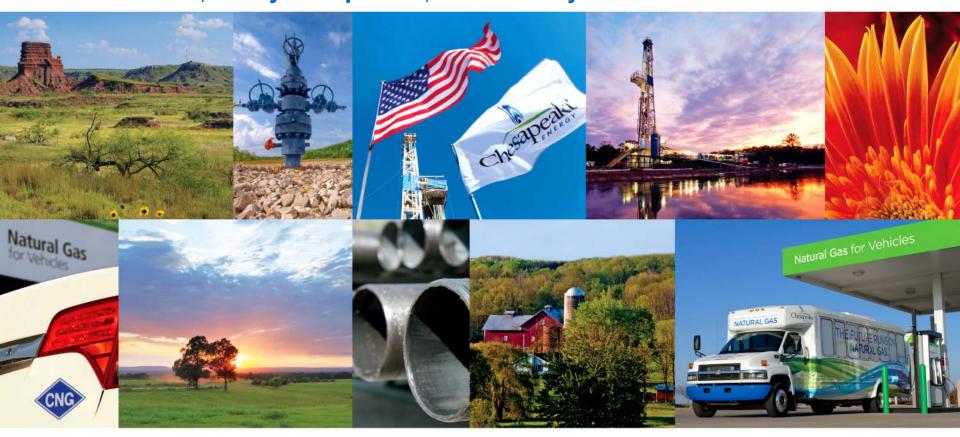
Renewable Power Applications at Natural Gas Well Sites



Natural Gas STAR Annual Implementation Workshop November 2, 2010 Zack Schaffer, Terry Chapman, Don Bredy



Agenda





- The Natural Gas STAR
 Program at CHK
- Solar Chemical Pump Replacements
- Portable Power Unit
- Questions

