



Methane to Markets

**Reducing Methane Emissions from Production Wells:
Reduced Emission Completions in Gas Wells; Smart
Automation of Gas Well Plunger Lifts**

**International Workshop on Methane Emissions Reduction
Technologies in the Oil and Gas Industry**

Lake Louise

14-16 September 2009

Agenda

- **Reduced Emissions Completions**
 - Methane Losses
 - Methane Recovery
 - Is Recovery Profitable?
 - Partner Experience
- Plunger Lift and Smart Automation
- Discussion
- Contacts

Methane Losses During Gas Well Completions

- Gas wells in tight formations and coal beds require hydraulic fracture
- It is necessary to clean out the well bore and formation
 - After new completion
 - After well workovers
- Operators produce to an open pit or tank to collect sand, cuttings, and fluids for disposal
- Vent or flare the natural gas produced
- 67 Bcf¹ (1.9 billion m³) of gas is vented or flared from completions and workovers in the U.S. resulting in 27 Bcf (0.8 billion m³) of methane emissions



Williams E&P, Glenwood Springs, CO

1 – EPA estimate.

Methane Recovery by Reduced Emission Completions

- Recover natural gas and condensate produced during flow-back following hydraulic fracture
- Portable equipment separates sand and water, processes gas and condensate for sales
- Route recovered gas through dehydrator and meter to sales line, reducing venting and flaring



Portable REC Equipment

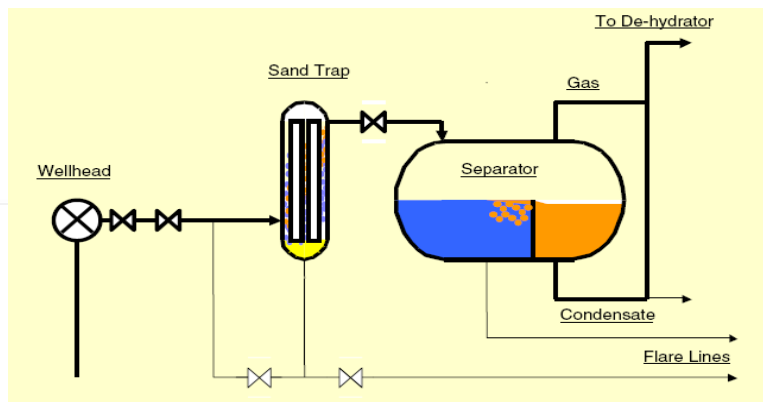
Source: Weatherford

Reduced Emission Completions: Preconditions

- Permanent equipment required on site before cleanup
 - Piping from well head to sales line
 - Dehydrator
 - Lease meter
 - Stock tanks for wells producing significant amounts of condensate
- Sales line gas can be used for compressor fuel and/ or gas lift in low pressure wells

Reduced Emission Completions: Equipment

- Skid or trailer mounted portable equipment to capture produced gas during cleanup
 - Sand trap
 - Three-phase separator
- Use portable desiccant dehydrator for workovers requiring glycol dehydrator maintenance



Temporary, Mobile Surface Facilities,
Source: BP



Source: Williams

Reduced Emission Completions: Low Pressure Wells

- Partners and vendors are perfecting the use of portable compressors when pressure in reservoir is low
 - Artificial gas lift to clear fluids
 - Boost gas to sales line
 - Manage slug flow
 - Adds cost to project



JERRY McBRIDE / Herald

Reduced Emission Completions: Benefits

- Reduced methane emissions during completions and workovers
- Sales revenue from recovered gas and condensate
- Improved relations with government agencies and public neighbors
- Reduced environmental impact
- Improved safety
- Reduced disposal costs

Is Recovery Profitable?

- Partners report recovering 2% - 89% (average of 53%) of total gas produced during well completions and workovers
- Estimate 7,000 – 12,500 Mcf (200 – 350 thousand m³) of natural gas can be recovered from each cleanup
 - \$50,000 to \$85,000 savings at \$7/Mcf
- Estimate 1 – 580 barrels of condensate can be recovered from each cleanup
 - \$50 - \$30,000 additional revenue at \$50/barrel
- Incremental contracted cost of typical REC is \$700 to \$6,500/day for 3 to 10 days of well cleanup
- Purchase of REC equipment costs \$500,000
 - Payback in 3 to 8 months for 25 well/year drilling program

Gas Price (US\$/Mcf)	\$3	\$5	\$7
Payback (year)	3.2	2.2	1.6
NPV (US\$)	15,384	68,455	121,526

