17th Annual Conference on Fossil Energy Materials

Desulfurization of Coal

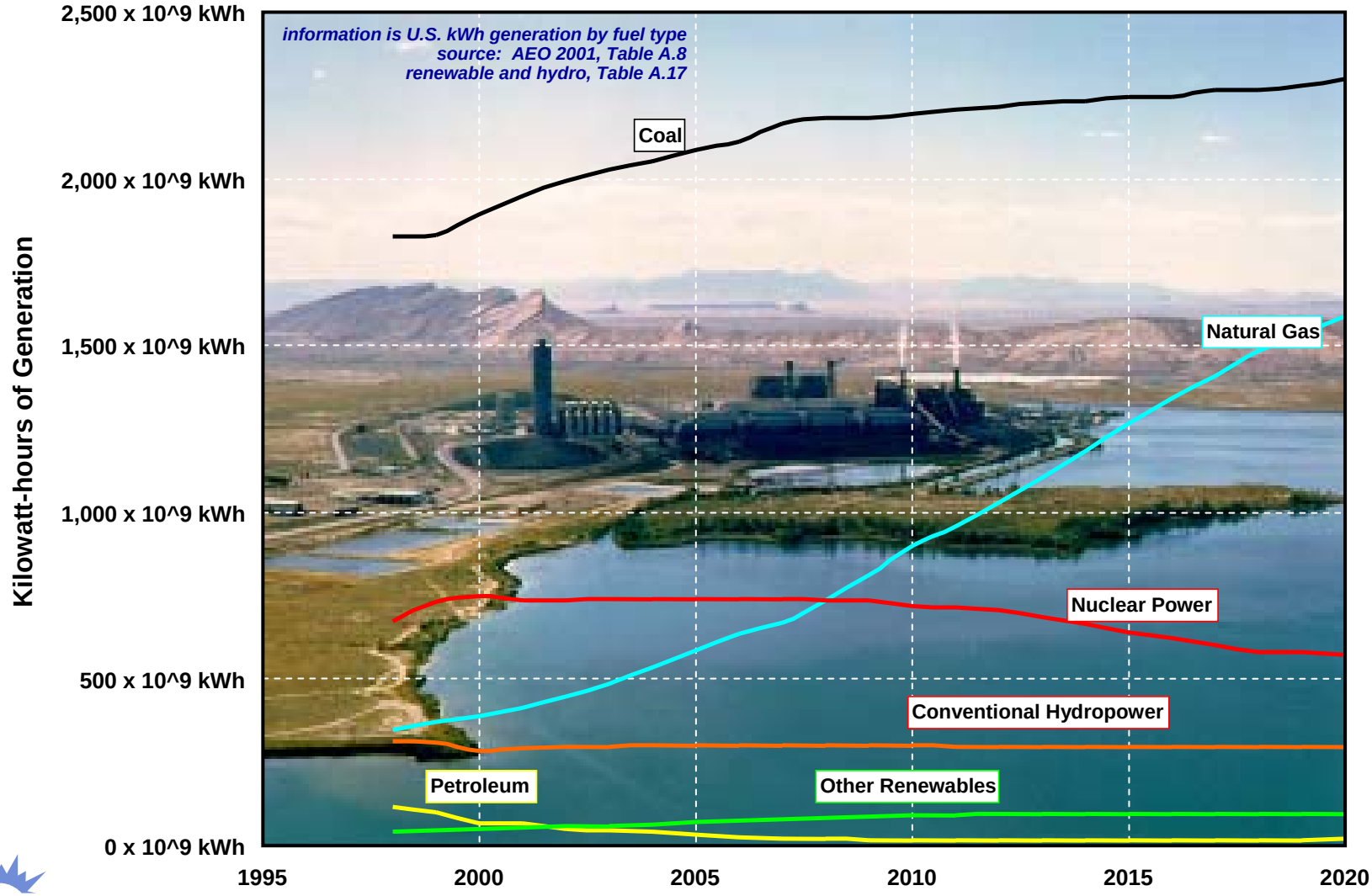
by

David A. Berry

April 22, 2003

National Energy Technology Laboratory

EIA Expectation Electric Generation kWh by Fuel Type

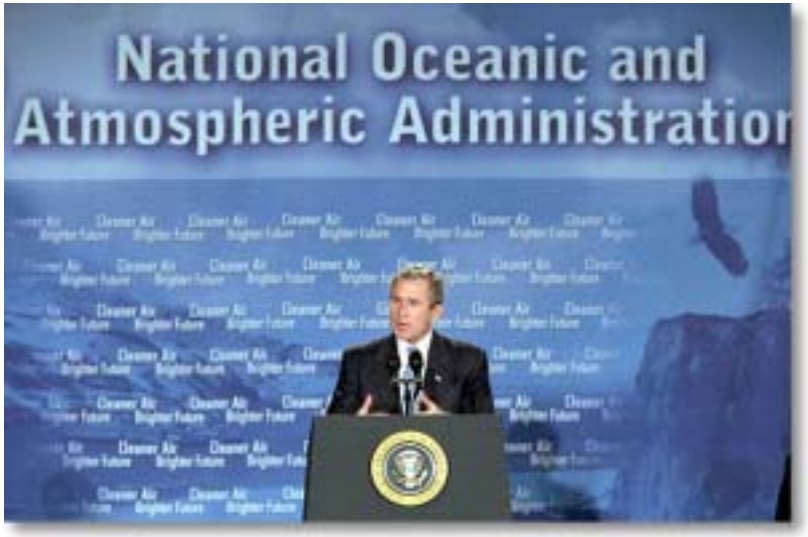


Coal Program Roadmap Supports Presidential Initiatives

- **Clear Skies**
  - Meets existing & emerging SO2, NOx, Hg regulations
- **Clean Coal Power**
  - Provides mechanism for demonstrating near-zero emission technologies
- **Climate Change**
  - Supports research to reduce CO2 emissions at acceptable costs
- **Homeland Security**
  - Keeps low-cost, abundant domestic coal competitive energy resource for the future
- **Hydrogen Initiative**
  - Coal as source of H2 essential to satisfying projected transportation fuel demand (e.g. Freedom Car)

