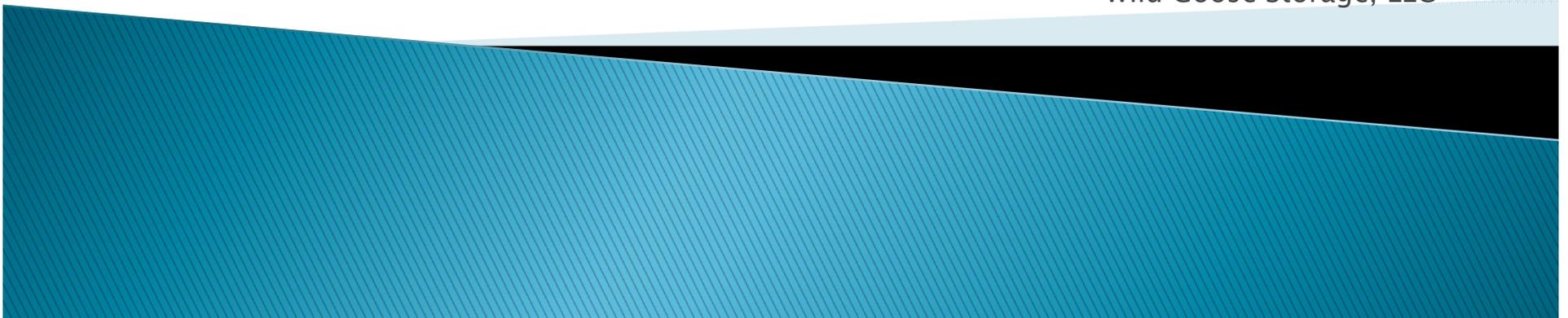


R.15-01-008 Natural Gas Leak Abatement

Cost-Effectiveness Workshop

November 3, 2016

Central Valley Gas Storage, LLC
Gill Ranch Storage, LLC
Lodi Gas Storage, LLC
Wild Goose Storage, LLC



Independent Storage Providers (ISPs) support safe, cost-effective and technologically feasible methane emission reductions

- ▶ ISPs' commitment to low emissions is illustrated by our proven track record of emission reduction efforts to date
- ▶ Options for emission reductions yielding the largest impact have been and continue to be investigated
 - Recently developed emission reduction measures incorporated into design and build-out
 - Operations actively managed to prevent, detect and address leaks
- ▶ The cost to reduce emissions further is high and varies greatly based on the design of each facility
- ▶ ISPs believe lower per unit cost reduction opportunities exist within the oil and gas industry that collectively will exceed the goal set by the state

