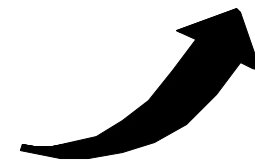
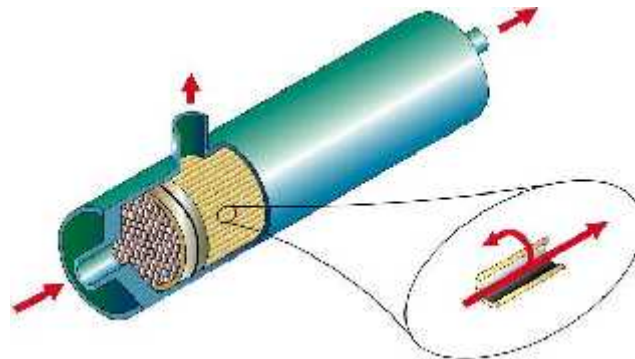
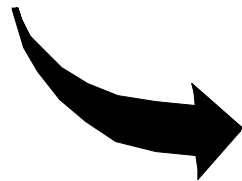


# Air Liquide Simplified Biogas to Pipeline



Advanced Energy 2009 Conference  
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# BIOGAS Sources

■ Microbes produce 50-60% CH<sub>4</sub> with balance CO<sub>2</sub>

■ Landfills

- ✓ >400 LFG to Energy projects in N. America
- ✓ >400 more landfills need energy projects
- ✓ 64 landfills in Québec

■ Digesters

- ✓ Municipal Waste Water
- ✓ Animal Manure
- ✓ Plant Material

**Landfill Gas Energy Projects and Candidate Landfills**



# BIOGAS Uses

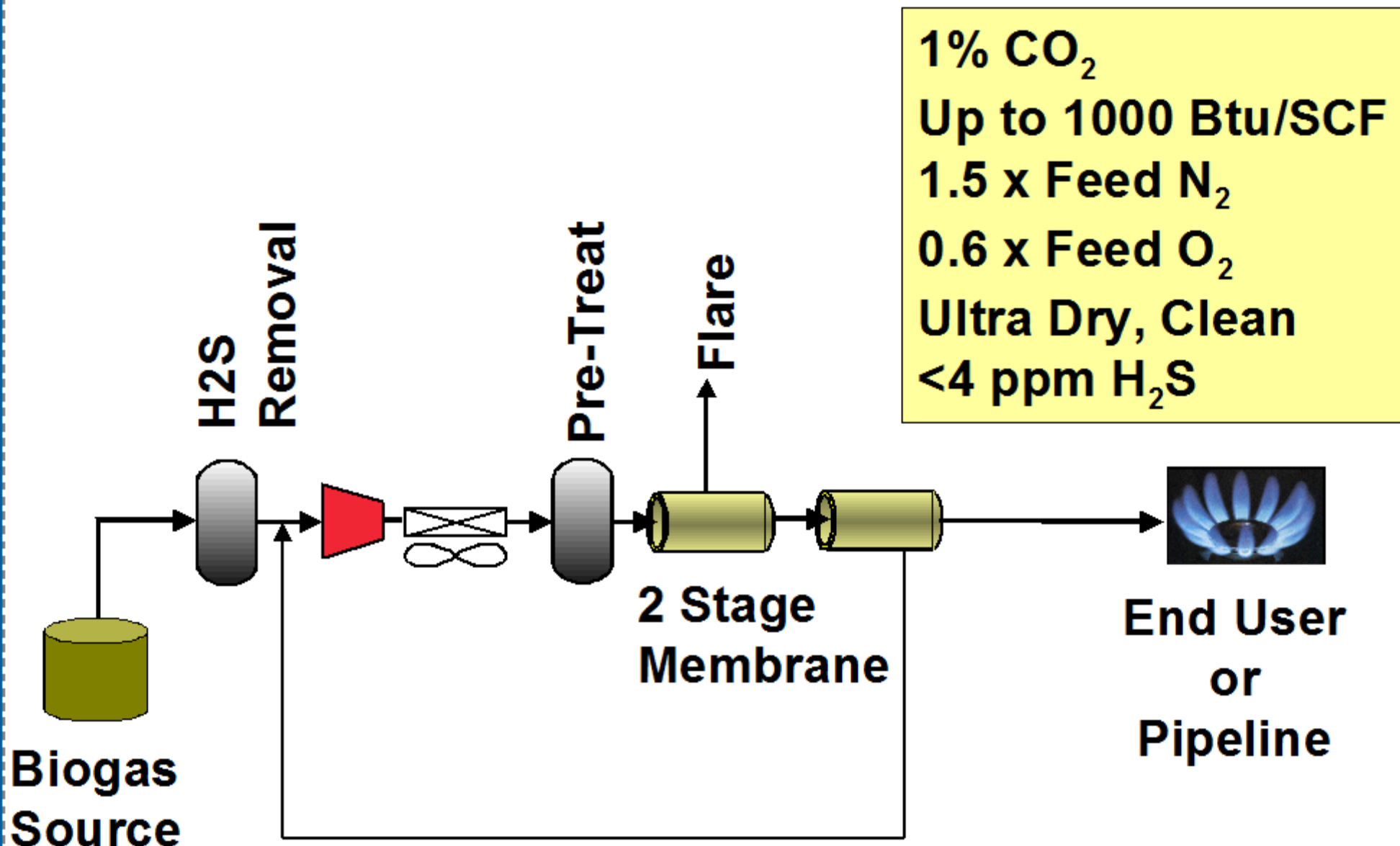
- Direct use
- Electric Generation & Cogen
  - ✓ Most LFG to Energy projects generate electric power
  - ✓ Small scale electric generation is fundamentally low efficiency
- High Heating Value
  - ✓ Most projects sell gas into pipelines
  - ✓ Latest “Hi Btu” systems (Air Liquide Biogaz) now proven and well received

