



Air Emissions Management in Kuwait Oil Company

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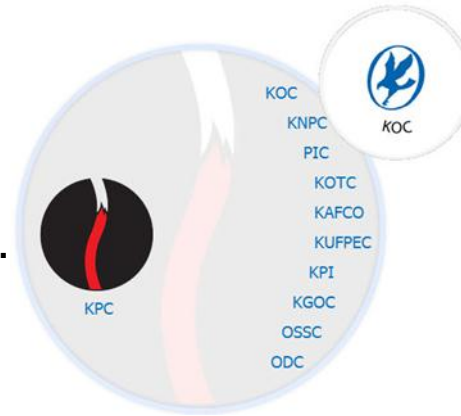
Outline

- ❖ **Background**
 - ❖ History
 - ❖ KOC HSE Policy
 - ❖ HSE Vision, Mission and Strategic Objectives
 - ❖ Operations
- ❖ **Air Emission Management.**
 - ❖ Emission Sources
 - ❖ Why Estimate Emissions?
 - ❖ Gas Flaring Reduction
 - ❖ GHG's Management
 - ❖ Air Compliance Management Program "ACMP"
 - ❖ Methane Emission Desktop Study



Introduction

- Kuwait Oil Company's Responsibilities under the KPC's Umbrella is involved in the exploration, drilling and production of oil and gas within the State of Kuwait.
- The Company is also involved in the storage of crude oil and delivery to tankers for export.
- **KOC HSE Policy:**
 - Besides its caring for Health & Safety of its employees, contractors and the community, KOC pays a great attention to conserving the Environment through its HSE Policy statement.



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1934 - KOC was Founded

1980 - Parent Company (KPC) was Formed



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1990 - Suspended Operations (Invasion)

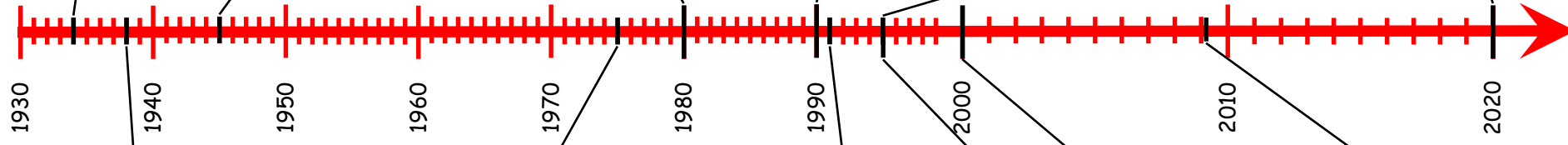


1995 - 1st Strategy



4 MM  /D
By 2020


1946 - First Oil Shipment




1938 - Oil in Burgan Field explored

Full Ownership
In 1975

1995 Reached

2 MM  /D

Reached

3MM  Capacity



1991 - The Oil Fires (more than 700 wells were set to fire)

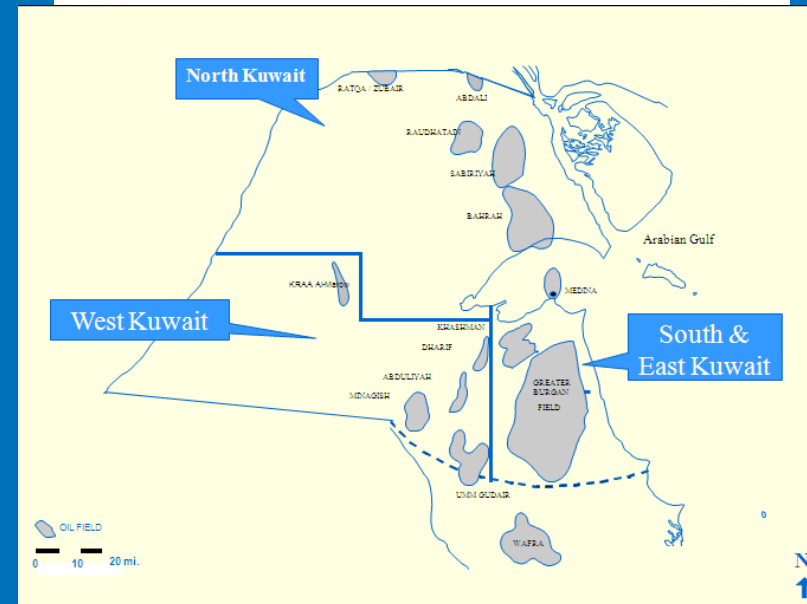
In 2000 started preparing
KOC 2020 Strategy
"Unlocking the Potential"

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 Kuwait Oil Company's
Achievements and Aspirations

KOC Operations

- Spread over 3 Assets
 - South and East Kuwait
 - West Kuwait
 - North Kuwait
- Producing Assets
 - 22 Gathering Centers
 - 7 Booster stations
 - >1647 Well heads
 - 2 Water Injection Plants
 - 2 Water disposal plants



HSE Vision, Mission & Strategic Objective...

HSE VISION:

KOC will maintain high industrial standards and continuous commitments toward the health, safety, and environmental performance in its operations to create a work and business culture of HSE leadership practices.

HSE MISSION:

KOC will provide a safe and healthy work environment by implementing a high quality and cost effective health, Safety and Environmental Management System.

HSE STRATEGIC OBJECTIVE:

To be an Industry and regional leader in Health, Safety and Environmental performance.



