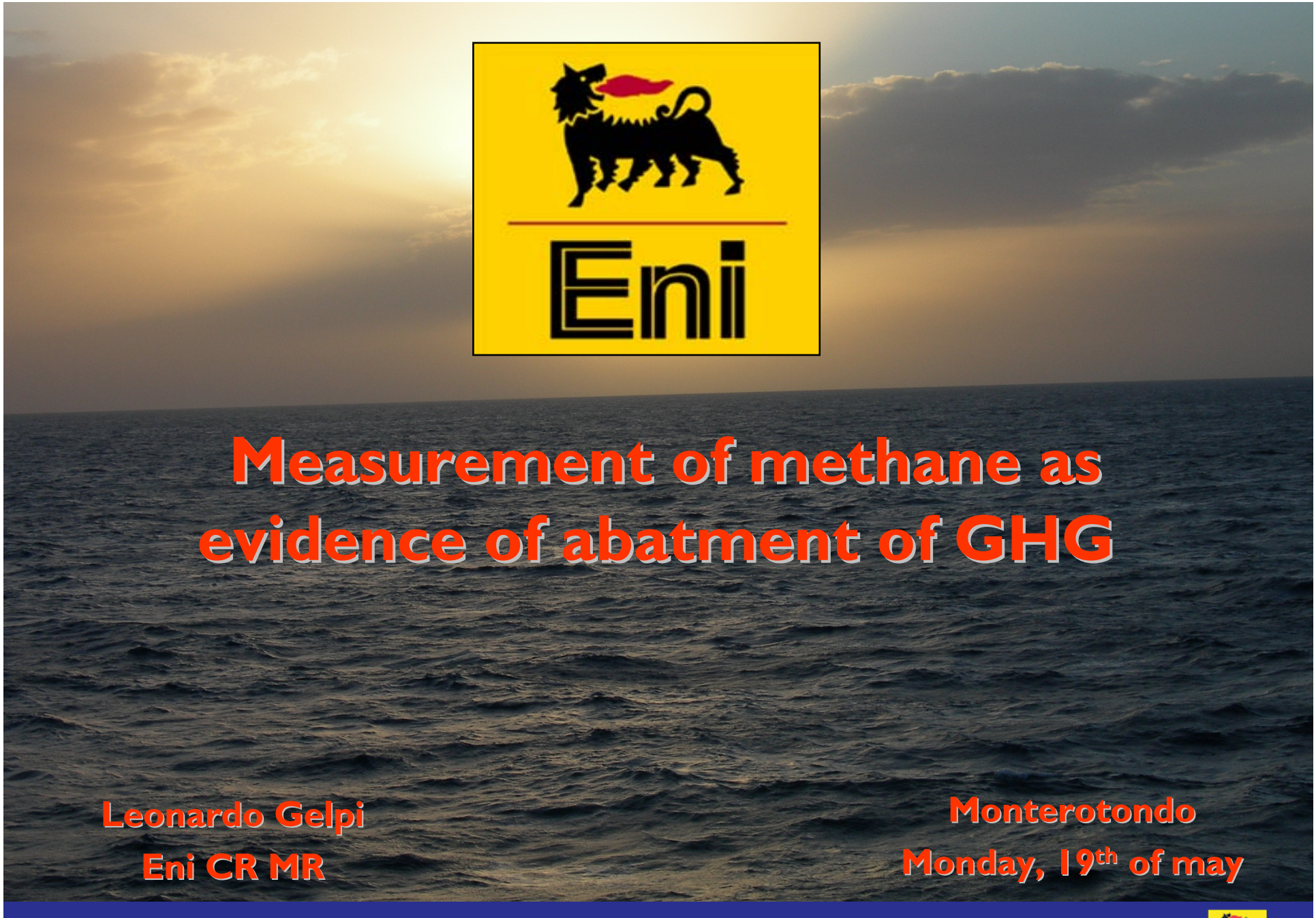

Measurement of methane as evidence of abatment of GHG

Leonardo Gelpi
Eni CR MR

Monterotondo
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Agenda

- Introduction – Flaring and GHG emissions
- Measurement Methods – Conventional
  - Indirect
  - FT- IR
- Experimental Activity – Bouri Field
- Results and Discussion

Introduction – Flaring and GHG emissions

What is Flaring ?

- Flaring is a high-temperature oxidation process used to burn combustible components of waste gases from industrial operations
- Flares are used in all segments of the oil and gas industry
- Emissions of GHG like CO_2 and N_2O are formed as product of combustion, while CH_4 emissions are due to incomplete combustion or to operational problems

Introduction – Flaring and GHG emissions

What is Venting ?

- Venting is an uncontrolled release in atmosphere of gases not used and not burned in flares
- Venting is used in all segments of the oil and gas industry
- Emissions of GHG like CH_4 are generally due to operational problems, leaks , pipes, storage or blow down

Introduction – Flaring and GHG emissions

Flaring and venting are considered one of the major source of GHG (both methane and CO2).