# Biogas to Hi Btu Summary (N. America)

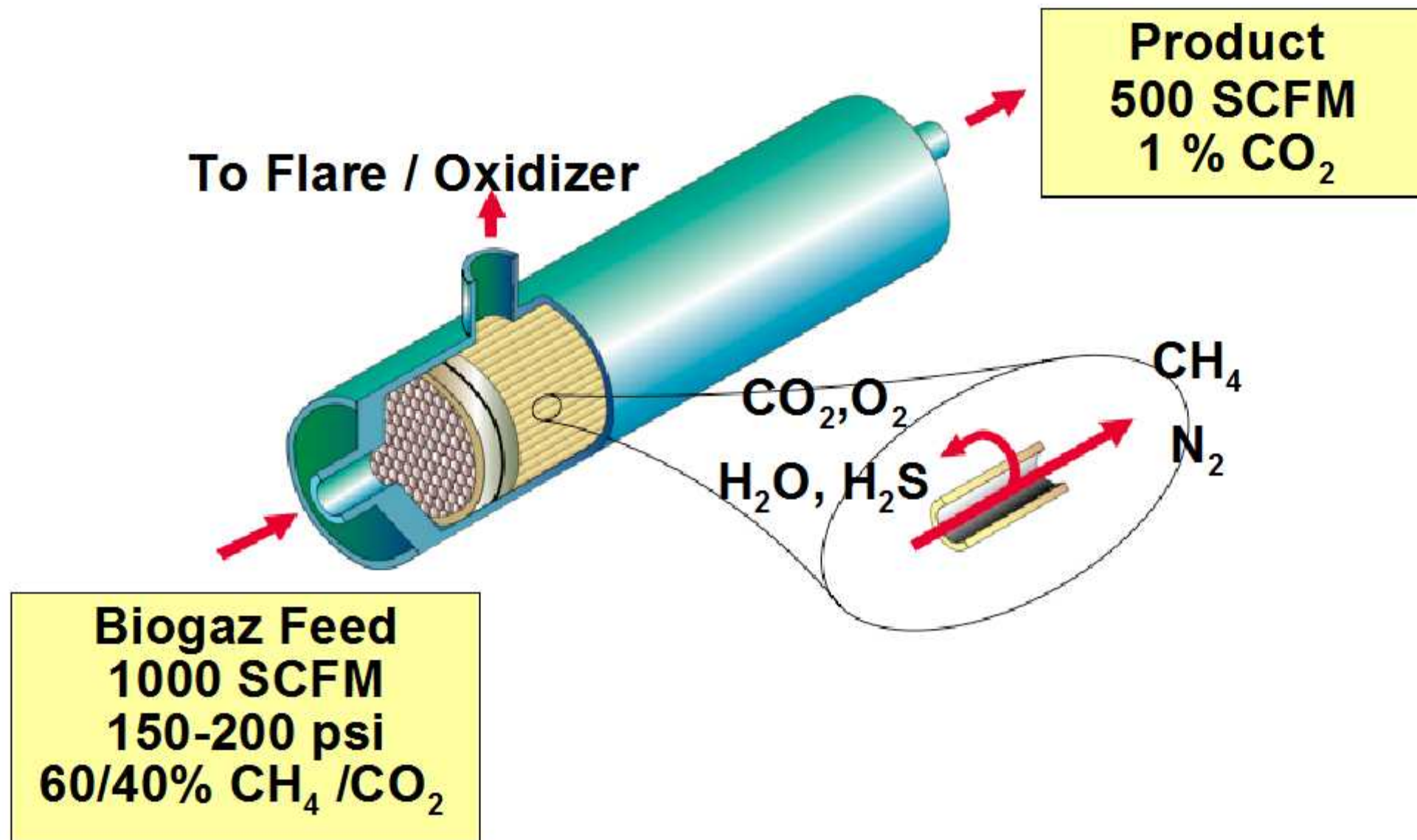
## ■ Air Liquide dominates since 2006

Project/Location	Start-up	Raw Feed (MMSCFD)	Sales Gas Destination
Laurel Highlands (Raeger Mtn, PA)	Jul-06	4	Dominion pipeline system
Iris Glen (Johnson City, TN)	Nov-06	2	Dedicated pipeline to Mountain Home VA Center co-gen facility
Greentree (Kersey, PA)	Jul-07	12	Interstate Pipeline System of National Fuel Gas Supply Corp
Imperial (Imperial, PA)	Sep-07	6	Interstate Pipeline System of National Fuel Gas Supply Corp
Shade (Cairnbrook, PA)	Jun-07	4	Dominion pipeline system
Southern (Davidsville, PA)	Jun-07	2	Dominion pipeline system
Oklahoma City (OKC, OK)	May-08	2	Southern Star Pipeline
Carter Valley (Church Hill, TN)	Nov-08	2	Intrastate pipeline system of T engasco, Inc.
Winder (Winder, GA)	Dec-08	6	Municipal Gas Authority of Georgia Local Distribution