REC Partner Experience: BP

- Capital investment of about \$500,000 per skid on portable three-phase separators, sand traps, and tanks in the Rocky Mountain Region
- Used Green Completions on 106 wells
- Total natural gas recovered about 350 MMcf/year (10 million m³)
 - 3.3 MMcf (93 thousand m³) per well average
 - Conservative net value of gas saved is \$20,000 per well¹
- 6,700 barrels/year condensate recovered
- 1.5 year payback based on British Petroleum's prices for natural gas and condensate

¹ Natural gas valued by company to be \$7/Mcf

Agenda

- Reduced Emissions Completions
- **Plunger Lift and Smart Automation**
 - Methane Losses
 - Methane Recovery
 - Is Recovery Profitable?
 - Partner Experience
- Discussion
- Contacts

Methane Emissions from Liquid Unloading in Gas Wells

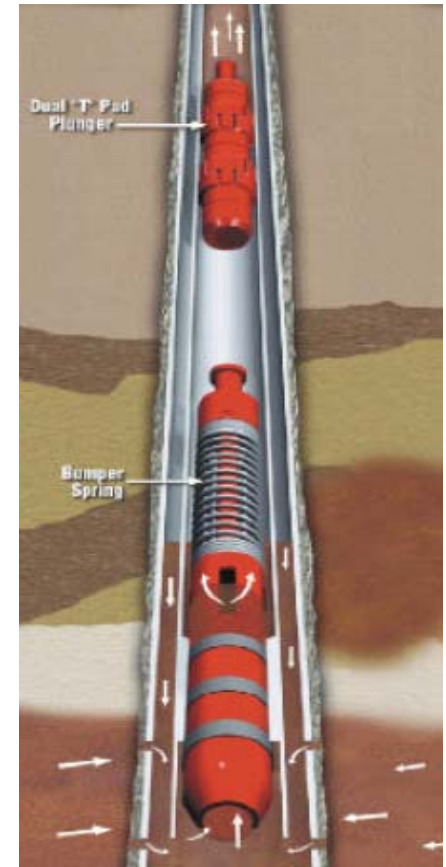
- Completion venting is not the only type of well venting
- Accumulation of liquid hydrocarbons or water in the well tubing reduces, and can halt, production
- Operators traditionally blew wells to atmosphere to expel liquids
- 59 Bcf¹ (1.7 billion m³) of methane emissions from liquid unloading in the U.S.



Source: BP

Methane Reductions from Plunger Lifts

- Plunger lifts automatically produce liquids without blowing the well to the atmosphere
- Shut-in gas pressure stored in the casing annulus periodically pushes the plunger and liquid load from the well bottom to surface separator
- Wells with the right combination of shut-in pressure, depth and liquid accumulation are kept productive with less operator attention