KOC HSE's Policy Statement

KOC will conduct business in a manner to protect, preserve, and enhance Health, Safety and the Environment (HSE). At all levels within KOC, employees and contractors will demonstrate the leadership and commitment for protecting HSE by:

- Complying with HSE laws and regulations and KOC HSE practices and procedures.
- Seek opportunities and promote prevention of pollution during all aspects of conducting business.
- Continually improve health, safety and environmental performance.
- Provide the resources, knowledge, and culture to carry out health, safety and environmental responsibilities.
- Proactively minimize the impacts of operations on health, safety and environment, even when regulatory requirements do not apply.



KOC Air Emissions Management

- KOC has a long history in managing Air Emissions through Gas Flaring reduction.
- Started in 1990's with an inventory of 6 major pollutants "CO₂, CO, CH₄ HC, Non-CH₄ HC, SO_x, NO_x" and estimated from "Gas Flaring" in all GC's.
- Currently a range of sources are included with about 21 pollutants.
- Main drivers for Emission Management and Inventory are to preserve the environment, Conserve Energy and Safeguard human health as "Air Pollution" can cause chronic health impacts for the local population and other global Environmental complications like Ozone Depletion & Global Warming, etc...

KOC Air Emissions Management

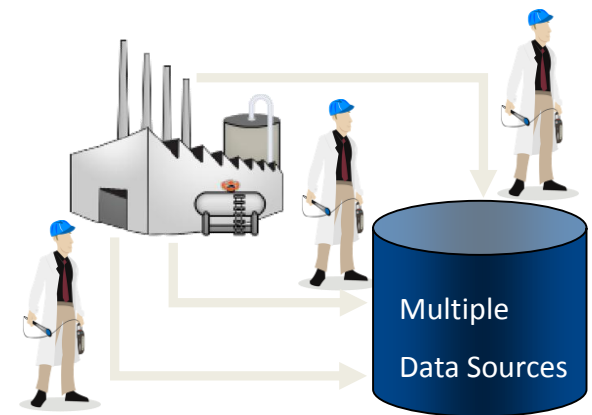
- ❖ 1997 – 1999 : BP Study for quantifying Air Emissions from all facilities using BP Emission Factors.
- ❖ 1999 – 2010 : Reporting of Air Emissions of 6 Major Pollutants: CO, CO₂, CH₄, NMHC, NO_x and SO_x using BP Emission Factors.
- ❖ 2010 – Current: Reporting of Air Emissions of 21 Pollutants using US EPA AP-42 methodologies

- | | |
|--|---|
| <ul style="list-style-type: none">• Carbon Dioxide• Methane• Nitrous Oxide• Benzene• Hydrogen Sulphide• Toluene• Xylene (Mixed Isomers)• Acetaldehyde• Ethyl benzene• Formaldehyde• Hexane | <ul style="list-style-type: none">• Naphthalene• PAH• Nitrogen Oxides• Carbon Monoxide• Sulphur Dioxide• PM₁₀• Soot• Total VOC,• Total Hydrocarbon• Non Methane Hydrocarbon |
|--|---|

