

Gasification's Contribution to Fuel Diversity: Displacing Natural Gas Demand in the Industrial Sector

**ELCON 2005 Annual Meeting
Las Vegas, Nevada
February 2, 2005**

**James Childress
Executive Director
Gasification Technologies Council**

GTC Members

- AFC Coal Properties
- Air Liquide America*
- Air Products and Chemicals, Inc.*
- American Electric Power*
- Aramco Services Company*
- Bechtel Corporation*
- Black & Veatch Corporation*
- BOC Gases*
- Boeing, Rocketdyne Propulsion & Power*
- Cinergy Corporation*
- ConocoPhillips*
- Constellation Energy*
- The Dow Chemical Company*
- Eastman Chemical Company*
- Ebara Corporation
- Emery Energy Company
- Fluor Corporation*
- Foster Wheeler Energy International Inc.*
- Gas Technology Institute
- GE Energy*
- Global Energy, Inc.*
- Kentucky Center for Applied Energy Research
- Lake Charles Cogeneration, LLC
- Linde Process Plants
- Lockwood Greene E&C / CH2M Hill
- Lurgi Oel Gas Chemie GmbH
- Mitretek
- Nexant, Inc.
- Parsons Energy & Chemicals Group Inc.*
- Porvair PLC
- Praxair, Inc.*
- Sasol Technology
- Sempra Generation
- Shell Global Solutions B.V.*
- Siemens Westinghouse Power Corporation*
- Snamprogetti S.p.A.
- Tennessee Valley Authority*
- Uhde Corporation of America*
- UOP
- * Denotes member of Board of Directors

Overview

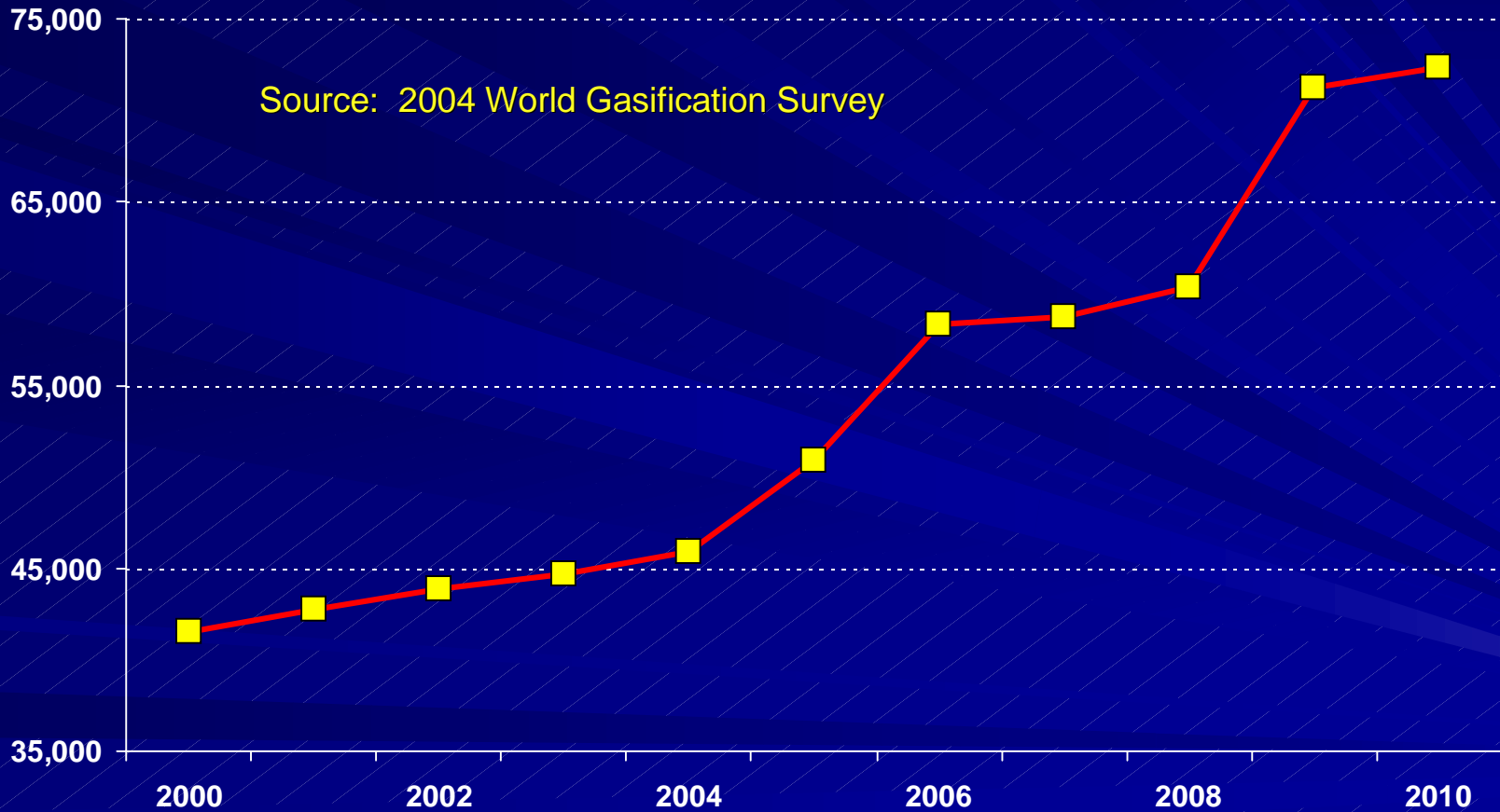
- **Survey of World & U.S. Gasification Industry**
- **Factors Driving Gasification Trends**
- **The Case for Gasification: Backing Out Natural Gas with Coal & Other Lower Cost Feedstocks**

