Transmission Best Management Practices and Opportunities

Lessons Learned from Natural Gas STAR

Transmission Technology Transfer Workshop

Duke Energy Gas Transmission,
Interstate Natural Gas Association of America (INGAA) and
EPA's Natural Gas STAR Program

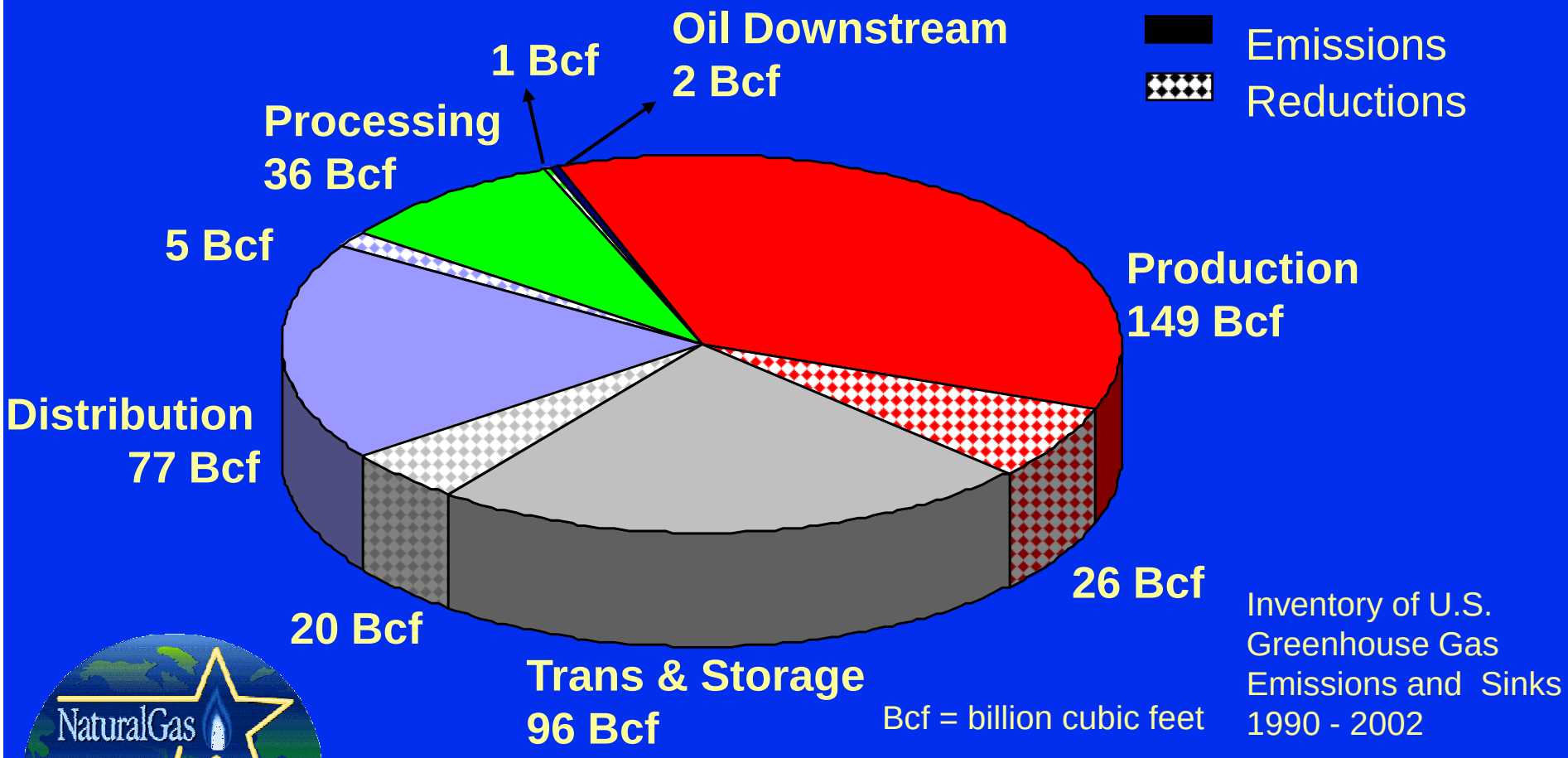
September 22, 2004

Transmission BMP: Agenda

- Transmission Sector Emissions
- Introduction to Partner Reported Opportunities (PROs)
- Selected PRO Overviews
- DI&M
- Industry Experience
- New Leak Detection Technology
- Discussion Questions