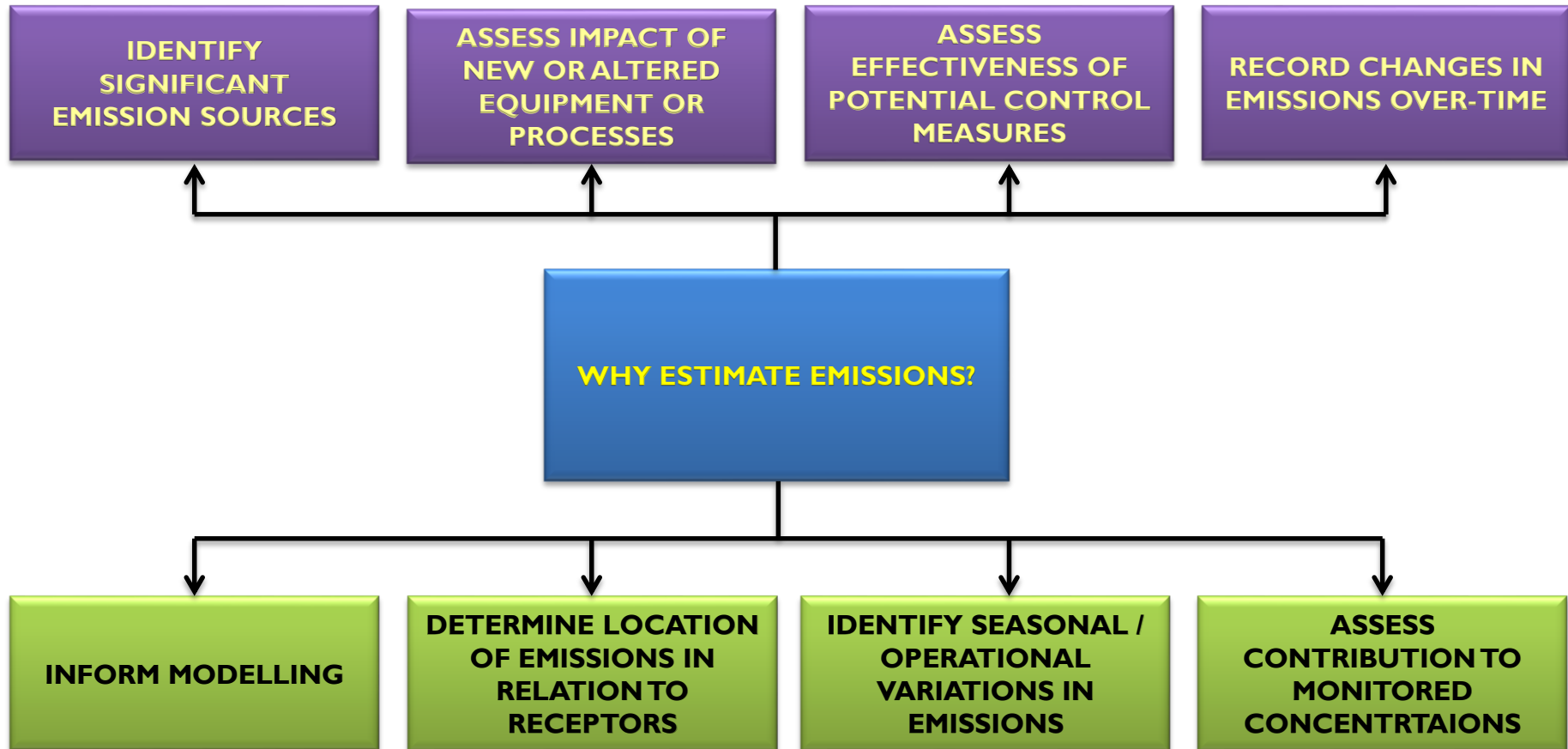
KOC's Emission Sources

Air Emission is calculated for the major sources:

- Heaters
- Flares
- Burning Pits
- Storage Tanks
- Vents
- Turbines
- CRU's
- Equipment leaks

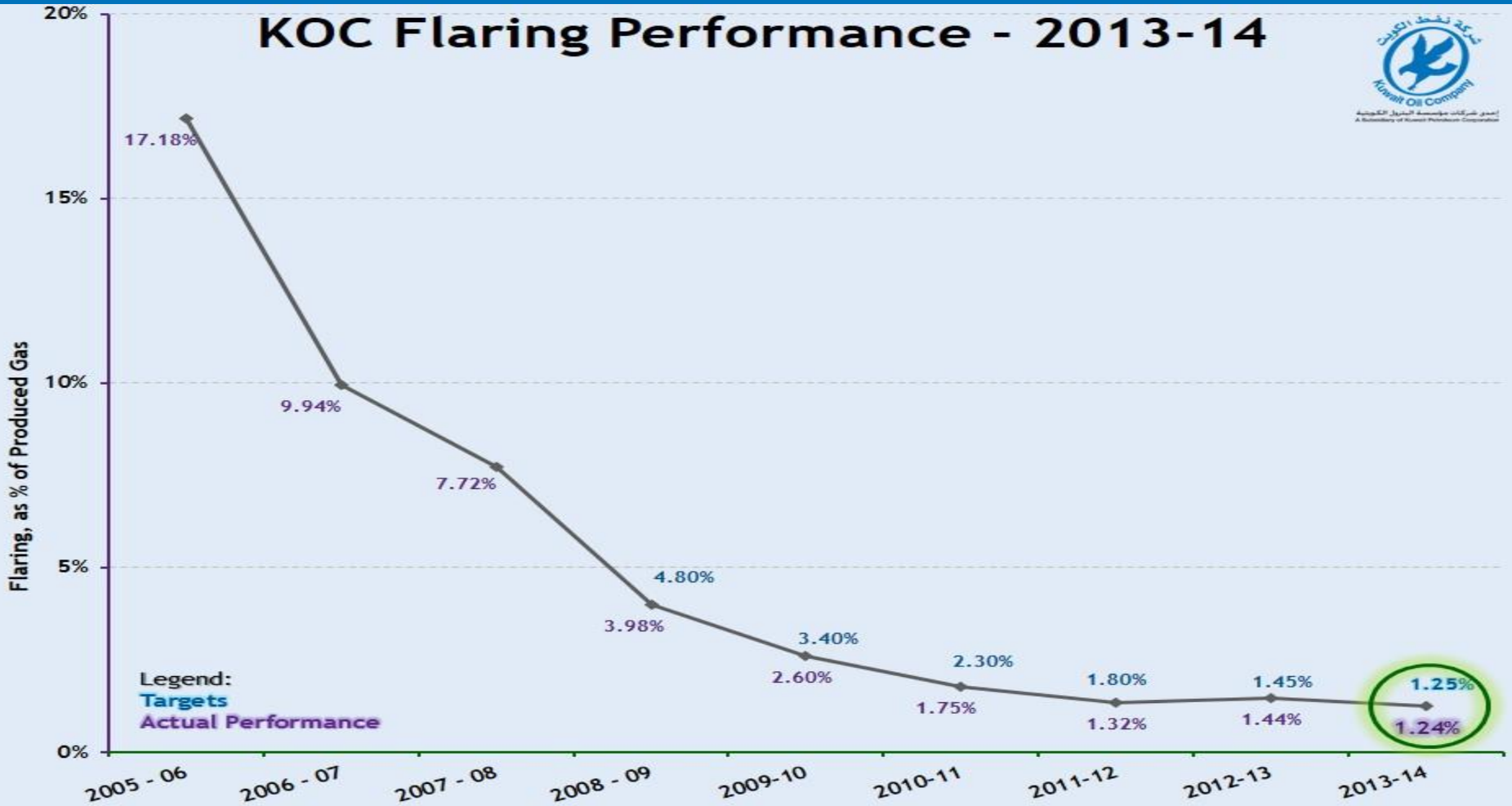


Why Estimate Emissions??