Live Oak (Atlanta, GA)	Feb-09	7	Atlanta Gas & Light Local Distribuion
Cedar Hills (Seattle, WA)	Feb-09	16	Puget Sound Energy Local Distribution
Seneca (Pittsburgh, PA)	Est'd Dec-09	4	Dominion pipeline system
River Birch (New Orleans, LA)	Est'd Feb-10	9	

# Air Liquide Simplified Biogaz System



# Biogaz Permeator Configuration



# Typical Sales Gas Composition

## ■ HHV min 950 - 980 Btu/SCF

- ✓ Depends upon feed  $N_2$ .  $N_2$  is primarily what keeps us away from 1000 Btu gas.

## ■ Wobbe (not required)

- ✓ 975 Btu/SCF means ~1280.

## ■ Moisture <7 #/MMSCF

- ✓ No sweat. Moisture will be << 7#/MMSCF.

## ■ $CO_2$ 2 - 4%

- ✓ No sweat. Can do 1%. Can do 0.5%.

## ■ $O_2$ 0.2 – 1.0%

- ✓ OK. ~0.6 x feed  $N_2$  without extra effort.

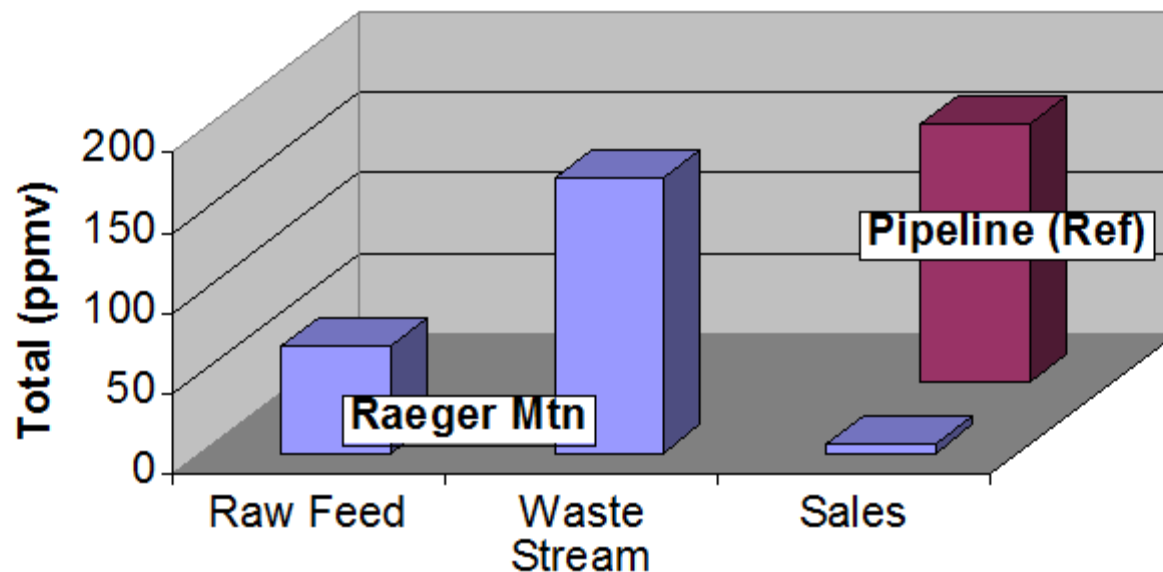
## Typical Sales Gas Composition (cont'd)