Natural Gas and Petroleum Industry Emissions

- Transmission sector responsible for large portion of emissions



Bcf = billion cubic feet

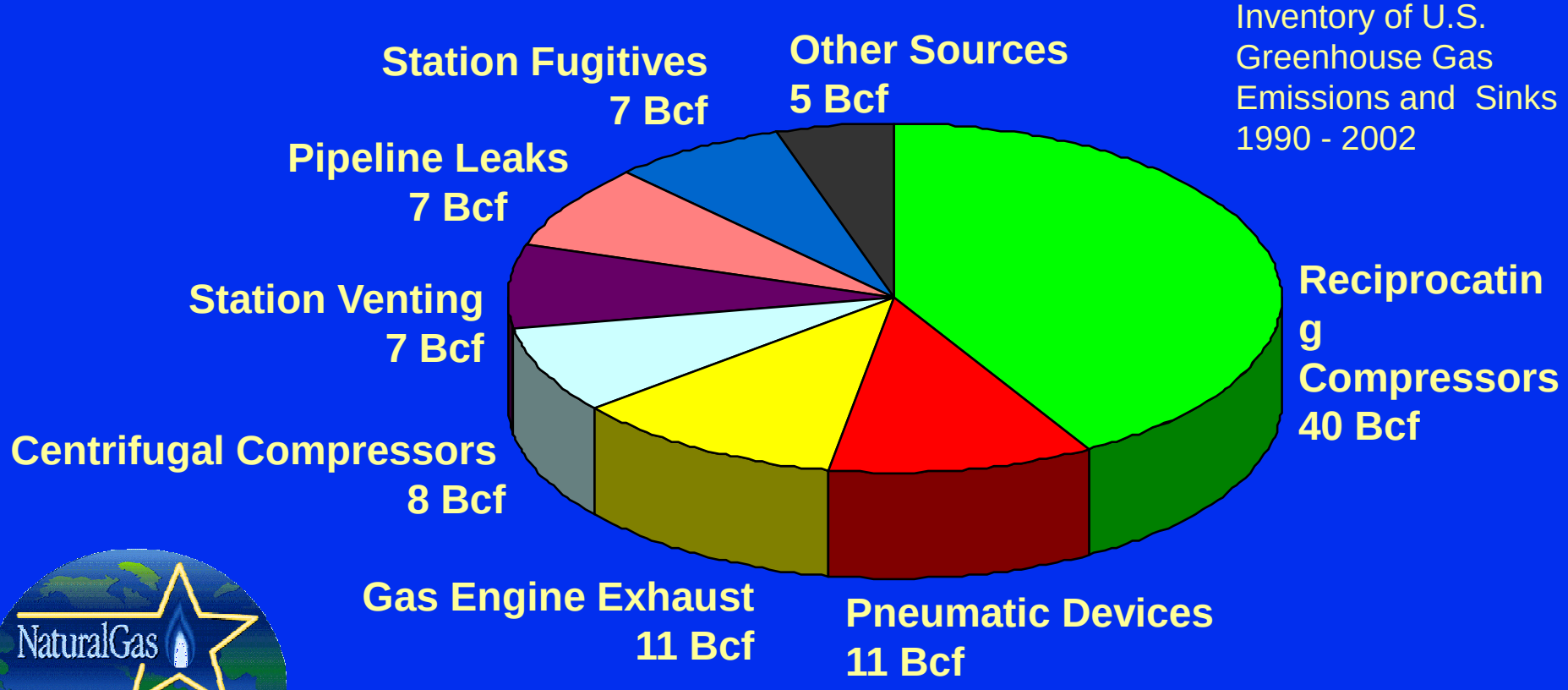
Inventory of U.S. Greenhouse Gas Emissions and Sinks 1990 - 2002

NaturalGas
EPA POLLUTION PREVENTER

Reducing Emissions, Increasing Efficiency, Maximizing Profits

Transmission Sector Emissions

- The transmission sector has several large methane emission sources that can be targeted for reductions