KOC Gas Flaring Reduction Over The Years

KOC Flaring Performance - 2013-14



GHG's Management in KOC

- KOC's successful gas flaring reduction is a result of several key factors:
 - A solid commitment from all levels of the company to make flare reduction a priority;
 - Significant financial investments in state-of-the-art facilities and operations;
 - A close cooperation within KOC departments and with downstream companies and customers in order to adapt to any unforeseen situations and limit the duration of flaring; and
 - A close, productive partnership with Global Gas Flaring Reduction "GGFR" since 2012 and other organizations to achieve the target.
 - Kuwait is the third country in the Middle East to join the World Bank-led Global Gas Flaring Reduction partnership following Iraq and Qatar.

KOC's Investments in Gas Flaring Reduction

Project Title

Upgrading of LP Gas Network in SEK

Modification in Tank Vapor System in EK GCs

New 30" HP Export Gas Line from BS-140 to GCMB

Facilities Modernization Project in SK (including 3 New Condensate Recovery Units in GC-3, 4 & 6)

Facilities Modernization Project in EK (including 8 New Condensate Recovery Units in GC-1, 2, 9, 10, 11, 19, 20 & 22)

GC-28 Capacity Expansion (Including 3rd Compressor Train)

Gas Sweetening Facility in WK (GSF)

New Booster Station BS - 160 at SEK

40" Gas Line from BS-131 (NK) to LPG Plant (MAA)

Installation of New Air-Assisted Flare Stacks at GC-17 / 27 / 28 & BS-170 & Liquid Separator Area Near GC-11

□ Total cost of completed projects ≈ US \$ 3.6 Billion

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2012 Excellence in Flaring Reduction “GGFR Award” And 2009 ESS Excellence Award.

We are extremely pleased and proud to announce that KOC has won:

- **2012 Excellence in Flaring Reduction GGFR Award,**

Based on KOC’s significant achievement of substantial Gas Flaring Reduction from 17.18% in 2005/06 to 1.32% in 2011/12 that resulted in carbon emission reduction which resulted in cleaner environment, increase in resource availability and revenue enhancement.

- **2009 ESS EXCELLENCE AWARD WINNER:**
KOC Streamlined Emissions Data Mgmt. for Corporate Social Responsibility and Efficiency Gains.



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GHG's Management in KOC

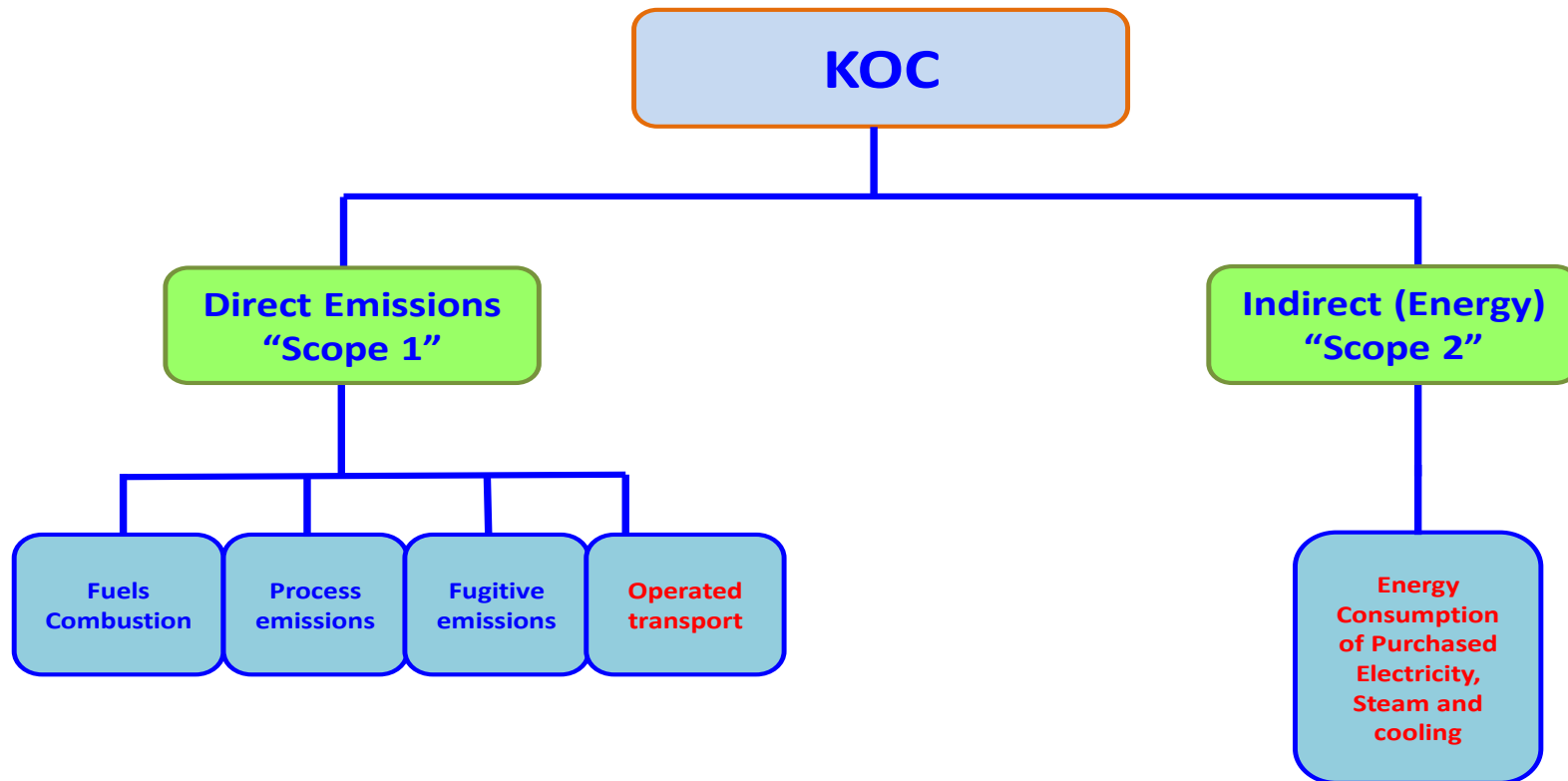
- Greenhouse Gases (GHGs) are trace gases that control energy flows in the Earth's atmosphere by absorbing infra-red radiation. There are 6 GHGs covered under the Kyoto Protocol:
 - Carbon Di-Oxide (CO₂), Methane (CH₄), Nitrous Oxide (N₂O), Hydro fluorocarbons (HFCs), Per fluorocarbons (PFCs) and Sulphur Hexafluoride (SF₆).
- CO₂ is the reference gas against which other GHGs are calculated.
- KOC recognizes Greenhouse Gases as a global issue and took a corporate leadership position of voluntarily committing to reduce its GHGs emissions from KOC operations through several projects related to Gas Flaring.
- Furthermore, KOC has taken numerous steps forward for quantifying the GHG emissions and processing them in order to estimate CO₂ equivalent from different sources.