ISPs support cost-effective best practices

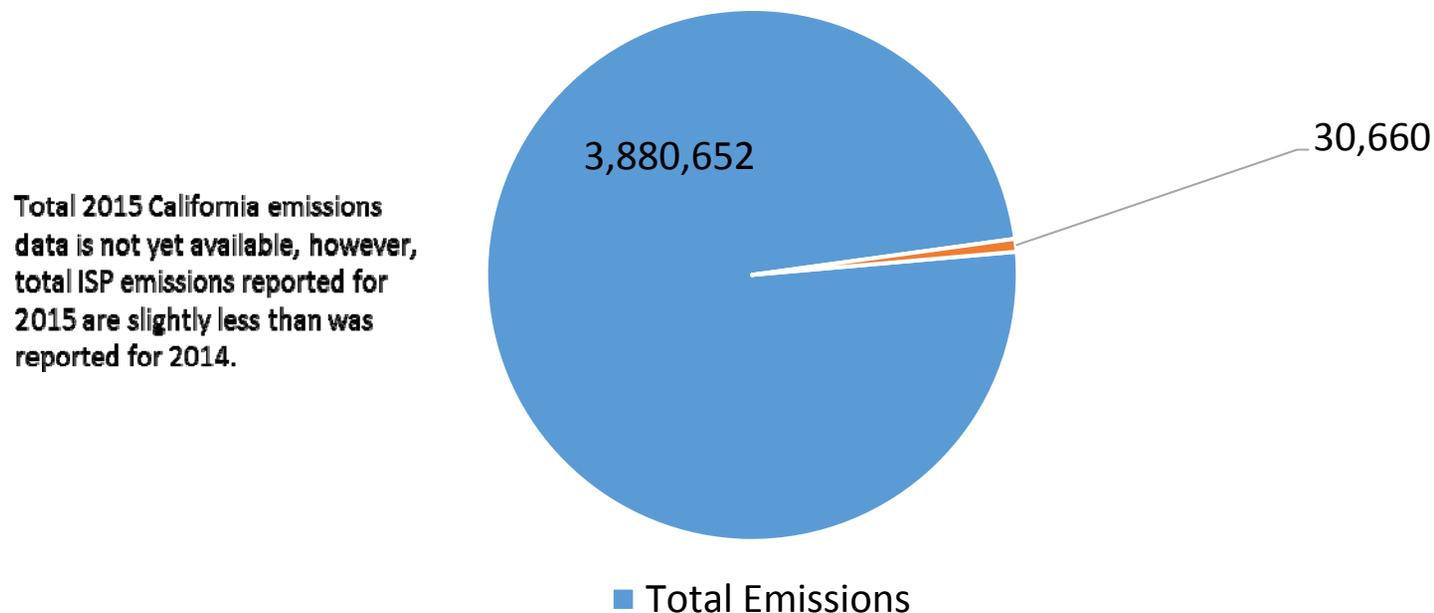
- ▶ Critical that best practices take into account:
 - Different operational system designs
 - Types of leaks and tools to mitigate – scale
- ▶ Focus should be on achieving largest reductions with the least cost
 - Large reductions from process changes for blowdowns
 - Systemic reductions from low cost technology implementation



