Solar Power Applications for Methane Emission Mitigation

Lessons Learned from the
Natural Gas STAR Program

Montana Petroleum Association
Producers and Processors
Technology Transfer Workshop

Billings, Montana
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epa.gov/gasstar

EPA

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

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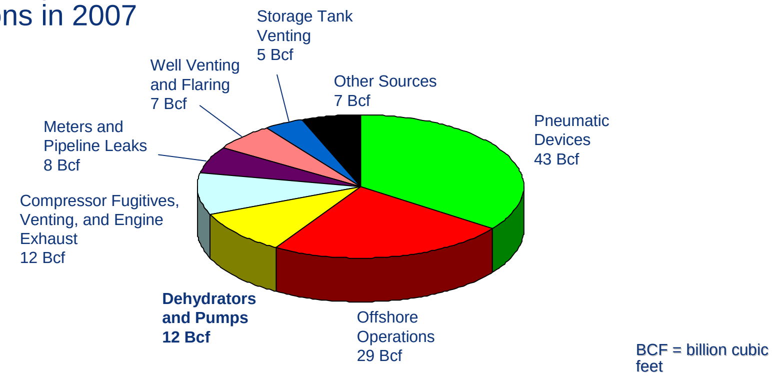
Methane Losses

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



EPA. *Inventory of U.S. Greenhouse Gas Emissions and Sinks 1990 – 2007.* April, 2009. Available on the web at: epa.gov/climatechange/emissions/usinventoryreport.html

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

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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

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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

Source: BP

1 - Values based on various SunPumper injection pump models

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
  - O_2/H_2S scavenger injection
- Solar injection pumps can handle a range of throughputs and injection pressures
  - Max output 38 – 100 gallons per day[1]
  - Max injection pressure 1200 – 3000 psig[1]

Source: BP

1 - Values based on various SunPumper injection pump models

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

Source: Anadarko (Formerly Western Gas Resources)

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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

Source: Anadarko (Formerly Western Gas Resources)

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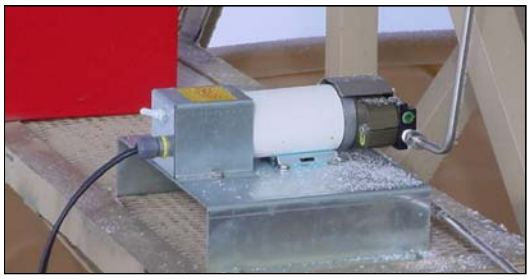
Industry Experience: Anadarko (Formerly Western Gas Resources)

- 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



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

Installation Cost:	$2,250
Annual Methanol Cost:	$2,519
Annual Gas Savings (Mcf):	800
Value of Gas:	$5,600
Payback (Months):	9

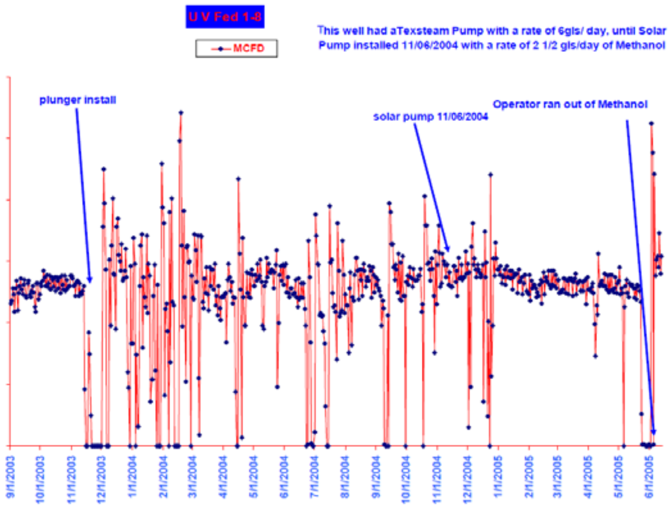
- Methanol costs are estimated at $1.15/gal with 3 gallons injected/MMcf gas
- Gas price at $7/Mcf