GHG's Management in KOC

- ❖ FY 2010 - 2011 : GHGs Inventory (Direct Emissions from Fixed Sources) using USEPA AP 42 Methodologies.
- ❖ FY 2011 – 2012 : Included other direct sources “Mobile” and Indirect Sources “Energy” using IPCC* Methodologies.
- ❖ FY 2012 – FY 2013: GHGs Inventory based on IPCC & KPC GHGs Tool.



GHGs Emission Inventory



Air Compliance Management Program, (ACMP)

- In addition to KOC initiatives, KOC has coordinate with KEPA in order to improve the residential air quality surrounding KOC's Operations.
- A 'Memorandum of Understanding' was signed on 23rd of December 2009 between KOC and KEPA to enhance cooperation between the two parties over air quality issues.
- Therefore, as part of its Corporate Social Responsibility, KOC put together a project titled **"Air Compliance Management Program"** in order to achieve regulatory compliance with both KEPA and international standards by KOC.



Air Compliance Management Program, (ACMP)

Highlights of the project:

- Regulatory Compliance.
- Emission Inventorying.
- Monitoring and Control.
- Emission Reduction.
- Performance Tracking.
- Capacity Building.



Air Compliance Management Program, (ACMP)

Benefits of the ACMP Monitoring Network:

- i) Enhanced representation of the Air Quality within the ACMP Network.
- ii) Assess the pollutant contribution by KOC sources.
- iii) Establish proactive monitoring of KOC sources.
- iv) Initiate remedial actions to improve performance.
- v) Avoid any liabilities against the Company.
- vi) Establish KOC as a regional leader in Environmental Protection.



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Global Methane Initiative Agreement between KOC & US EPA

- In its continuous efforts towards seeking the excellence in the field of Emission Management, KOC has signed a Memorandum of Agreement with US EPA on 13th of November 2013.
- Therefore, A desktop study of 3 KOC facilities has been conducted to estimate their **methane emissions** and identify potential recovery opportunities.



Methane Emission Desktop Study of 3 Oil & Gas Facilities



- The facilities are: GC-25, GC-27 and BS-131. Those facilities are more modern construction than the U.S. natural gas system, most of the best practice technologies:

- Dry seals on gas compressors
- Vapor recovery on oil stock tanks
- Closed flare system for system pressure relief and vents



- This study found a few potential opportunities for further cost-effective GHG's and methane emission reductions.



- overall assessment reveals that the 3 facilities have very low methane emissions that can be made even lower with economic projects.

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Methane Emission Study - Study Methodology

- For desktop studies:
Number of sources x average emissions per source = emissions
- Sources evaluated
 - Fugitive (unintended leaks)
 - Vents (designed or intentional release of gas)
 - Combustion (CO₂ and unburned hydrocarbon methane)
- Fugitive emission factors from many studies
- Vent emission factors from vendor design or models
- Combustion emission factors from many studies

Methane Emission Study - Study Methodology (Cont.)

