THE SNIFFERS

Realizing your Environmental and Sustainability Ambition

An **intero** Company

Methane Mondays

OGMP 2.0 compliant emission measurements

Date: 16/05/2022

Cindy Verhoeven – Regional Business Manager

Emission Reduction
Energy Savings
Pipeline Integrity

The Sniffers Environmental & Integrity Service Provider

Emission Management
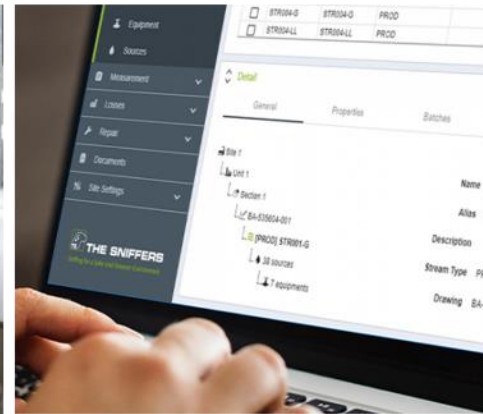Pipeline Integrity

35 Countries
Worldwide experience

9.000
Emission Reduction Projects

Innovative Technologies,
Equipment and Applications

Certified & accredited
ISO 9001- 14001 / ISO 17025

612-TEST Belac   389-TEST Israc

Realizing your Environmental, and Sustainability Ambitions and safe Pipeline Operations

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Emission Reduction Broad range of Services

LDAR
Fugitive Emission
Management
HFS / PID / FID

Hybrid LDAR
Fugitive Emission
Management
OGI Camera

Methane Accounting
Program / OGMP 2.0
compliance

Storage Tank, LNG
Emission
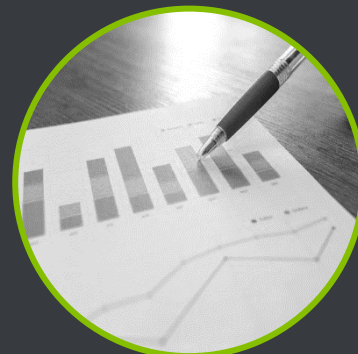Management

Emission
Management
Software
SFEMP

IoT, Ai,
Remote Sensing,
Drones & Satellites
Innovation

Training
Competence
Development

Environmental
Program
Development

Benchmarking
Emission
Performance

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Level Scenario

Level 1	Venture / Asset Reporting
	• Single, consolidated emission factors
	• Only applicable where company has limited information sharing

Level 2	Emission Category
	• Report emissions based on methane emissions categories
	• Estimates based on emission factors

Level 3	Emission Source Level **Source based inventory**
	• Emissions allocated to individual source types
	• Estimates based on generic emission factors

Level 4	Emission Source Level
	• Emissions allocated to individual source types
	• Estimates based on specific EFs and direct measurements

Level 5	Site Level
	• Emissions allocated to individual source types
	• Reporting based on site-level measurements to reconcile source and site level emissions estimates

GOLD Standard
Plan in place to report at level 4/5 within 3 years (5 for JV's)

Saudi Aramco - Fadhili Gas Plant

Reporting against OGMP2.0

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What do companies want?

- Understand current emission picture
- Compliance
- Targets: Able to monitor improvements
- Data intelligence
- Reassurence: validation, prognoses...

Data needs to be:

- Complete
- Reliable
- Traceable
- Actionable
- Comparable

Methane intensity %

How?

Inventorizing
measuring
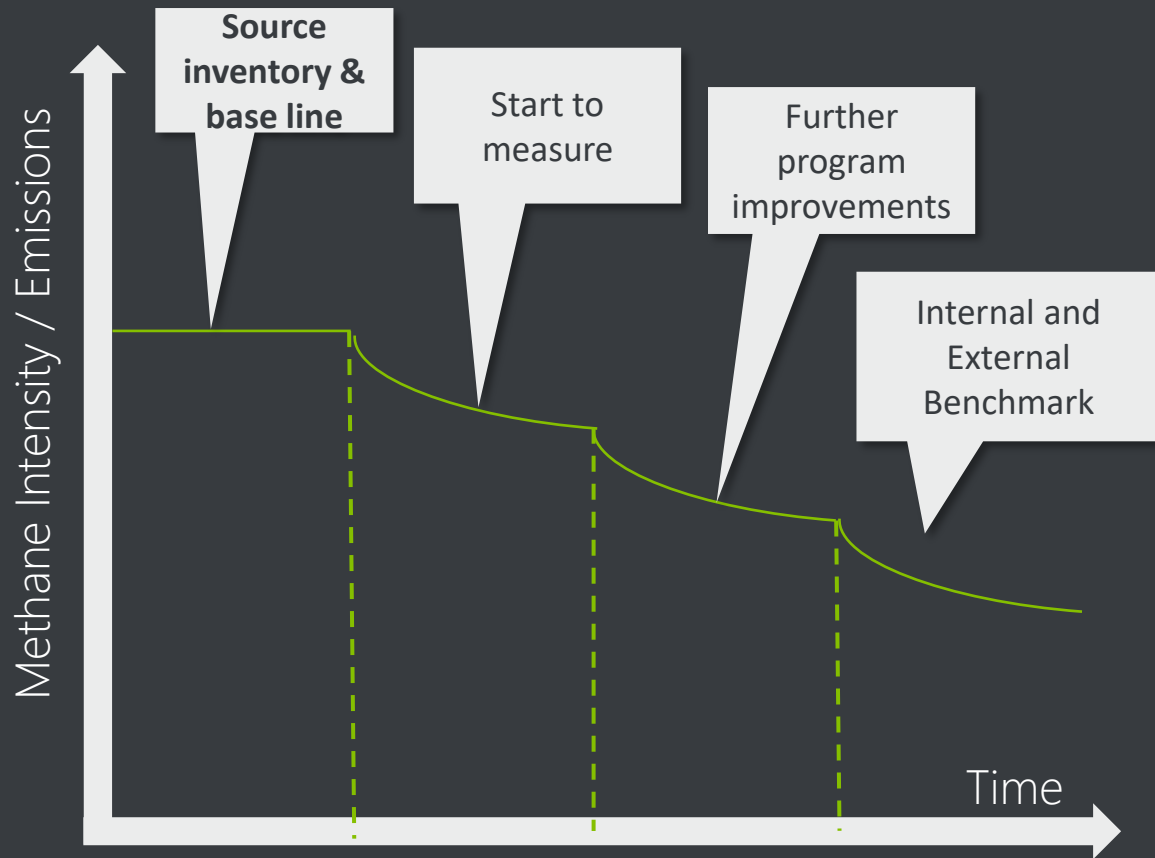Structured programs: LDAR

