Methane to Markets

Directed Inspection & Maintenance and Infrared Leak Imaging
定向检修与红外泄漏检测成像

Methane to Markets : International Workshop on Methane Emission Reduction Technologies in the Chinese Oil and Natural Gas Industry

甲烷市场化：中国石油天然气公司降低甲烷排放技术国际会议

Qingdao, China（中国，青岛）

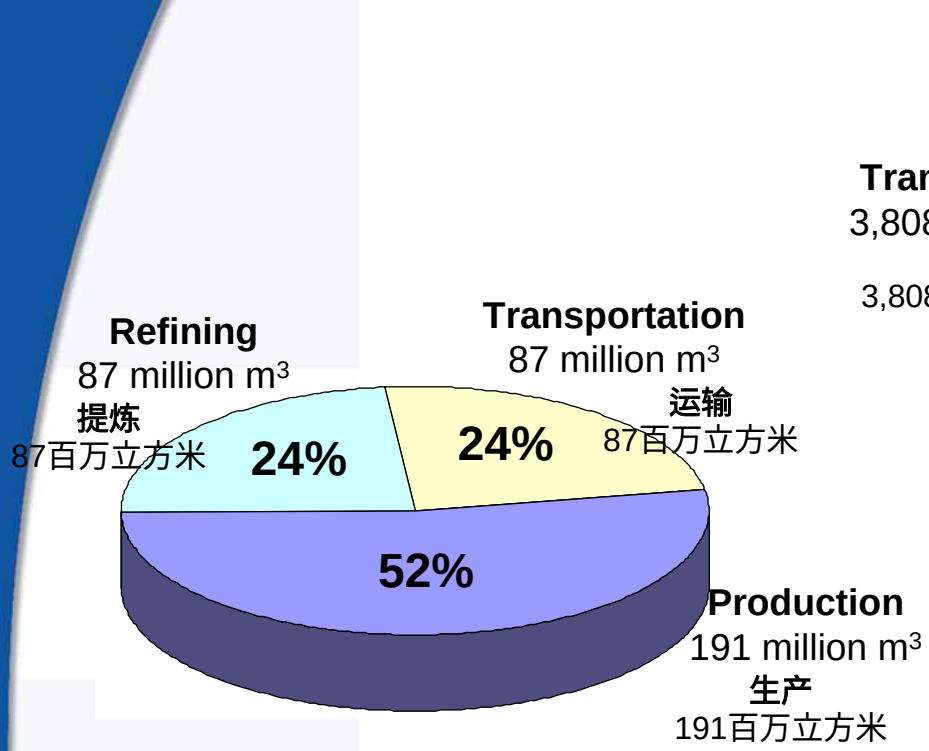
17-18 April, 2008（2008年4月17-18日）

Directed Inspection & Maintenance and Infrared Leak Imaging Agenda
定向检修和红外线泄漏成像技术汇报提纲

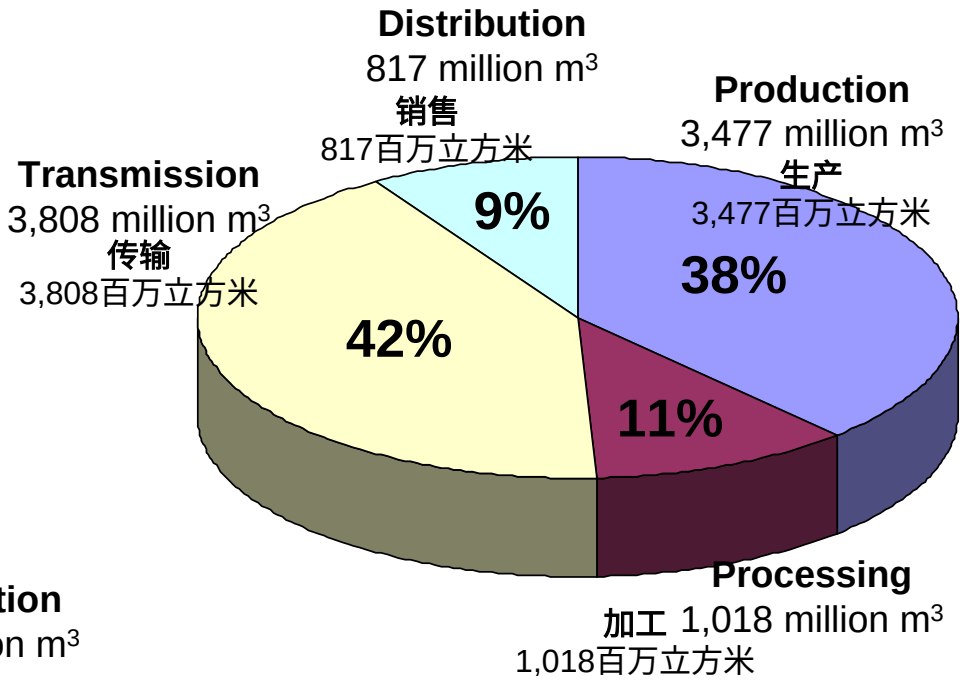
- China Oil and Gas Methane Emissions
  中国油气系统的甲烷泄漏
- Methane Losses
  甲烷损失
- Methane Recovery
  甲烷回收
- Remote Leak Detection
  远程泄漏监测
- Industry Experience
  工业经验
- Lessons Learned
  取得的经验