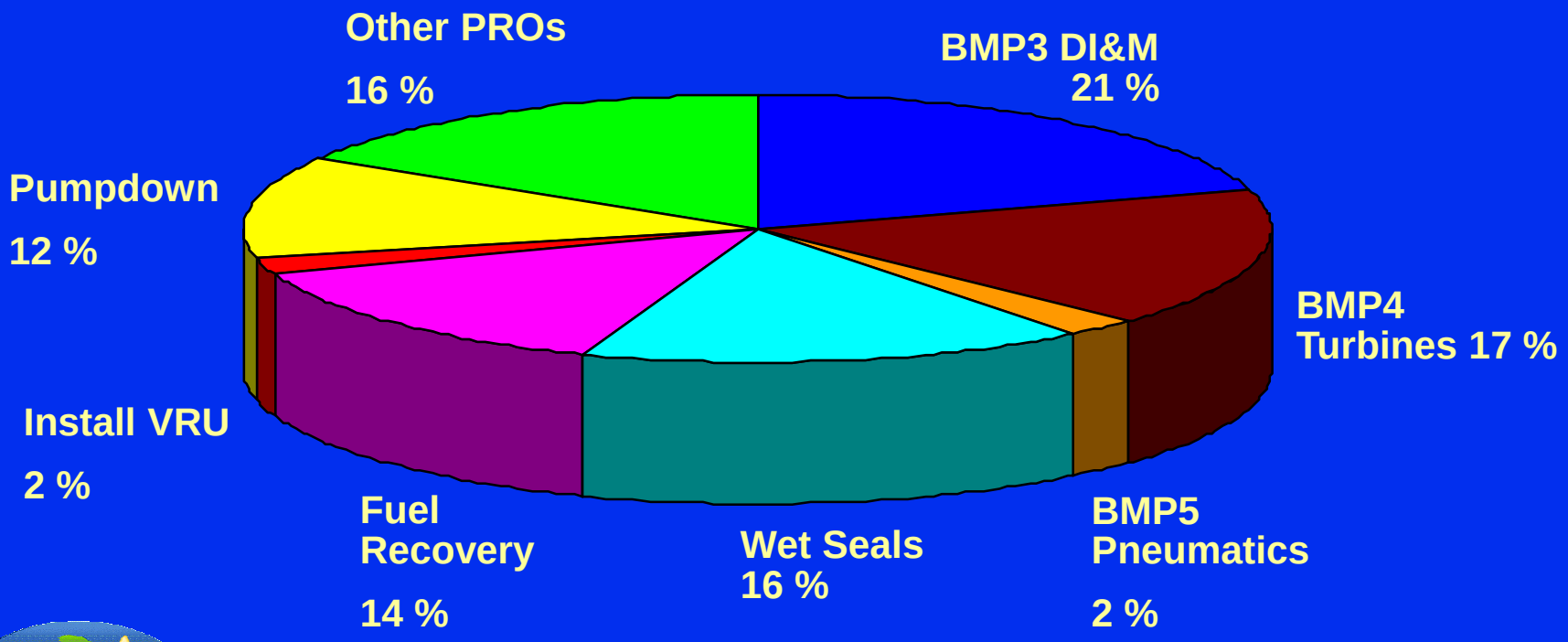
Inventory of U.S. Greenhouse Gas Emissions and Sinks 1990 - 2002

Transmission & Distribution Sector Best Management Practices

- BMP 1: Directed inspection and maintenance at gates stations and surface facilities
- BMP 2: Identify and rehabilitate leaky distribution pipe
- BMP 3: Directed inspection and maintenance at compressor stations
- BMP 4: Use of turbines at compressor stations
- BMP 5: Identify and replace high-bleed pneumatic devices
- BMP 6: Partner Reported Opportunities

Transmission BMP

- 60% of the transmission sector reductions came from PROs



Why Are Partner Reported Opportunities (PROs) Important?

- Partner Annual Reports document Program accomplishments
  - **BMPs: The consensus best practices**
  - **PROs: Partner Reported Opportunities**
- Simple vehicles for sharing successes and continuing Program's future
  - **PRO Fact Sheets**
  - **Lessons Learned: Expansion on the most advantageous BMPs and PROs**
  - **Technology Transfer Workshops**

Why Are Partner Reported Opportunities (PROs) Important?