How not:

estimating
modelling
Random projects

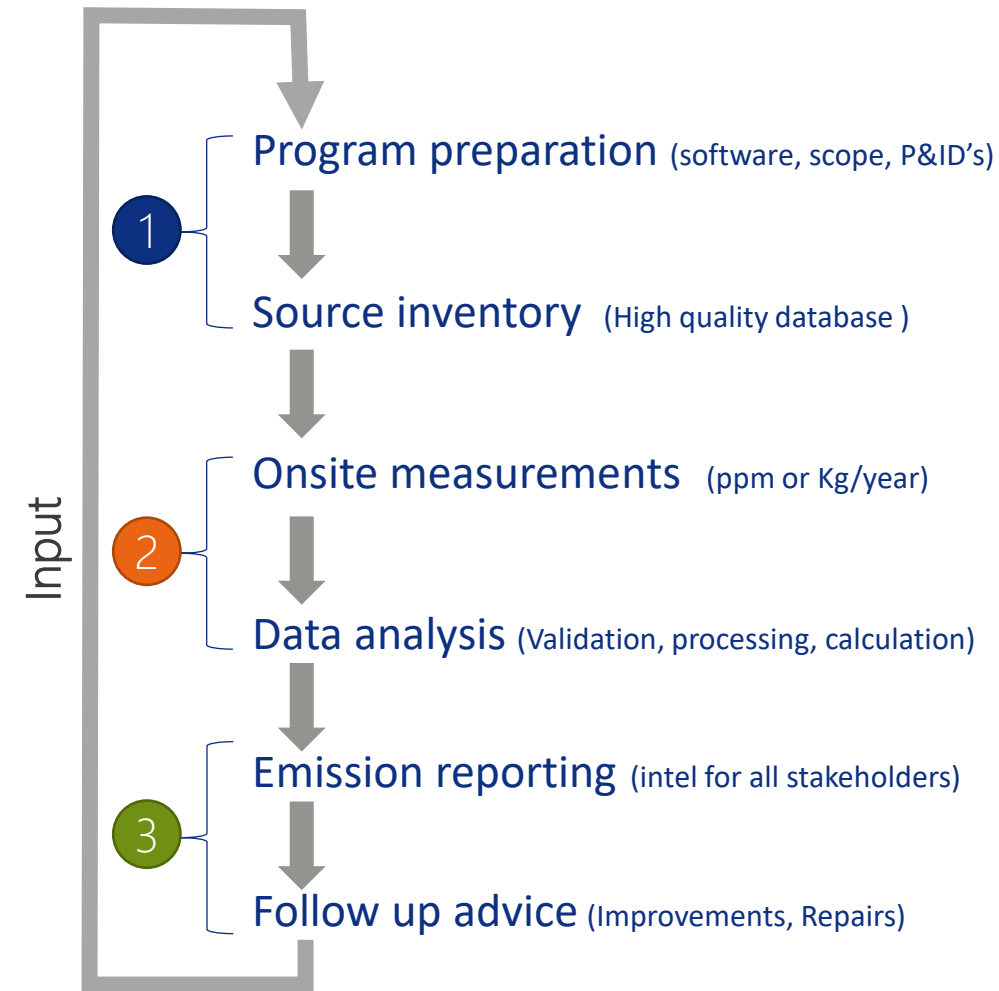# OGMP 2.0   Moving from L1 to L5

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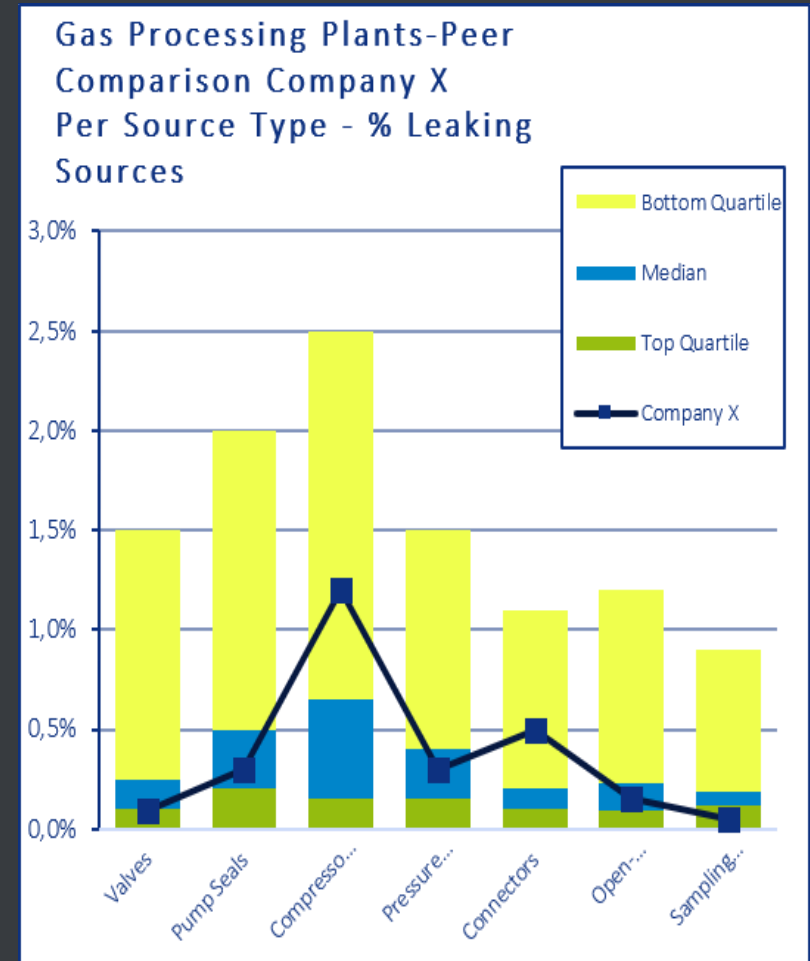
Detailed and reliable emission data allows stepwise improvements

reliable and robust project execution :

1. **LDAR protocol**, standards / regulation (EPA M21, EN15446, OGMP 2.0, NTA8399)

2. **LDAR scope cycle:** Define annual measurement scope

3. **Inventory** of sources + VOC streams: Detailed, high quality and always up to date

4. **Combine <u>carefully chosen</u> measurement techniques:** FID / (Q)OGI / HFS / flowmeter / VPAC / drone / VSIR / fixed sensor …

5. **<u>people</u> :** Dedicated, skilled, experienced

6. Emission management **software** (forget about Excel)

7. **Optimize:** automization, innovation, software integration

8. **Discipline:** stick with the program cycle
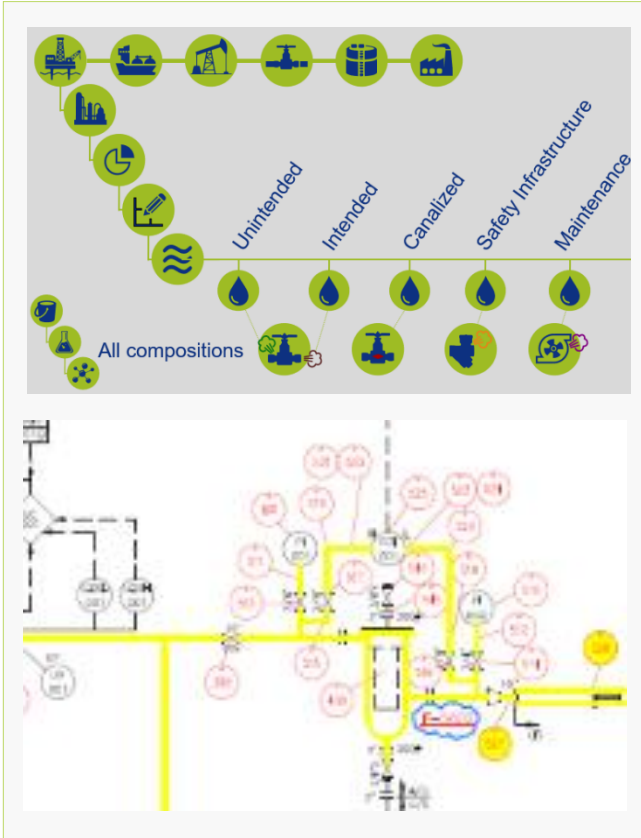
① = Identify   **②** = quantify   **③** = Improve

LDAR cycle:

Input

Program preparation (software, scope, P&ID's)

①

Source inventory (High quality database)

Onsite measurements (ppm or Kg/year)