Source: Hy-bon Engineering

China Oil and Gas Methane Emissions in 2005
2005年中国油气系统的甲烷排放



Petroleum Systems Emissions
石油系统泄漏



Natural Gas Systems Emissions
天然气系统泄漏

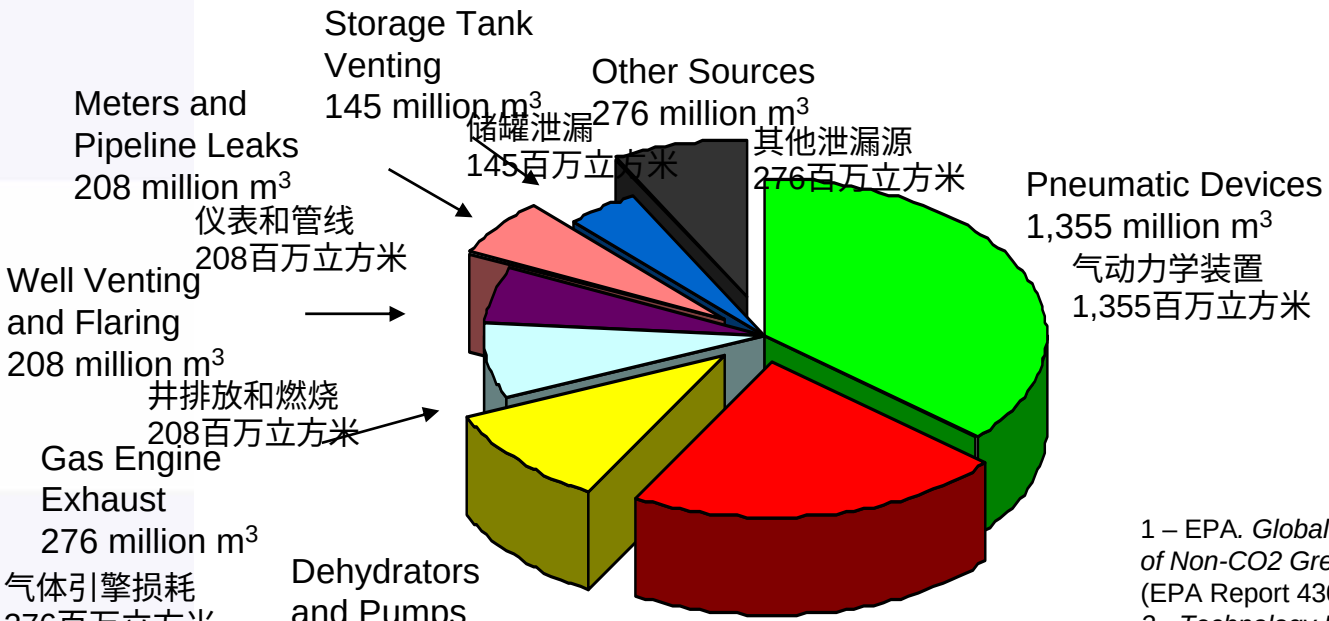
m^3 = cubic meters

Sources: 1 – EPA. *Global Anthropogenic Emissions of Non-CO2 Greenhouse Gases 1990-2020* (EPA Report 430-R-06-003). China emissions.
2 – Technology Drives Methane Emissions Down, Profits Up, Oil and Gas Journal, August 13, 2007
Note: It is assumed that all natural gas produced, goes through gas processing.