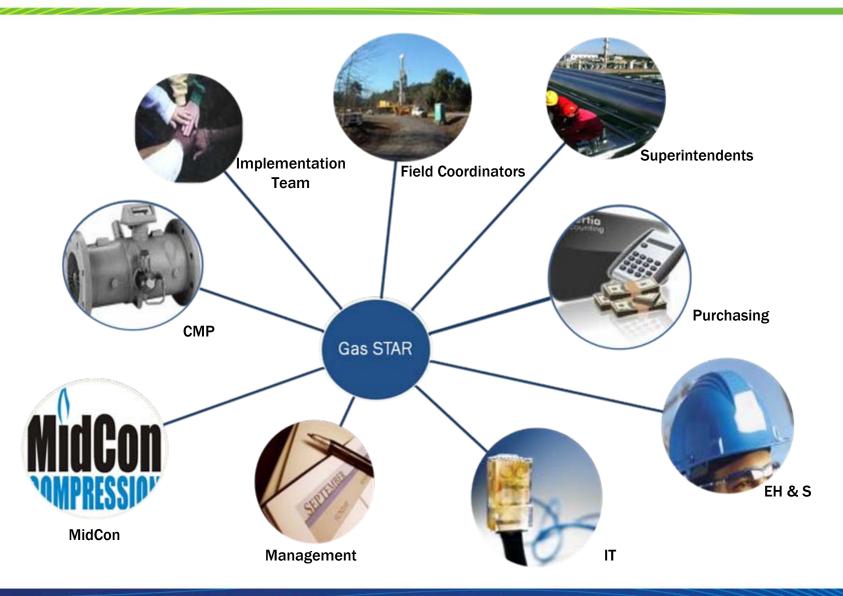
CHK's Primary Operating Areas





CHK Natural Gas STAR Program

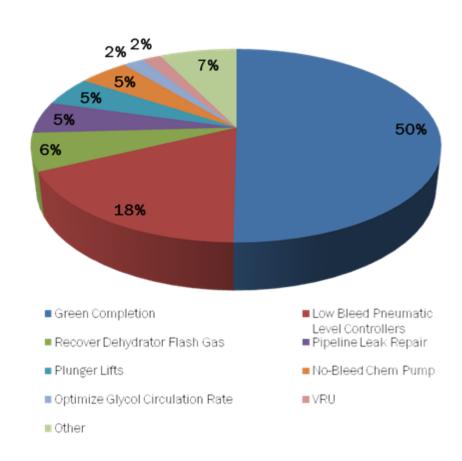




2009 CHK Methane Emissions Reductions



Methane Reduction Activity	Methane Reductions (Mcf)	
Green Completion	50.2%	
Low Bleed Pneumatic Level Controllers	17.6%	
Recover Dehy Flash Gas	6.3%	
Pipeline Leak Repair	5.3%	
Plunger Lifts	4.9%	
No-Bleed Chem Pump	4.6%	
Optimize Glycol Circ Rate	1.9%	
VRU	1.8%	
Replace Prod Unit w/Mech Dump Sep	1.2%	
De-Water/Unload with Gas Lift	1.1%	
Flir Camera Leak Repair	0.9%	
De-Water/Unload with Foaming Agents	0.8%	
Apogee Leak Repair	0.6%	
Install Elec Glycol Pump	0.6%	
Workover - Other Documented Reduction	0.6%	
Workover - Green Re-Completion	0.5%	
Snubbing Operations	0.2%	
Pressure/Hydraulic SWAB	0.2%	
Compressor Startup W/ No Blowdown	0.1%	
Vert Seps - Install Mech Dumps	0.1%	
Other	0.4%	



Pneumatic Chemical Pumps in Barnett





Nearly 500 pneumatic pumps operating in the Barnett Shale

- Mix of WellMark and CheckPoint pumps
 - ¼" plunger
 - 1,000 -1,500 psig discharge pressure
 - Average injection rate of 1 gallon/day
- Most inject corrosion/scaling inhibitors
 - Some foaming agents
 - Some methanol

Quantifying Losses from Chemical Pumps



- Factors that impact gas venting from pneumatic chemical injection pumps
 - Make and model of pump
 - Injection rate
 - Plunger size
 - Discharge pressure
 - Chemical type

How to quantify?

No Natural Gas STAR documentation on gas vented from chemical pumps



Measurement of Gas Losses



- All chemical pump venting measured by Hi-Flow Sampler
- Vinyl containment bag placed over entire pump
- Average leak rate over a 5 minute measurement period
- Vent measurements from 79 individual pumps



CheckPoint Pumps

Samples	32 pumps	
Min	0.05 scf/min	72scf/day
Max	0.65 scf/min	936 scf/day
Average	0.15 scf/min	216scf/day

WellMark Pumps

Samples	47 pumps	
Min	0.02 scf/min	29 scf/day
Max	0.34 scf/min	490 scf/day
Average	0.07 scf/min	101 scf/day

Average 0.11 scf/min 158 scf/day

Reducing Emissions - Solar Chemical Pumps

Chesapeake

- Implemented program to replace all pneumatic chemical pumps with Sun Pumper Model 880 pumps
 - ▶ 3/8" plunger
 - Max output: 100 gal/day
 - Max injection: 1,200 psig
 - Explosion-proof model available for higher discharge pressures
- All pneumatics pumps in Barnett to be replaced within 2 years
 - To date over 140 pneumatic pumps replaced



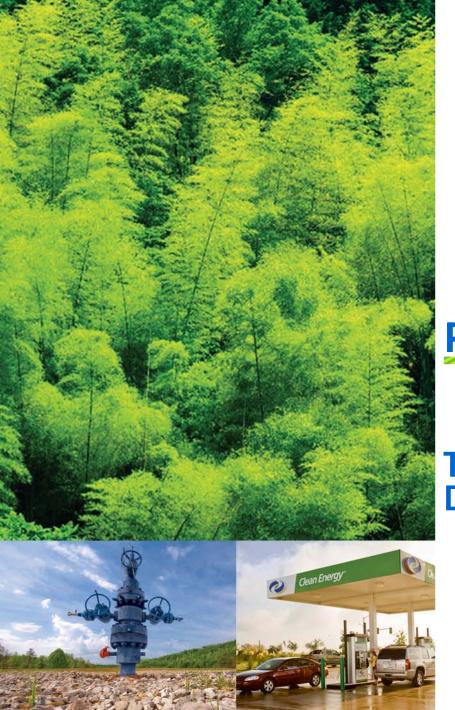


Project Economics



- Installation costs and annual operating costs of replacement pumps are minimal
- Pneumatic pump replacement more attractive at higher gas prices
 - Replacing pumps at end of service life
- Potential for carbon credits?

