



Petroleos Mexicanos Report  
Oil and Gas Subcommittee Meeting

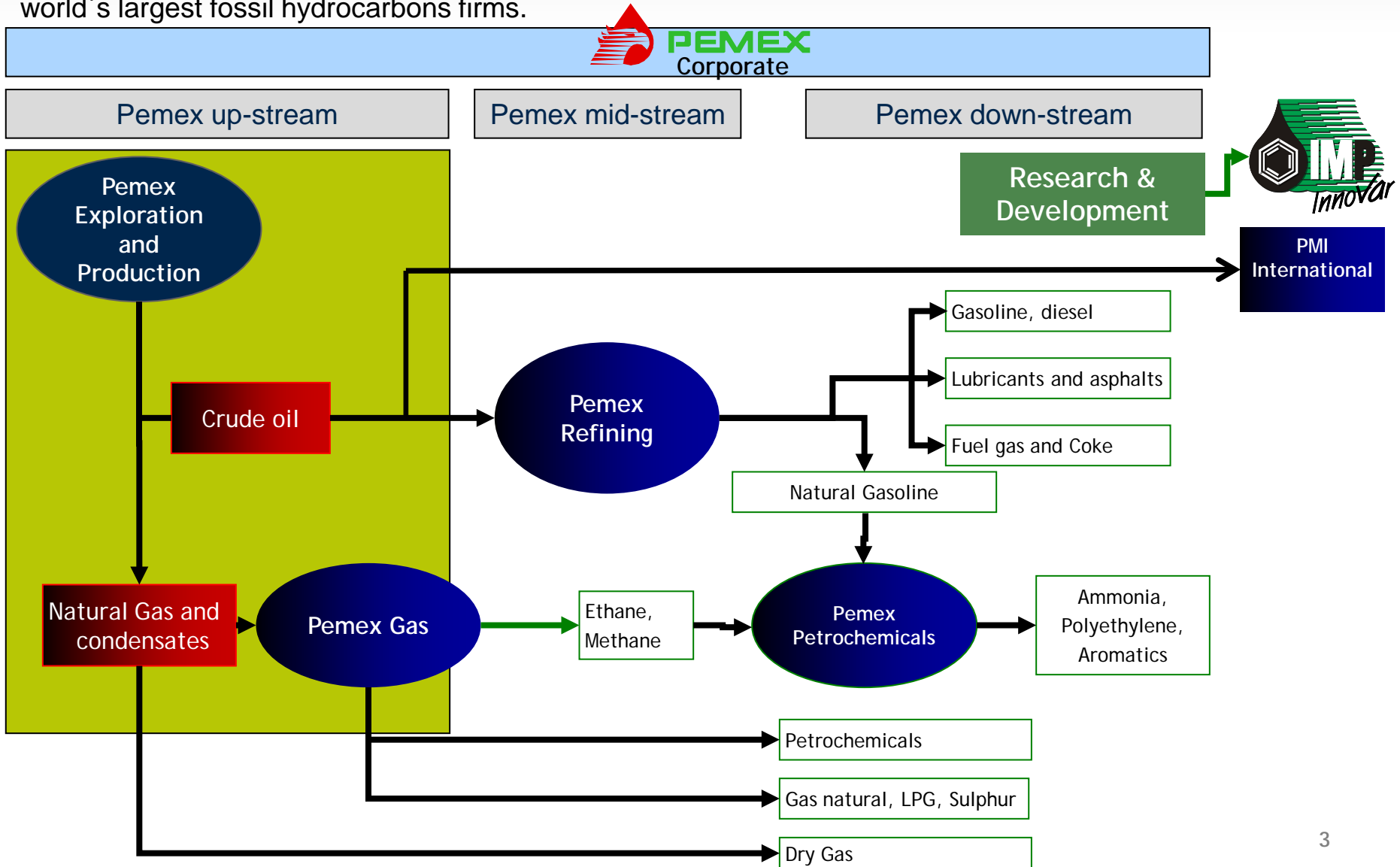


Krakow, Poland, October 2011



- Introduction
- Mitigation of methane fugitive emissions
  - Measurement campaigns
  - Methane emissions inventory
  - Methane Abatement Cost Analysis (MAC)
- Next steps

Pemex is the oil and gas State owned company of Mexico, the main corporation of the country and one of the world's largest fossil hydrocarbons firms.