2004 World Gasification Industry

- Summary Findings
 - Geographical Distribution
 - Feedstock Distribution
 - Product Distribution

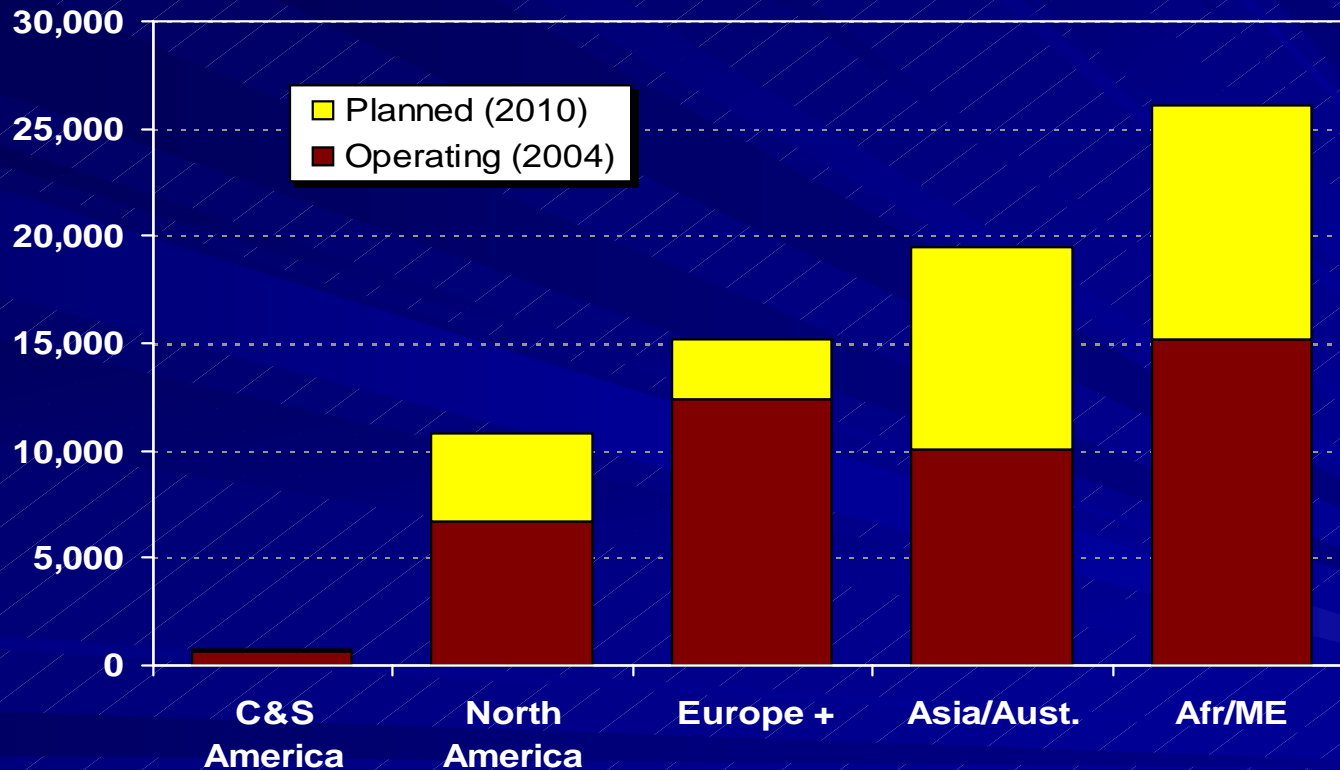
World Gasification Capacity Growth 2000-2010