How can we estimate Flare and Venting Emissions?

Literature (EPA, API) and producers provide Emission Factors based on:

- fuel volume;
- composition of flared gas;
- theoretical efficiency.

EPA suggest that "properly operated flares achieve at least **98%** combustion efficiency"

Introduction – Flaring and Venting GHG emissions

These data are affected by high uncertainties as they are based on:

- Flows of flared/vented gas generally not metered
- Leakage not accounted for
- Low reliability of combustion efficiency

The preferred methods for estimating emissions are

TEST DATA

Field measurements can highlight substantial differences from emission factors

Introduction –GHG emissions

ENI R&M CR MR is involved in some projects related to GHG reductions from industrial sources.

Optical system with FT-IR Remote Sensing is the only safe method to measure point source emissions without sampling ports (chimneys, stacks and flares)

Measurements Methods

The main analytical methods for monitoring GHG emissions from Flares/vent in safe conditions are:

- **Conventional methods** applicable in controlled conditions
- **Indirect methods:** flow* and composition measurement, calorimeter + engineering calculations
- **FT-IR** Remote Sensing Method (Passive and Active Mode)
- **VIDEOIMAGING** IR and UV (laser)

* Volumetric flow is detected by sensing velocity in the pipe multiplied by cross sectional area

Measurements Methods – FT-IR

FT-IR K300 – Passive Remote Sensing System for the detection of:

- CO, CO_2
- NO, NO_2, N_2O
- HCl, SO_2, H2O, CH_4

Applicable to any emission source with T° > 70 °C, including Flares

In active mode all major GHG can be detected

FT- IR:
Fourier
Trasformed
InfraRed
Spectroscopy

Measurements Methods – FT-IR

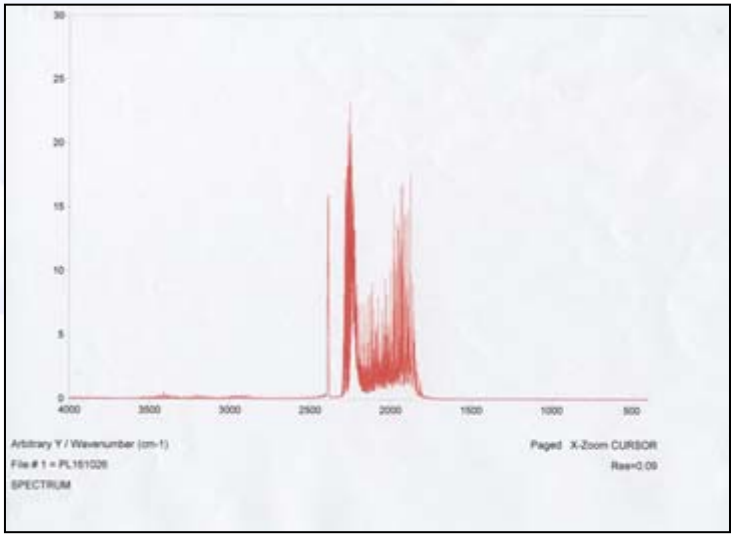
- Intensities of characteristic bands are used to identify the compounds of interest

- Algorithms were developed to subtract background level, water absorption in the optical path, temperature gradients in the plume, slant distance etc.

Parameters needed for the elaboration:

- geometric data (distance from the tip, heigth and diameter of stack)

- meteo data (Pa, T° and UR%)



