METHANE EMISSIONS

ECOPETROL-EPA COLLABORATION
Global Methane Initiative

SUPERINTENDENCIA DE OPERACIONES DE MARES
INSTITUTO COLOMBIANO DEL PETRÓLEO
ENVIRONMENTAL PROTECTION AGENCY (EPA)
MARCH 2013
COMPANY STRATEGIC ALIGNMENT

Organizational Culture:
- Commitment to Life
- Responsibility

Strategic Guidelines:
- Profitable Growth
- Corporate Responsibility
- Organizational consolidation

Strategic Advisers:
- Production
- Environmental management and relationship with stakeholders
- Innovation and Technology
REASONS FOR DOING IT

GREENHOUSE GAS

¿What we do?, ¿Implement Investment Projects? ¿Legislative changes?

- Environmental Legal Breaches
- Claims
- Losses
- Climate change

Generate, evaluate and implement alternatives to the use of this non-renewable resource, to continue operating the oil fields in compliance with legal and environmental regulations, creating wealth for the company.

To mitigate or eliminate emissions of methane, also mitigate or eliminate other compounds:

- ethane, propane, butane, pentane, hexane,
- carbon dioxide (CO₂), carbon monoxide (CO),
- hydrogen sulfide (H₂S)

METHAN 84%

16%
FIELD APPLICATION

**GRM**
Superintendencia La Cira Infantas
Superintendencia del Río
Superintendencia de activos en Asociación
Campo Escuela Colorado
*Superintendencia de Operaciones de Mares*

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**CUENCA DEL VALLE MEDIO DEL MAGDALENA**

**BASEN MIDDLE MAGDALENA VALLEY**

A  Activo Lisama
B  Activo Llanito
C  Activo Provincia (Provincia y Bonanza)
C' Activo Provincia (Tisquirama y San Roque)
**FIELD APPLICATION**

<table>
<thead>
<tr>
<th>FIELD</th>
<th>OOIP (MMBls)</th>
<th>RF (%)</th>
<th>WELLS</th>
<th>DEVELOPMENT DATE</th>
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<tbody>
<tr>
<td>PROVINCIA</td>
<td></td>
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</tr>
<tr>
<td>PROVINCIA</td>
<td>757</td>
<td>26</td>
<td>160</td>
<td>1960</td>
</tr>
<tr>
<td>BONANZA</td>
<td>154</td>
<td>12</td>
<td>39</td>
<td>1964</td>
</tr>
<tr>
<td>TISQUIRAMA</td>
<td>173</td>
<td>4</td>
<td>19</td>
<td>1965</td>
</tr>
<tr>
<td>SAN ROQUE</td>
<td>62</td>
<td>5</td>
<td>7</td>
<td>1966</td>
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<tr>
<td>LLANITO</td>
<td></td>
<td></td>
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<tr>
<td>LLANITO</td>
<td>321</td>
<td>16</td>
<td>104</td>
<td>1964</td>
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<tr>
<td>GALÁN SAN SILVESTRE</td>
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<td>8</td>
<td>147</td>
<td>1953</td>
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<tr>
<td>LÍRIDA PROFUNDO</td>
<td>25.1</td>
<td>3</td>
<td>1</td>
<td>2006</td>
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<tr>
<td>TESORO</td>
<td>42.4</td>
<td>17</td>
<td>43</td>
<td>1979</td>
</tr>
<tr>
<td>NUTRIAN</td>
<td>115</td>
<td>8</td>
<td>47</td>
<td>1982</td>
</tr>
<tr>
<td>PEROLES</td>
<td>5.9</td>
<td>20</td>
<td>12</td>
<td>1978</td>
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<tr>
<td>GUARIQUÍES</td>
<td>25.4</td>
<td>0</td>
<td>1</td>
<td>2011</td>
</tr>
<tr>
<td>SAN LUIS</td>
<td>8.11</td>
<td>10</td>
<td>10</td>
<td>1950</td>
</tr>
<tr>
<td>AGUAS BLANCAS</td>
<td>60</td>
<td>2</td>
<td>10</td>
<td>1960</td>
</tr>
<tr>
<td>TENERIFE</td>
<td>21.9</td>
<td>3</td>
<td>3</td>
<td>1968</td>
</tr>
<tr>
<td>TECA COCORNÁ</td>
<td>602</td>
<td>17</td>
<td>376</td>
<td>1967</td>
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<table>
<thead>
<tr>
<th>TOTAL OOIP (MMBls)</th>
<th>RF AVERAGE (%)</th>
<th>TOTAL WELLS</th>
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<tr>
<td>2989</td>
<td>11</td>
<td>1182</td>
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Ecopetrol S.A. in Magdalena’s Valley has the operation of 17 Hydrocarbons fields development since 1950.
MAIN ECOPETROL METHANE EMISSIONS