(MWth Equivalent)



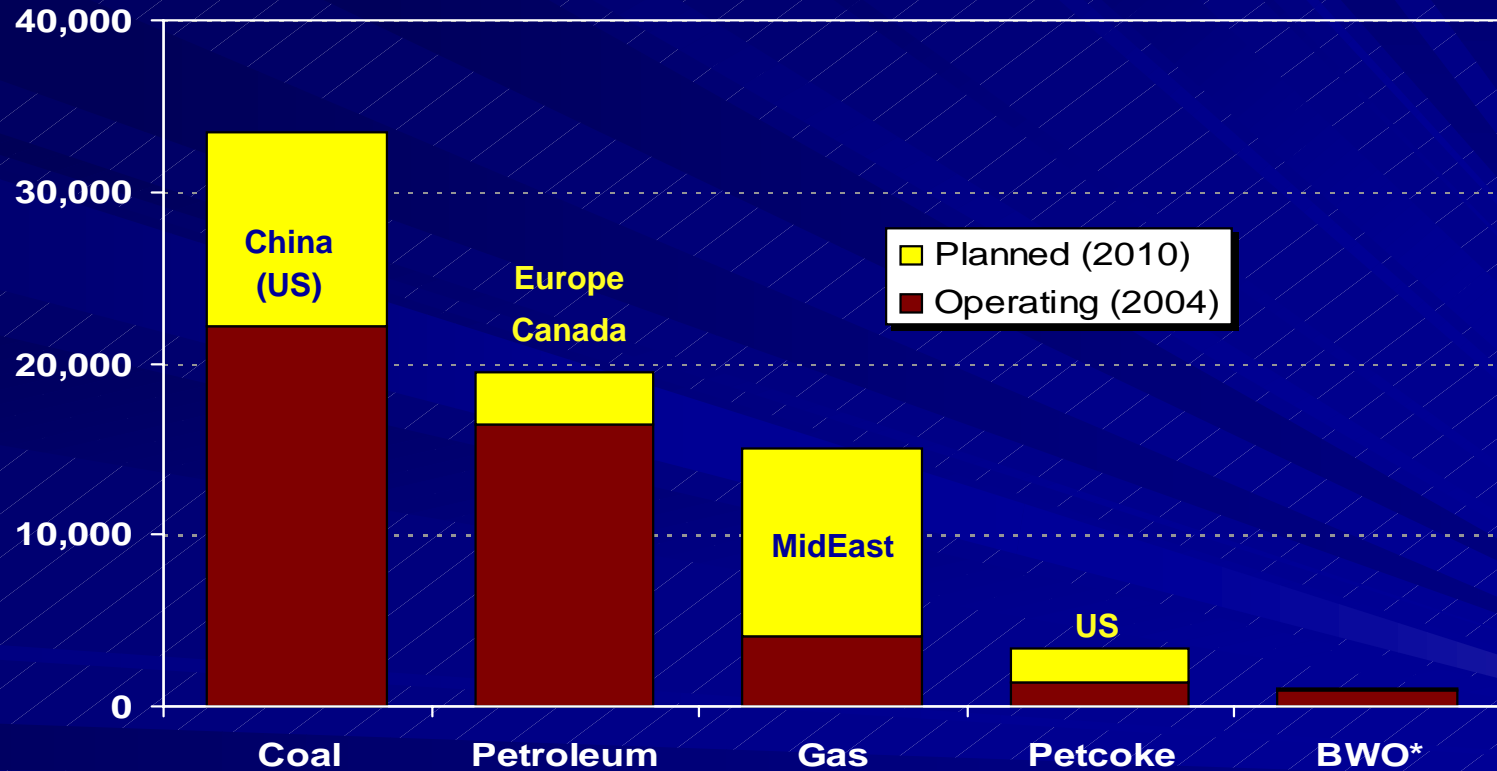
Geographical Distribution of World Gasification Capacity

(MW_{th} Equivalent)