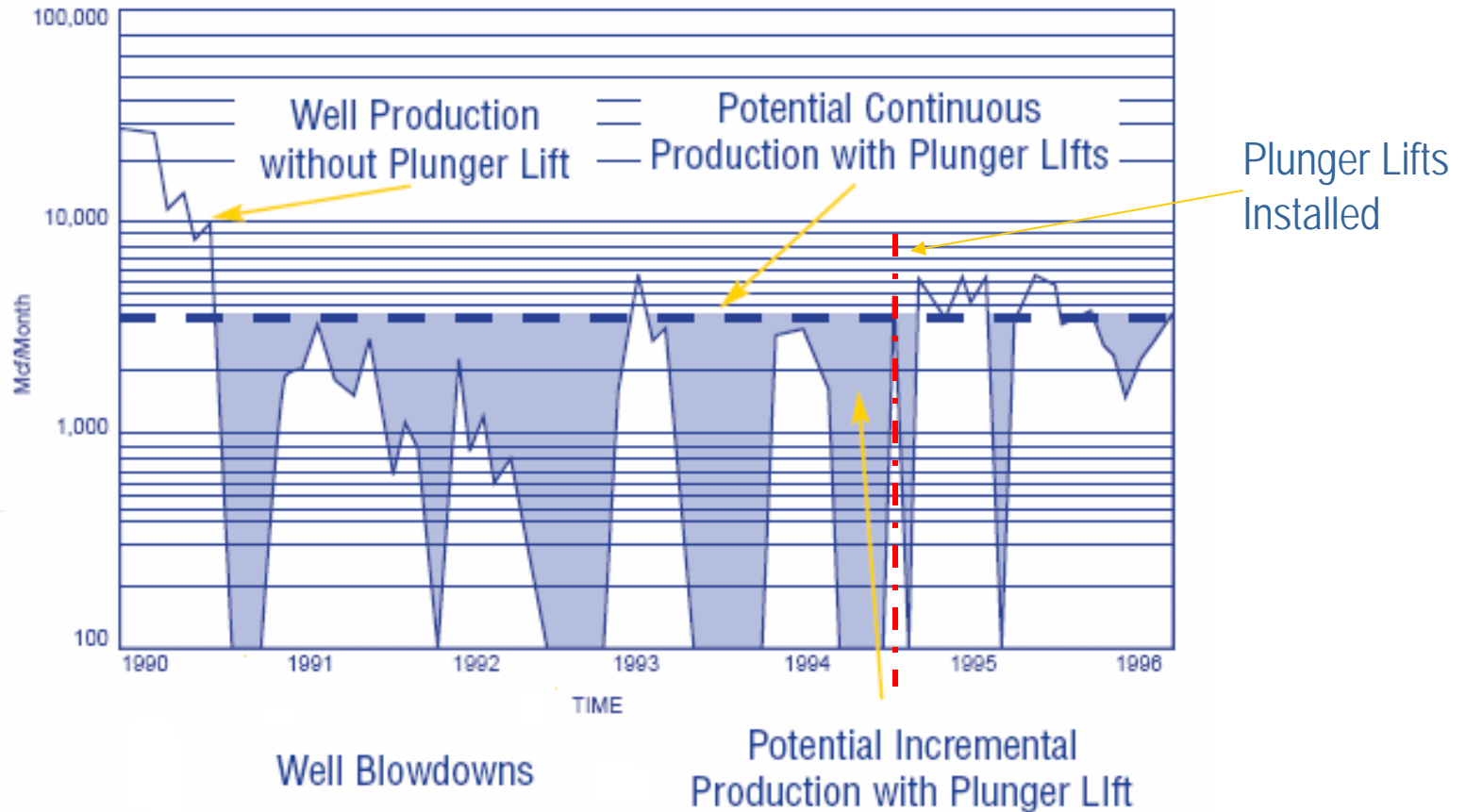
Source: Weatherford

Plunger Lift Applications

- Plunger lifts are a long term solution
- Common plunger lift applications include
 - Wells with gas-to-liquid ratios of 400 scf/bbl (11.33 m³/bbl) per 1,000 feet of depth
 - Wells with shut-in pressure that is 1.5 times the sales line pressure
 - Gas wells with coiled tubing
 - Wells in need of paraffin and scale control

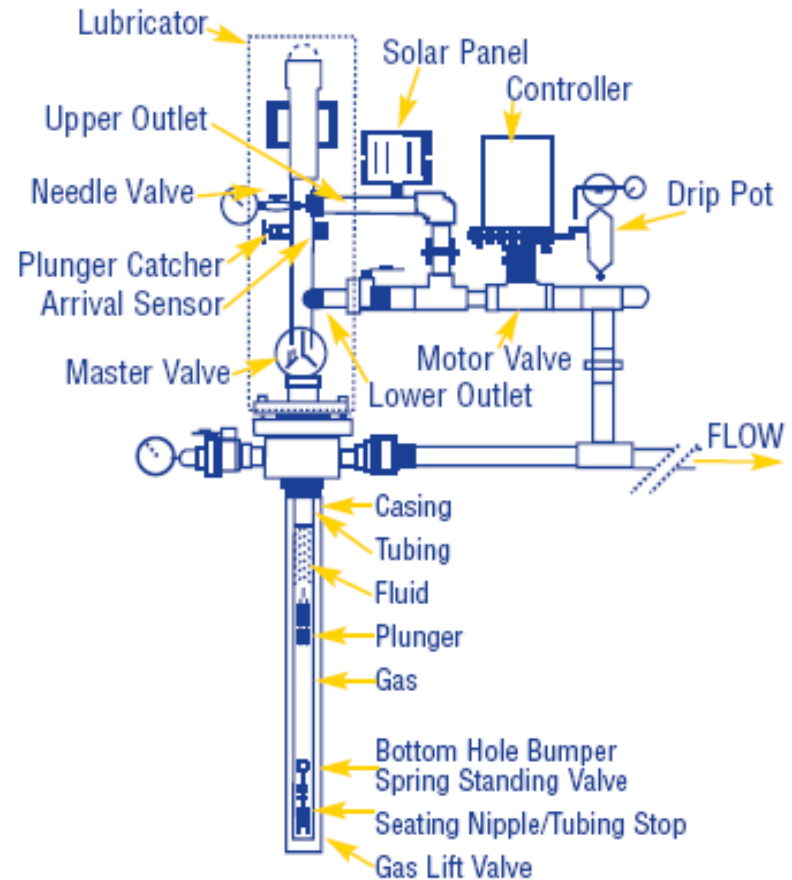
The Real Benefit is Increased Production