②

Data analysis (Validation, processing, calculation)

Emission reporting (intel for all stakeholders)

③

Follow up advice (Improvements, Repairs)

How to ensure success and drive emission reduction results?

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1. Identify:
Detailed & high quality inventory

2. Quantify:
Fit for purpose measurements

3. Improve:
Emission reporting and benchmarking, Software

# Emission Management Program

- Bagging / HFS:
  - Measurements: 25-50 sources / day
  - Direct loss measurement (Kg/yr)
  - Most accurate field measurement
  - Development of new emission correlation factors (e.g. CH4)
- Sniffing (FID, PID, CH4 laser) :
  - Measurements: 800-2000 sources / day
  - Concentration measurement, converted into loss using correlation tables (EN15446, EPA M21 PI/SOCMI)
- OGI (infrared camera):
  - Screening: 2000-5000 sources / day
  - Only qualitative, converted into loss using Leak-no-leak factors, or combined with HFS / QOGI tablet / sniffing for quantification
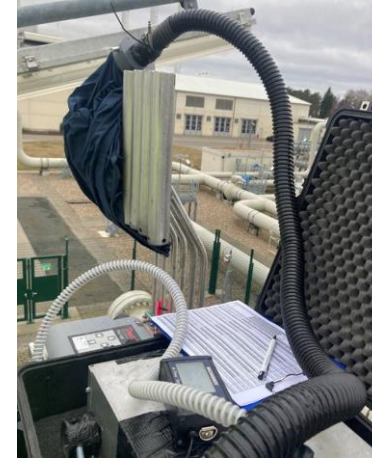
High quality Sources based measurements for fugitive emissions: Most common techniques

