Producer and Processor Partner Reported Opportunities

Lessons Learned from Natural Gas STAR

Producers and Processors Technology Transfer Workshop

Western Gas Resources and EPA’s Natural Gas STAR Program
Gillette and Rock Springs, WY
May 9 & 11, 2006

Producer and Processor Partner Reported Opportunities: Agenda

- Production Sector Emissions
- Processing Sector Emissions
- Top Partner Reported Opportunities (PROs)
- Gas Prices and Methane Savings
- Other Opportunities
- Discussion Questions
Methane Losses from the Natural Gas Industry

- Production Sector Emissions
  - The production sector has several large methane emission sources that can be targeted for reductions.
Producer Best Management Practices (BMPs)
- BMP 1: Identify and replace high bleed pneumatic devices
- BMP 2: Install flash tank separators on glycol dehydrators
- BMP 3: Partner Reported Opportunities (PROs)
  - 81% of production sector reductions came from PROs

Processing Sector Emissions
- The processing sector emits less methane, but still has several large emission sources

Processor Best Management Practices

- BMP 1: Replace gas pneumatics with instrument air systems
- BMP 2: Install flash tank separators on glycol dehydrators
- BMP 3: Directed Inspection and Maintenance at Gas Plants and Booster Stations
- BMP 4: Partner Reported Opportunities
  - 91% of processing sector reductions came from PROs

Highly Implemented PROs

- The Gas STAR program has identified
  - 42 production sector PROs
  - 29 processing sector PROs
- Ten “top” PROs from each sector:
  - PROs most reported by Gas STAR partners in production and processing sectors
  - All target major emissions sources
  - Responsible for over 65% of all emission reductions in the production and processing sectors
Production and Processing Top PROs

<table>
<thead>
<tr>
<th>Top PROs</th>
<th>Sector</th>
<th>Payback¹</th>
<th>Methane Savings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Install flares</td>
<td>x</td>
<td>x</td>
<td>None</td>
</tr>
<tr>
<td>Install vapor recovery units</td>
<td>x</td>
<td>x</td>
<td>1-3 yr</td>
</tr>
<tr>
<td>Install plunger lifts</td>
<td>x</td>
<td></td>
<td>&lt;1 yr</td>
</tr>
<tr>
<td>Install instrument air systems</td>
<td>x</td>
<td></td>
<td>&lt;1 yr</td>
</tr>
<tr>
<td>Eliminate unnecessary equipment and/or systems</td>
<td>x</td>
<td>x</td>
<td>&lt;1 yr</td>
</tr>
<tr>
<td>Perform green completions</td>
<td>x</td>
<td></td>
<td>1-3 yr</td>
</tr>
<tr>
<td>Conduct leak surveys</td>
<td>x</td>
<td></td>
<td>&lt;1 yr</td>
</tr>
<tr>
<td>Install electric compressors</td>
<td>x</td>
<td>x</td>
<td>&gt;10 yr</td>
</tr>
<tr>
<td>Consolidate crude oil production and water storage tanks</td>
<td>x</td>
<td></td>
<td>1-3 yr</td>
</tr>
<tr>
<td>Alter blowdown piping</td>
<td>x</td>
<td></td>
<td>1-3 yr</td>
</tr>
<tr>
<td>Use hot taps for in-service pipeline connections</td>
<td>x</td>
<td></td>
<td>1-3 yr</td>
</tr>
<tr>
<td>Redesign blowdown systems and alter ESD practices</td>
<td>x</td>
<td></td>
<td>1-3 yr</td>
</tr>
<tr>
<td>Rerouting of glycol skimmer gas</td>
<td>x</td>
<td></td>
<td>&lt;1 yr</td>
</tr>
<tr>
<td>Shut down compressors</td>
<td>x</td>
<td></td>
<td>&lt;1 yr</td>
</tr>
<tr>
<td>Replace gas starters with air</td>
<td>x</td>
<td></td>
<td>&lt;1 yr</td>
</tr>
<tr>
<td>Replace glycol dehydration units with methanol injection</td>
<td>x</td>
<td></td>
<td>&lt;1 yr</td>
</tr>
</tbody>
</table>