Production Control Services
Spiro Formation Well 9N-27E



Plunger Lift: Benefits

- Continuous production
- Lower maintenance
- Increased efficiency
- Reduced methane emissions



Is Recovery Profitable?

- Partners report annual gas savings of \$90,000 to \$130,000¹ per well by the installation of plunger lifts
- Estimate 4,700 – 18,250 Mcf (130 – 520 thousand m³) per well of natural gas can be recovered by the installation of plunger lifts
 - \$32,900 to \$127,750 savings at \$7/Mcf
- Benefits from both increased gas production and emissions savings are well and reservoir specific and will vary considerably
- Cost of implementation ranges from \$2,591 to \$10,363 per well
- Purchase of plunger lifts costs \$7,772¹
 - Payback in 2 to 14 months for incremental gas production ranging from 30 Mcf/day (850 m³/day) to 3 Mcf/day (85 m³/day)

Gas Price (US\$/Mcf)	\$3	\$5	\$7
Payback (months)	2.8	1.9	1.5
NPV (US\$)	120,630	176,157	231,684

Smart Automation: Continuous improvement on plunger lifts

- Plunger lifts are an improvement over blowing down wells to unload liquids, but there are limitations to conventional plunger lifts:
 - Fixed timer in conventional plunger lifts requires manual adjustments of the plunger cycle time
 - Manual adjustments are not performed regularly
 - Do not account for gathering line pressure fluctuations, declining well performance, plunger wear
- Results in manual venting to atmosphere when plunger lift is overloaded and production loss when liquids are not unloaded efficiently



Source: BP

Smart Automation Well Venting

- Automation can enhance the performance of plunger lifts by monitoring wellhead parameters
 - Tubing and casing pressure
 - Reservoir pressure recovery time
 - Sales line pressure
 - Flow rate
 - Plunger travel time
- Using this information, the system is able to optimize plunger operations
 - To minimize well venting to atmosphere
 - Recover more gas
 - Further reduce methane emissions

Smart Automation: Methane Savings

- Methane emissions savings is a secondary benefit
- Optimized plunger cycling to remove liquids increases well production by 10 to 20%¹
 - Additional 1%¹ production from avoided venting
 - Conventional plunger lift reduces venting by 50%
 - Smart Automation recovers another 25 - 40% of vent gas
- 6,300 Mcf/year (180 thousand m³/year) methane emissions savings for average U.S. well venting 9,400 Mcf/year (270 thousand m³/year)



Source: BP

¹ Reported by Weatherford

Smart Automation: Other Benefits

- Reduced manpower cost per well
- Continuously optimized production conditions
- Remotely identify potential unsafe operating conditions
- Monitor and log other well site equipment
 - Glycol dehydrator
 - Compressor
 - Stock Tank
 - Vapor Recovery Unit



Source: BP

Is Recovery Profitable?