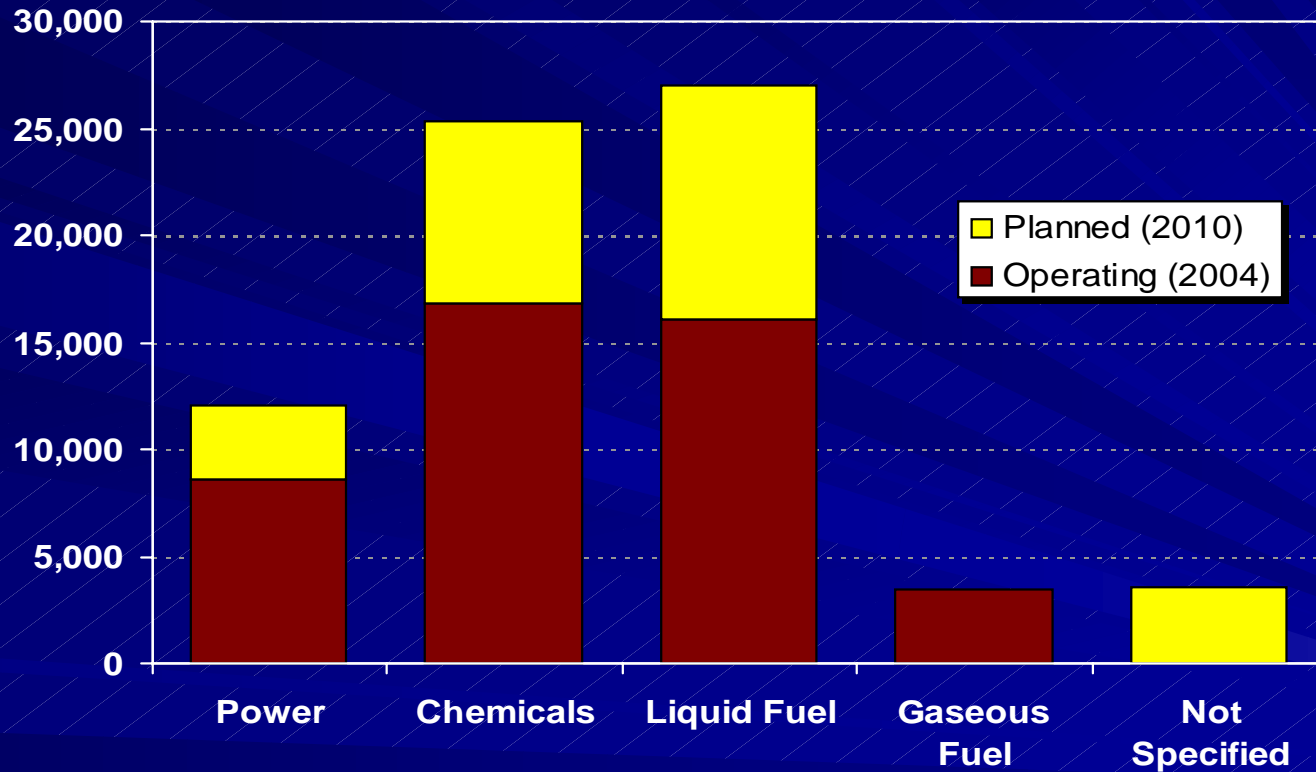
Feedstock Distribution of World Gasification Capacity

(MW_{th} Equivalent)



Product Distribution of World Gasification Capacity

(MW_{th} Equivalent)



Factors Driving Gasification Trends

■ Asia

- Fertilizers & Chemicals (China, poss. India)
- Power (China/Japan future)
- Fuels (Longer term)
- Wild Card – China, Environmental Issues & Econ. Growth; Japan, Policy Shift Toward IGCC?

■ Europe

- Refinery Models – Environment Driven Toward Cleaner Fuels
 - Pernis (Hydrogen, Power)
 - Italian Plants (Power)
- CO₂ Concerns