Industry Experience: BP

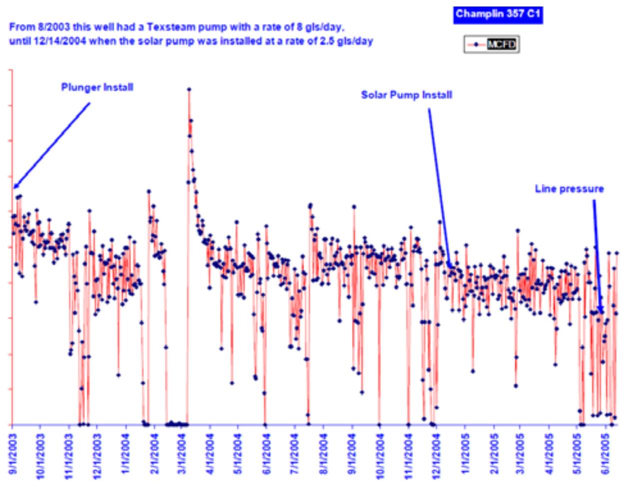
- Economic replacement of 160 diaphragm-methanol pumps with solar-methanol pumps at Moxa, WY
- Increased reliability and reduced production downtime
- Reduced methane emissions
- Reduced methanol consumption from 5.5 to 3.5 gallons/day
- Elimination of fuel lines and freezing problems during winter

Source: BP

Industry Experience: BP



Industry Experience: BP



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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 mcfd for 6 months = $1.3 M

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

Source: BP

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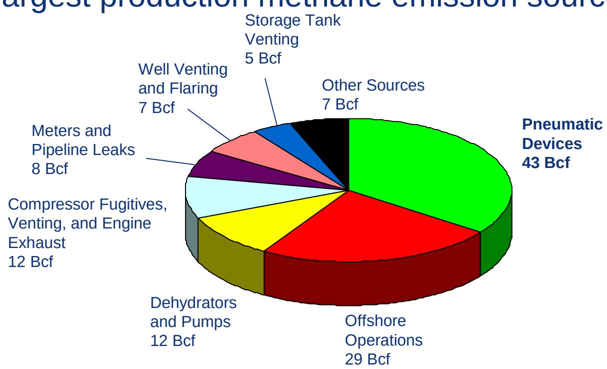
Methane Recovery: Replace Gas Powered Pneumatics with Instrument Air

- 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



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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

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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

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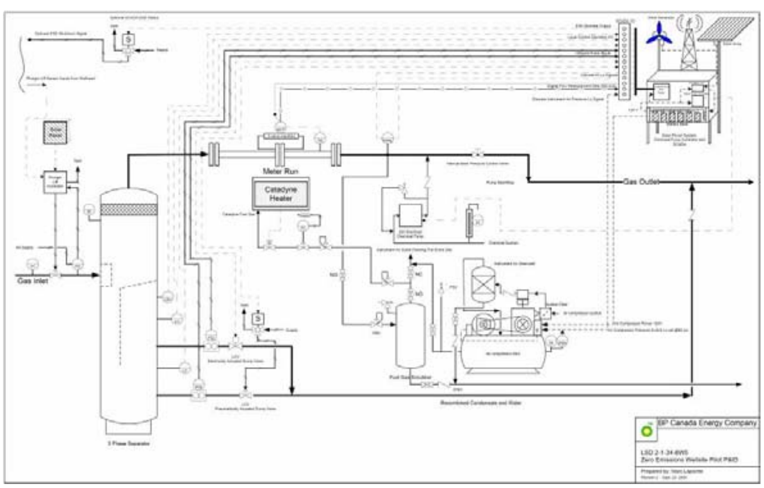
Industry Experience: BP (Canada)



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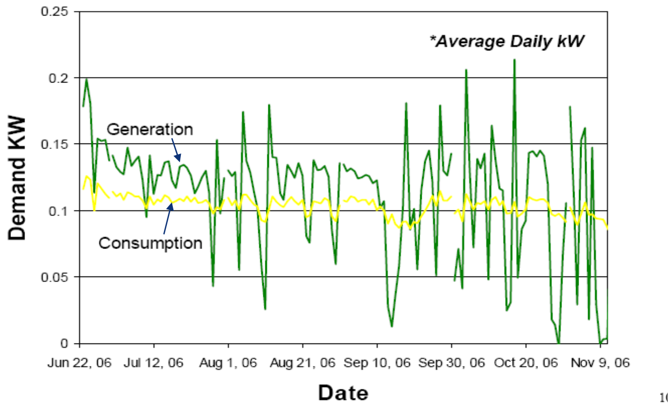
Industry Experience: BP (Canada)

- Daily Demand Profile



kW = KiloWatt

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

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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

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Industry Experience: BP (Canada)

- Summary of major equipment costs

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

Source: BP

Industry Experience: Chevron[1]

- 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

1 Natural Gas STAR Technology Transfer Workshop, Chevron's Experience in Methane Release Mitigation from Offshore Platforms, New Orleans, May 6 2008.

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

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Industry Experience: Chevron

Natural Gas Supply Skid

24VDC Compressed Air Supply

Source: Chevron

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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?

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