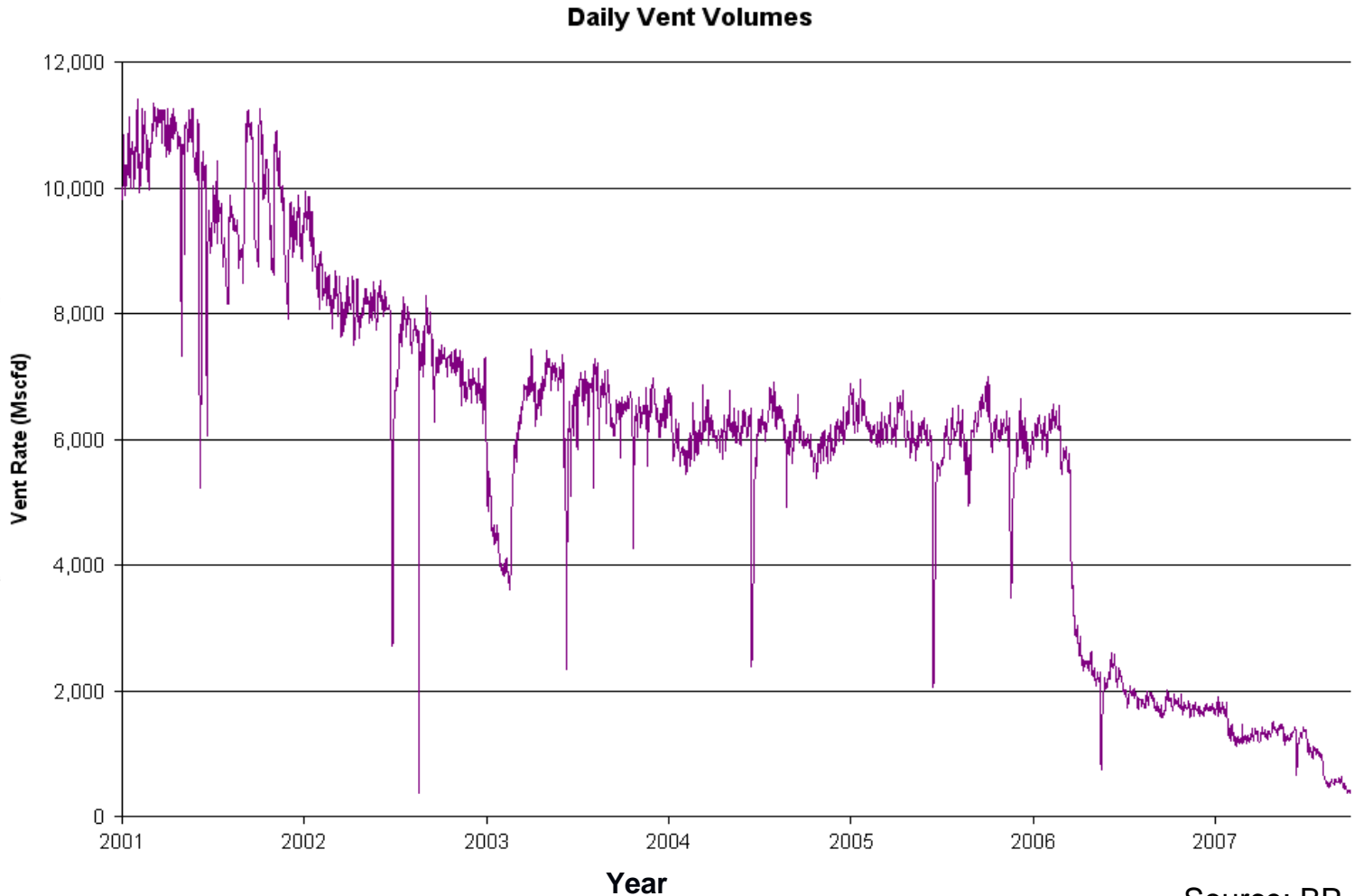
- Estimate 6,260 – 24,300 Mcf (177 – 688 thousand m³) per well of natural gas can be recovered by the installation of smart automation
 - \$44,000 to \$170,000 savings at \$7/Mcf
- Benefits from significant reductions in gas venting volumes along with production improvements
- Automation System can be installed at a cost of less than \$12,000 per well
 - Payback in 1 to 3 years

Gas Price (US\$/Mcf)	\$3	\$5	\$7
Payback (months)	16	10	7
NPV (US\$)	40,548	82,247	123,945

Smart Automation Partner Experience: BP

- BP's first automation project designed and funded in 2000
- Pilot installations and testing in 2000
 - Installed plunger lifts with automated control systems on ~2,200 wells
 - ~\$15,000 per well Remote Terminal Unit (RTU) installment cost
 - \$50,000 - \$750,000 host system installment cost
- Achieved roughly 50% reduction in venting from 2000 to 2004