Clear Skies Initiative

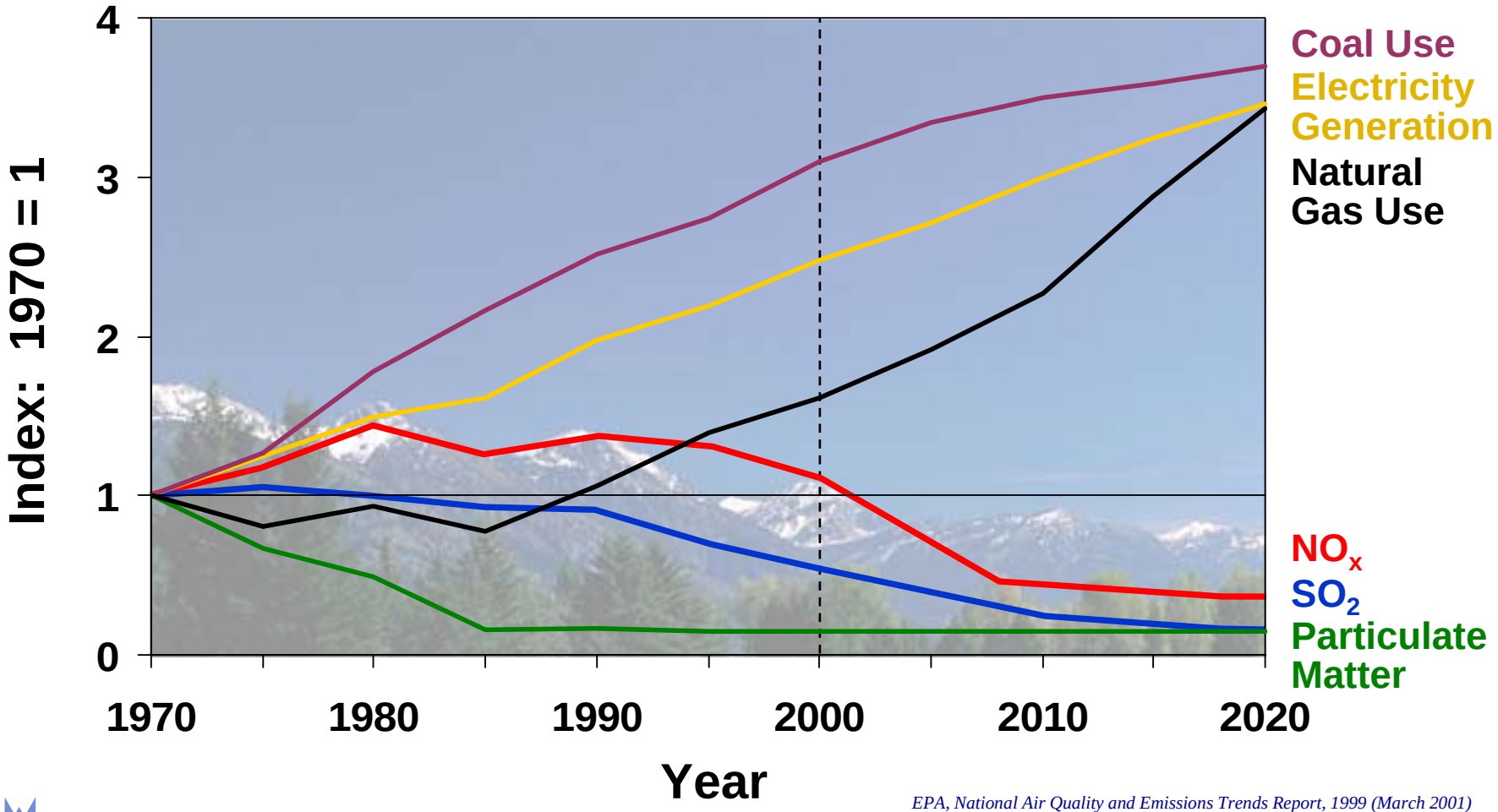
"Today, I call for new clean skies legislation that sets tough new standards to dramatically reduce the three most significant forms of pollution from power plants — sulfur dioxide, nitrogen oxides, and mercury."



President Bush
February 14, 2002

White House photo: Paul Morse

Proposed Clear Skies Initiative Would Make Criteria Pollutants Essentially a Non-Issue



EPA, National Air Quality and Emissions Trends Report, 1999 (March 2001)
DOE, EIA Annual Energy Review
Projections for NO_x and SO_2: Clear Skies Initiative

Table 1
Proposed Emissions Reductions
Electric Power Plants (Tons / Year)

			Clear Skies	
Emission	***Actual 2001***	***Baseline***	***2008/2010 Cap***	***2018 Cap***
SO_2	10.6 M	8.9 M	4.5 M	3.0 M
NO_x	4.7 M	4.0 M	2.1 M	1.7 M
Mercury	48	48	26	15
CO_2	2.2 B	2.2 B	_	_

Advanced Energy Applications

- **FutureGen-** Combine electricity and hydrogen production with the virtual total elimination of harmful emissions, including greenhouse gases.

- **Vision 21 -** 21st century energy plants with virtually no environmental impact.