Estimated Methane Losses from China Production
中国生产过程中的甲烷损失

- **Estimated fugitive emissions for the natural gas and oil production sectors are 3,668 million m³**

中国油气生产部门逃逸性甲烷泄漏3,668百万立方米



1 – EPA. *Global Anthropogenic Emissions of Non-CO2 Greenhouse Gases 1990-2020* (EPA Report 430-R-06-003)
2 - Technology Drives Methane Emissions Down, Profits Up, Oil and Gas Journal, August 13, 2007
3 - Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2005

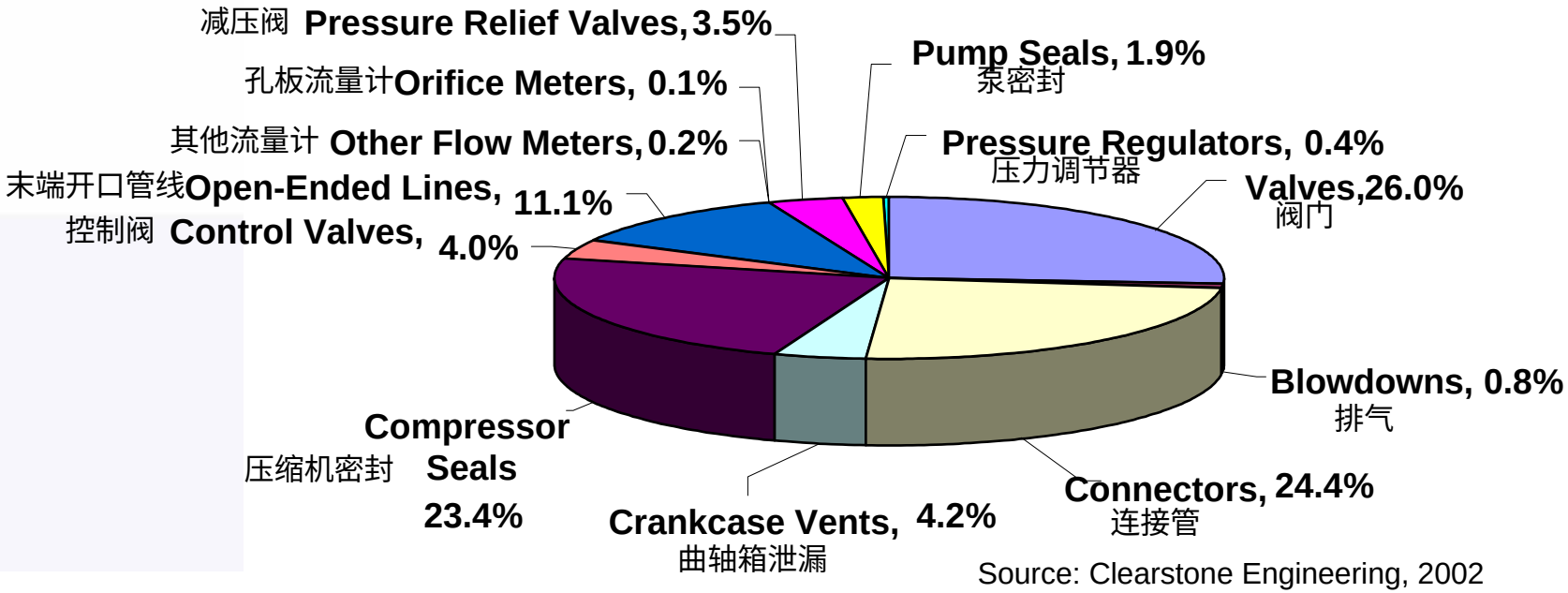
Note: "Offshore Operations" and "Other Sources" include fugitive, vented, and uncombusted methane emissions.