ISPs' methane reduction investments have been successful

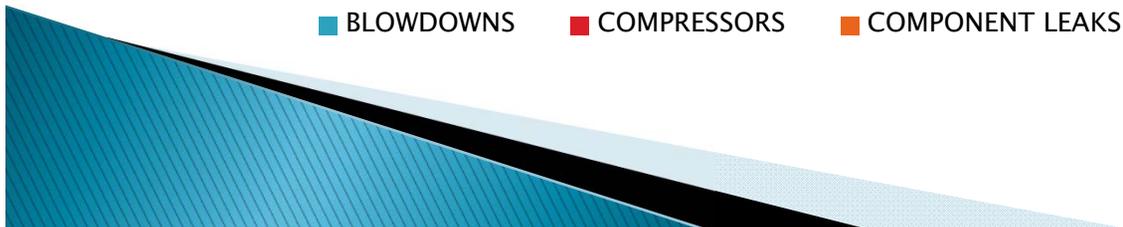
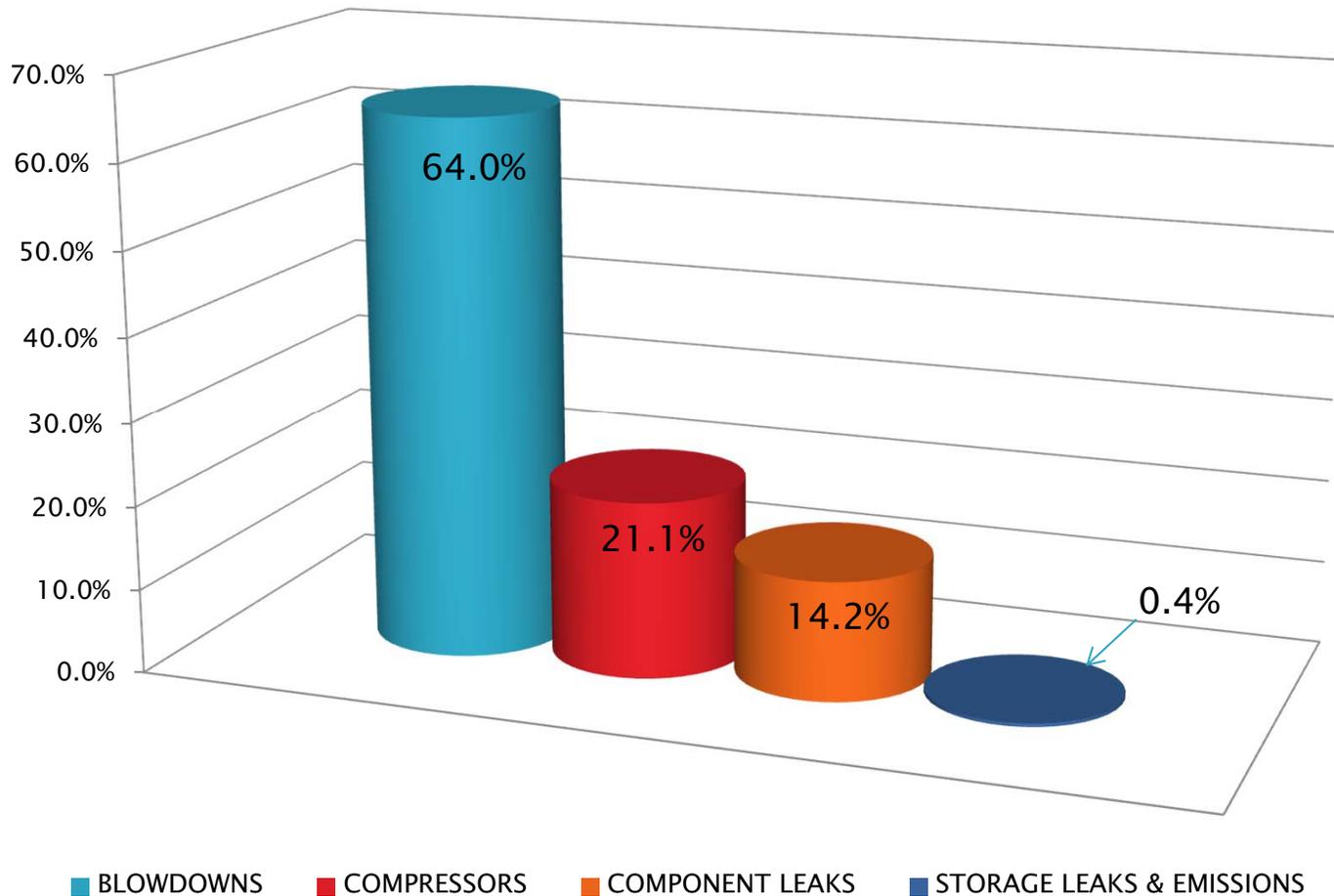
- ▶ ISPs represent de minimus portion of statewide methane emissions

Total 2014 California Emissions (Mscf)*



* CARB and CPUC Joint Staff Report Analysis of the Utilities' May 15, 2015, Methane Leak and Emissions Reports Required by Senate Bill (SB) 1371 (Leno) and Rulemaking (R.)15-01-008 (February 22, 2016); <http://www.cpuc.ca.gov/WorkArea/DownloadAsset.aspx?id=10263>.