¹ – based on $3/Mcf gas price

Production Top PROs

- Determine which top PROs are not currently implemented at your company
- Revisit economics of top PROs using current gas price

<table>
<thead>
<tr>
<th>Partner Reported Opportunities</th>
<th>Methane Savings in 2004 (Mcf)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Install flares</td>
<td>2,231,586</td>
</tr>
<tr>
<td>Install vapor recovery units</td>
<td>4,187,078</td>
</tr>
<tr>
<td>Install plunger lifts</td>
<td>4,441,045</td>
</tr>
<tr>
<td>Install instrument air systems</td>
<td>410,214</td>
</tr>
<tr>
<td>Eliminate unnecessary equipment and/or systems</td>
<td>327,896</td>
</tr>
<tr>
<td>Perform green completions</td>
<td>6,497,087</td>
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<tr>
<td>Conduct leak surveys</td>
<td>14,061</td>
</tr>
<tr>
<td>Install electric compressors</td>
<td>116,947</td>
</tr>
<tr>
<td>Consolidate crude oil production and water storage tanks</td>
<td>709,404</td>
</tr>
<tr>
<td>Alter blowdown piping</td>
<td>198,419</td>
</tr>
</tbody>
</table>
Production Top PROs Currently Reported

<table>
<thead>
<tr>
<th>Partner Reported Opportunities</th>
<th>ExxonMobil</th>
<th>Chevron</th>
<th>ConocoPhillips</th>
<th>BP</th>
<th>Marathon</th>
</tr>
</thead>
<tbody>
<tr>
<td>Install flares</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Install vapor recovery units (VRUs)</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Install plunger lifts</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Install instrument air systems</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Eliminate unnecessary equipment and/or systems</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Perform green completions</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Conduct leak surveys</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Install electric compressors</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Consolidate crude oil production and water storage tanks</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Alter blowdown piping</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
</tbody>
</table>

Processing Top PROs

- Determine which top PROs are not currently implemented at your company
- Revisit economics of top PROs using current gas price

<table>
<thead>
<tr>
<th>Partner Reported Opportunities</th>
<th>Methane Savings in 2004 (Mcf)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Install flares</td>
<td>78,878</td>
</tr>
<tr>
<td>Use hot taps for in-service pipeline connections</td>
<td>30,008</td>
</tr>
<tr>
<td>Install vapor recovery units (VRUs)</td>
<td>3,796</td>
</tr>
<tr>
<td>Redesign blowdown systems and alter ESD practices</td>
<td>2,310</td>
</tr>
<tr>
<td>Eliminate unnecessary equipment or systems</td>
<td>354,167</td>
</tr>
<tr>
<td>Install electric compressors</td>
<td>49,743</td>
</tr>
<tr>
<td>Redoing of glycol skimmer gas</td>
<td>9,512</td>
</tr>
<tr>
<td>Shut down compressors</td>
<td>10,850</td>
</tr>
<tr>
<td>Replace gas starters with air</td>
<td>6,982</td>
</tr>
<tr>
<td>Replace glycol dehydration units with methanol injection</td>
<td>79,244</td>
</tr>
</tbody>
</table>
Processing Top PROs Currently Reported

<table>
<thead>
<tr>
<th>Partner Reported Opportunities</th>
<th>Enterpr</th>
<th>Western Pro</th>
<th>Direct Energy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Install flares</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Use hot taps for in-service pipeline connections</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Install vapor recovery units (VRUs)</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Redesign blowdown systems and alter ESD practices</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Eliminate unnecessary equipment or systems</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Install electric compressors</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rerouting of glycol skimmer gas</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Shut down compressors</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Replace gas starters with air</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Replace glycol dehydration units with methanol injection</td>
<td>x</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Implementation of Top PROs

- These PROs have been proven to reduce emissions economically
- Top PROs target the largest sources of methane emissions in the production sector
- Room for a great deal of further emissions reductions
Emissions Targeted by Top PROs