- Emission sources in Gas Compression units
 - Compressor seals (dry seals on all compressors)
 - Compressor blowdown (to flares)
 - Oil tank emissions (to vapor recovery unit or flare)
 - Water tank emissions (to atmosphere)
 - Fugitive component count (from API Compendium)
 - Combustion emissions (turbines, heaters, flares)
- Emission reductions at Gas Compression units
 - Find and fix fugitive leaks
 - Route tank emissions to Vapor Recovery Unit (VRU)
 - Route blowdown vents to fuel gas

Methane Emission Study - GC-25 Results - Emissions

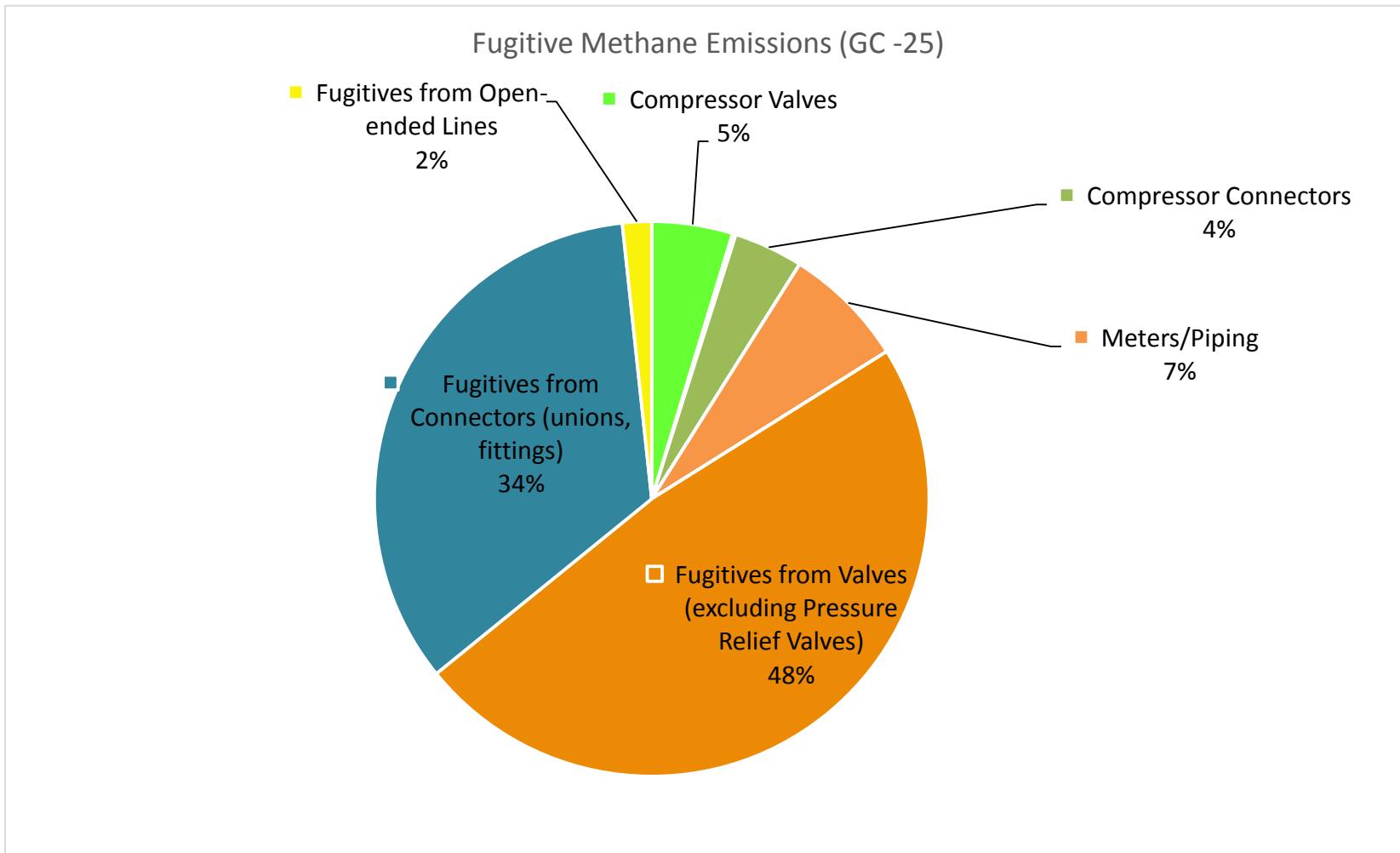
▶ EMISSIONS SUMMARY

TOTAL Methane Emissions from GC-25	MMcf CH4/year	tonnes CO2e/year	tonnes CO2e/month
Vented	7	2,954	246
Fugitive	2	666	55
Combustion	28	11,289	941
Total	37	14,923	1,244

Top Methane Emitting Sources	MMcf CH4/year	tonnes CO2e/year	tonnes CO2e/month		
1 Flare Emissions	27.9	11,257	938	75.5%	of total
2 Oily Water Degassing Tank Vent	3.7	1,495	125	10.0%	of total
3 Centrifugal Compressor Dry Seals	3.6	1,457	121	9.8%	of total
4 Fugitives from Valves (excluding Pressure Relief Valves)	0.8	320	27	2.1%	of total
5 Fugitives from Connectors (unions, fittings)	0.6	227	19	1.5%	of total
Total	32.9	13,309	1,109	99.0%	of total