# Pemex's main infrastructure, 2010



•Production fields:	405
•Production wells:	7,476
•Off-shore Platforms:	233
•Refineries:	6
•Gas processing complexes:	10
•Petrochemical Complexes:	8
•Refinates Products Storage and Distribution Terminals:	77
•LPG Distribution Terminals:	18
•Pipelines (Kms)	65,811

PACIFIC OCEAN

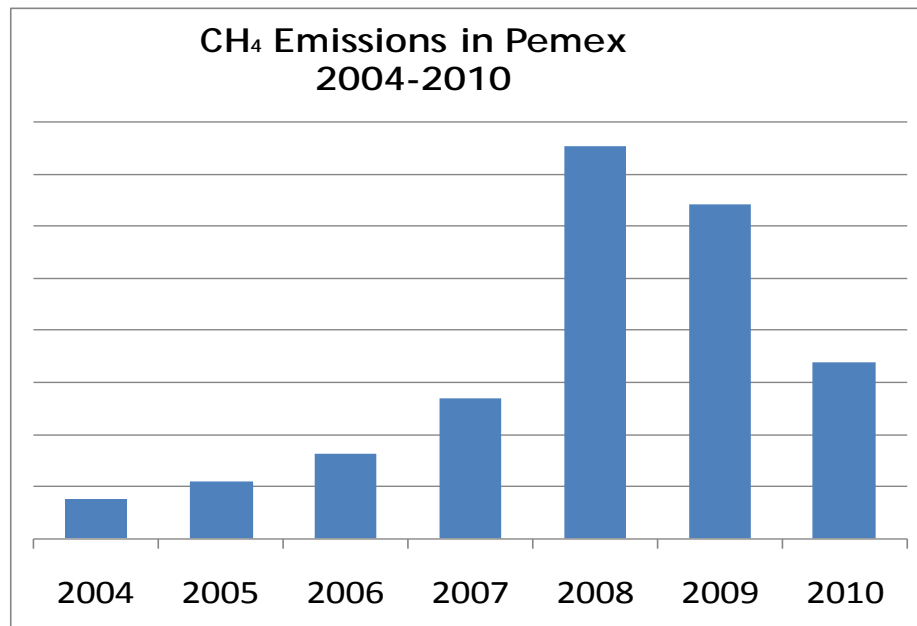
- The Global Methane Initiative (GMI) is a significant framework for international cooperation to reduce methane emissions to increase energy security, enhance economic growth, improve air quality, get better industrial safety and reduce emissions
- On behalf of the Mexican Government, since 2005 Pemex has been co-chair of the GMI Oil and Gas Industry Subcommittee, which is responsible for guiding the oil and gas sector activities and engaging all representatives of the private, public and non-governmental parties in those activities. The O&G Subcommittee's main concerns are:
  - ✓ Identify methane recovery opportunities and describe available technologies and best practices
  - ✓ Identify key barriers and issues for project development
  - ✓ Discuss country-specific needs, opportunities and priorities
  - ✓ Identify possible joint activities to increase methane recovery and use in the sector
  - ✓ Identify project finance opportunities and mechanisms



- The joint efforts of GMI and Pemex produced a number of results, mainly in the following aspects:
  - Identification of methane reduction opportunities in several Pemex's facilities.
  - First Pemex CH<sub>4</sub> inventory,
  - Marginal Abatement Cost model (MAC)
  - Technical workshops
- During the last year, besides the works executed in the gas processing area, an action program has been developed in exploration and production
- To sustain these efforts in the long term, the methane recovery issue has been introduced in the Pemex's business plan



- The reduction of methane emissions during the period 2004-2010 is the result of the projects implemented by PEP to increase the utilization of natural gas, mainly in the Cantarell complex
- To reduce CH<sub>4</sub> emissions from hydrocarbons flaring, Pemex has become a member of the World Bank's Global Gas Flaring Reduction partnership (GGFR)
- There are important synergies among Pemex, GMI and GGFR to reduce methane emissions and other SLFC in flaring systems



	(Tons*)
2004	152,855
2005	219,027
2006	324,754
2007	535,810
2008	1'506,727
2009	1'279,796
2010	677,167

\* Estimated. AP-42/SISPA.





# 1. Measurement and project identification campaigns

In recent years, PEMEX has completed a number of activities on methane emissions reduction projects in several facilities, improving gas recovery and reducing emissions.



