Lessons Learned from the Natural Gas STAR Program

Montana Petroleum Association
Producers and Processors
Technology Transfer Workshop

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epa.gov/gasstar

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Solar Power Applications

- Methane Losses
- Replace Glycol Dehydrators with Solar Methanol Injection Pumps
  - Methane Savings
  - Industry Experience
- Replace Gas Pneumatics with Solar Powered Instrument Air
  - Methane Savings
  - Industry Experience
- Discussion
Methane Losses

- Dehydrators and chemical injection pumps, and pneumatic devices in production contributed over 12 Bcf of methane emissions in 2007

![Methane Losses Diagram]


Note: Natural Gas STAR reductions from gathering and boosting operations are reflected in the production sector.

Methane Recovery: Replace Dehydrators with Methanol Injection

- Gas hydrate formation presents a serious problem in gas wells and gas pipelines:
  - Hydrates may cause production downtime and unsafe operations
  - Hydrate formation can be avoided by removing water (dehydration) or inhibiting hydrate formation
  - Glycol dehydrators may not operate effectively at low temperatures
  - Methanol injection is a cost-effective method for lowering hydrate formation temperature
Methanol Injection Pumps

- Chemical injection pumps are used to inject methanol and other chemicals into wells and flow lines.
- Injection pumps are often gas-powered at remote production locations.
  - These pumps are typically sized for 6-8 gallons of methanol injection a day.
  - The pneumatic gas vents methane to the atmosphere.

1 - Values based on various SunPumper injection pump models.

Source: BP

Replace Pneumatic Pumps with Solar Pumps

- Solar injection pumps can replace gas-powered pumps to reduce methane emissions.
- Solar pump applications include:
  - Methanol injection for hydrate inhibition
  - Foaming agent injection to reduce well unloading
  - Corrosion inhibitor injection
  - O₂/H₂S scavenger injection
- Solar injection pumps can handle a range of throughputs and injection pressures:
  - Max output 38 – 100 gallons per day¹
  - Max injection pressure 1200 – 3000 psig¹

¹ - Values based on various SunPumper injection pump models.

Source: BP
Solar Pump Advantages

- Solar pumps reduce methane gas venting
- Spill incident reduction due to less refilling
- More reliable than diaphragm pumps therefore less down-time in production
- Lower operating attention and maintenance

Industry Experience: Anadarko (Formerly Western Gas Resources)

- Cold winter temperatures and low gathering pressure led to hydrate formation and downtime when glycol pumps froze up
- Solar powered methanol injection pumps were installed at 70+ locations
Industry Experience: Anadarko (Formerly Western Gas Resources)

- Replacing dehydrators with methanol injection saved an average of 800 thousand cubic feet (Mcf)/yr
- Methanol injection pumps were installed at an average cost of $2,250 per installation

![Image of a pump](source: Anadarko (Formerly Western Gas Resources))

Industry Experience: Anadarko (Formerly Western Gas Resources)

- Methanol injection pump replacing a 2 million cubic feet (MMcf)/day glycol dehydrator

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>Installation Cost</td>
<td>$2,250</td>
</tr>
<tr>
<td>Annual Methanol Cost</td>
<td>$2,519</td>
</tr>
<tr>
<td>Annual Gas Savings (Mcf)</td>
<td>800</td>
</tr>
<tr>
<td>Value of Gas</td>
<td>$5,600</td>
</tr>
<tr>
<td>Payback (Months)</td>
<td>9</td>
</tr>
</tbody>
</table>

- Methanol costs are estimated at $1.15/gal with 3 gallons injected/MMcf gas
- Gas price at $7/Mcf
Industry Experience: BP

- Economic replacement of 160 diaphragm-methanol pumps with solar-methanol pumps at Moxa, WY
- Increased reliability and reduced production downtime
- Reduced methane emissions
- Reduced methanol consumption from 5.5 to 3.5 gallons/day
- Elimination of fuel lines and freezing problems during winter

