Solar Power Applications for Methane Emission Mitigation

Lessons Learned from the
Natural Gas STAR Program

Chevron Corporation,
New Mexico Oil and Gas Association,
Texas Oil and Gas Association

Producers and Processors Technology Transfer Workshop

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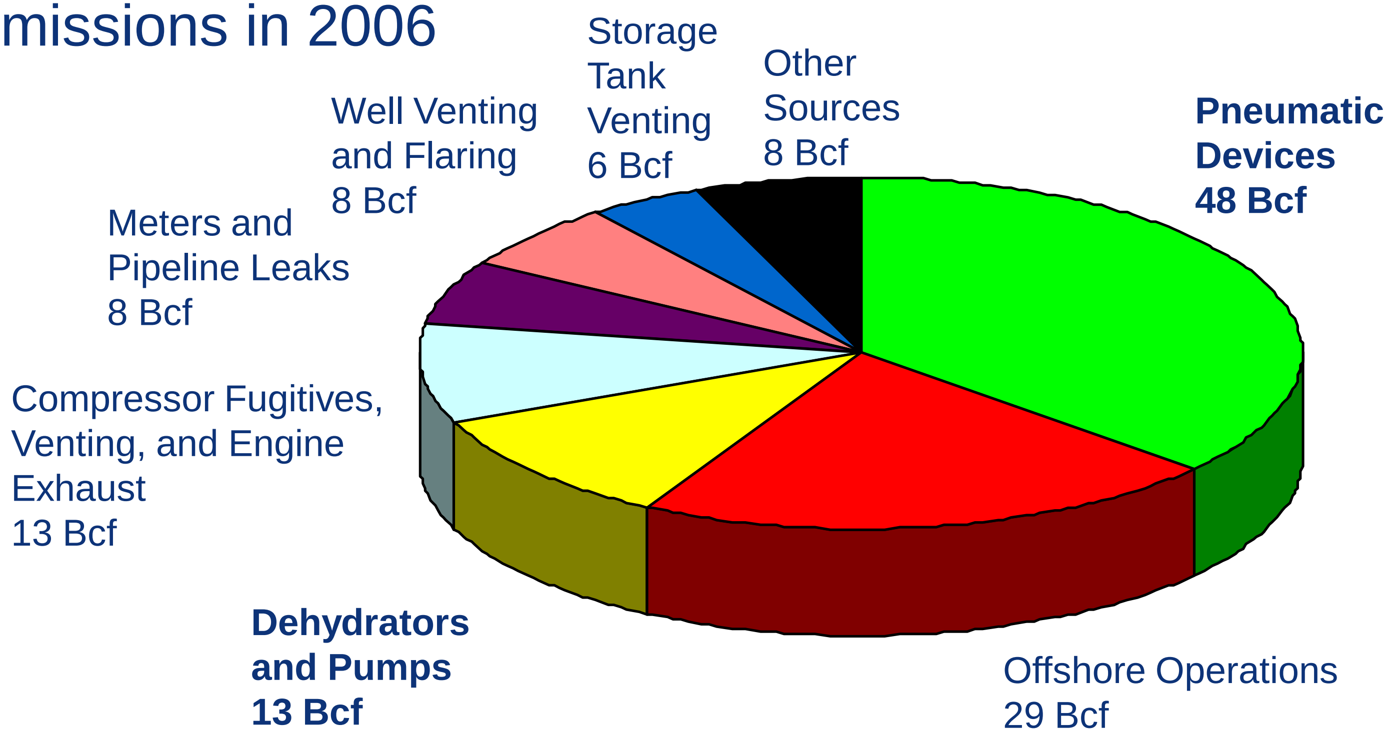
epa.gov/gasstar

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 61 Bcf of methane emissions in 2006



BCF = billion cubic feet

EPA. *Inventory of U.S. Greenhouse Gas Emissions and Sinks 1990 – 2006.* April, 2008. 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.

Methane Recovery: Replace Dehydrators with Methanol Injection

- Gas hydrate formation presents a serious problem to gas pipelines
- Hydrate formation can be avoided by removing water (dehydration) or lowering water's dew point (inhibition)
- Glycol dehydrators may not operate effectively at low temperatures
  - Methanol injection can be a more cost-effective method for managing hydrate formation problems

Methanol Injection Pumps

- Chemical injection pumps are used to inject methanol and other chemicals at the well site
- Injection pumps are often gas-powered at remote production locations
  - Solar injection pumps can replace gas-powered pumps to save gas losses, reduce methane emissions
- 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]

1 - Values based on various SunPumper injection pump models

Solar Powered Chemical Injection Pump Applications

- Methanol injection for hydrate inhibition
- Foaming agent injection to reduce well unloading
- Corrosion inhibitor injection
- O_2/H_2S scavenger injection

Source: Anadarko (Formerly Western Gas Resources)