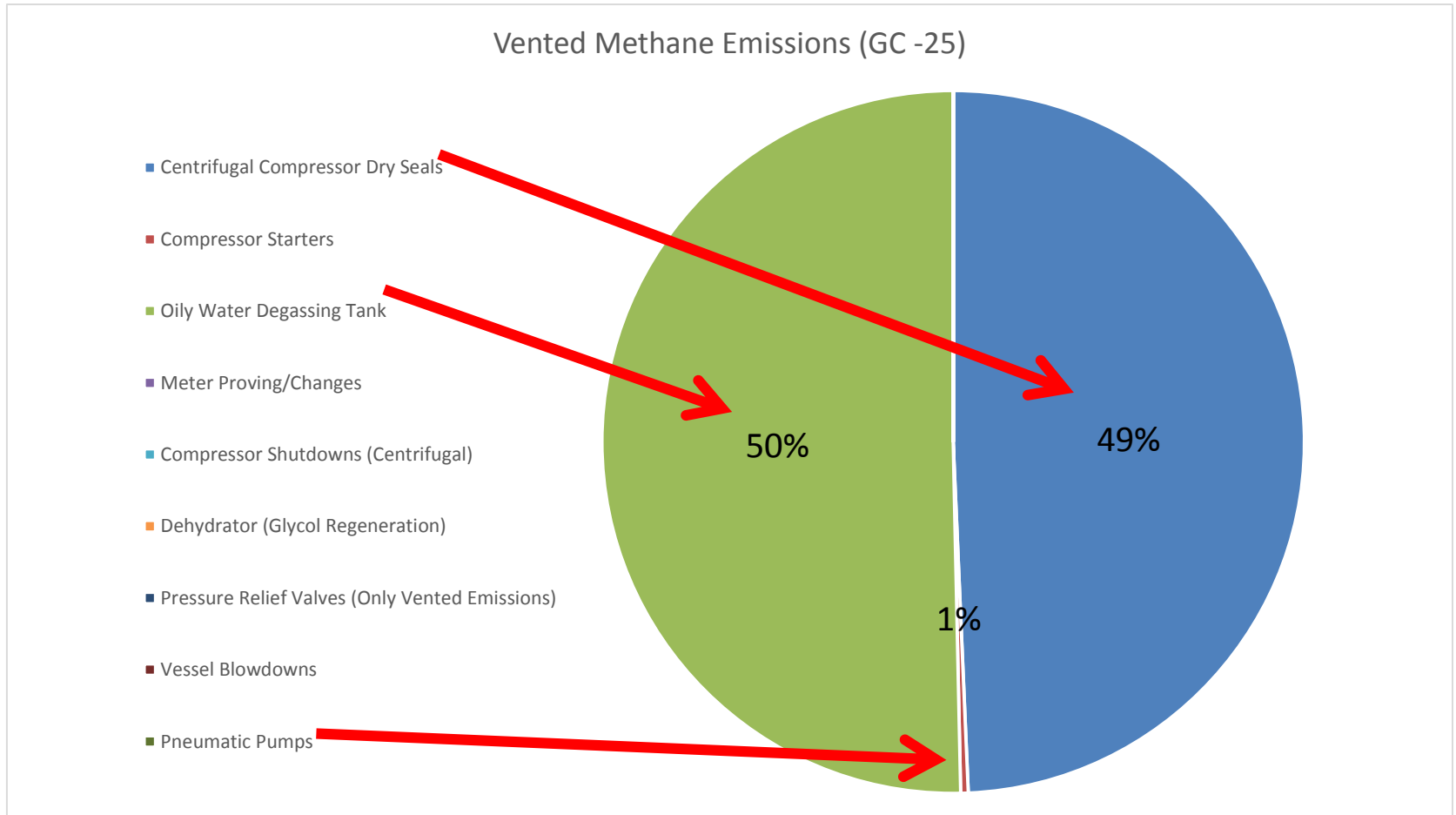
Methane Emission Study - GC-25 Results

Fugitive Methane Emissions



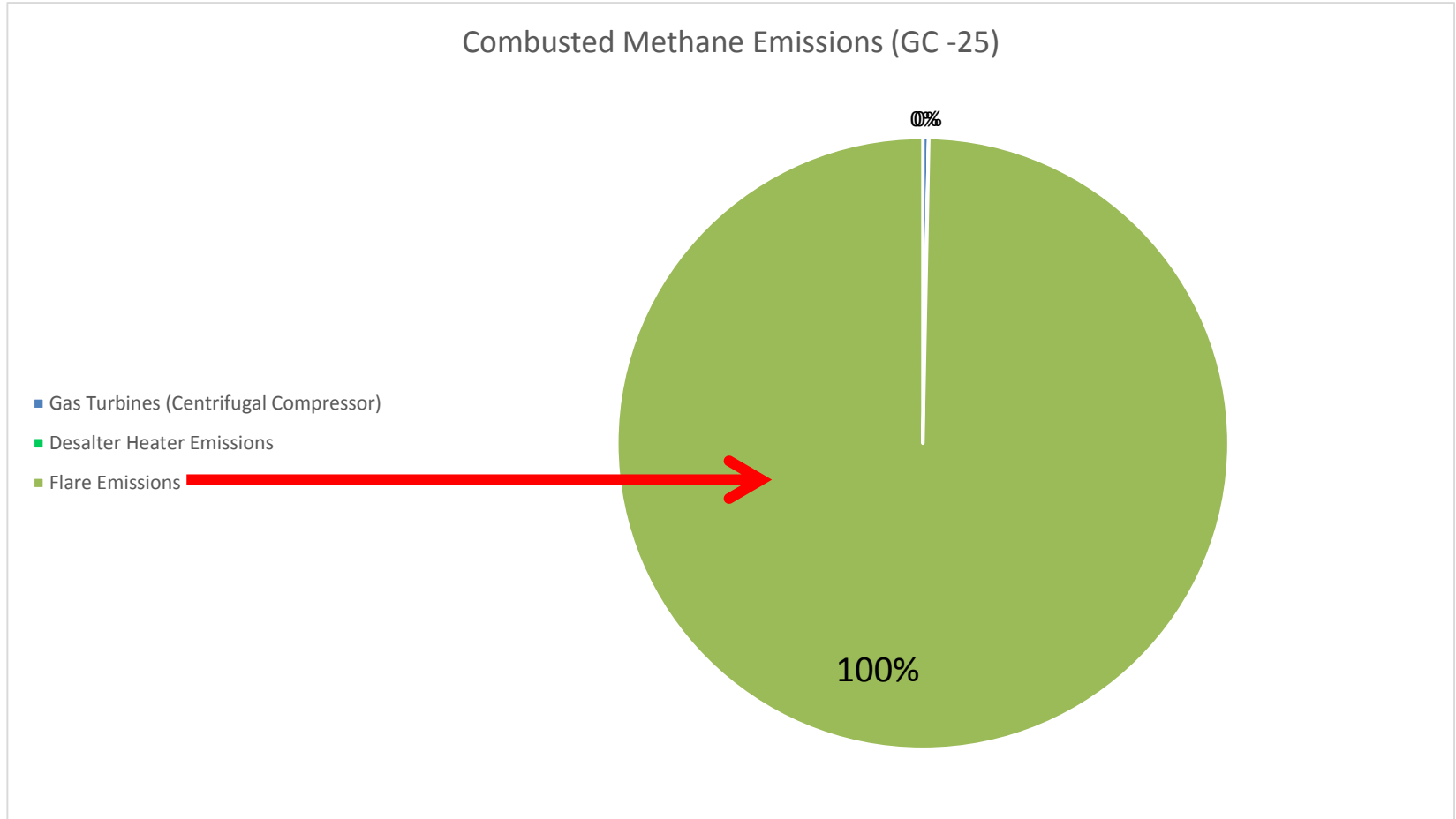
Methane Emission Study - GC-25 Results

Vent Methane Emissions



Methane Emission Study - GC-25 Results

Combustion Methane Emissions



Methane Emission Study - GC-25 Results

Emission Reductions

Emission Type	Emission Source	Methane gas emissions	Whole gas emissions	Potential emission reduction	Annual Value of Gas Saved @ \$5/Mcf	Estimated cost of opportunity	Simple payback	Estimated O&M Cost (if applicable)
Fugitives	Valves, open-ended lines, connectors	2 MMcf/yr	2.5 MMcf/yr	1.8 MMcf/yr	\$9,000	\$5,250 - DI&M	7 months	Facility routine maintenance
Vented	Oily water degassing tank	3.7 MMcf/yr	4.7 MMcf/yr	4.5 MMcf/yr	\$22,300	\$2,000-4,300	1-2 months	\$1,500
Flared	Route compressor blowdown to fuel	26 MMcf/yr	1,313 MMcf/yr	6.4 MMcf/yr	\$32,000	\$6,000-13,000	2-5 months	---

^[1] Based on assumed screening cost of \$1/component and estimated 5,250 components at the facility.

Cost basis from EPA Lessons Learned: *Directed Inspection and Maintenance at Gas Processing Plants and Booster Stations*.

^[2] Based on Natural Gas STAR default value of 70% of fugitives can be cost-effectively repaired.

^[3] 95% recovery per EPA Lessons Learned: *Installing Vapor Recovery Units on Storage Tanks*

^[4] Estimated cost of piping to route vapors to existing screw compressor estimated from EPA Lessons Learned: *Pipe Glycol Dehydrator to Vapor Recovery Unit and Connect Casing to Vapor Recovery Unit*

^[5] EPA 2006. Estimated cost of additional electricity per Lessons Learned – *Pipe Glycol Dehydrator to Vapor Recovery Unit*.