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PID-FID
- EPA Method 21 Petroleum Industry factors

Equipment Type (all services)	Default Zero Emission Rate (kg/hr/source)	Pegged Emission Rates (kg/hr/source) Mar		Correlation Equation[b] (kg/hr/source)
		10.000 ppmv	100.000 ppmv	
Leak Rates for Petroleum Industry (Refinery, Marketing Terminals and Oil and Gas Production)				
Valve	7.8E-06	0.064	0.14	$2.29E-06 \times SV^{0.746}$
Pump	2.4E-05	0.074	0.16	$5.03E-05 \times SV^{0.610}$
Other[c]	4.0E-06	0.073	0.11	$1.36E-05 \times SV^{0.589}$
Connector	7.5E-06	0.028	0.030	$1.53E-06 \times SV^{0.735}$
Flange	3.1E-07	0.085	0.084	$4.61E-06 \times SV^{0.703}$
Open-ended line	2.0E-06	0.030	0.079	$2.20E-06 \times SV^{0.704}$
Leak Rates for Synthetic Organic Chemical Manufacturing Industry (SOCMI)				
Gas valve	6.6E-07	0.024	0.11	$1.87E-06 \times SV^{0.873}$
Light liquid valve	4.9E-07	0.036	0.15	$6.41E-06 \times SV^{0.797}$
Light liquid pump	7.5E-06	0.14	0.62	$1.90E-05 \times SV^{0.824}$
Connector	6.1E-07	0.044	0.22	$3.05E-06 \times SV^{0.885}$

Optical Gas Imaging - OGI
- Leak/No Leak Factors

Component type	Emission factor type	Emission factor (g/h/component) for specified leak definition (g/h)			
		3	6	30	60
Valves	No-leak	0.019	0.043	0.17	0.27
	Leak	55	73	140	200
Pumps, compressors	No-leak	0.096	0.13	0.59	0.75
	Leak	140	160	310	350
Flanges	No-leak	0.0026	0.0041	0.01	0.014
	Leak	29	45	88	120
Other components	No-leak	0.007	0.014	0.051	0.081
	Leak	56	75	150	210

o Development of new specific emission factors and CH4 correlation factors

Mass Emission Calculations

High Flow Sampling or Bagging

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Our custom made HFS in detail

1. Heavy-duty trolley
2. 1 ½" tubing, 2 auto-quick connectors
3. 3D-printed Intake
4. 3D-printed Exhaust + FID/PID connection for concentration (ppm)
5. Air fan, constant flow ± 205lpm, Explosion protected zone 1
6. Anti-static Capture bag, 80cm x 80cm with a 3D-printed connector
7. Methane Gas Detector 0,1ppm → 100VOL%
8. In-line flow meter, daily check-up the flow of the air fan.

HighFlowSniffer

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Hybrid emission calculation

equipment	equipment_type	source	position	Equipment_location	access_level	ppm_value LDAR	loss_amount correlation socmi (kg/yr)	loss_amount correlation refinery (kg/yr)	loss_amount OGI factor 6g/h (kg/yr)	loss_amount OGI factor 3g/h (kg/yr)	loss_amount high flow sampler (kg/yr)
CN	NR	CN	OU	6m tWv V-190	0	80000	559,52	51,61	630	470,4	80,30
CN	RA	CN	IN	tZOv V-190, h = 1m	1	20000	164,06	18,63	630	470,4	17,04
CN	RA	CN	IN	tZOv V-190, h = 1m	1	10000	88,83	11,19	630	470,4	17,94
CN	RA	CN	IN	tZOv V-190, h = 1m	1	40000	302,97	31,01	630	470,4	7,36
CN	NR	CN	IN	midden in V280 en V250	0	10000	88,83	11,19	630	470,4	48,51
CN	NR	CN	OU	tOv production area	0	30000	234,87	25,10	630	470,4	Hersteld
CV	NR	CN	MI	2m tNWv V-910	0	50000	369,12	36,54	630	470,4	37,15
CV	NR	CN	OU	op TK365	1	8000	72,91	9,50	630	470,4	893,53
VA	BA	FL	IN	tWv TK130, h = 1,8m	2	80000	559,52	108,36	378	243,6	142,71
VA	NE	CN	OU	tOv TK335, h = 4m	0	10000	88,83	11,19	630	470,4	Hersteld
VA	BA	CN	OU	tWv TK335	0	9000	80,93	10,36	630	470,4	Hersteld
CN	EL	CN	IN	tWv V180	2	6000	56,53	7,69	630	470,4	40,55
CN	NR	CN	OU	tWv compressorgebouw	2	80000	559,52	51,61	630	470,4	2,37
CN	RA	CN	OU	tNOv V350	3	4900	47,25	6,63	630	470,4	1,25
VA	BA	CN	OU	tZv compressorgebouw	4	80000	559,52	51,61	630	470,4	121,11
VA	BA	CN	IN	tZWv koelbanken	4	90000	620,99	56,28	630	470,4	173,53
VA	BA	CN	OU	tZWv koelbanken	4	50000	369,12	36,54	630	470,4	171,60
CN	RA	CN		tNv brug	1	90000	620,99	56,28	630	470,4	Niet bereikbaar
CN	NR	CN		tZWv flair 16m, h = 2,5m	0	40000	302,97	31,01	630	470,4	1214,93