- BMPs and top PROs target over 75% of production and processing sector emissions
- This means:
  - Partners that report PROs recognize major sources of methane losses and are taking steps to mitigate emissions
  - Partners not practicing all BMPs and top PROs may have further opportunities for methane savings

Gas Prices and Methane Savings

- Economics of implementing new PROs change with gas price
- PRO fact sheets use nominal gas price of $3/Mcf
- Many PROs were reported when gas price <$2
Install Pressurized Storage of Condensate

- This PRO is reported to save 7,000 Mcf/yr but requires high capital investment for pressurized transport vehicles.
- A partner estimated the capital cost at $37,500 with an annual operating cost of $2,500.
- The decision to implement this PRO depends upon current gas prices.

Economics of Pressurized Condensate

<table>
<thead>
<tr>
<th>Gas Price ($/Mcf)</th>
<th>$3</th>
<th>$5</th>
<th>$7</th>
<th>$8</th>
<th>$10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gas Saved (Mcf/yr)</td>
<td>7,000</td>
<td>7,000</td>
<td>7,000</td>
<td>7,000</td>
<td>7,000</td>
</tr>
<tr>
<td>Annual Savings ($/yr)</td>
<td>$21,000</td>
<td>$35,000</td>
<td>$49,000</td>
<td>$56,000</td>
<td>$70,000</td>
</tr>
<tr>
<td>Installed Cost</td>
<td>$37,500</td>
<td>$37,500</td>
<td>$37,500</td>
<td>$37,500</td>
<td>$37,500</td>
</tr>
<tr>
<td>Operating Cost</td>
<td>$2,500</td>
<td>$2,500</td>
<td>$2,500</td>
<td>$2,500</td>
<td>$2,500</td>
</tr>
<tr>
<td>Payback Period (yr)</td>
<td>1.9</td>
<td>1.1</td>
<td>0.8</td>
<td>0.7</td>
<td>0.6</td>
</tr>
</tbody>
</table>

- High gas prices make the economics of implementing this PRO much more attractive.
- Efforts to reduce emissions should be intensified when gas prices are high and capital investments pay back quickly.
Other Opportunities

The Gas STAR Program has the following PRO Fact Sheets available:

**Production**
- 8 Compressor
- 6 Dehydrator
- 2 Pneumatics/Controls
- 3 Pipelines
- 5 Tanks
- 6 Valves
- 9 Wells
- 3 Other

**Processing**
- 9 Compressor
- 5 Dehydrator
- 2 Pneumatics/Controls
- 2 Pipelines
- 3 Tanks
- 6 Valves
- 2 Other

Other PROs with High Potential Savings

<table>
<thead>
<tr>
<th>PRO</th>
<th>Sector</th>
<th>Payback¹</th>
<th>Methane Savings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrogen Rejection Unit Optimization</td>
<td>Production</td>
<td>x</td>
<td>&lt;1 yr</td>
</tr>
<tr>
<td>Install Compressor to Capture Casinghead Gas</td>
<td>x</td>
<td></td>
<td>&lt;1 yr</td>
</tr>
<tr>
<td>Zero Emissions Dehydrators</td>
<td>x</td>
<td>x</td>
<td>&lt;1 yr</td>
</tr>
<tr>
<td>Connect Casing to Vapor Recovery Unit</td>
<td>x</td>
<td></td>
<td>&lt;1 yr</td>
</tr>
<tr>
<td>Inspect &amp; Repair Compressor Station Blowdown Valves</td>
<td>x</td>
<td>x</td>
<td>&lt;1 yr</td>
</tr>
<tr>
<td>Use Ultrasound to Identify Leaks</td>
<td>x</td>
<td>x</td>
<td>&lt;1 yr</td>
</tr>
</tbody>
</table>

¹ - based on $3/MMcf gas price

- Partners implementing all top PROs have further opportunities for emissions reductions
- These PROs reduce emissions and with higher gas prices pay back more quickly
Discussion Questions

• Do you find any of the top PROs to be economically unattractive?
• How do you take into account the price of gas when examining which PROs to implement?
• What are some of the other issues that are preventing you from implementing these practices?