- Many transmission facilities have identified practical, cost-effective methane emissions reduction practices
- Transmission Partners report saving 134 Bcf since 1993, 60% from PROs
- Replacing wet seal with dry seals account for 16% of PRO emissions reductions
  - **Lessons Learned study available**

Gas STAR PRO Fact Sheets

- 43 PROs apply to transmission Sector
  - **19 focused on operating practices**
  - **24 focused on technologies**

- PRO Fact Sheets are derived from Annual Reports 1994 to 2002
  - **Total 57 posted PROs**
  - **epa.gov/gasstar**

Gas STAR Lessons Learned Studies

- 9 Lessons Learned studies are applicable to transmission sector
  - **5 focused on operating practices**
  - **4 focused on technologies**

- All 16 Lessons Learned studies are on Gas STAR web site
  - **epa.gov/gasstar**

Lessons Learned Studies for Transmission Sector

- Using hot taps for in service pipeline connections
- Convert gas pneumatic controls to instrument air
- Using pipeline pump-down techniques to lower gas line pressure before maintenance
- DI&M at compressor stations
- Reducing emissions when taking compressors off-line
- Reducing emissions from compressor rod packing systems
- Replacing wet seals with dry seals in centrifugal compressor
- Options for reducing methane emissions from pneumatic devices in the natural gas industry
- Composite wrap for non-leaking pipeline defects

PRO Operating Practices

- Rerouting of glycol skimmer gas
- Close main and unit valves prior to blowdown
- Pipe glycol dehydrator to vapor recovery unit
- Perform leak repair during pipeline replacement
- Inspect and repair compressor station blowdown valves

Rerouting of Glycol Skimmer Gas

- What is the problem?
  - **Non-condensable gas from the condensate separator is vented**
- Partner solution
  - **Reroute the condensate separator gas to reboiler firebox for fuel use**
- Methane savings
  - **Based on a dehydrator having a gas entrainment rate of 3 cf/ gallon of glycol and gas containing 95% methane**
- Applicability
  - **All dehydrators with vent condensers**

Methane Savings

7,600 Mcf/yr

Project Economics

Project Cost	**< $1,000**
Annual O&M Costs	**$100 - $1,000**
Payback	**< 1 yr**

Close Main and Unit Valves Prior to Blowdown

- What is the problem?
  - **Main valves are closed for maintenance practices and the gas is vented to the atmosphere**
- Partner solution
  - **Close main AND unit valves AND blow down isolated sections of equipment**
- Methane savings
  - **Based on venting of high pressure equipment, large volume vessels or pipeline segments to the atmosphere during routine maintenance**
- Applicability
  - **All compressor stations**

Methane Savings

4,500 Mcf/yr

Project Economics

Project Cost	**None**
Annual O&M Costs	**$100 - $1,000**
Payback	**< 1 yr**

Pipe Glycol Dehydrator to Vapor Recovery Unit

- What is the problem?
  - **Methane gas from glycol dehydrator is vented to the atmosphere**
- Partner solution
  - **Reroute vented gas to Vapor Recovery Unit (VRU)**
- Methane savings
  - **Based on an electric or energy exchange circulation pump, can recover 3 to 9 Mcf of methane per MMscf of gas processed**
- Applicability
  - **No limitations when the VRU discharges to fuel gas or main compressor station**

Methane Savings

3,300 Mcf/yr

Project Economics

Project Cost	**$1,000 - $10,000**
Annual O&M Costs	**> $1,000**
Payback	**< 1 yr**

Perform Leak Repair During Pipeline Replacement

- What is the problem?
  - **Corrosion and debris in pipelines accumulate in valve seats, preventing tight closures and causing emissions during isolation of pipelines**
- Partner solution
  - **Inspect and repair pipeline valves in vicinity of ongoing pipeline repair/ replacement projects**
- Methane savings
  - **Based on leak rates through gate valves ~ 130 Mcf/yr and gate valve stem packing ~ 120 Mcf/yr**
- Applicability
  - **All pipeline repair and replacement projects**

Methane Savings

2,500 Mcf/yr

Project Economics

Project Cost	**None**
Annual O&M Costs	**$100 - $1,000**
Payback	**1 - 3 yrs**

Inspect & Repair Compressor Station Blowdown Valves

- What is the problem?
  - **Pressure, thermal and mechanical stresses wear blowdown valves making them significant emission sources through inaccessible vent stacks**
- Partner solution
  - **Annually inspect and repair leaking blowdown valves at compressor stations**
- Methane savings
  - **Based on EPAs emission factor for transmission compressor station blowdown valves**
- Applicability
  - **Applicable to all sites**

Methane Savings

2,000 Mcf/yr

Project Economics

Project Cost	**None**
Annual O&M Costs	**$100 - $1,000**
Payback	**< 1 yr**

Technology Enabled PROs

- Install pressurized storage of condensate
- Use of composite wrap repair
- Use ultrasound to identify leaks
- Install flares
- Use YALE® closures for emergency shut down (ESD) testing
- Convert gas-driven chemical pumps to instrument air