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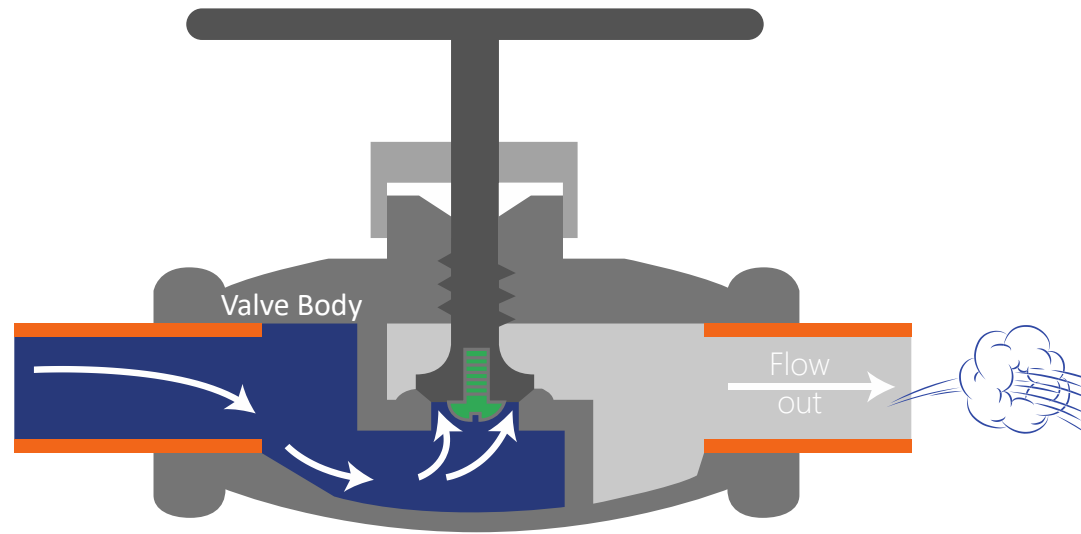# Leak Quantification by QOGI

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Flaring or Venting

Loss of VOC's, CH_4

Internally passing equipment

High losses

Examples:
pressure relief valves, safety valves, bypass valves, automatic regulated valves, check valves …

Valve Body

Flow out

Vent and Flare Losses

• Vent and Flare Loss Monitoring with VPAC II

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Results from Gas Plant Survey

Equipment	# Sources	# Leaks	% leaks	Loss (Kg/year)
Control Valve	41	3	7,3	1.854.074
Hand Valve	108	3	2,8	39.852
Pressure Safety Valve	78	1	1,3	221
Other	1	0	0,0	0
TOTAL	228	7	3,1	1.894.147

Repairing only 3 control valves saves
+1.800.000 kg/year of product

SMART scoping: Optimized effectiveness, lower cost

For building reliable emission data, it is not necessary to measure everything all the time!

100% Inventory All Sources

LDAR 25% + Leaks + HAPs + G1

OGI 75% + NA

Scope

100%

75%

50%

25%

0%

Year 1 2 3 4
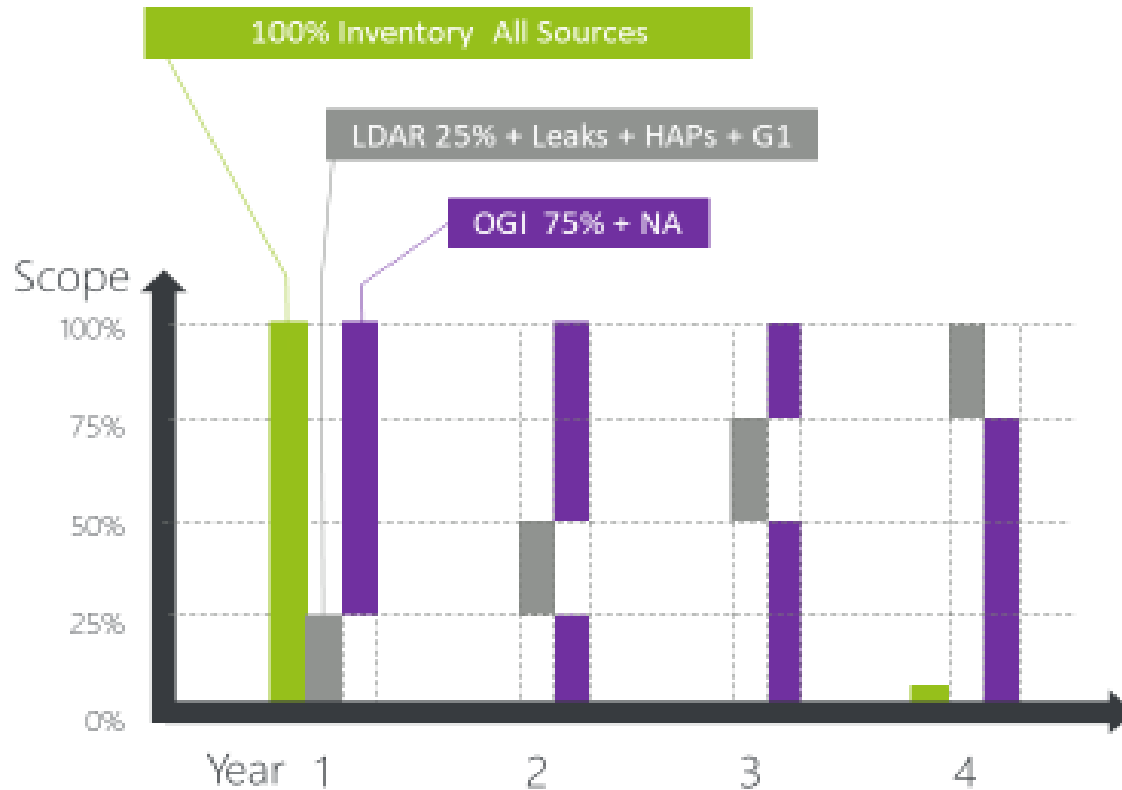
- Combined Sniffing and OGI scope + HFS
- Detect all leaks above repair threshold
- Add Sniffing scope to keep level of detail
- Attention for equipments that have a high risk of leaking: e.g. pump seals, compressor seals
- Hazardous products (HAP's) are covered
- Bottom Up approach → Actionable, data driven program