What is the Problem?
存在的问题

- Natural gas equipment leaks are *invisible* and *go unnoticed*

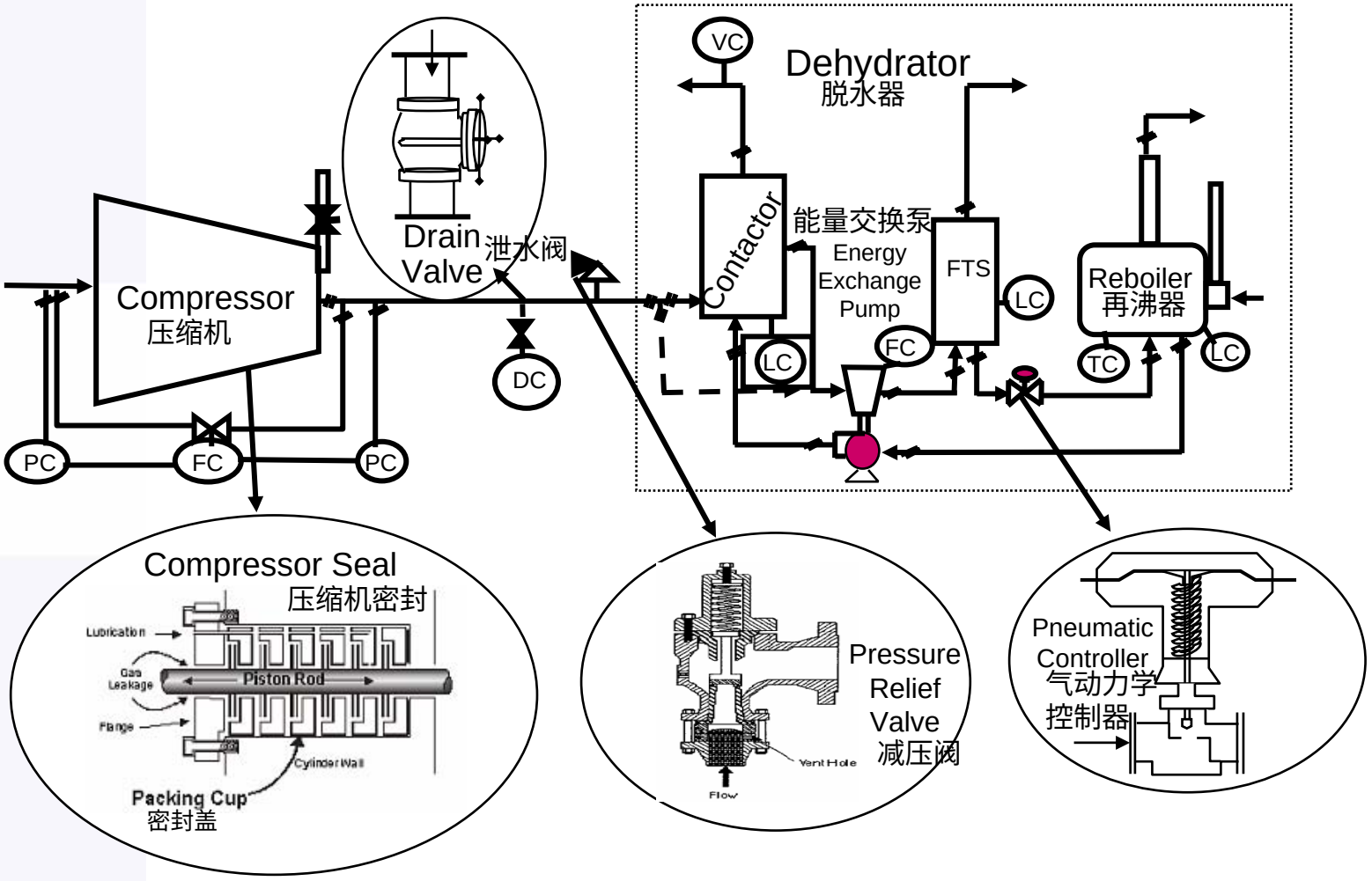
  天然气装置泄漏是不可见的，且未被注意到
- Valves, connectors, compressor seals, open-ended lines (OELs), pipelines, and meters are major equipment leak sources

  阀门、连接管、末端开口管线、管线和仪表是装置的主要泄漏源



Source: Clearstone Engineering, 2002

Methane Losses
甲烷损失



Methane to Markets

How Much Methane is Emitted?
甲烷泄漏量

Summary of Natural Gas Losses from the Top Ten Leak Sources[1] 前十位泄漏源天然气损失总结				
Plant Number 设备编号	**Gas Losses From Top 10 Leak Sources 前10位泄漏源气体损失 (m3/day)**	**Gas Losses From All Leak Sources 所有泄漏源气体损失 (m3/day)**	**Contribution By Top 10 Leak Sources 前10位泄漏源所占比例 (%)**	**Percentage Components Leaking 泄漏设备百分比 (%)**
1	1,240	3,469	35.7	1.78
2	3,777	5,847	64.6	2.32
3	6,346	9,982	63.6	1.66
4	2,166	5,983	36.2	1.75
Combined	13,530	25,281	53.5	1.85