Install Pressurized Storage of Condensate

- What is the problem?
  - **Condensate from compressor scrubbers, when transferred to atmospheric tanks, flash methane to the atmosphere**
- Partner solution
  - **Pressurized storage and transport of condensate recovers methane and NGLs**
- Methane savings
  - **Based on estimate of condensate production of 0.01 barrel per Mscf of gas and methane emissions of 0.25 Mcf/ barrel**
- Applicability
  - **Compressor stations receiving field production gas**

Methane Savings

7,000 Mcf/yr

Project Economics

Project Cost	**> $10,000**
Annual O&M Costs	**> $1,000**
Payback	**1 to 3 yrs**

Use Ultrasound to Identify Leaks

- What is the problem?
  - **Leakage through blowdown, vents and PRVs cannot be easily detected when discharged through roof vents**
- Partner solution
  - **Use Ultrasonic leak detectors which can detect leaks inside a valve**
- Methane savings
  - **Assumption that 100 leaks can be found through the operation's with an emission rate of 20 Mcf/yr/valve**
- Applicability
  - **All in-service shut-off valves with open ended discharge**

Methane Savings

2,000 Mcf/yr

Project Economics

Project Cost	**< $1,000**
Annual O&M Costs	**> $1,000**
Payback	**1 to 3 yrs**

Use YALE® Closures for ESD Testing

- What is the problem?
  - **Gas from dump valves during ESD testing is vented to the atmosphere**
- Partner solution
  - **Use YALE® closures to block dump valves for testing individual valve with minimal gas venting**
- Methane savings
  - **Based on retrofitting ten 8 inch ESD valves with a 3 foot stack and relief rate of 400 Mcf/minute on a 500 psig system**
- Applicability
  - **All ESD valves**