G1 = Group 1 equipments (high risk potential)
NA = Non-Accessible sources
HAP's = Hazardous Products (e.g. benzene)

High quality program, focused on leaks with highest probability and consequence (RBI), and with limited investments

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- **Maintenance:** Leak traceability and repair information, SAP integration, Inventory updates, bad actors.
- **HSE:** Leak follow up information and emission values, high focus on HAPS and risks, Emissions per medium, regulatory compliance.
- **Management:** Success rate of LDAR program, benchmarking
- **Board:** Corporate social responsibility, positioning of the company
- **Authorities:** Compliance audits, legislation, audit trails

Reports: different results for different stakeholder

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SFEMP

- Dashboard
- Inventory
  - Site
  - Units
  - Sections
  - Drawings
  - Streams
  - Equipments
  - Sources
- Composition
- Measurement
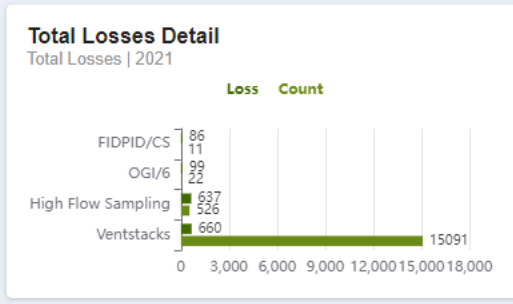- Leak & Repair
- Reporting
- Documents
- Site Settings

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Total Emissions and Savings
Total Losses | 2021

Total Emissions

1,481 kg/y

15650 sources

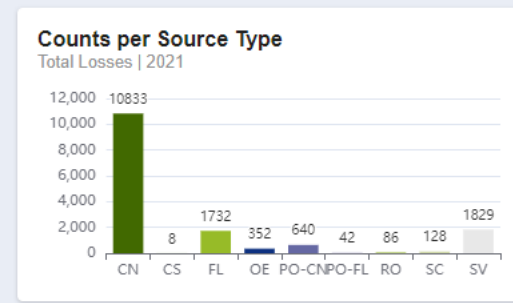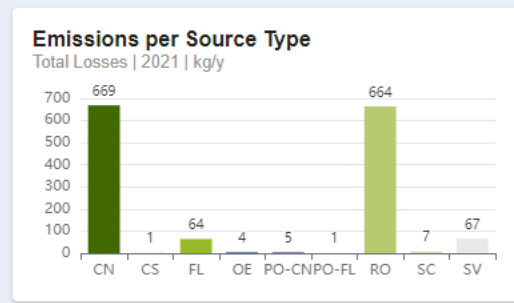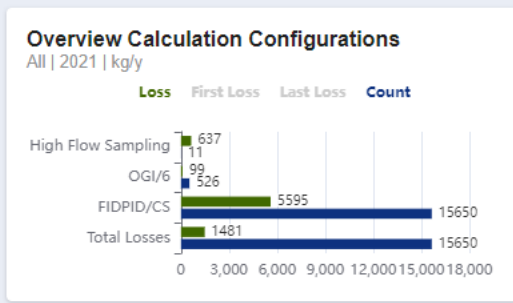First Measurement
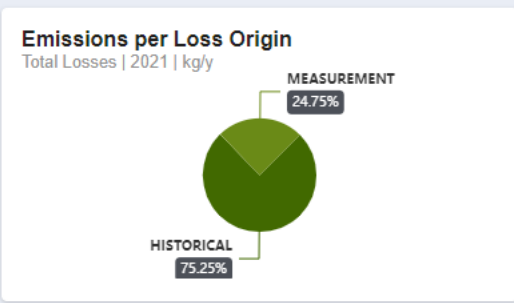1,481 kg/y

Saved Emissions
0 kg in 2021

Total Losses Detail
Total Losses | 2021

Loss   Count

FIDPID/CS   86 / 11
OGI/6   99 / 22
High Flow Sampling   637 / 526
Ventstacks   660 / 15091

0   3,000 6,000 9,000 12,000 15,000 18,000

Site Overview

Units: 3	Batch: 20	Cycle: 8
Sections: 3	Composition: 1	Project: 31
Drawings: 24	ActiveMedium: 1	ProjectScope: 33
Streams: 20	Custom Medium: 0	ProjectScopeItem: 32732
Equipments: 6051		Measurement: 32766
Sources: 15660		

Emissions per Loss Origin
Total Losses | 2021 | kg/y

MEASUREMENT 24.75%

HISTORICAL 75.25%

Overview Calculation Configurations
All | 2021 | kg/y

Loss   First Loss   Last Loss   Count

High Flow Sampling   637 / 11
OGI/6   99 / 526
FIDPID/CS   5595 / 15650
Total Losses   1481 / 15650