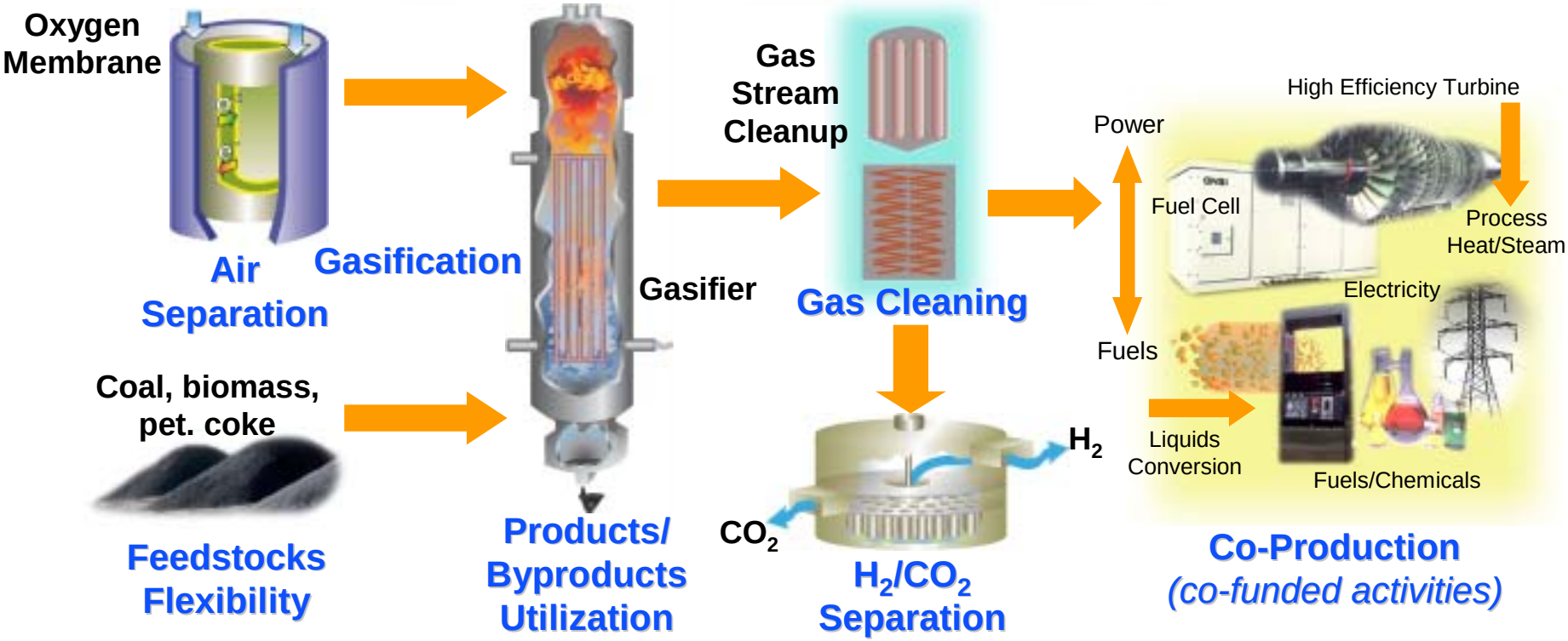
Coal Power Program Roadmap Addresses Short- and Long-Term Needs

- **Short-term: existing fleet**
  - Cost-effective environmental control technologies to comply with current and emerging regulations
- **Long-term: Vision 21**
  - Near-zero emissions
  - Power + fuels / chemicals
  - Maximize Efficiency
  - Plants with CO_2 management capability