Experimental Activity

BOURI FIELD

SLOUG

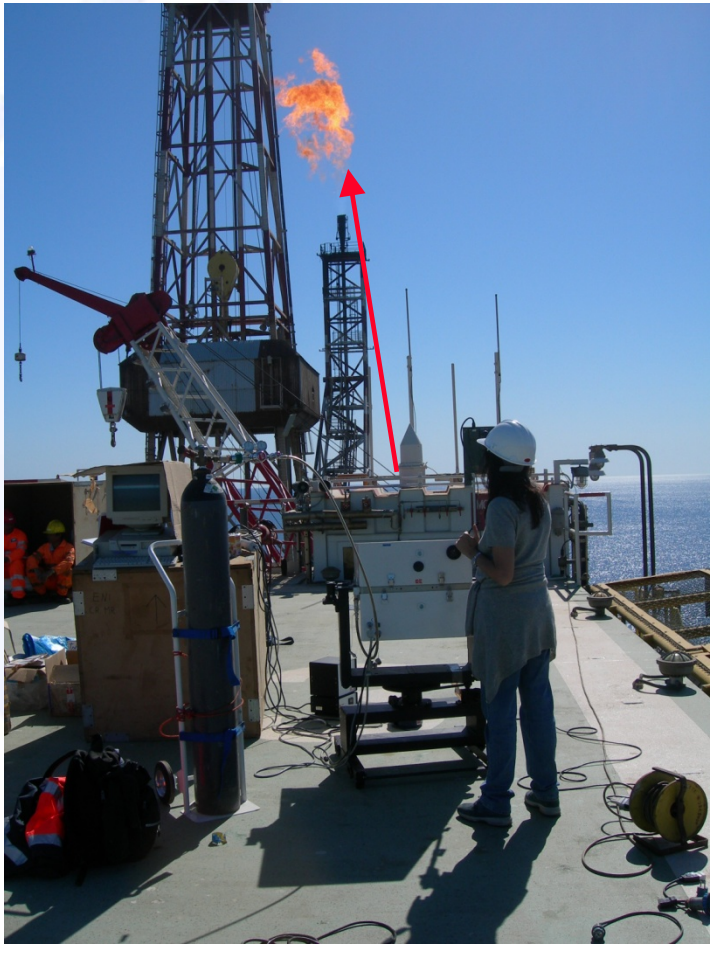
DP4

DP3

Experimental Activity

Remote Sensing FTIR Positioning

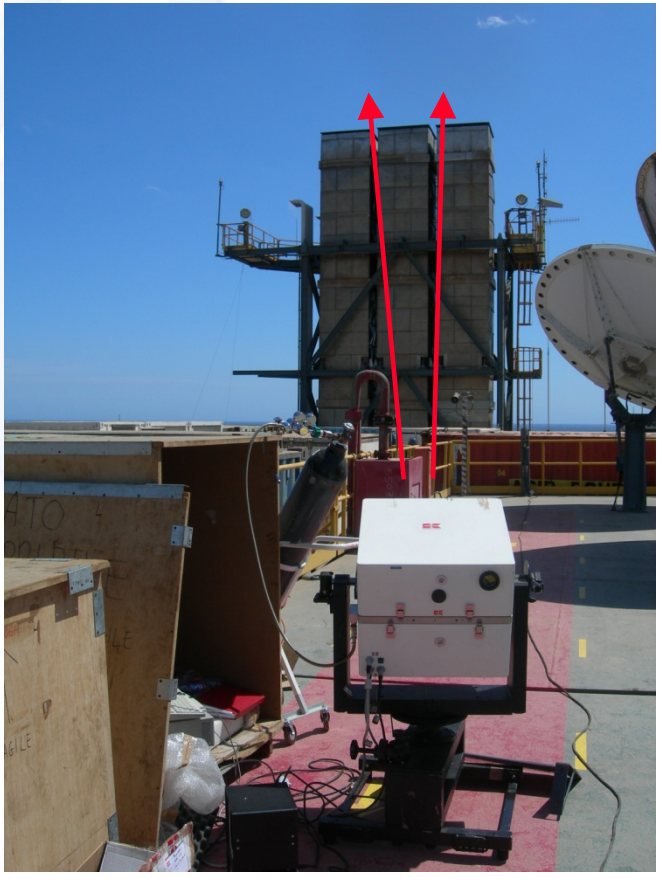
- Open Torch DP3



Experimental Activity

Remote Sensing FTIR Positioning

- K300 is pointed directly in (or over) the target gas plume
- Remote applications are possible around the flame (unburned zones)



Experimental Activity

Geometric Parameters

Emission	Heigh (m)	Optical path (m)	Diameter (m)
Port Boiler Sloug	21	37	1
Starboard Boiler Sloug	21	37	1
Torch DP3	37	115	0.7
Torch DP4	38	164	1.3
Turbine 1,2,3	13.7	37	2.1

Experimental Activity

Apportionment of CH_4 (as CO_2 equivalent) on total GHG

Emission	Temp.	H_2O	CO_2	CH_4 @ CO_2 eq	N_2O @ CO_2 eq	CE efficiency
	(°C)	(%)				(%)
Port Boiler Sloug	119.8	15.6	98.26%	**0.08%**	1.66%	99.99
Starboard Boiler Sloug	133.7	13.8	99.47%	**0.07%**	0.46%	99.99
Torch DP3	253	45.9	99.80%	**0.03%**	0.17%	99.96
Torch DP4	370	26	99.84%	**0.02%**	0.13%	-
Turbine – Hot Oil Heater B	339.5	4.9	96.01%	**0.13%**	3.85%	99.66

Discussion

- Meteorological effects on efficiency may be investigated
- Methane is below detection limits in the cases investigated
- Combustion efficiency may be controlled directly with Remote Sensing

Conclusions

- FT-IR technique was applied in off shore Eni sites: methane was below detection limit
- IR techniques can successfully be used to detect pollutant emissions from flaring and venting

Critical remarks

- The assessment of GHG emitted and removed from the atmosphere is high on both political and scientific agendas
- Methods for proper accounting are needed to verify the compliance to the emission trading schemes
- Achieving reliable GHG emission inventories at facility level is an important topic
- Detecting and analyzing emission changes with uncertainties will require the development, the validation and disseminated use of high quality – possibly certified – analytical methods for GHG emissions

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