Blowdowns: The main source of ISP methane emissions based on 2015 data

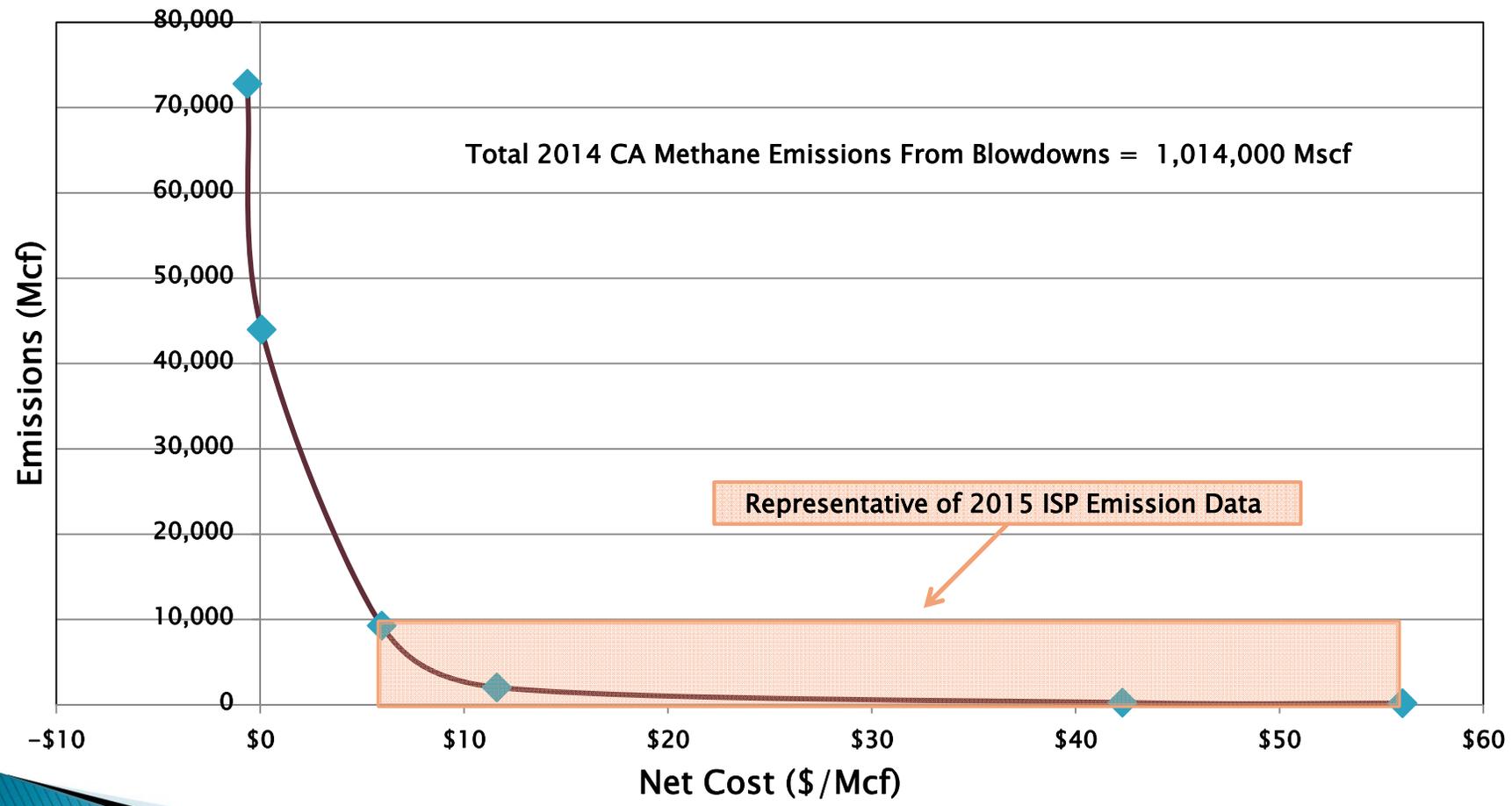


Scale of ISP blowdowns is low relative to larger emitters, resulting in much higher unit costs to achieve reductions

- ▶ Estimated range for ISPs' costs to reduce blowdown emissions by >40% ranges from \$6.00 to \$56.00 per Mscf (net of methane savings @ \$3.00 per Mscf)
- ▶ Costs for larger emitters with more opportunities for reductions estimated to range from breakeven (\$0) to -\$1.00 per Mscf
 - Cost difference between large emitters and ISPs primarily due to the ability to amortize the large capital investment over a greater volume of blowdown gas
- ▶ Net paybacks of ISP emission reduction capital investments range from 20 to 131 years



Cost per unit of methane emission reduction for ISP blowdowns is significantly higher than for other blowdown sources in California