## Gas processing and transport

- **Gas processing complexes:**  
Cactus, Ciudad PEMEX, Nuevo PEMEX, Poza Rica and Burgos
- Pipeline. Sector Cárdenas

## Petrochemicals

- **Ammonia complex:** Cosoleacaque

## Exploration and production

### South Region

- **Gas compression:** Cunduacán and José Colomo
- **Production fields:** Chilapilla and Jose Colomo
- **Gas collection:** San Roman
- **Separation battery:** Vernet
- **Maritime terminal:** Dos Bocas.
- **Separation battery and gas compression:** Ogarrio 4 and Cinco Presidentes 4 and Samaria II

### North Region

- **Production field:** Nejo 1, Activo Integral Burgos

### Northeast Maritime Region

- **Gas compression:** Atasta

### Southwest Maritime Region

- **Production complex:** Abkatun – D

- At the end of each measurement campaign, a valuable technical report is produced and delivered to Pemex
- It includes the main findings, a technical and economic analysis and the recommended actions to reduce CH<sub>4</sub> emissions, to improve gas utilization and to increase the efficiency of the operations in the facility



## REPORTE TÉCNICO

### Oportunidades de Reducción de Emisiones de GEI y de Eficiencia Energética en la Estación de Compresión Cunduacán

Octubre 2009

Este informe ha sido preparado por Clearstone Engineering Ltd., y PA Government Services Inc., Arlington, VA, subsidiaria de PA Consulting Group ([www.paconsulting.com](http://www.paconsulting.com)), bajo contrato con Eastern Research Group (ERG), financiado por el programa Metano a Mercados (M2M) de la Agencia para la Protección Ambiental de los Estados Unidos (USEPA).

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Potential methane reduction in **exploration and production**, according to GMI studies and 2009 Pemex methane inventory

Source	Avoidable Methane Emissions		
	(10 <sup>3</sup> m <sup>3</sup> /y)	(tCH <sub>4</sub> /y)	(tCO <sub>2</sub> e/y)
Fugitive emissions in equipment and venting of pneumatic devices	34,396	24,655	517,759
Gas Flashing and venting tanks of crude and condensed without VRU's	25,058	17,961	377,191
Venting in seals of centrifuge compressors	3,488	2,500	52,500
<b>Total E&amp;P</b>	<b>62,942</b>	<b>45,117</b>	<b>947,449</b>

Potential methane reduction in **gas processing**, according to GMI studies and 2009 Pemex methane inventory

Source	Avoidable Methane Emissions		
	(10 <sup>3</sup> m <sup>3</sup> /y)	(tCH <sub>4</sub> /y)	(tCO <sub>2</sub> e/y)
Fugitive emissions in equipment and venting of pneumatic devices	3,301	2,366	49,682
Venting in seals of centrifuge compressors	20,694	14,833	311,500
<b>Total Gas processing</b>	<b>23,994</b>	<b>17,199</b>	<b>361,182</b>

Total potential methane reduction in **hydrocarbons exploration and production and gas processing**, according to GMI studies and 2009 Pemex methane inventory

Source	Avoidable Methane Emissions		
	(10 <sup>3</sup> m <sup>3</sup> /y)	(tCH <sub>4</sub> /y)	(tCO <sub>2</sub> e/y)
E&P	62,942	45,117	947,449
Gas processing	23,994	17,199	361,182
<b>TOTAL</b>	<b>86,936</b>	<b>62,316</b>	<b>1,308,631</b>



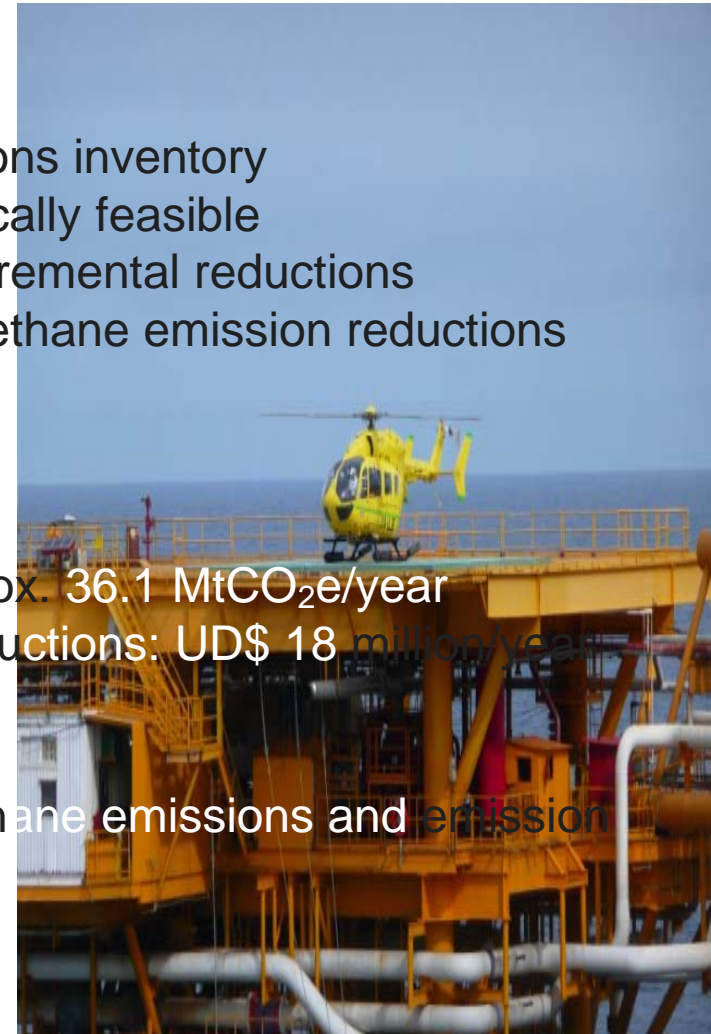
PEMEX and GMI have undertaken a detailed inventory of PEMEX methane emissions and their mitigation potential (based on 2008 data).