Methane Savings

1,800 Mcf/yr

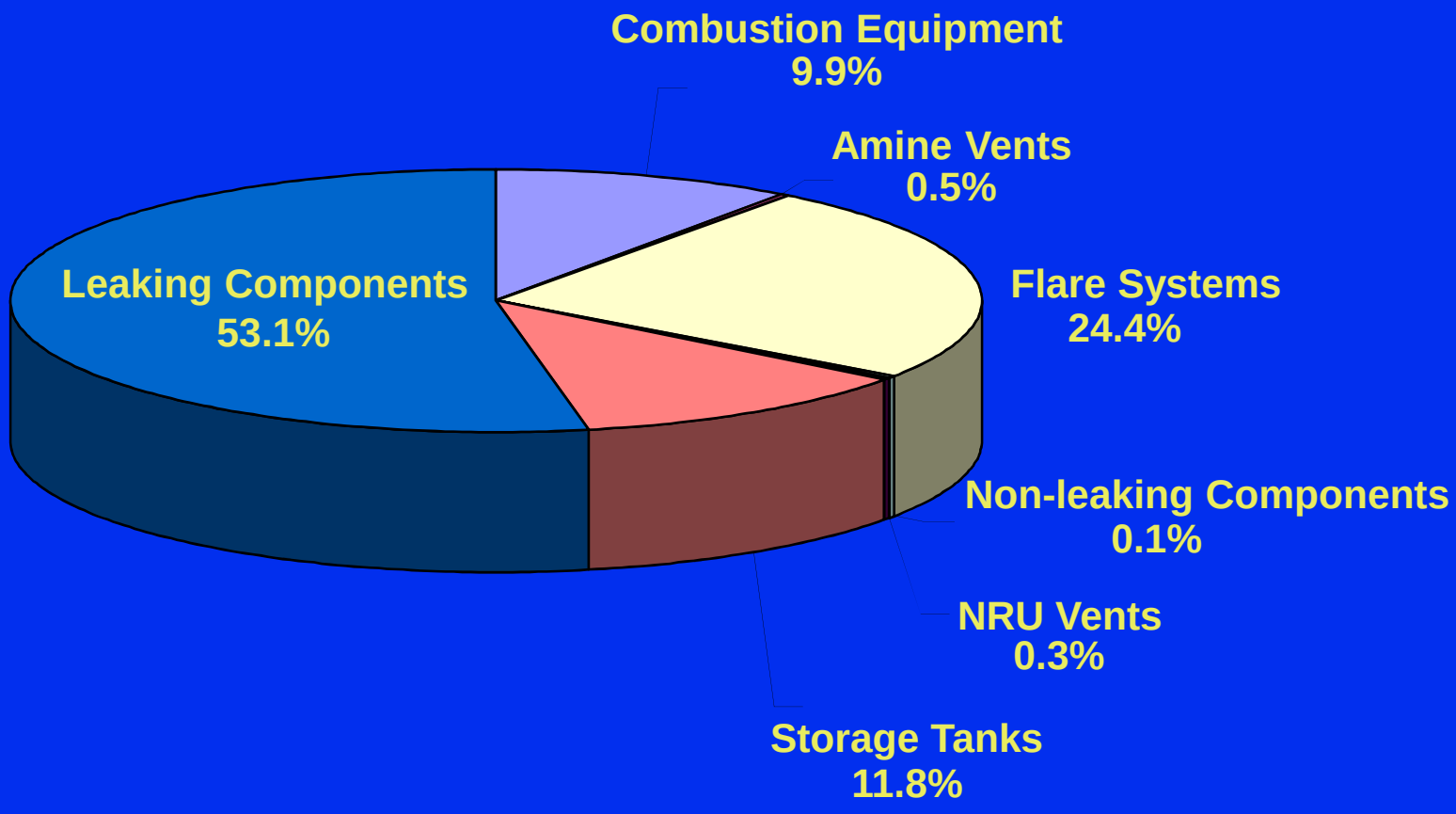
Project Economics

Project Cost	**$1,000-$10,000**
Annual O&M Costs	**$100 - $1,000**
Payback	**1 to 3 yrs**

Directed Inspection and Maintenance at Compressor Stations

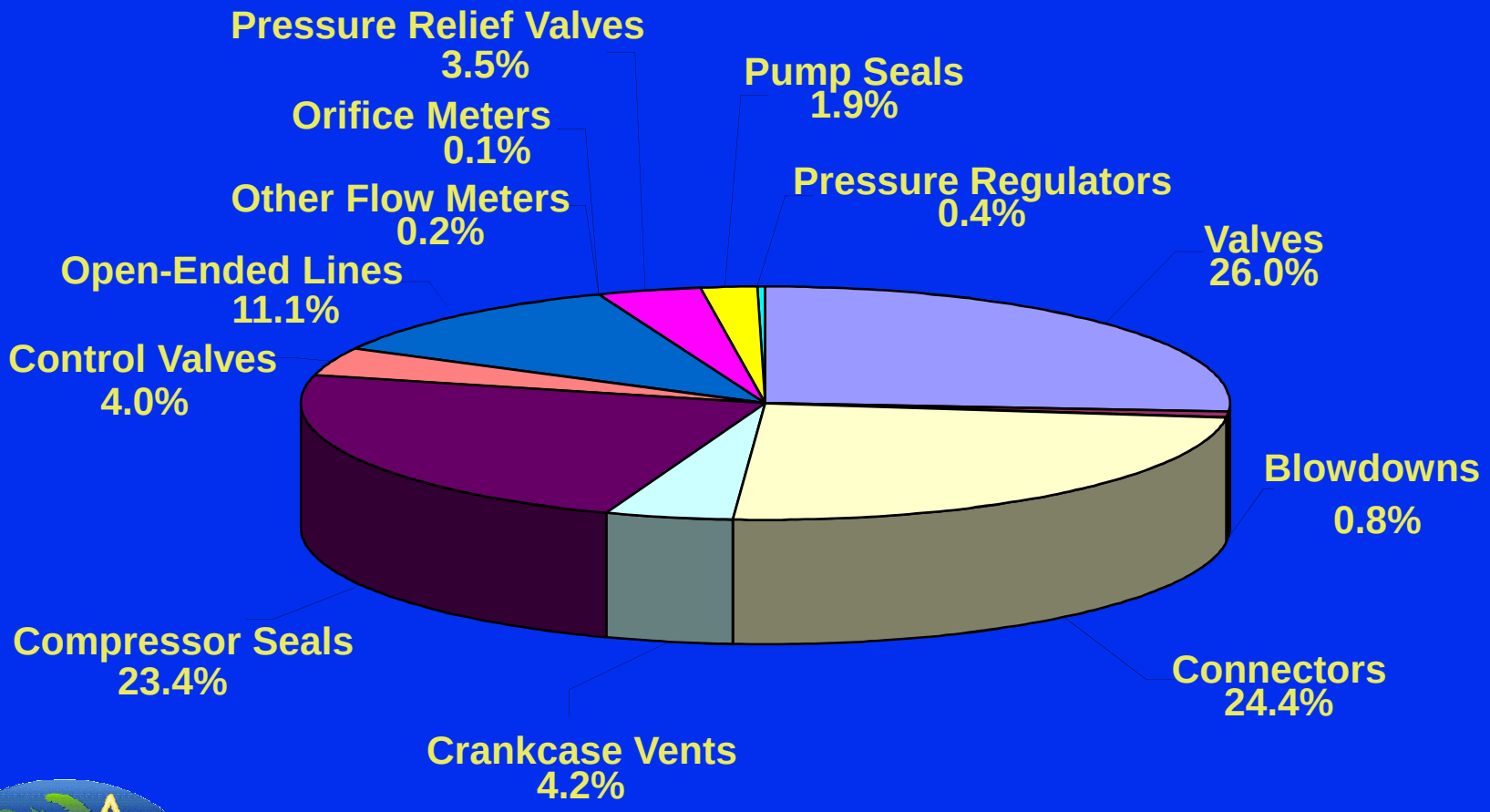
- What is the problem?
  - **Gas leaks are *invisible*, *unregulated* and *go unnoticed***
- STAR Partners find that valves, connectors, compressor seals and open-ended lines (OELs) are major sources
  - **27 Bcf methane emitted per year by reciprocating compressors seals and OELs**
  - **Open ended lines contribute half these emissions**
- Facility fugitive methane emissions depend on operating practices, equipment age and maintenance