1 – Excluding leakage into flare system
1－不包括泄漏进点火系统的气体损失

Note: Numbers may not add up due to rounding
注意：因为循环，设备数量不增加

Methane Recovery: Directed Inspection & Maintenance (DI&M)
甲烷回收：定向检修（DI&M）

- Fugitive losses can be reduced dramatically by implementing a DI&M program
  应用DI&M程序可以明显降低逃逸损失
  - Voluntary program to identify and fix leaks that are cost effective to repair
    检测和维修泄漏的自动程序
  - Choice of leak detection technologies
    泄漏检测技术选择
  - Provides valuable data on leakers with information of where to look
    提供关于泄漏的有价值信息
  - Strictly adapted to company's needs
    严格符合公司需要
  - Cost-effective practice, by definition
    定义有效费用实践

Infrared Leak Imaging Camera
红外泄漏照相机

Methane Recovery: Directed Inspection & Maintenance (DI&M)
甲烷回收：定向检修（DI&M)

- Technical documents available in Chinese
  中文技术文献

在压缩站进行针对性检修

DIRECTED INSPECTION AND MAINTENANCE AT COMPRESSOR STATIONS

1 内容提要

美国天然气运输网络的管线长度超过 279 000 英里。沿着这个运输网络，压缩站是最大的甲烷排放源之一，估计每年从泄漏的压缩机和其他设备部件（如阀门、法兰、接头和开口管线）中排放的甲烷气量大约有 507 亿立方英尺。天然气 STAR 计划合作伙伴提供的数据显示，95%的甲烷排放量来自压缩站中 20%的泄漏部件。

实施针对性检修（DI&M）计划是一种探测、测量、优先处理和维修泄漏设备以减少甲烷排放量的业已证明的、经济有效的方法。DI&M 计划首先进行基准线调查以识别和定量描述设备泄漏情况。然后对那些维修起来在经济上比较合算的泄漏部件进行维修。后续调查工作以前期调查获得的数据为基础，这样可使得作业者将精力主要集中在那些最有可能发生泄漏并且维修起来有利可图的设备

How Do You Implement DI&M?
如何实施DI&M？

How Do You Detect the Leaks?
如何检测泄漏？

- Screening - find the leaks

  检测－查找泄漏
  - Soap bubble screening
    肥皂泡检测
  - Electronic screening (sniffer)
    电子检测
  - Toxic Vapor Analyzer (TVA)
    有毒蒸汽分析仪（TVA）
  - Organic Vapor Analyzer (OVA)
    有机蒸汽分析议（OVA）
  - Ultrasound Leak Detection
    超声波泄漏检测
  - Acoustic Leak Detection
    声波泄漏检测
  - Infrared Leak Detection/Imaging
    红外泄漏检测/照相

Toxic Vapor Analyzer

有毒蒸汽分析仪

Acoustic Leak Detection

声波泄漏检测

How Do You Measure the Leaks?
如何测量泄漏？

- Evaluate the leaks detected - measure results

泄漏评估－测量结果

  - High Volume Sampler

    大容积取样器

  - TVA (correlation factors)