### Objectives:

- Prepare a comprehensive baseline CH<sub>4</sub> emissions inventory
- Estimate abatement potential that is technologically feasible
- Quantify the costs and benefits of achieving incremental reductions
- Provide a basis for PEMEX to set targets for methane emission reductions as part of its climate strategy

### Results:

- PEMEX baseline CH<sub>4</sub> emissions inventory: Aprox. 36.1 MtCO<sub>2</sub>e/year
- Estimate of savings from cost-effective CH<sub>4</sub> reductions: UD\$ 18 million/year @4.0 USDIs/MMBTU
- Full analysis of 16 mitigation actions
- Technical and economic model of PEMEX methane emissions and emission reduction projects



- Exploration and production is responsible for 96% of total emissions
- Methane from incomplete burning in flares is the largest single source, accounting for 78% of total emissions.

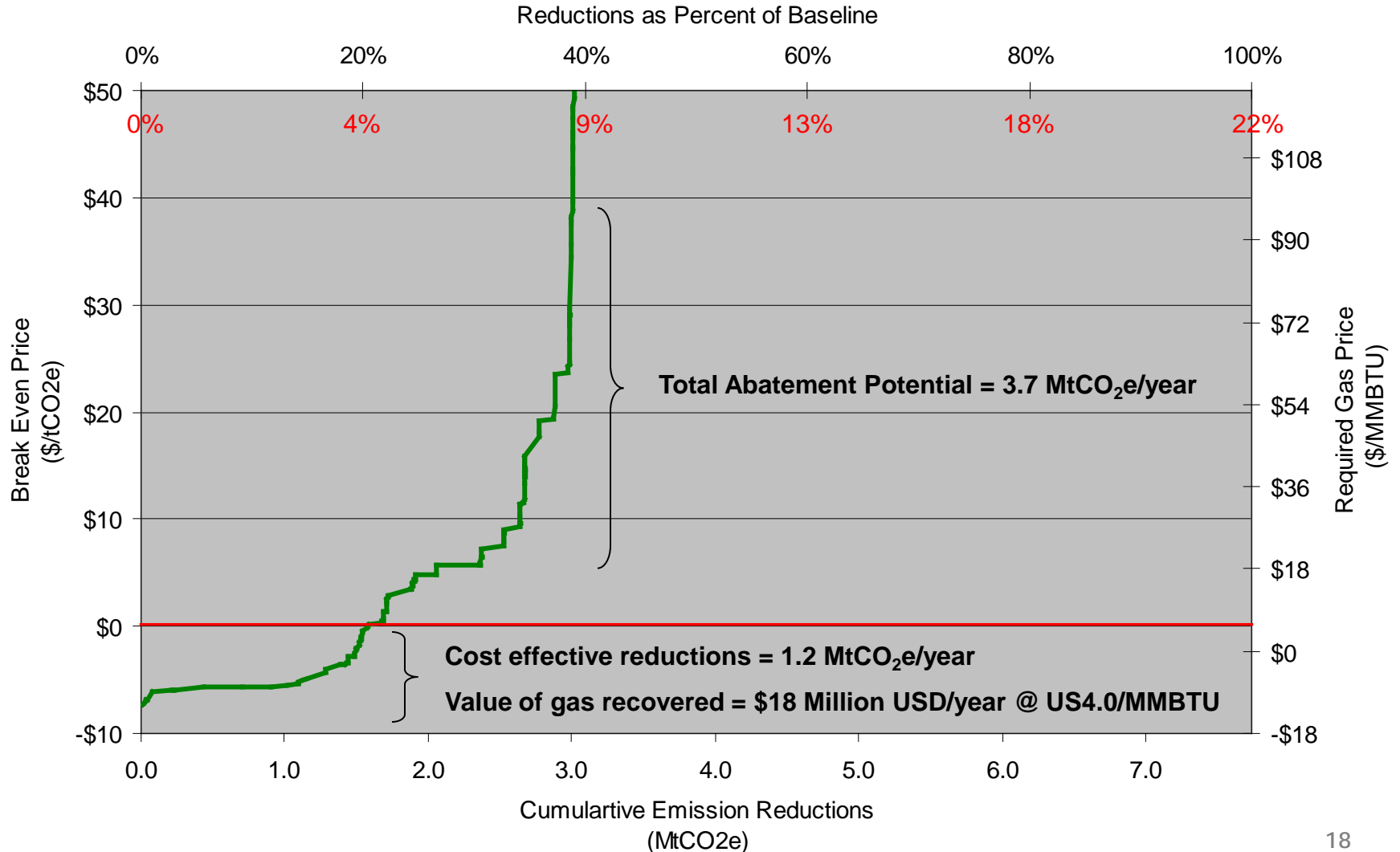
PEMEX Subsidiary	Annual Emissions (tCH4)	Annual Emissions (MtCO2)	% of Baseline Emissions
PEP	1,654,798	34.75	96.3%
<i>Flaring System</i>	1,350,085	28.35	78.6%
PGPB	60,772	1.28	3.5%
<i>Gas Transmission</i>	30,421	0.64	1.8%
PREF	2,826	0.06	0.16%
PPQ	211	0.00	0.01%
<b>Total Annual CH4 Emissions</b>	<b>1,718,607</b>	<b>36.09</b>	<b>100%</b>