0   3,000 6,000 9,000 12,000 15,000 18,000

Emissions per Source Type
Total Losses | 2021 | kg/y

CN	CS	FL	OE	PO-CN	PO-FL	RO	SC	SV
669	1	64	4	5	1	664	7	67

Counts per Source Type
Total Losses | 2021

CN	CS	FL	OE	PO-CN	PO-FL	RO	SC	SV
10833	8	1732	352	640	42	86	128	1829

Repaired Leaks
2021

Repaired Leaks

80 confirmed repairs

Saved 0 kg

Open Leakers

NORMAL   11
REPAIR   14

0   3   6   9   12   15

Measurements
2021

AANTREK RONDE 2 2021   1
|AANTREK RONDE 2021   10
210019 Ventstacks Grijpskerk   22
210019-HFS   33
210019 Gasunie OGI + HFS   526
191534AL Gasunie LDAR 25% 2021   3326

0   500 1000 1500 2000 2500 3000

Emissions per Medium
Total Losses | 2021 | Top 5 | kg/y

M   1481

0   300   600   900   1,200 1,500
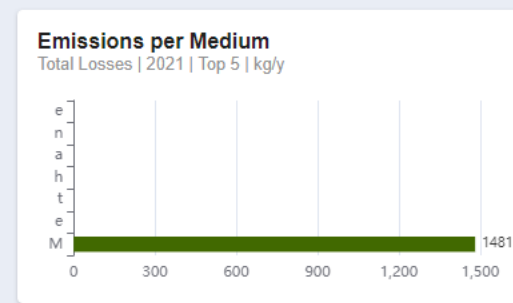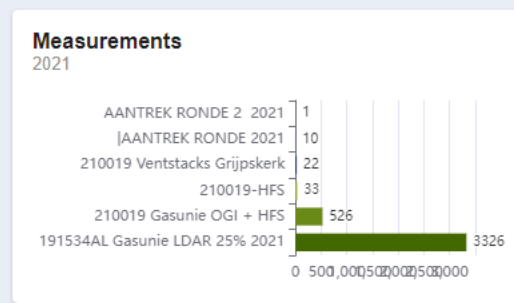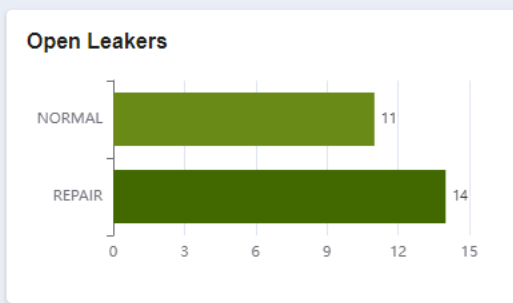
Project Status

191534BG 25% LDAR 2022

Overview:

Emissions per LossOrigin & Threshold
Total Losses | 2021 | kg/y

Loss   First Loss   Last Loss   Count

11776
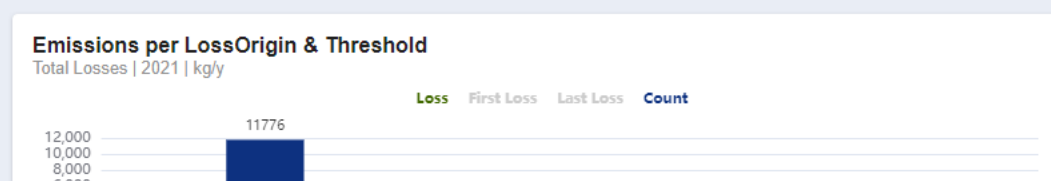
Emission Management Software – SFEMP®

SFEMP Mobile: auditable processing of field data

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Emissions per Source kg/year
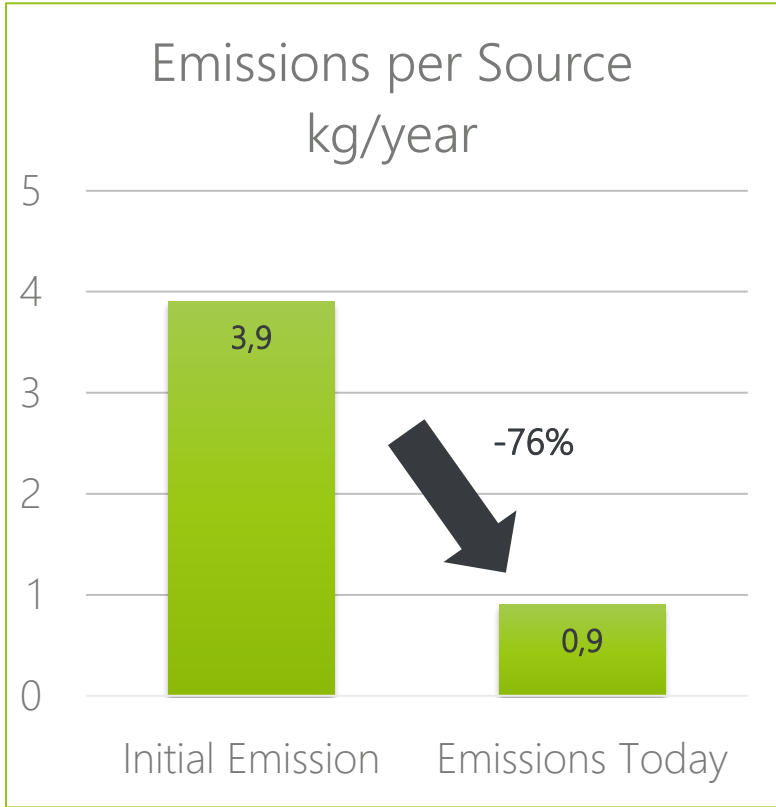
The Sniffers Study : 64 Companies - 2Mio Sources – Evolution over 6 years Fugitive