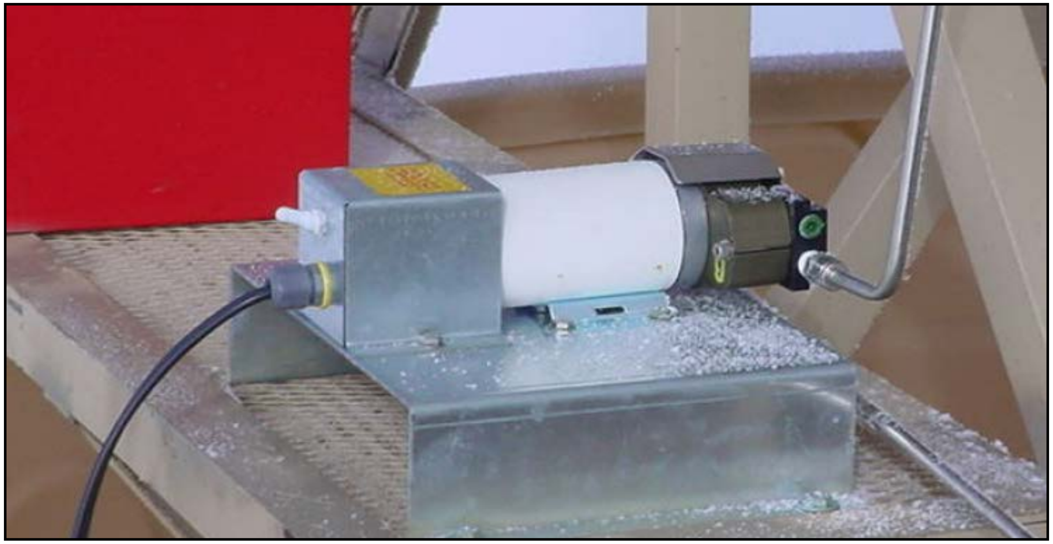
Industry Experience: Anadarko (Formerly Western Gas Resources)

- 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)

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
- Reduced methanol consumption by 5.5-3.5 gallons/day
- Reduction in methane emissions

Source: BP

Industry Experience: BP

- Capital cost for the replacement of 160 methanol pumps: $500,000
- Payback period: 1.3 years (less than 3 months in winter conditions)
- Methanol savings: $395,000
- Emission reduction savings for 6 months: $1.3 million

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
- Significant cost savings can be achieved by switching to compressed instrument air systems
  - Substitution of compressed air for the pressurized natural gas eliminates methane emissions
  - Additional safety benefits

Solar Powered Instrument Air System

- 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

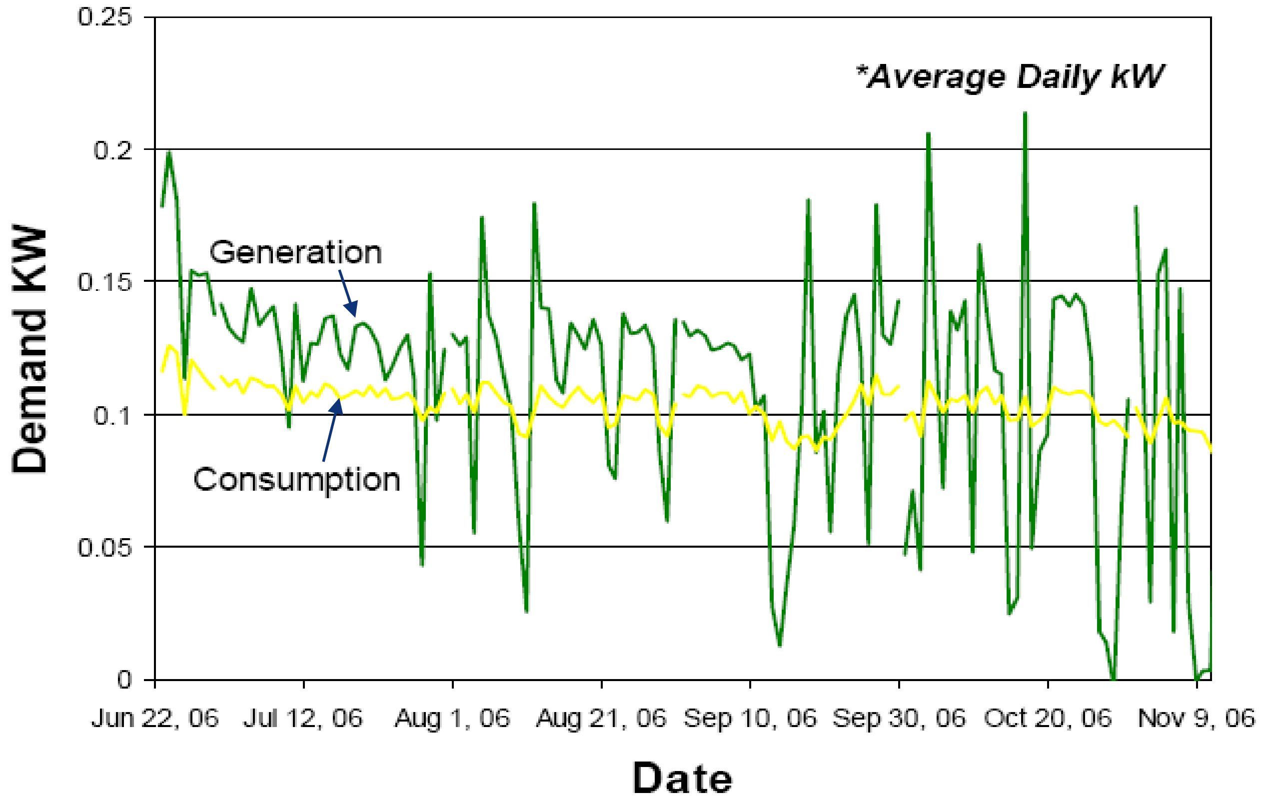
Industry Experience: BP (Canada)

- 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 capital cost
  - $1000/ solar stand capital cost

Source: BP

Industry Experience: BP (Canada)

- Daily Demand Profile



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kW = KiloWatt

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

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
- 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
- Lessons Learned
  - Battery life limited
  - Essential to minimize leaks

Industry Experience: Chevron

Natural Gas Supply Skid

24VDC Compressed Air Supply

Source: Chevron

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?