Natural Gas Losses by Source



Clearstone Engineering, 2002

Natural Gas Losses by Equipment Type



Clearstone Engineering, 2002

Methane Leaks by Equipment Type

Methane Emissions from Leaking Components at Gas Plants			
Component Type	**% of Total Methane Emissions**	**% Leakers**	**Estimated Average Methane Emissions per Leaking Component (Mcf/Yr)**
Valves (Block & Control)	26.0%	7.4%	66
Connectors	24.4%	1.2%	80
Compressor Seals	23.4%	8.1%	372
Open-Ended Lines	11.1%	10.0%	186
Pressure Relief Valves	3.5%	2.9%	844
Clearstone Engineering, 2002, Identification and Evaluation of Opportunities to Reduce Methane Losses at Four Gas Processing Plants. Report of results from field study of 4 gas processing plants in WY and TX to evaluate opportunities to economically reduce methane emissions.			

How Much Methane is Emitted?

Summary of Natural Gas Losses from the Top Ten Leakers[1]				
Plant No.	Gas Losses From Top 10 Leakers (Mcf/d)	Gas Losses From All Equipment Leakers (Mcf/d)	Contribution By Top 10 Leakers (%)	Percent of Plant Components that Leak
1	43.8	122.5	35.7	1.78
2	133.4	206.5	64.6	2.32
3	224.1	352.5	63.6	1.66
4	76.5	211.3	36.2	1.75
Combined	477.8	892.84	53.5	1.85

[1]Excluding leakage into flare system

How Can These Losses Be Reduced?