Eliminate Environmental Concerns from Use of Fossil Energy

Gasification Technologies Program

Clean, Affordable Energy Systems



Mission

- **Mission:**

  Foster the commercialization of gasification-based processes

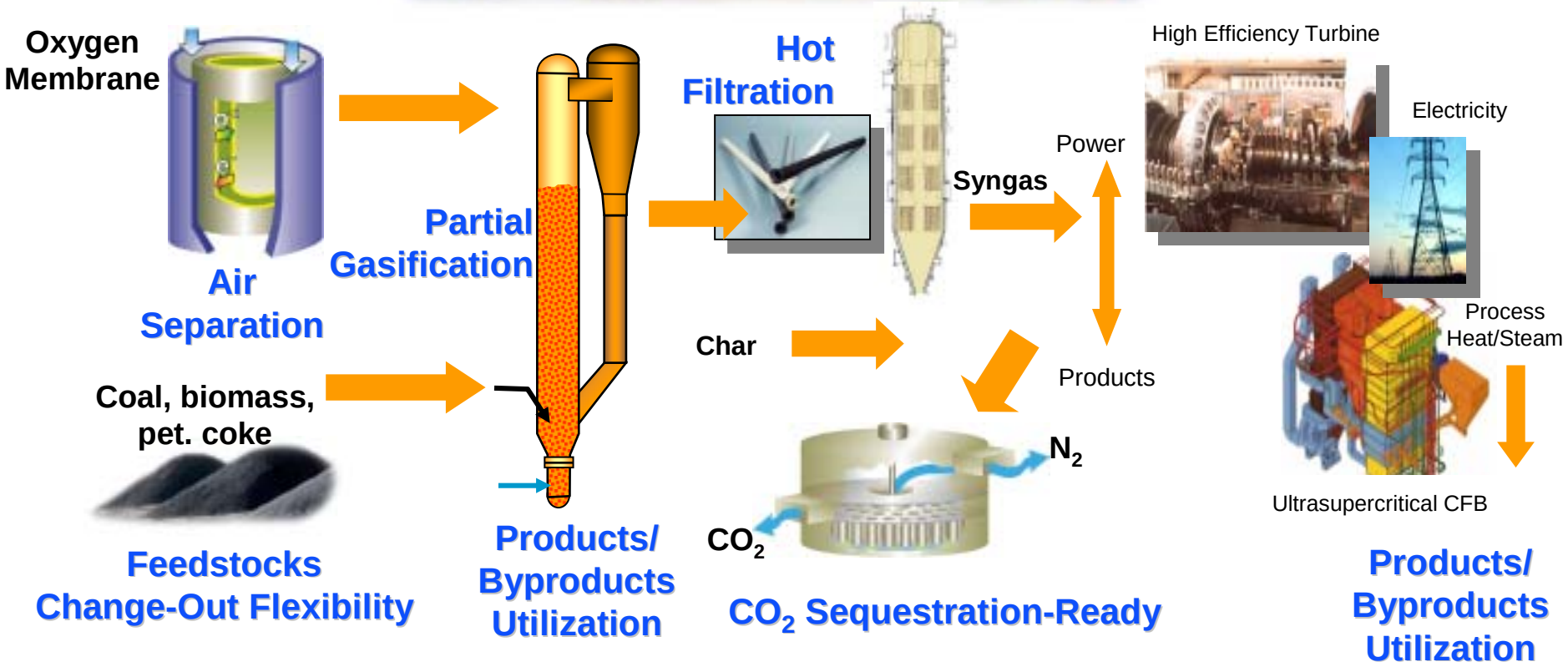
- **Performance Goals:**

Year	Capital Costs ($/kWe)	Efficiency (%HHV)	Environment
2002	1250	42	1/10 NSPS
2008	1000	50	<1/10 NSPS
2015	850	>60	Near-zero

- **Unique Capabilities:**
  - Feedstock and product flexibility (Market adaptability)
  - Most economical technology for CO_2 capture (vs. NGCC and PC)

Combustion Technologies Program

Clean, Affordable Energy Systems



Mission

- **Mission:**

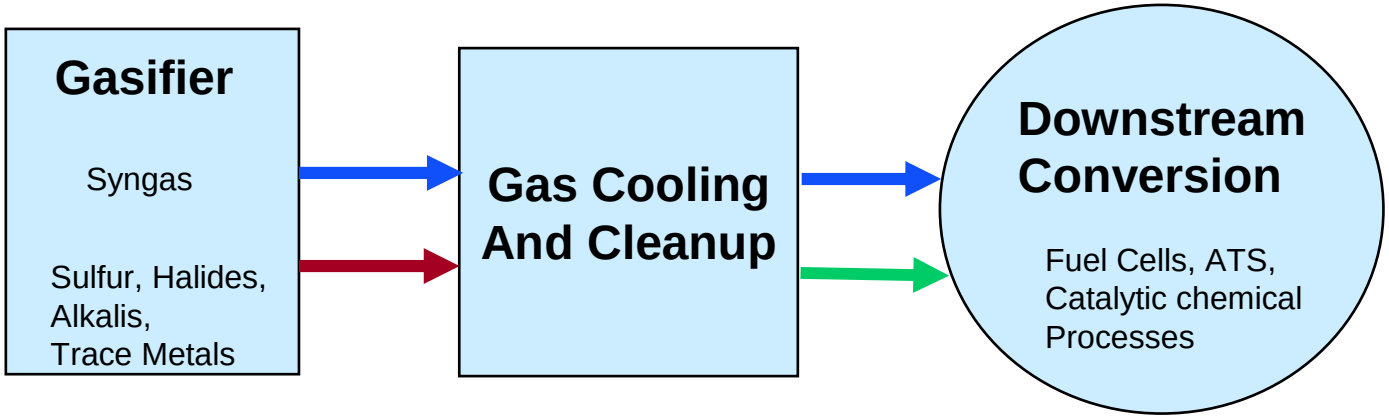
  Promote the development and commercialization of advanced combustion based power generation technologies that are ultra-clean, efficient and affordable for use in new & existing utility, industrial, and commercial applications

- **Performance Goals:**

Year	Capital Costs ($/kWe)	Efficiency (%HHV)	Environment
Today	1250	38-42	1/10 NSPS
2008	1000	47-50	<1/10 NSPS
2015	850	55->60	Near-zero

- **Unique Capabilities:**
  - Market adaptability via feedstock flexibility throughout plant life
  - Continues to be the most economical coal-fired technology
  - Best choice for repowering existing units