Source: BP
Industry Experience: BP

- 160 solar pumps cost $500,000.
- Methanol savings pay out is 1.3 years.
- Texsteam & Western pump rate of 6-8 gal/day
  - $1.5 gal x 160 pumps x 7 gal/day = $613,200 / year
  - Solar pump rate of 2.5 gal/day
  - $1.5 gal x 160 pumps x 2.5 gal/day = $219,000 / year
- Methanol savings of $395,000 / year
- 4 wells down at 300 mcf/day for 6 months = $1.3 M

*Solar pumps pay out in less than 3 months in winter conditions*

Source: BP
Methane Recovery: Replace Gas Powered Pneumatics with Instrument Air

- Pneumatic instrument systems powered by natural gas used for process control
- Constant bleed of natural gas from these controllers is the largest production methane emission source

![Pie chart showing various methane emission sources](chart.png)

Solar Powered Instrument Air System

- Significant cost savings can be achieved by switching to compressed instrument air systems
- Reliability of instrument air system dependent on compressor and electric power source
- Solar-powered battery-operated instrument air system reduces
  - Methane emissions
  - Power consumption

Source: Chevron
Industry Experience: BP (Canada)

- BP replaced gas pneumatics with electrical devices powered by solar energy
  - Captured solar and wind energy were converted into electricity, which was stored in a bank of batteries
  - The electricity was used to power electrical pneumatic equipment via an air compressor
- 9 – 150 watts (W) generated by each solar panel (during daylight hours)
  - $1000/ panel
  - $1000/ solar stand
- Savings in lost product and elimination of GHG, CAC offset the additional cost
  - Magnitude is dependant on venting volumes

Source: BP
Industry Experience: BP (Canada)

Daily Demand Profile

![Graph showing daily demand profile with generation and consumption data.]

*Average Daily kW

Note: Generation is sum of the total electricity generated by wind, solar, and pressure energy.

Industry Experience: BP (Canada)

Cost

- Total new installations ~$10-15k greater in cost than “old pneumatic package”
- Retrofit with an instrument air compressor ~ $24-30k
- Payback period of 4 years with no greenhouse gas (GHG) credits or 2 year payback with GHG credits

Source: BP
Industry Experience: BP (Canada)

- Summary of major equipment costs

<table>
<thead>
<tr>
<th>Unit</th>
<th>Cost/Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wind (400 W)</td>
<td>$6,000 - $7,000</td>
</tr>
<tr>
<td>Solar Panel (150 W)</td>
<td>$1,000/Panel</td>
</tr>
<tr>
<td>Solar Stand</td>
<td>$1,000</td>
</tr>
<tr>
<td>Turbine (100W)</td>
<td>TBD (Pilot)</td>
</tr>
<tr>
<td>Battery Box</td>
<td>$450/box</td>
</tr>
<tr>
<td>Battery (140 A-hr, 12V)</td>
<td>$320/battery</td>
</tr>
<tr>
<td>IA Compressor + Control Panel</td>
<td>$11,000</td>
</tr>
<tr>
<td>Pump (Electric vs. Pneumatic)</td>
<td>Similar Price</td>
</tr>
<tr>
<td>Valve (Electric vs. Pneumatic)</td>
<td>Electric 100-150% Greater</td>
</tr>
</tbody>
</table>

Source: BP

Industry Experience: Chevron¹

- Replaced natural gas supply skid with 24 VDC solar powered air compressor package on un-manned offshore platform
- Before compressed air supply
  - Instrument bleed – 4.5 Mcf/day (~$31/day)
  - Other usages – 1 Mcf/day (~$7/day)
- Overcoming resistance to change; operations and engineering
- Total installation cost ~$25,000

Industry Experience: Chevron

- Improve equipment reliability
- Eliminate supply gas users (efficiency)
  - Regulators (4), controllers (2), and scrubber pump (1) – fugitives gas emissions
  - 5.5 Mcf/day (~$14,000/ year)
- Total savings: $ 1.4 million/ year in O&M plus gas savings
- Lessons Learned
  - Battery life limited
  - Essential to minimize leaks
Discussion Questions

- To what extent are you implementing these opportunities?
- Can you suggest other applications for these technologies?
- How could these opportunities be improved upon or altered for use in your operation?
- What are the barriers (technological, economic, lack of information, regulatory, focus, staffing, etc.) that are preventing you from implementing these technologies?