■ Remote Gas

- F-T Liquids

■ North America

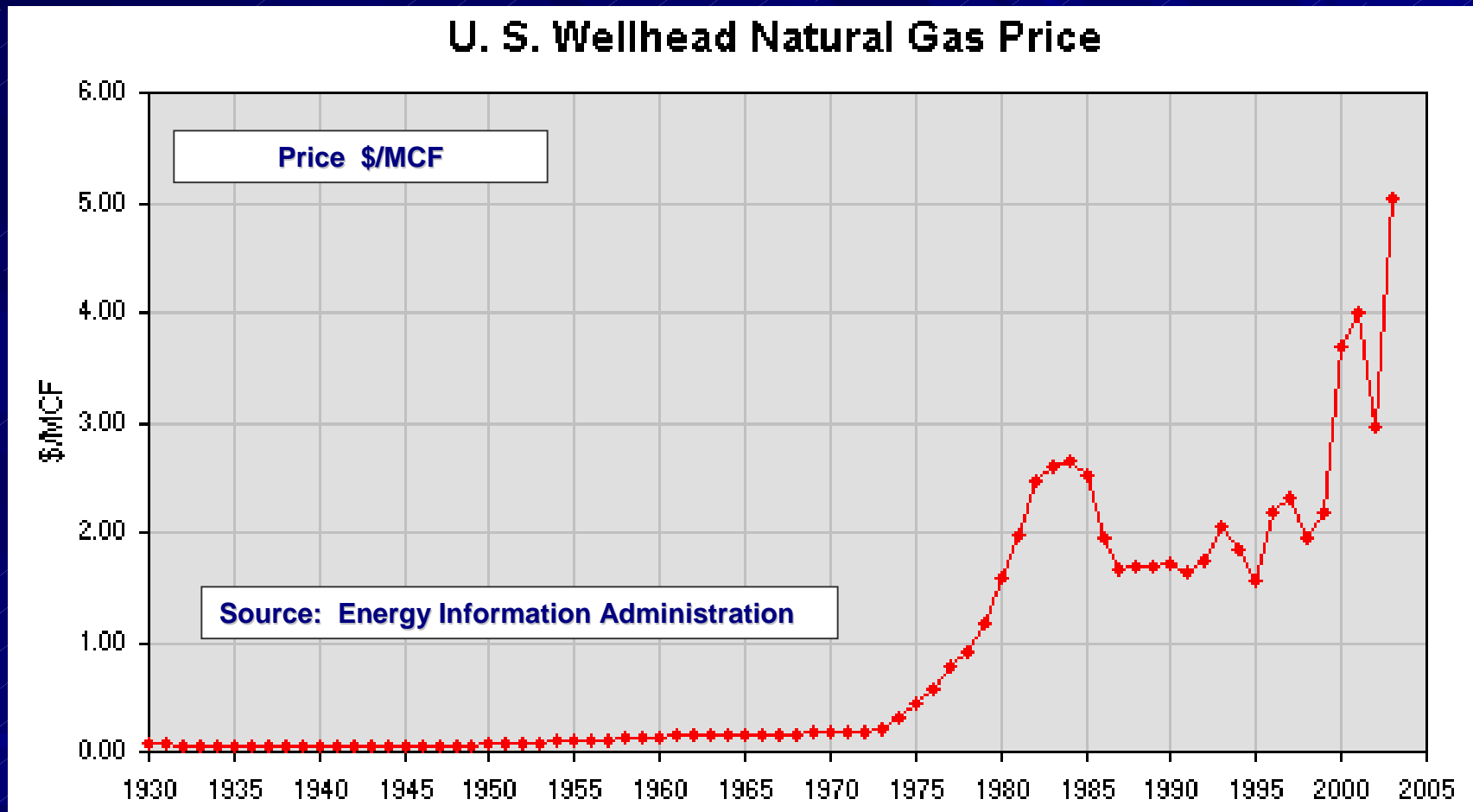
- U.S. Coal, Power, Environment (The AEP Model)
- U.S. Petcoke (Hydrogen, Power)
- Possible Public Sector Incentives (\$\$ + Regulations)
- Canada – Tar Sands, Coal