ISPs' opportunities for reduction are much more limited,
increasing unit costs for each company to reduce
emissions

- ▶ Small relative size of annual emissions
- ▶ High capital investment for equipment to mitigate emissions
- ▶ Incremental operational and maintenance costs
- ▶ Limited space for installation of required equipment



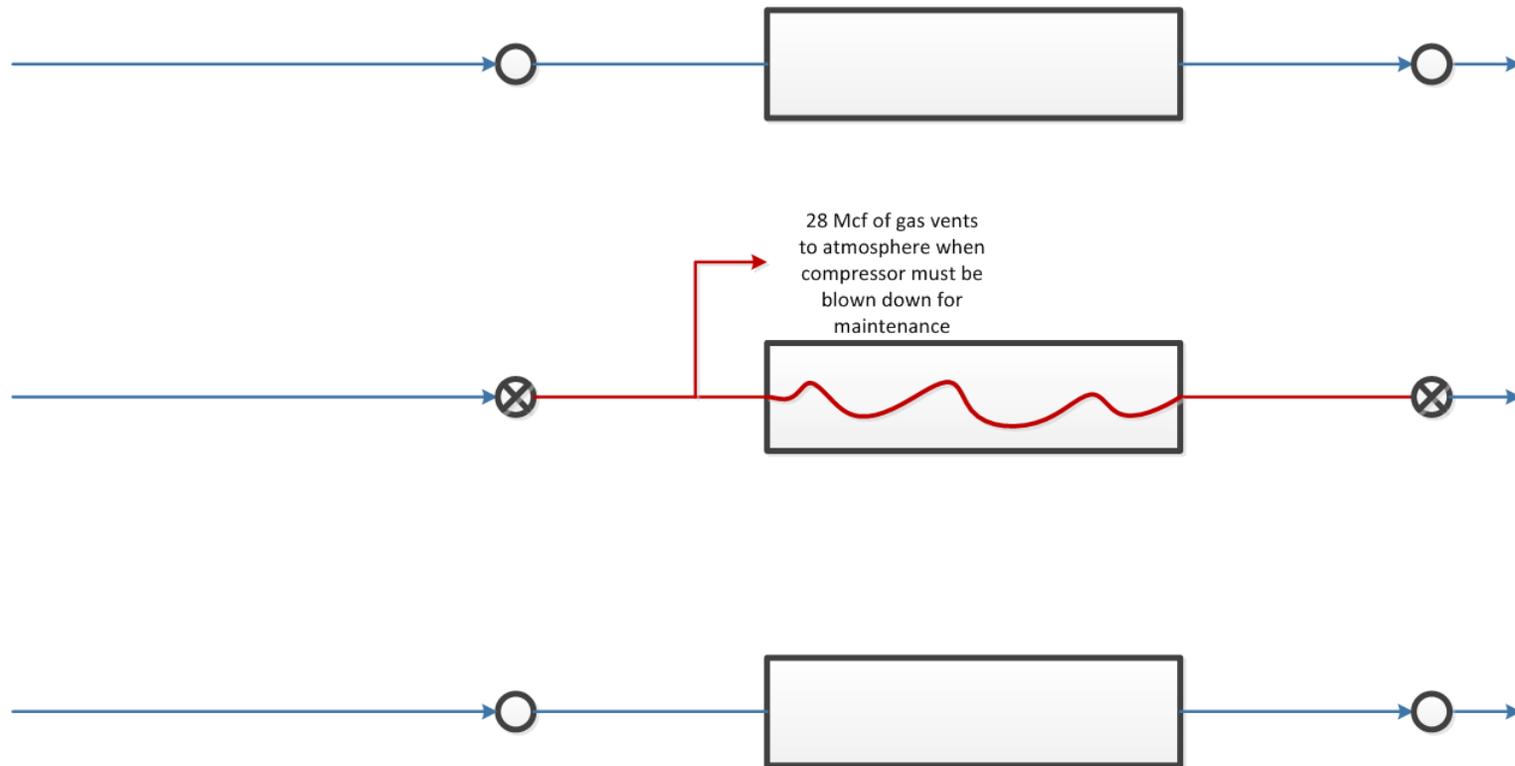
Cost-effectiveness of best practices evaluated by ISPs is highly variable