Barnett Chemical Pump Replacements					
	To Date	Project Total			
Total CH ₄	7,528	26,078			
Emissions					
Reductions					
(Mcf/year)					
Total Natural Gas	8,094	28,041			
Savings					
(Mcf/year)					
Replacement Cost	\$188,300	\$652,000			
Payback @ \$4/Mcf	5.8	5.8			
(years)					
Payback @ \$5/Mcf	4.7	4.7			
(years)					
Payback @ \$6/Mcf	3.9	3.9			
(years)					





Portable Power Unit

Terry Chapman Don Bredy

Powering Remote Well Sites





Kingfisher field office

- Wanted to run pump-off control on remote well site to optimize production
 - Reduce lifting costs
- Examined costs to bring grid power to location
- Examined alternative methods of powering site
 - Portable power unit
 - » Portable power of up to 18.6kW (25HP) using renewable energy

Portable Power Unit (PPU) Overview



- Portable power of up to 18.6kW (25HP)
- Hybrid energy using renewable energy (solar and wind) as

well as NG backup generator

- Energy storage is a lead acid battery pack with quick charging system
- ●VFD regenerative drive system recovers energy during the down stroke of the rod pump
- Designed for a fully green, 25% demand cycle on 25hp load
- 11 hp NG genset allows for an additional 25% demand cycle



PPU Applications





Cyclical loads with variable demand

- Stripper wells needing electrical service
 - High utility cost to electrify well
 - Replacement of diesel genset units
 - Wanting to run the well on pump-off controller (POC)
- Vapor recovery units (VRU)
- Chemical pumps
- Cathodic protection

PPU Costs





- \$92,000 18.5kW (25HP) PPU
- \$10,000 Installation, one year parts and warranty
- Quarterly service contract -\$4,000/year (four visits)
- \$24,500 overhaul price after 7 10 Years
- Total cost of ownership single unit (10 Years) ~\$167,000 includes overhaul

PPU Benefits





Reduced fuel consumption and GHG emissions

- Smaller GHG footprint than gas fired pumping unit or electric pumping unit running on grid power
- Small methane emissions savings
- Power at remote well site to run pump-off control
 - Produce well more efficiently

PPU Emissions Comparison



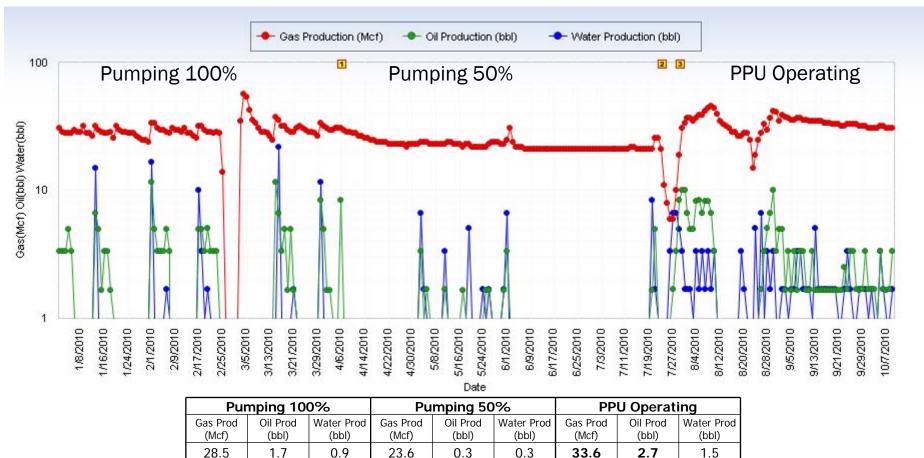
Driver	Case	Fuel Consumed	Fuel Cost (\$/year)	Methane Emissions (scf/year)	GHG Emissions (tCO ₂ e/year)
Arrow C-96	100% Operating Time	1,593 Mcf/year	\$6,371	86	93.0
Arrow C-96	50% Operating Time	796 Mcf/year	\$3,185	43	46.5
Electric Motor	50% Operating Time, Grid Power	65,700 kWh/year	\$4,599	39	49.4
PPU	50% Operating Time, Low Wind Case	701 Mcf/year	\$2,803	38	40.9
PPU	50% Operating Time, High Wind Case	350 Mcf/year	\$1,402	19	20.5
PPU	25% Operating Time, Fully Green	None	\$0	0	0.0

- Assuming \$4/Mcf gas price
- Assuming \$0.07/kWh grid electricity price
- Indirect emissions from grid power based on eGrid SPSO sub-region

PPU – Production Impacts



Pauline 1



- Production increase of 3.5 MMcf/year gas and 850 bbl/year oil at current levels
- Increased revenue of \$75,000/year





Summary

- CHK is actively pursuing renewable power projects to reduce methane and GHG emissions
- Implementing proven technologies such as solar chemical pumps
- Piloting new technologies such as the PPU
- Looking for additional opportunities