The Case for Gasification in the U.S. Industrial & Power Sectors

Stark Realities Facing Industrial Natural Gas Consumers

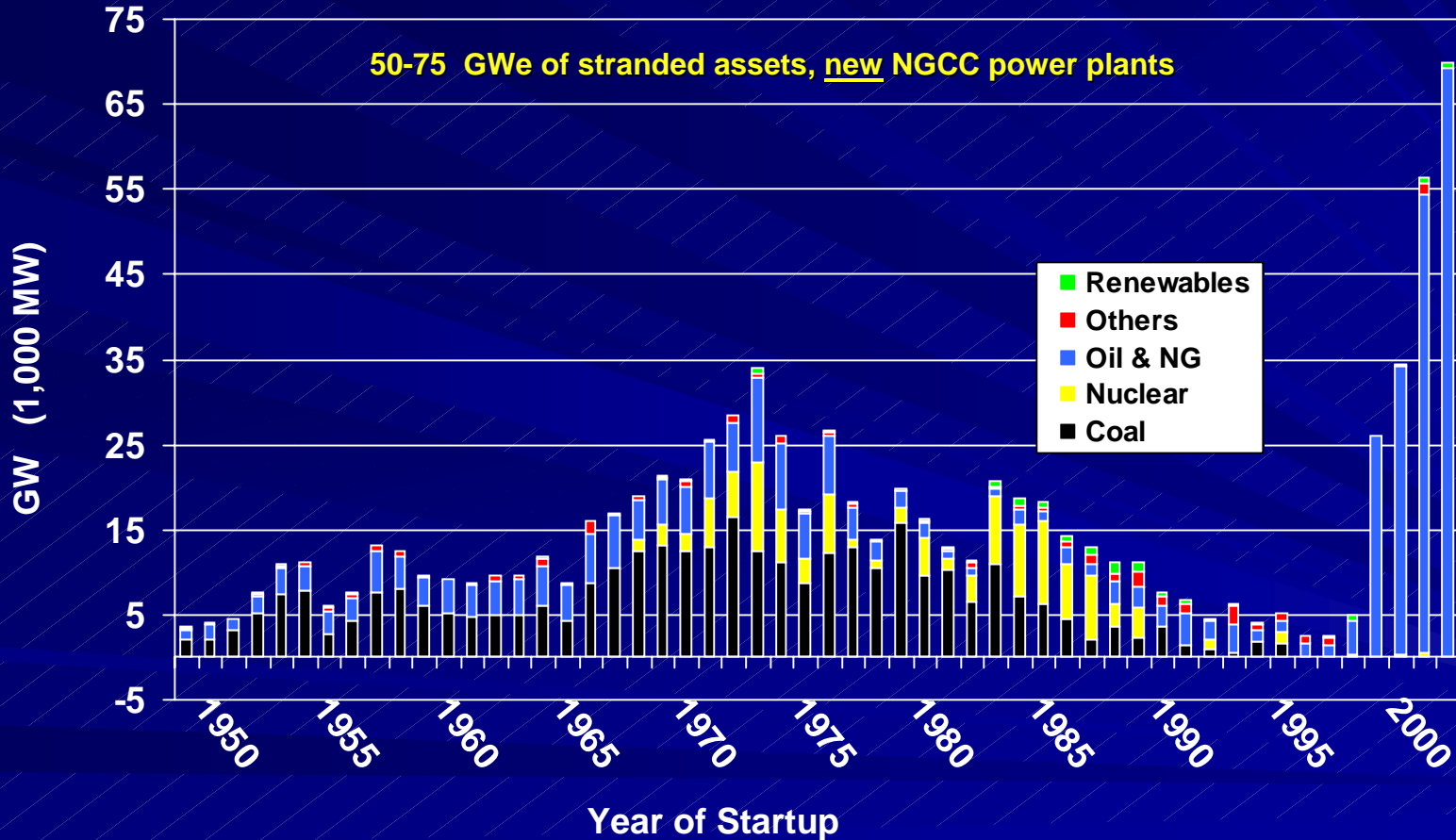
- **Natural gas use for power generation in the U.S. is the 800 pound gorilla.**
- **If you use natural gas as a feedstock, gas prices are killing you.**
- **If you use natural gas for self-generation, gas prices are killing you.**

U.S. Wellhead Natural Gas Prices 1930-2003



Source: SFA Pacific, 2004 GTC

Operating U.S. Power Plants By Years of Startup for 1950-2003



Source: SFA Pacific, EIA Data, 2004 GTC

**Gasification Offers One Route to Diversify
Fuels for U.S. Power Generation and to
Provide Industrial Energy Consumers with
Alternative Energy & Feedstock Resources**

Gasification Benefits

- Provides Fuel/Feedstock Diversity (Get Off Gas)
- Provides Product Diversity (Polygeneration)
- Achieves Exceptional Environmental Performance