- ▶ Capture and recompression of blowdown gas
 - Cost ranges from \$6.00 to \$56.00 per Mscf, net of methane savings @ \$3.00/Mscf
 - Cost-effectiveness highly dependent on the specific situation at the storage facility
 - Significant capital investment required for the installation of high pressure compressor
 - Assumed to capture 80% of available gas volume from planned blowdowns
- ▶ Installation of low emission compressor packing
 - Estimated cost is \$17.90 per Mscf, net of methane savings @ \$3.00/Mscf
 - Technology is untested
 - Estimated reduction of packing emissions is 50% (unproven)
 - Expected life of 35,000 operating hours (similar to current packing)

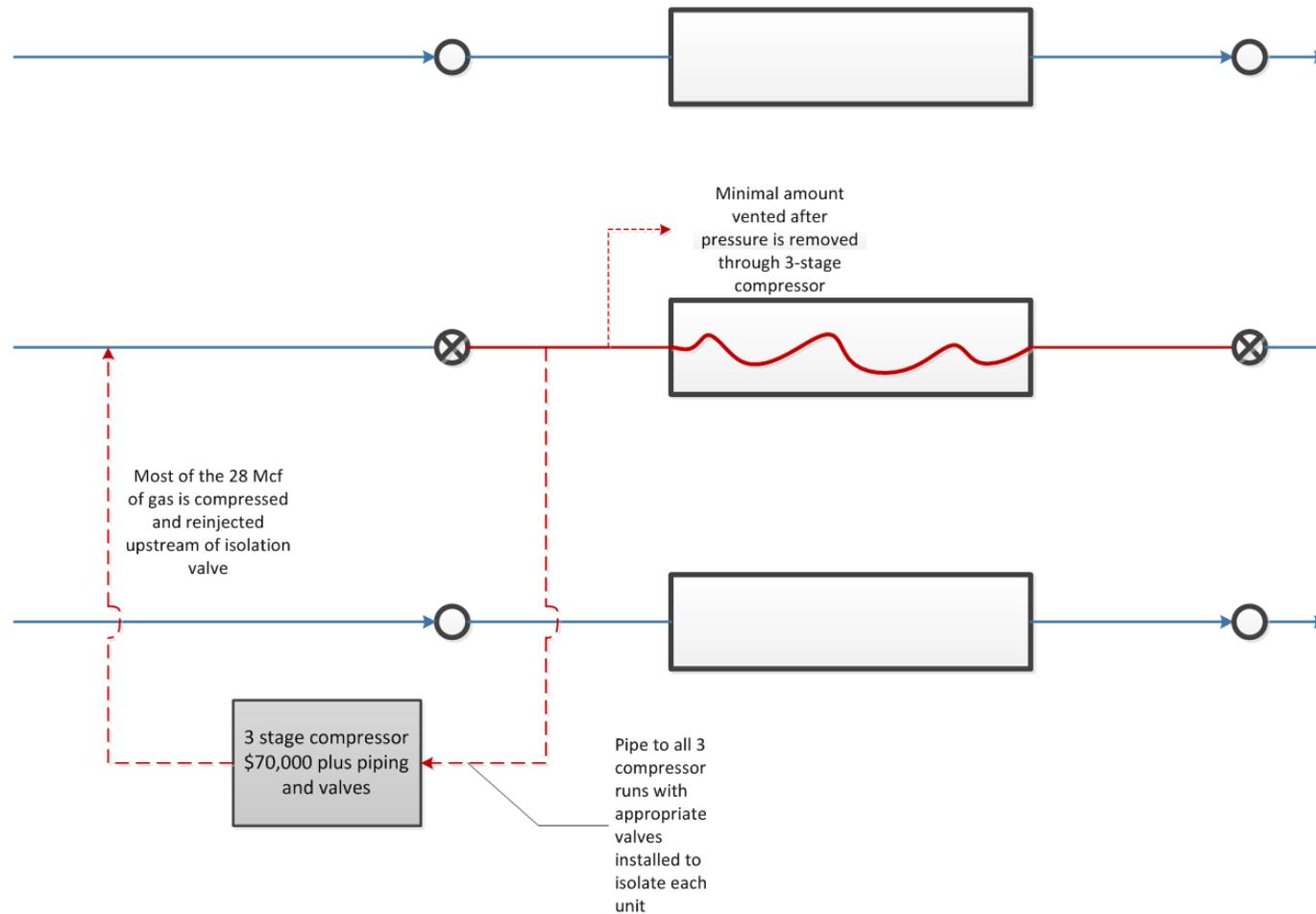
Cost-effectiveness of best practices evaluated by ISPs is highly variable (cont.)