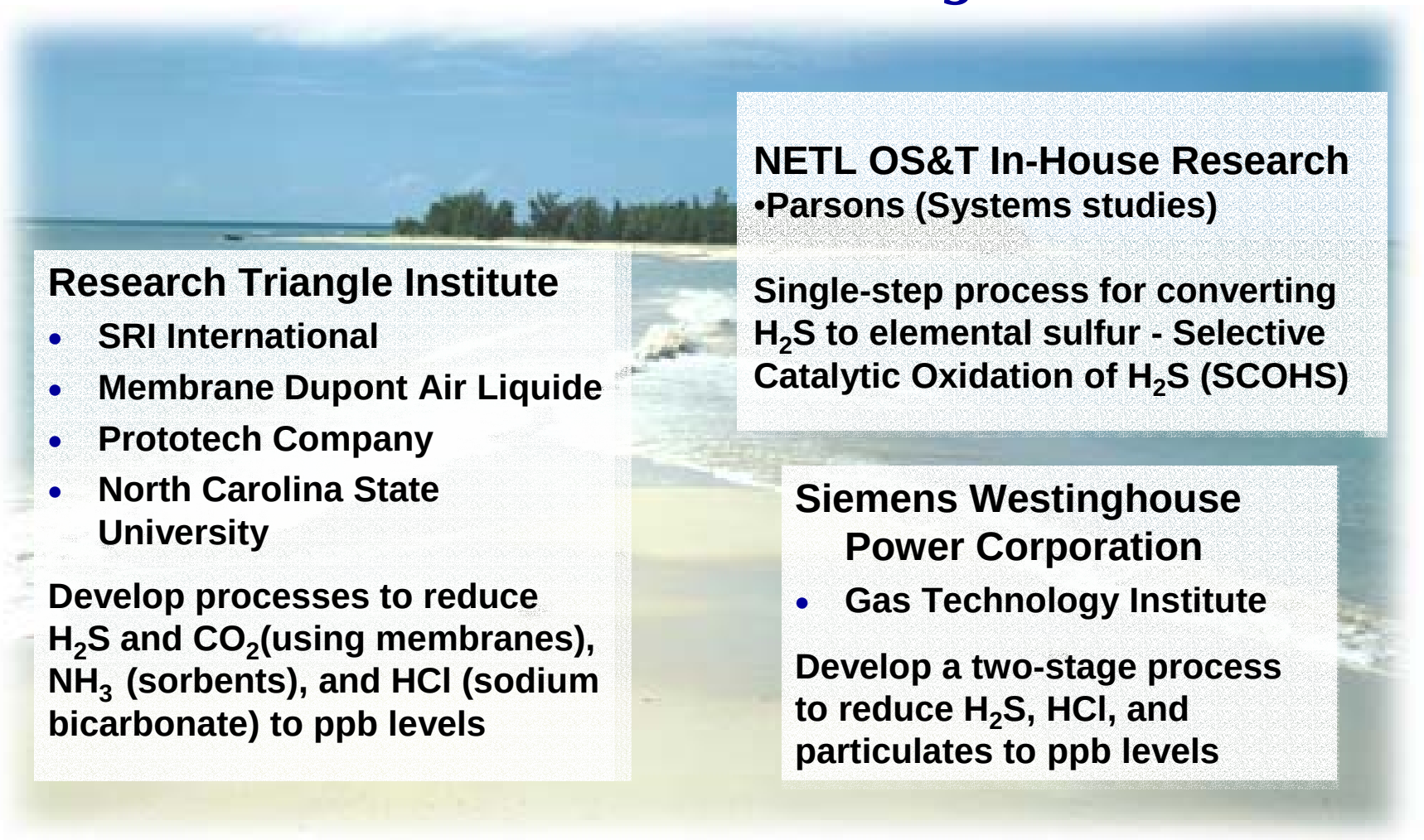
Syngas Cleanup



- **Commercial Technology is Primarily Low-Temperature**
  - Effective for low-level contaminant (sulfur) removal
  - Limited heat integration reduces system efficiency
  - Large and costly equipment train

- **Current Development Efforts Focused on Warm-Gas (300-700 °F)**
  - Allows for higher system efficiency and good heat integration with downsteam conversion devices / technology.
  - Can be incorporated into existing fleet technologies as well as basis for future advanced technologies (Accelerates Industrial commercialization opportunities).

Gasification Technologies Program
Ultra Gas Cleaning



NETL OS&T In-House Research
- Parsons (Systems studies)

Single-step process for converting H_2S to elemental sulfur - Selective Catalytic Oxidation of H_2S (SCOHS)

Research Triangle Institute
- SRI International
- Membrane Dupont Air Liquide
- Prototech Company
- North Carolina State University

Develop processes to reduce H_2S and CO_2(using membranes), NH_3 (sorbents), and HCl (sodium bicarbonate) to ppb levels

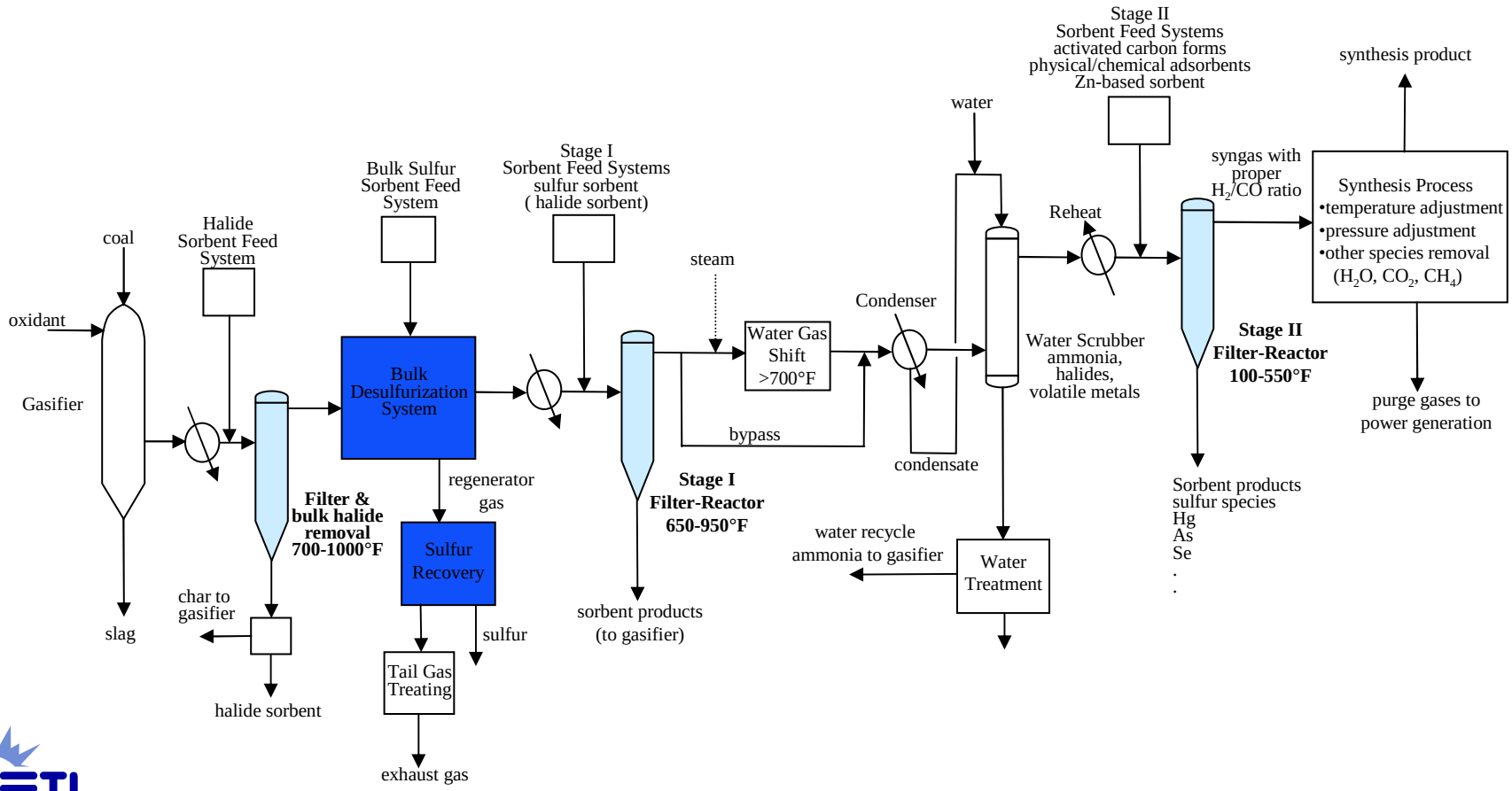
Siemens Westinghouse Power Corporation
- Gas Technology Institute