- **H<sub>2</sub>S <4 ppm**
  - ✓ OK.
- **Total sulfur (not including H<sub>2</sub>S) 1 - 20 ppm**
  - ✓ OK.
- **Free of objectionable materials** including volatile metals, bacteria and other constituents that interfere with the merchantability of pipeline natural gas.
  - ✓ Siloxanes strongly removed.
- **On balance, processed biogas can be cleaner than pipeline gas**

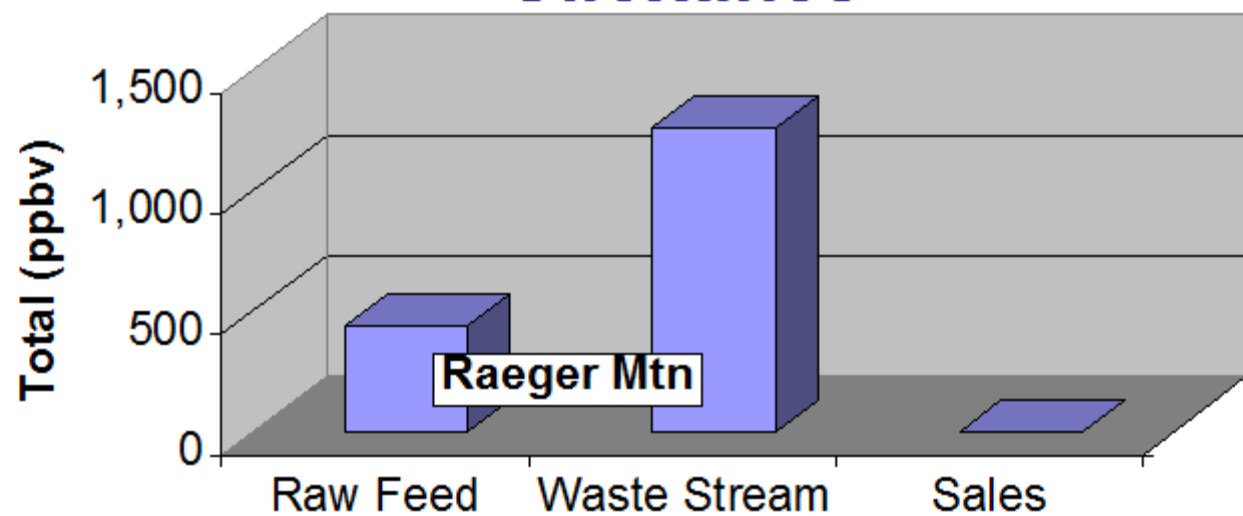


# Cleaner Than Pipeline Gas

## VOCs



## Siloxanes



# Pictures

# JRE, Laurel Highlands LF, Johnstown, PA



The world leader in gases for industry, health and the environment

# ESG, Iris Glen LF, Johnson City, TN



The world leader in gases for industry, health and the environment

# Beacon Landfill Gas Holdings, Greentree Landfill, PA



# Beacon Landfill Gas Holdings, Imperial Landfill, PA



# Timberline Energy, Oklahoma City



# Tengasco, Carter Valley LF, Churchill, TN





# RSG, Oak Grove LF, Winder, GA



# Jacoby Energy, Live Oak LF, Atlanta, GA



# Ingenco, Cedar Hills LF, Seattle, WA