    有毒蒸汽分析仪（相关因子）

  - Rotameters

    转子流量计

  - Calibrated Bag

    校准袋

  - Engineering Method

    工程方法

Leak Measurement Using High Volume Sampler
用大容积取样器测量泄漏

Methane to Markets

How Do You Implement DI&M?
如何实施DI&M？

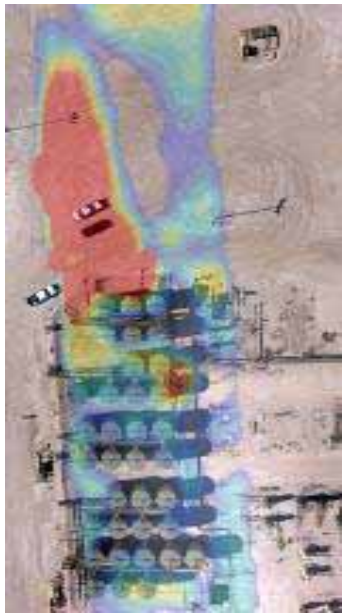
Summary of Screening and Measurement Techniques 检测技术总结		
Instrument/ Technique 仪器/技术	**Effectiveness 效率**	**Approximate Capital Cost 大约资本费用**
Soap Solution 肥皂泡方法	★★	$
Electronic Gas Detector 电子气体检测器	★	$$
Acoustic Detector/ Ultrasound Detector 声波/超声波检测器	★★	$$$
TVA (Flame Ionization Detector) TVA（火焰电离检测器）	★	$$$
Calibrated Bagging 校准袋	★	$$
High Volume Sampler 大容积取样器	★★★	$$$
Rotameter 转子流量计	★★	$$
Infrared Leak Detection 红外泄漏检测	★★★	$$$

* - Least effective at screening/measurement 检测最小效率
*** - Most effective at screening/measurement 检测最大效率

$ - Smallest cost 最小费用
$$$ - Largest cost 最大费用

DI&M with Remote Leak Detection
用远程泄漏检测装置进行定向检修（DI&M）

- The challenge has always been finding those few large leaks among the hundreds of components
  在众多装置中查找少数发生泄漏的装置很困难
- Real-time detection of gas leaks
  气体泄漏实时检测
  - Quicker identification and repair of leaks
    鉴别和维修泄漏更快
  - Screen hundreds of components an hour
    一小时可以检测很多装置
  - Easily screen inaccessible areas
    可以很容易地检测难于接近的地区



Remote Sensing and Leak Detection Video
远程遥感和泄漏检测录像

- Techniques to find fugitive leaks with new technology and equipment
  用新技术和装置检测逃逸性泄漏的技术