Develop a two-stage process to reduce H_2S, HCl, and particulates to ppb levels

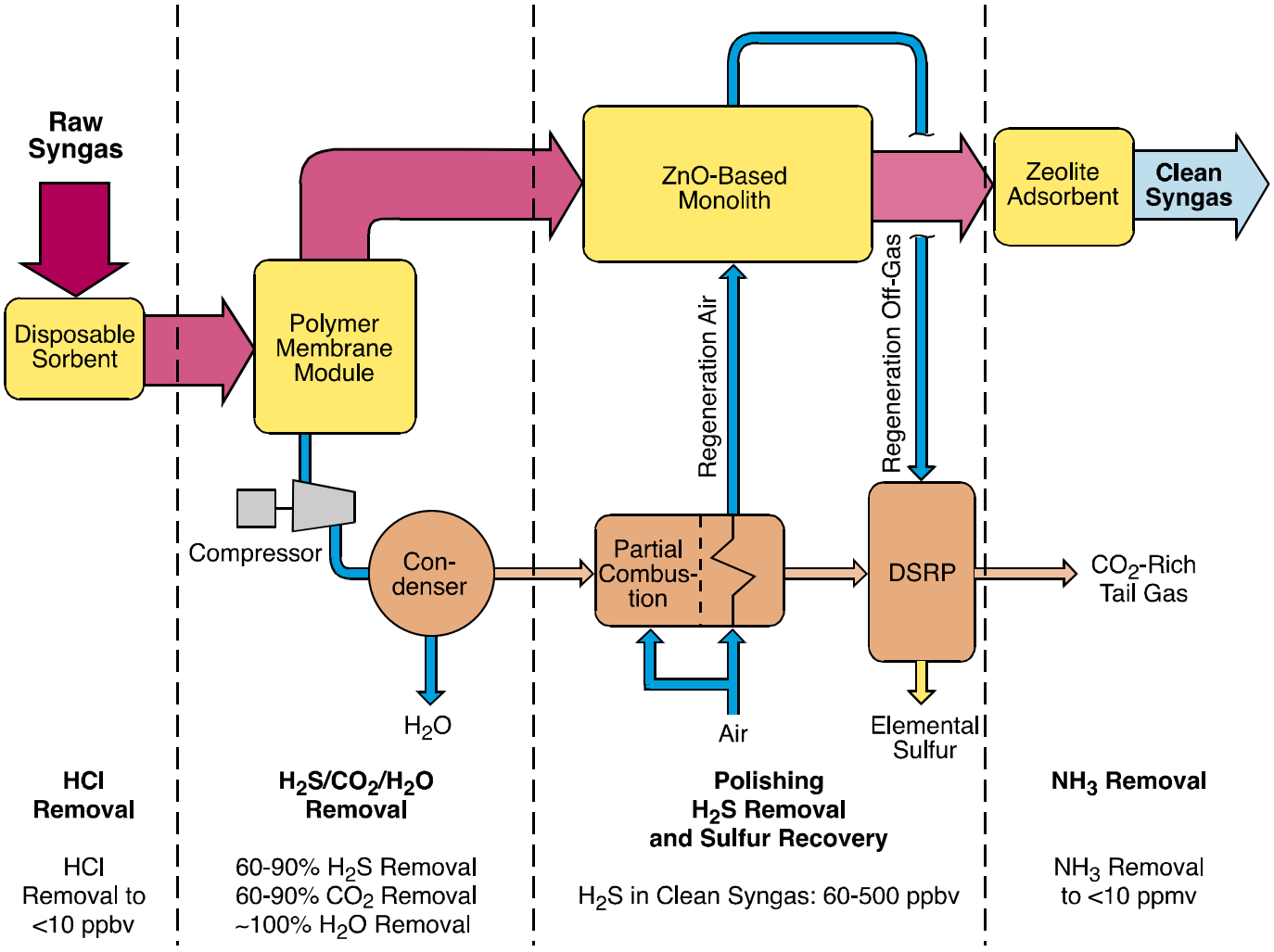
Siemens Westinghouse Power Corporation
Ultra Gas Cleaning