- Venting
  - Artificial Lift System
  - Compressors
  - Recollection Facilities

- Flaring
  - Artificial Lift System
  - Compressors
  - Recollection Facilities
  - Process Plants

- Movile Emissions
  - Movile Systems (workover, well service and generally transportation)
PROJECT APPROACH

METHODOLOGY

Quantification
Alternatives Analysis
Pilots
Projects

Elimination Flaring and Venting

Methodology Structure
Velasquez Field Visit
10 Compressors Pilots

PETROBRAS Guando field Visit

Wells

Facilities

Initiation and implementation of the agreement Ecopetrol – EPA

Gas capture projects Production Wells at Ecopetrol

Gas capture projects Production Facilities at Ecopetrol
QUANTIFIED EMISSIONS

METHANE EMISSIONS

Venting and Flaring, Facilities (27%, 1.43 MMSCFD)

Venting and Flaring, Wells (73%, 3.8 MMSCFD)
WHAT WAS SURPRISING
¿FACILITIES EMISIONS?

MEASURE STUDY

• The measure study was made in May 2012 in Magdalena Valley Field Facilities:
  – Santos Field Facilities and Compressor Station
  – Suerte Field Facilities and Compressor Station
  – Bonanza Field Facilities and Compressor Station
  – Provincia Procces Plant

• Methane Emissions:
  131 MMSCF/Year
  30 MMSCF/Year anothers HC.

Proposed action: Improvements Maintenance Routines, Life Cycle Analysis, Technological Adaptations
WHAT WAS SURPRISING
¿FACILITIES EMISIONS?

• Methane economy recovery 99,4 MMSCF/Year

• It means:
  – Savings over USD $559,000 / year
  – Reduction emissions equivalent 40,000 tCO2e
  – Liquid value recover
  – Improve safety operations
WHAT WE FOUND IT TO BE IMPORTANT
PRODUCED GAS APPLICATIONS

- Improve Gas and Oil Sales. (Increase efficiency in artificial lift systems)
- Self-generated energy. (Bonanza Field Applications)
- Wells Stimulation / EOR. (CO₂ projects)
- Gas Storage.
WHAT WE LEARNERD
FINANCIAL STUDY

MONEY LOSSES (In Colombia the company operator pays 20% royalties for the vented/flare gas)

<table>
<thead>
<tr>
<th>FIELD</th>
<th>GAS GOBERMENT TAXES FLARING AND VENTING (KPC)</th>
<th>GAS PRICE (USD/MMBTU)</th>
<th>MONEY LOSSE (USD)</th>
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<tbody>
<tr>
<td>BONANZA</td>
<td>97,309</td>
<td>3.6</td>
<td>$ 350,312.4</td>
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<tr>
<td>LLANITO</td>
<td>9,782</td>
<td>4</td>
<td>$ 39,148</td>
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<tr>
<td>LISAMA</td>
<td>31,682</td>
<td>5.3</td>
<td>$ 167,914.6</td>
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PROJECT FINANCIAL RESULTS

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<th>FIELD</th>
<th>NPV</th>
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<tr>
<td>BONANZA</td>
<td>-121,546</td>
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<tr>
<td>LLANITO</td>
<td>2,936,845</td>
</tr>
<tr>
<td>LISAMA</td>
<td>2,987,611</td>
</tr>
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NPV MMUSD 6

2012 LOSSES > USD 500,000
NEW INDICATOR
GAS EMISSIONS REDUCTION
SUPERINTENDENCIA DE OPERACIONES
DE MARES (T CO2 eq / YEAR)

2012
REAL: 26,423 TON
GOAL: 7,098 TON

2013
REAL: 30,124 TON
GOAL: 86,423 TON
JANUARY 2013
OTHER OPPORTUNITIES

PLAN 2012-2014

- 2013-2014 Tisquirama Field. collection and self-generation or gas for oil well stimulations.
- 2013-2014 Gas collection system compression in Suerte, Santos and Tesoro Facilities with Vapor Recovery Units.
- 2013-2014 Compressor system for low pressure Bonanza Field Facilities.
- 2013-2014 CO2 Capture and EOR process, Galán Field.
Thanks...