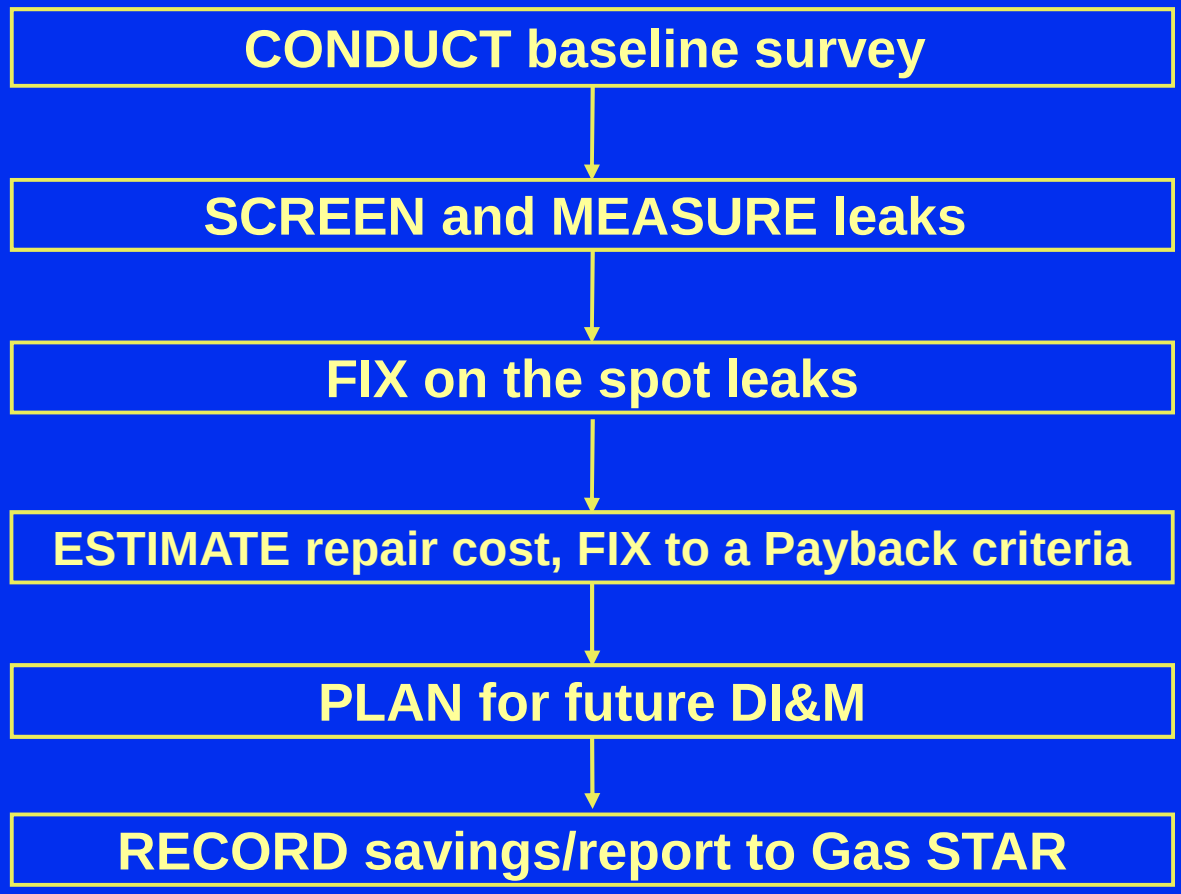
- Implementing a Directed Inspection and Maintenance (DI&M) Program

Clearstone Engineering

What is a DI&M Program?

- Voluntary program to identify and fix leaks that are cost-effective to repair
- Outside of mandatory LDAR
- Survey cost will pay out in the first year
- Provides valuable data on leakers

How Do You Implement a DI&M Program?



Screening and Measurement

Summary of Screening and Measurement Techniques		
Instrument/ Technique	***Effectiveness***	***Approximate Capital Cost***
Soap Solution	* *	$
Electronic Gas Detectors	*	$$
Acoustic Detection/ Ultrasound Detection	* *	$$$
TVA (FID)	*	$$$
Bagging	*	$$$
High Volume Sampler	* * *	$$$
Rotameter	* *	$$

EPA's Lessons Learned Study

Cost-Effective Repairs

Repair the Cost Effective Components			
Component	**Value of Lost Gas[1] ($)**	**Estimated Repair Cost ($)**	**Payback (Months)**
Plug Valve: Valve Body	12,641	200	0.2
Union: Fuel Gas Line	12,155	100	0.1
Threaded Connection	10,446	10	0.0
Distance Piece: Rod Packing	7,649	2,000	3.1
Open-Ended Line	6.959	60	0.1
Compressor Seals	5,783	2,000	4.2
Gate Valve	4,729	60	0.2
Hydrocarbon Processing, May 2002 [1]Based on $3/Mcf gas price			

How Much Gas Can Be Saved?

- Natural Gas STAR Lessons Learned study for DI&M at compressor stations estimates
  - **Potential Average Gas Savings ~ 29,000 Mcf/yr/compressor station**
  - **Value of gas saved ~ $87,000 / compressor station**
  - **Average initial implementation cost ~ $26,000 / compressor station**

DI&M by Leak Imaging

- Real-time visual image of gas leaks
  - **Quicker identification & repair of leaks**
  - **Screen hundreds of components an hour**
  - **Screen inaccessible areas simply by viewing them**

Infrared Gas Imaging Technology

- Shoulder- and/or tripod- mounted
  - **Hand-held prototype**
- Aerial surveillance applications
- Require battery and/or power cord
- Most very large leaks (> 3cf/hr) clearly seen

Infrared Gas Imaging

- Video recording of fugitive leak found by infrared camera

Discussion Questions

- To what extent are you implementing these opportunities?
- Can you suggest other opportunities?
- 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, manpower, etc.) that are preventing you from implementing these practices?