Gasifier Pressure
800 - 1600 psia

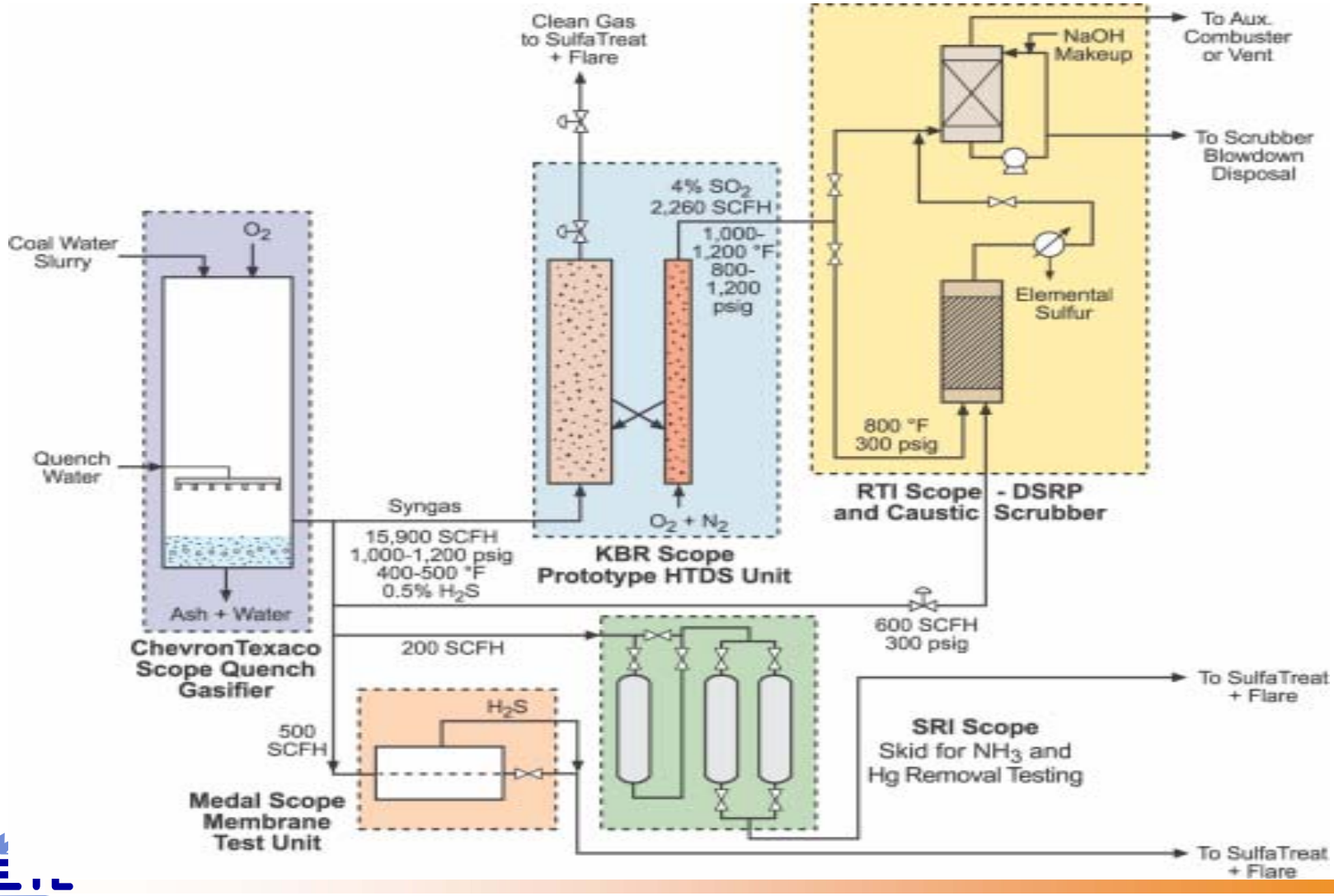
Synthesis Conditions
500-3000 psia
400-850°F