### 3. MAC Analysis - Typical Findings (preliminary)

- The results will allow to identify the cost-effective methane emissions reductions measures for PEMEX to implement





# Methane abatement cost analysis model

IN-OUT

Click to Run MAC Model

Adjust model inputs in the *User Defined* column - values in GREEN

Then click Run MAC Model button above to update results in the summary tables.

### Inputs Table

MAC Model Inputs	Model Default Values	User Defined Values
Year of Emissions Inventory	2008	2008
Avg. Energy Intensity (btufft <sup>3</sup> )	1,030	1,030
CH <sub>4</sub> Density (kg/m <sup>3</sup> )	0.7168	0.7168
GWP of CH <sub>4</sub> (100yr time horizon)	21	21
<b>Finance Parameters</b>		
Gas Price (2008 \$/USD / Mcf of natu)	\$5.83	\$5.83
Real Discount Rate (Required %IRR)	12%	12%
Tax Rate	45%	45%

### Summary Results Table

Break Even Price (\$/tCO <sub>2</sub> e)	Emission Reductions (MtCO <sub>2</sub> e)	% of Baseline (w/o Flaring)	% of Baseline (with Flaring)
-\$5	1.18	14%	3%
\$0	1.60	20%	4%
\$5	2.08	25%	6%
\$10	2.67	33%	7%
\$15	2.70	33%	7%
\$20	2.87	35%	8%
\$25	2.98	36%	8%
\$30	2.98	37%	8%
\$35	2.99	37%	8%
\$40	3.01	37%	8%
\$45	3.01	37%	8%
\$50	3.02	37%	8%
>\$60	3.50	43%	10%

### Summary of Top 50 - Most Cost Effective Options

Abatement Measure	Avg. Break Even Price (\$/tCO <sub>2</sub> e)	Incremental Reduction (MtCO <sub>2</sub> e)	Avg. Payback Period (Months)	Avg. [IRR] Internal Rate of Return [%]
Surge vessels for station venting	-\$7.44	0.04	1.1	1091%
Fuel Gas Retrofit on Reciprocating Compressors	-\$6.82	0.01	5.9	210%
DI&M - Processing plants	-\$5.59	0.01	5.2	206%
Reducing the glycol circulation rates in dehydrators	-\$5.48	0.02	3.3	#DIV/0!
Replace High-bleed pneumatic devices	-\$4.19	0.48	28.4	77%
Installing Vapor Recovery Units on Crude Oil Storage	-\$2.32	1.09	28.9	45%
DI&M - Compressor Stations	-\$0.69	0.03	5.6	565%
Installation of Flash Tank Separators	-\$0.11	0.03	63.1	12%
Convert Gas Pneumatic Controls to Instrument Air	\$1.34	0.02	13.5	-15%
<b>Totals</b>	-	<b>1.71</b>	-	-

\*See MACA sheet for individual results.