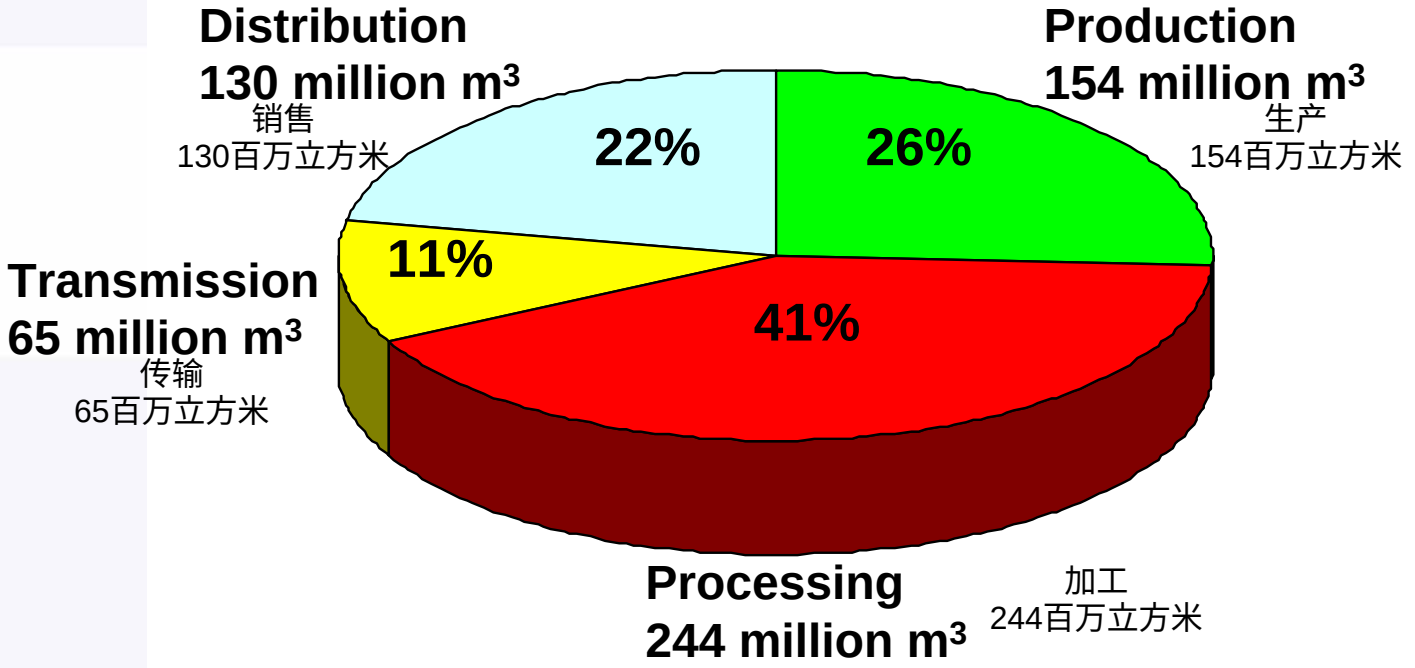
5 minutes

Available for download at www.epa.gov/gasstar

Industry Experience
工业经验

- Over 110 Gas STAR Program Partners across four sectors have reported 593 million m^3 cumulative methane emissions reductions via DI&M

横跨四个部门的110多个天然气之星合作伙伴报道，通过使用DI&M方法累积减少甲烷泄漏593百万立方米



Source: iSTAR Database, 2008.

Ukraine Experience – Cherkassytransgas Natural Gas Transmission Company (CT)

乌克兰的经验－ Cherkassytransgas天然气运输公司（CT）

- **Surveyed 2 compressor stations in March 2002, using soap solution and catalytic oxidation/ thermal conductivity detectors**

  2002年3月，用肥皂泡方法和催化氧化/热传导探测器检测了2个压缩机站

  - Found 280 leaks 发现有280个压缩机发生泄漏
  - Methane emissions of 2,951,900 m^3/year 甲烷泄漏速率2,951,900m^3/年
- **Using Hi Flow Sampler® quantified and prioritized leaks**

  使用Hi流动取样器对泄漏进行量化和排序

  - Repaired 227 leaks 修复227处泄漏
  - 1,953,900 m^3/year emissions reductions (66% of total measured emissions)

    泄漏减少速率为1,953,900m3/年（占检测到泄漏的66%）
  - Initial investment of $19,000 初始投资19,000美元
- **CT expanded the study to 21 other compressor stations**

  CT公司将研究成果扩展到了其他21个压缩机站上

Kyrgyzstan Experience – Kursk Natural Gas Distribution Company (Kurskgas)
吉尔吉斯斯坦经验－Kursk天然气销售公司（Kurskgas）

- **Surveyed 47 regulator stations in November 2005, using catalytic oxidation/ thermal conductivity detectors**

  2005年11月，用催化氧化/热传导探测器检测47个管理站

  - Surveyed 1,007 components 检测1,007个装置
  - Found 94 leaks 发现94处泄漏

- **Using Hi Flow Sampler® quantified leaks as 900,000 m^3 per year**

  用Hi流动取样器量化泄漏＝900,000m^3/年

  - Initial investment of $30,000 初始投资30,000美元
  - Produced revenue from verified carbon credits
    从碳检测上获得收益

- **So successful, Kurskgas expanded study beyond initial 47 stations and covered over 3,300 components**

  Kurskgas将研究成果扩展到47家以外压缩机站，覆盖了3,300多个装置

Methane to Markets

Lessons Learned
取得的经验

- A successful, cost-effective DI&M program requires measurement of the leaks

  一个成功的、有成本效益的DI&M程序需要测量泄漏
- A high volume sampler is an effective tool for quantifying leaks and identifying cost-effective repairs

  大容积取样器是量化泄漏和辨别有成本效益维修的有效工具
- A relatively small number of large leaks contribute most fugitive emissions

  只有几个大型泄漏对大多数逃逸泄漏有影响
- The business of leak detection is changing dramatically with new technology like infrared cameras that make DI&M faster and easier

  新技术如红外照相机（它使DI&M更快更容易）使泄漏检测发生了明显变化

Discussion Questions
问题讨论

- To what extent do you have opportunities to implement this practice?
  您有机会在何种程度上应用这些技术？
- How could these opportunities be improved upon or altered for use in your operation?
  这些机会对您的操作有多少改善或改变？
- Can you suggest other methods for reducing fugitive emissions?
  你能对减少逃逸泄漏的其他方法提一些建议吗？
- What are the barriers (technological, economic, lack of information, regulatory, focus, labor, etc.) that are preventing you from implementing these practices?
  阻碍您应用这些技术的障碍（技术、经济、信息缺乏、管理、焦点、劳力等）是什么？