Research Triangle Institute
Ultra Gas Cleaning

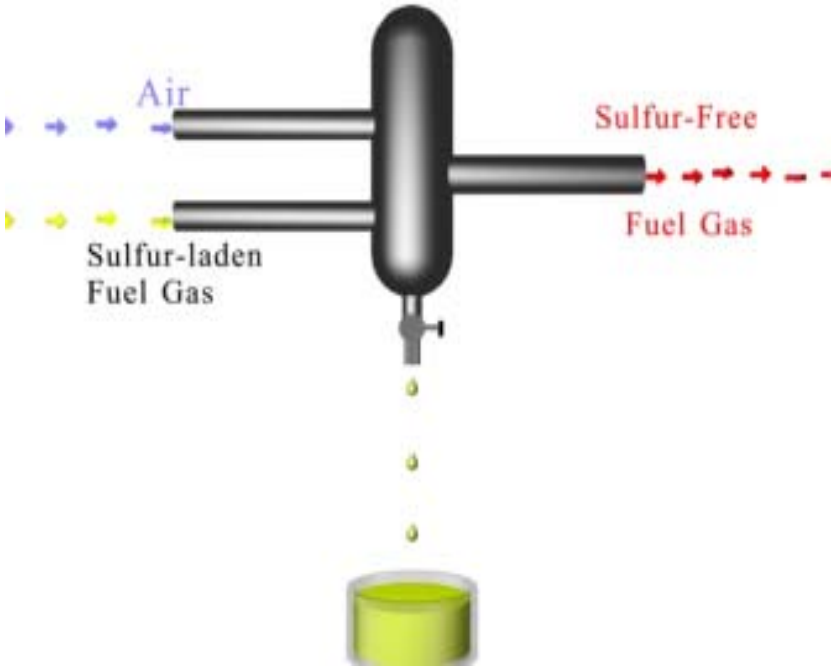


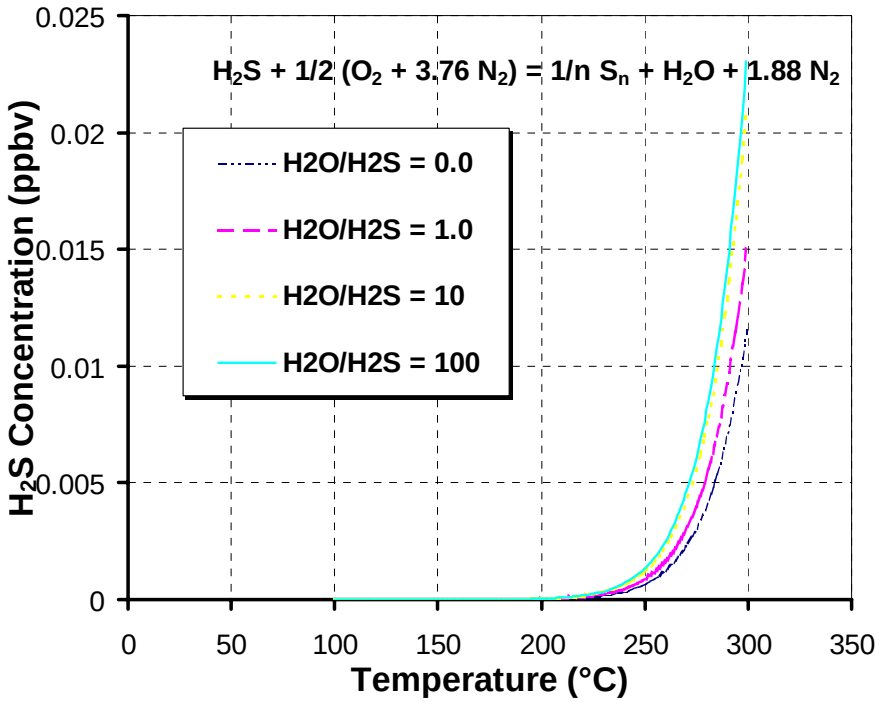
Research Triangle Institute
Chevron Texaco Field Demonstration



National Energy Technology Laboratory
Ultra Gas Cleaning - SCOHS

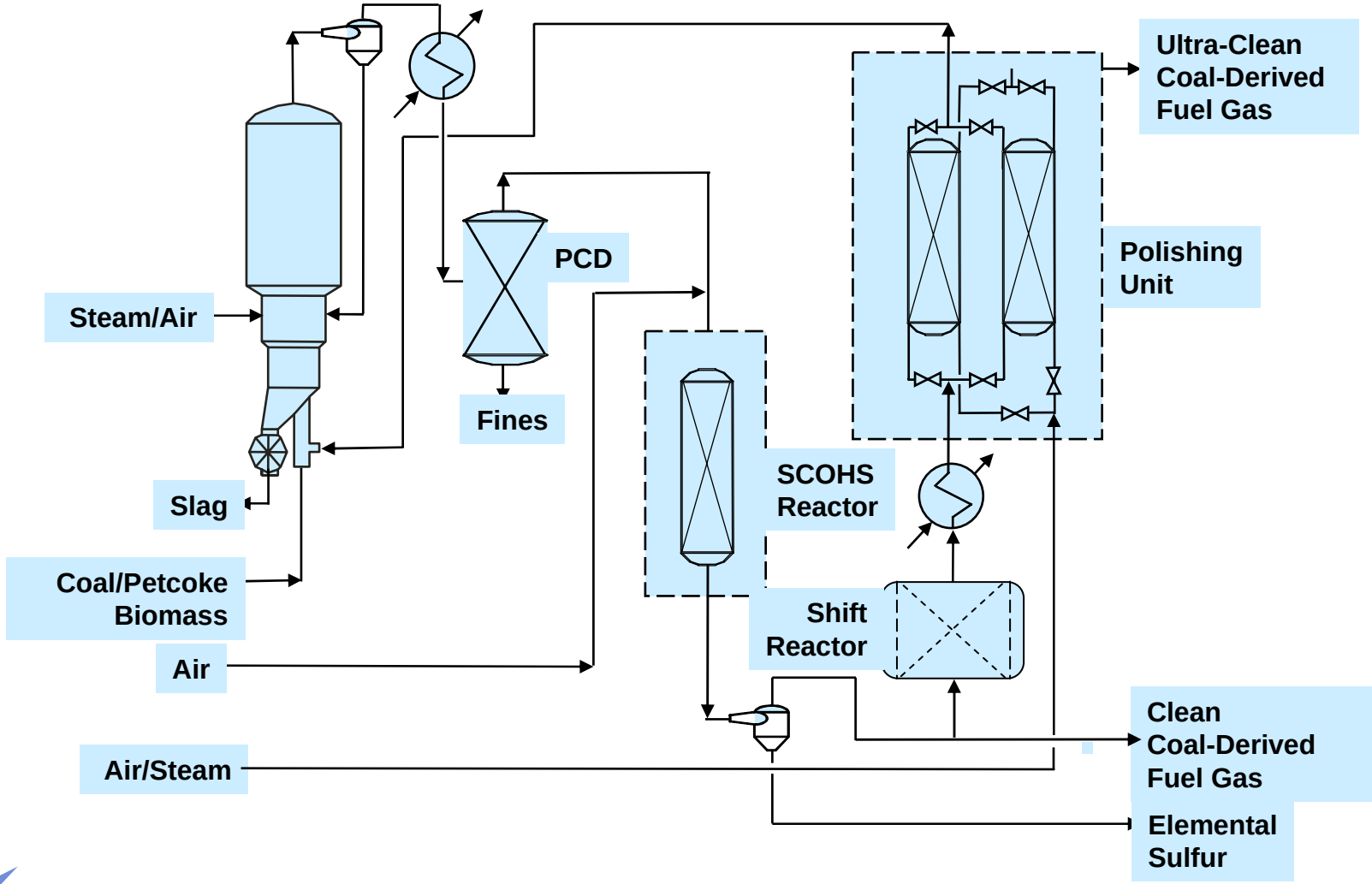
$$H_2S + 1/2\,(O_2 + 3.76\,N_2) = 1/n\,S_n + H_2O + 1.88\,N_2$$





National Energy Technology Laboratory

Ultra Gas Cleaning - SCOHS



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