### Summary of Emissions Inventory by Segment

Oil and Gas Segment	(tCH <sub>4</sub> )	(MtCO <sub>2</sub> e)
Production (Oil and Gas)	1,677,144	35.22
Flaring System	1,350,005	28.35
Processing (Gas)	30,351	0.64
Transmission (Gas)	28,176	0.59
Refining (Oil)	2,826	0.08
Petrochemical (Oil)	211	0.00
<b>Annual Emissions</b>	<b>1,738,708</b>	<b>36.51</b>

### Emissions Baseline with No Reductions (MtCO<sub>2</sub>e)

Emissions Baseline ( without Flaring )	8.16
Emissions Baseline ( with Flaring )	36.51

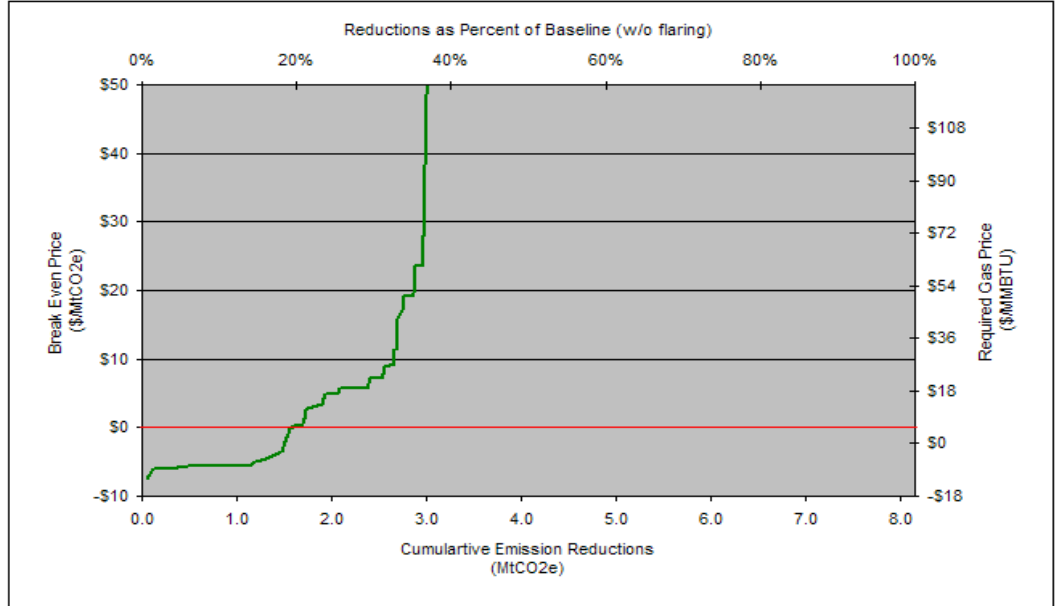
### Disclaimer -

The PEMEX MAC model is an analytical tool developed by U.S. EPA's Methane to Markets Program and Petróleos Mexicanos (PEMEX). The model is intended for internal use by PEMEX for planning purposes only.

The **Emissions Inventory** provides a cross-sectional snapshot of emissions in 2008. Changes in production or infrastructure and adoption of mitigation measures may effect the baseline emissions estimate in future years.

The MACA sheet provides detailed results of the MAC analysis.

PEMEX Marginal Abatement Cost Curve (Current Gas Price - red line)



# Estimation of Methane emissions mitigation. Gas processing



- The E&P up-coming methane workshop and measurement actions (November 2011)
- To define the Pemex-GMI action program for 2012
- Review and complete methane emissions inventory
- Integrate CH<sub>4</sub> baseline and MAC analysis in the design of the Pemex's operations
- Identify measures to reduce flaring and methane emissions from incomplete burning
- Implement operational working plans to reduce emissions of CH<sub>4</sub>, other pollutants and GHG in Pemex's facilities.
- Acquisition of methane measurement equipment





**PEMEX**®

Thank you!!!



**Oil and Gas Subcommittee Meeting**

Krakow, Poland, October 2011