^[6] Estimated fuel gas for two desalter heaters (18.73 MMBTU/hr, each) and fuel gas heater (0.413 MMBTU/hr) for 98% operating factor of each LP and MP compressors.

^[7] Estimated cost of piping to route compressor blowdown vents to desalter heater fuel gas estimated from

EPA Lessons Learned (as 3 separate piping projects): *Pipe Glycol Dehydrator to Vapor Recovery Unit and Connect Casing to Vapor Recovery Unit*

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Methane Emission Study Recommendations

- Five projects may save 18 MMcf/yr methane emissions, valued at \$115,000 @ \$5/Mcf gas price
- Cost for a field verification survey by a third party consultant “i.e. ICF” is ~\$50,000
- Projects pay back in <1 year

Source	Annual Emissions (MMcf CH4/year)	Annual Emissions (tonnes CO2e/year)	Annual Emissions (tonnes CO2e/month)
All fugitive emissions (all three facilities)	13	5,241	437
Oily water degassing tank (GC-25)	4	1,495	125
Pneumatic chemical injection pumps (GC-27)	1.4	566	47
Compressor shutdowns (BS-131)	0.05	20	2
PRV vents and vessel blowdowns (BS-131)	0.01	4	0
Total Potentially Controlled	18.13	7,326	610

Methane Emission Study

Way Forward

- Validate assumptions in desktop study
- Determine reasonableness of analysis and recommendations
- Consider whether other GC units have equivalent/ more/ less emissions
- Expand desktop to additional GC and BS units
- Conduct field verification study



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Conclusion

Managing our Emissions will Strengthen our Commitment to the Environment & thus will contribute directly to the health of our people and others abroad.

THANK YOU