Methane Reduction after Repair Tons/year

Total 1,400 Ton Methane Savings
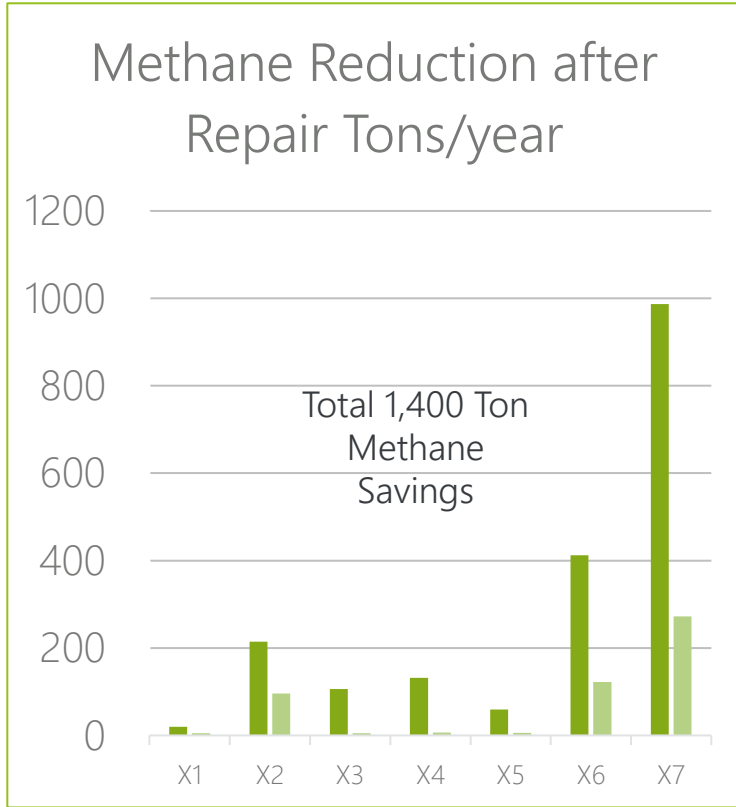
The Sniffers Study : 7 Gas Processing Plants -70% in one year Methane

LDAR Results -75% emission reduction

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Q&A
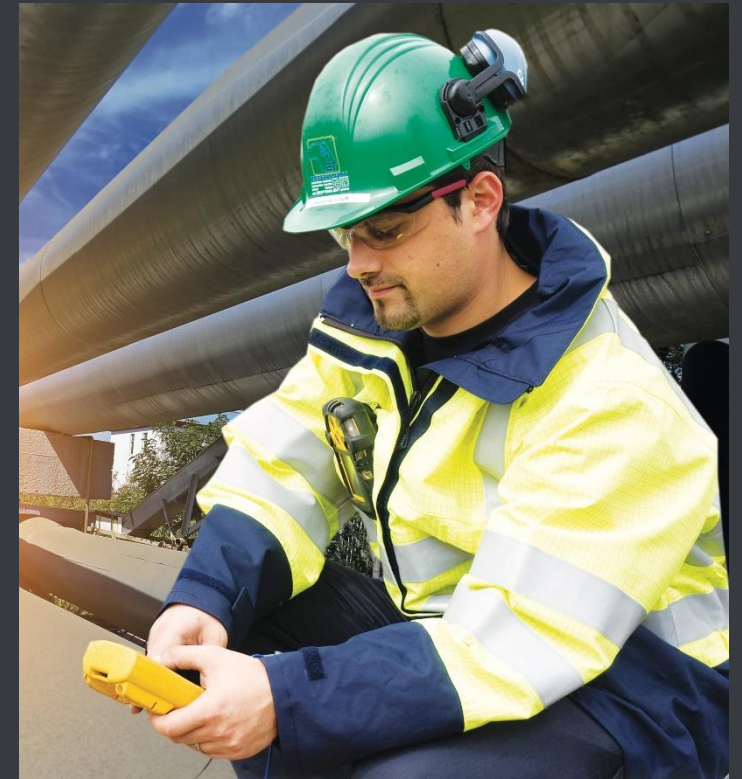
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Realizing your Environmental and Sustainability Ambition
An **intero** Company

Why mix measurement technologies?
EXAMPLE: OGI versus SNIFFING

Overview per leak class				
Class	**Number measured**	**Leaks>9ppm**	**Number leaks>RD**	**Leaks IR**
ZERO	10340	-	-	0
Below 1000	358	358	-	0
1000+	225	225	225	0
10.000+	113	113	113	12
50.000+	6	6	6	4
100.0000+	167	167	167	119
TOTAL	**11209**	**869**	**511**	**135**

LDAR study:

FID (sniffing) measurements compared to OGI camera

- Only **135** out of **869** leaks detected with OGI camera = 15,5%
- Also big leaks are missed with OGI camera
- With current OGI technology, leaks < 10.000 ppm remain undetected. CH4, as the smaller molecule is more difficult to detect by the camera.
- CH4 : Relatively large amount of small leaks, responsible for a substantial part of the total emissions
- With OGI a secondary measurement is needed for accurate quantification
- Main advantage of OGI vs Sniffing: non-accessibles can be screened from a distance

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