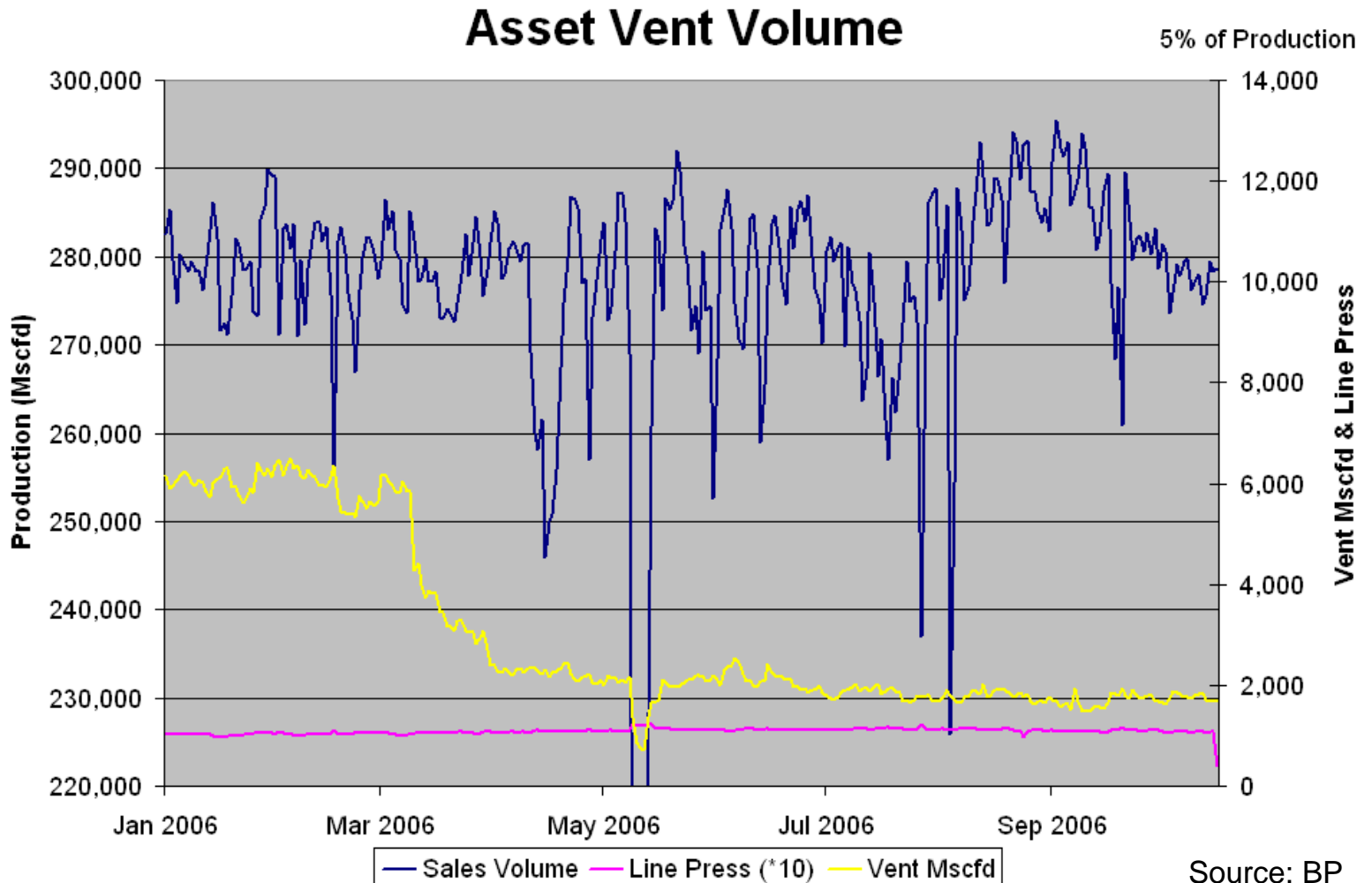
Smart Automation Partner Experience: BP



Smart Automation Partner Experience: BP

- BP designed two pilot studies in 2006 to further improve well scientific control
 - Interviewed control room staff and worked closely with the field automation team leader
 - Established a new procedure based on plunger lift expertise and pilot well analysis
- In mid 2006, “smarter” automation was applied to wells
 - 1,424 Mcf (40 thousand m³) reported annual savings per well

Smart Automation Partner Experience: BP



Discussion

- Industry experience applying these technologies and practices
- Limitations on application of these technologies and practices
- Actual costs and benefits

Contact Information

- **Jerome Blackman**
202-343-9630
blackman.jerome@epa.gov
- **Carey Bylin**
202-343-9669
bylin.carey@epa.gov
- **Roger Fernandez**
202-343-9386
fernandez.roger@epa.gov
- **Suzie Waltzer**
202-343-9544
waltzer.suzanne@epa.gov

www.epa.gov/gasstar
www.methanetomarkets.org