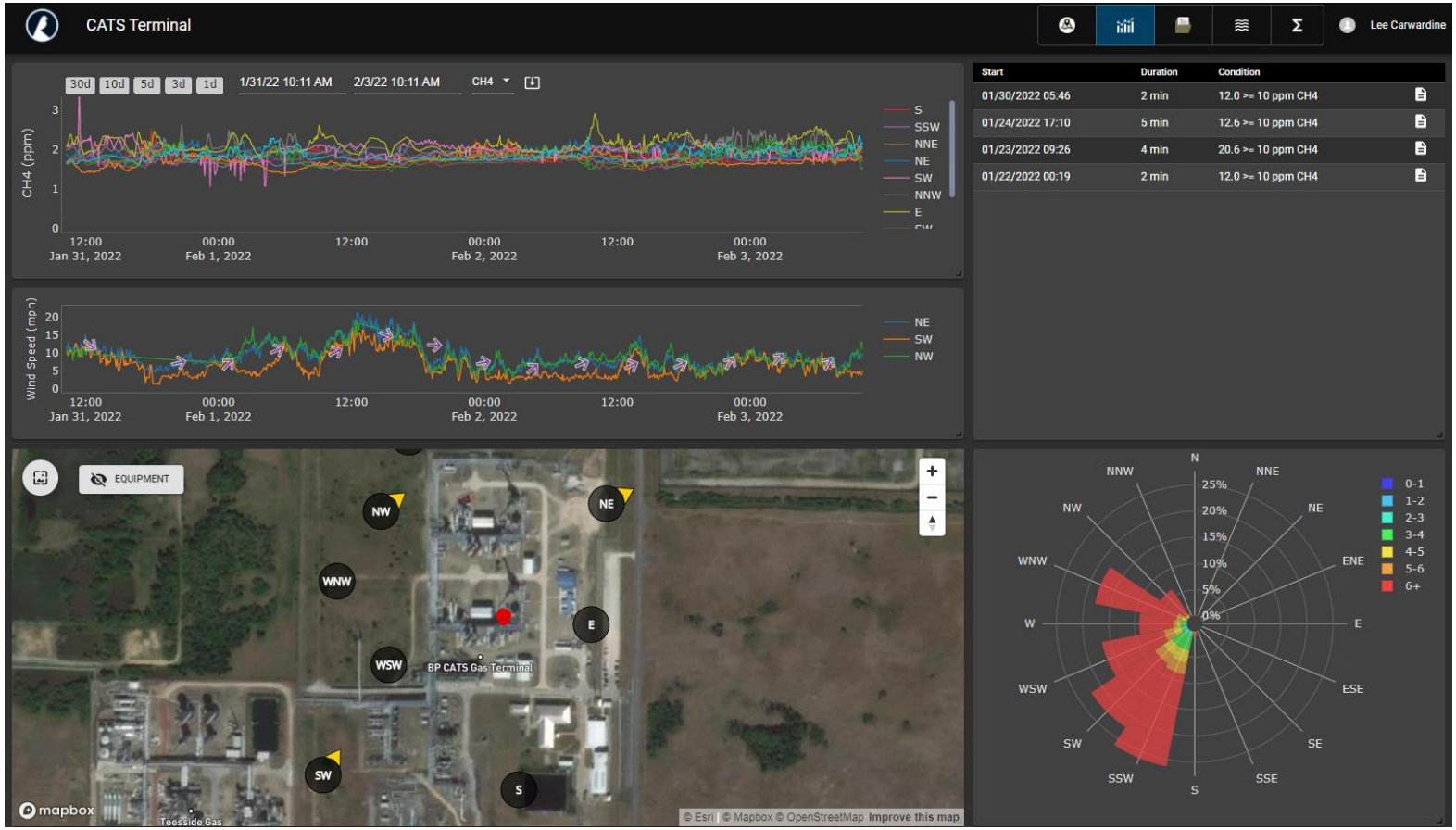
Installation & Initial Operating Experience

Detect, locate and quantify emission sources, allowing operators to quickly catch and remediate leaks

- Working with the Project Canary Team has been straightforward, even though based in US
- Training has been rolled out to key users in the engineering and ops teams
  - Minimal time zone challenges, and customs delivery issues
  - Contract discussions were straight forward – we are leasing the units for a fixed period (several years) at a fixed annual fee
- The delivery, install and commissioning went well
  - Support from a Project Canary Technician on-site during the install was beneficial as there were a few issues getting some Canary Units connected to the 4G network.
- Training has been rolled out to key users in the engineering and ops teams
- Dashboard is easy to use

Dashboard Screenshot – ‘baseline’

3 days data from CATS Terminal (February 2022) – consistently measuring ‘background’ levels of ~ 2 ppm CH4



- Top left graph shows Methane readings in ppm (background ~ 2ppm).
- Middle graph shows wind speed and direction – to aid diagnostics when determining potential release points for likely emissions
- Radar plot - the colour represents the wind speed (in mph) and the percentage represents the duration of time that the wind has been from that direction at the associated speed

Dashboard Screenshot – ‘event’

Short duration excursion (methane peak at ~20ppm identified in SW corner of CATS Terminal on 23 January 2022

- Wind direction suggests the event emanated from offsite and lasted for less than 5 minutes
- Detection by only one Canary X suggests the event/source was extremely localised