- ▶ Capture methane from intermittent bleed device and use as fuel in catalytic heater
 - Either set up for continual operation
 - Actually increases total methane consumption due to need to operate in non-winter months when heater would otherwise not be required
 - Or set up for seasonal operation when heater is required
 - Net annual savings of 7 Mscf during 4 months in operation
 - \$5,000 investment required resulting in 238 year payback @ \$3.00/Mscf

Cost-effectiveness example: Existing situation for blowdowns during compressor maintenance or repair



Cost-effectiveness example: Mitigation measure to capture and re-inject compressor blowdown gas



Cost-effectiveness example: Re-inject compressor blowdown gas

- ▶ Methane Emission Reduction:
 - Facility emitted 368 Mscf during compressor blowdowns in 2015
 - Assume 90% of blowdowns known in advance
 - Assume 80% gas can be captured when blowdown is known in advance
 - Emission Reduction is:
$$368 \text{ Mscf} \times 0.9 \times 0.8 = 265 \text{ Mscf}$$
 - Value of gas recovered
$$265 \text{ Mscf} @ \$3.00 = \$795/\text{yr.}$$

Cost-effectiveness example: Re-inject compressor blowdown gas

▶ Investment Required and Cost-Effectiveness:

- Purchase 3-stage compressor: \$70,000
- Installation (piping, valves) \$10,000
\$80,000
- Cost per Mscf Reduced
 - Annualized cost recovery for depreciation, fuel, maintenance, repairs, etc. = \$12,000
 - $\$12,000 / 265 \text{ Mscf} = \$45.28 / \text{Mscf}$
 - Cost net of \$795 methane savings = $\$11,205 / 265 \text{ Mscf}$ or $\$42.28 / \text{Net Mscf}$ (Methane savings @ \$3.00/Mscf)
- Payback Period
 - $\$80,000 / \$795 / \text{yr.} = 100.6 \text{ years}$
 - This does not include any ongoing electricity costs, maintenance costs or repairs for operating the 3-stage compressor

Additional best practices are being evaluated for their feasibility and cost-effectiveness

- ▶ Isolation of vent stack during ESD testing eliminating a blowdown of the facility
- ▶ Utilizing compressed air in place of methane to operate automated valves with low bleed controllers at remote wellpad locations
- ▶ Utilize a pressurized coupon retrieval tool to eliminate blowing down the vessel housing the coupon



ISPs believe the measure of cost-effectiveness should be to achieve the highest reduction for the lowest per unit cost

- ▶ ISPs are committed to reducing methane emissions that are high volume reduction for low unit costs
- ▶ ISPs operate new, state-of-the-art facilities that incorporate designs with modern technology and sound operating practices
- ▶ ISPs represent a very small fraction of the overall methane emissions statewide (0.79%) so reductions are likely to also be small
- ▶ Over 85% of ISP methane emissions are from blowdowns and compressor operations where reductions involve significant capital investments
- ▶ Larger emitters have the opportunity to make more effective use of the capital equipment required to reduce emissions