U.S. Gasification Experience

20 Plants Operating

Feedstocks

- Coal/Petcoke - 7
- Gas - 9
- Petroleum - 4

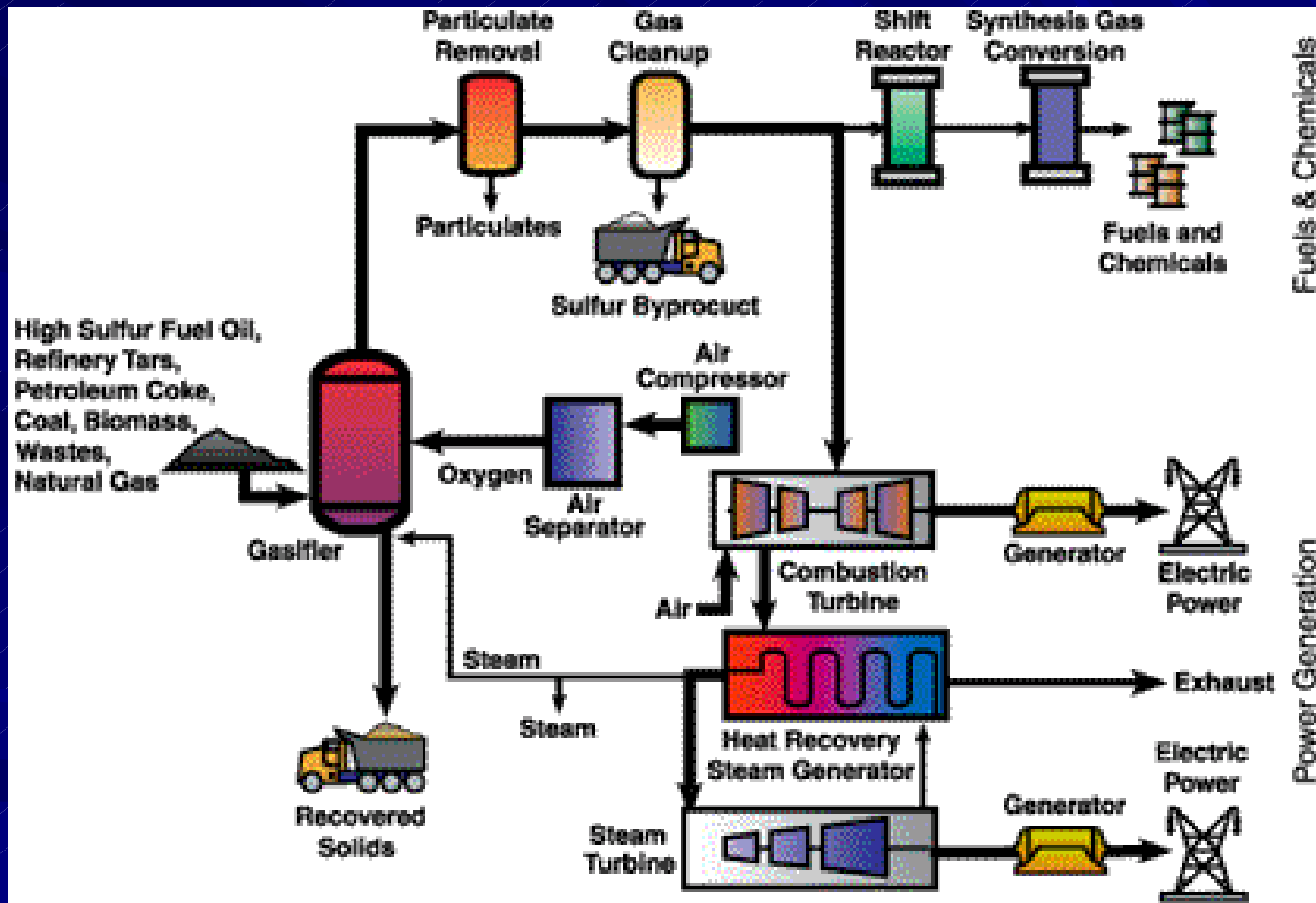
Products

- Chemicals - 14
- Power - 4
- Gas - 2

U.S. Gasification Plants

Eastman Kingsport	1983	1600000	Coal	Chemicals
Great Plains Synfuels Plant	1984	13900000	Coal	Gaseous fuels
Polk County IGCC Project	1996	3300000	Coal/Petcoke	Power
Houston Oxochemicals Plant	1977	2100000	Gas	Chemicals
LaPorte Syngas Plant	1979	4800000	Gas	Chemicals
Oxochemicals Plant	1983	400000	Gas	Chemicals
Texas City Syngas Plant	1983	830000	Gas	Chemicals
Taft Syngas Plant	1995	432000	Gas	Chemicals
LaPorte Syngas Plant	1996	1850000	Gas	Chemicals
Texas City Syngas Plant	1996	1920000	Gas	Chemicals
Oxochemicals Plant	1998	350000	Gas	Chemicals
Longview Gasification Plant	2002	1558000	Gas	Chemicals
Wabash River Energy Ltd.	1995	4320000	Petcoke	Power
Frontier Energy El Dorado	1996	80559	Petcoke	Power
Coffeyville Nitrogen Plant	2000	2141200	Petcoke	Chemicals
Premcor Refinery Delaware City	2002	3800000	Petcoke	Power
Baton Rouge Oxochemicals	1978	570000	Petroleum	Chemicals
Oxochemicals Plant	1979	500000	Petroleum	Chemicals
Convent H2 Plant	1984	1880000	Petroleum	Chemicals
Baytown Syngas Plant	2000	2540000	Petroleum	Gaseous fuels

Gasification Process



IGCC Cost & Environmental Performance

Comparative Criteria Emissions

(lb/MMBtu)	Coal Fired ^[2]	E-Gas Greenfield IGCC	E-Gas NGCC ReFueling	NGCC
SO ₂	0.15 - 0.18	0.014	0.008	0.003 ^[3]
NO _x	0.07 - 0.08	0.059	0.012 ^[1]	0.012 ^[1]
VOC	0.004	0.003	0.003	0.002
CO	0.11 - 0.12	0.066	0.066	0.03
PM/PM-10	0.015 - 0.018	0.011	0.011	0.007
Hg (lb/10 ¹² Btu)	1.0 - 4.0	0.5	0.5	-

[1] 3 ppmvd @ 15% Oxygen

[2] Range covers recently issued air permits for SCPC, PC, and CFB projects

[3] Based on 1 gr H₂S / 100 scf NG spec

Source: ConocoPhillips, 2004 GTC

Gasification Technologies Council

Cost and Performance for 500 MW Power Plant

Pittsburgh #8 Bituminous Coal –for National Coal Council Report

	Pulv. Coal Subcritical	Pulv. Coal Supercritical	IGCC with Spare	NGCC
Total Capital Requirement, \$/kW	1,430	1,490	1,610	475
Ave. Heat Rate, Btu/kWh (HHV)	9,300	8,690	8,630	7,200
Capacity Factor, %	80	80	80	80/40
Levelized Fuel Cost, \$/MBtu	1.50	1.50	1.50	5.00
<i>Levelized COE, \$/MWh (2003\$)</i>	<i>46.5</i>	<i>46.6</i>	<i>49.9</i>	<i>47.3/56.5</i>

Comparative Costs of CO₂ Removal

Technology	IGCC GE Quench	IGCC GE RSGC	IGCC E-Gas	IGCC Shell	PC Ultra Supercritical
MW no capture	512	550	520	530	600
TPC \$/KW no capture	1300	1550	1350	1650	1235
COE \$/MWh no capture	50.1	55.7	50.2	57.2	45.0
MW with capture	455	485	440	465	460
TPC \$/kW with capture	1650	1950	1900	2200	2150
COE \$/MWh with capture	62.7	69.6	68.9	75.1	76.2
Avoided Cost of CO ₂ \$/mt	18	22	29	29	42

Technology Performance: Commercially Viable

Summary of IGCC Status

IGCC offers SO_2 , NO_x , and particulate emissions below recent pulverized coal plants' permit limits.

Mercury removal >95% at 1/10th the cost for PC plant.

CO_2 capture costs 43% of PC plant (COE basis).

ConocoPhillips, GE, and Shell gasifiers have been successfully operated at commercial size on a variety of feedstocks to produce power, fuels & chemicals.

Existing single train IGCC coal plants have achieved availability of 85% on a quarterly basis. Commercial multi-train plants with spare gasifiers will achieve >90% availability.

IGCC is currently being commercially used in many plants worldwide based on the gasification of petroleum residuals providing power, steam and hydrogen to refineries. These plants provide additional operating experience on key components and unit operations.

Source: Holt, et. al.

**But is IGCC ready for
prime time?**

- AEP, Cinergy announce plans to build commercial scale coal-IGCC plants (~600-1,000 mWe each)
- Feasibility studies underway
- Site selection, PUC discussions underway
- Drivers:
 - Expectations of more stringent criteria+Hg limits
 - Expectations of CO₂ limits
 - Desire to keep coal in their energy mix

References: <http://www.aep.com/environmental/default.htm>

http://www.cinergy.com/sustain/environmental_improvement.asp

“As part of its future plans to mitigate the economic impacts of its emissions, AEP has committed to accelerating IGCC deployment by building one, or more, commercial-scale, base-load IGCC plants (up to 1,000 megawatts) as soon as 2010.”

AEP Press Release, 8/31/04

CoalFleet Participants

- AEP
- AES
- Ameren
- Associated Electric
- Austin Energy
- B&W
- Cinergy
- ConocoPhillips
- CSX
- U.S. DOE
- Duke Energy
- Dynegy
- EnBW
- E.ON UK
- First Energy
- Fluor Corporation
- GE Energy
- Great River Energy
- LG&E Energy
- Minnesota Power
- New York Power Authority
- PacifiCorp
- Portland General Electric
- Progress Energy
- Public Service New Mexico
- Seminole Electric
- Southern California Edison
- Southern Company
- Tri-State
- TXU
- Wisconsin Public Service

2005 Gasification Technologies Conference

San Francisco, October 9-12

Questions?

For further information: <http://www.gasification.org>