



GTI Gasification and Gas Processing R&D Program



>> GTI at a glance



- > Research, deployment and training for the Natural Gas Industry and energy markets
- > 65 years, 1000+ patents, 500 products
- > 18 acre campus, 200,000 ft² of lab and office space
- > 50 years of Gasification R&D



Goals

- > Increase the use of coal and biomass through the development, evaluation and commercialization of new gasification technologies.
- > Develop and evaluate new technologies to clean/treat syngas for various end use applications.
- > Integrate advanced gasification-based technologies with end-use technologies for production of power, fuels, and chemicals.

*Increasing Energy Supply with Advanced Processes to
Convert Coal and Biomass to Power, Fuels, and
Chemicals.*

Gasification and Gas Process R&D Expertise



> Advanced gasification systems



> Gas cleanup systems for sour gas and syngas

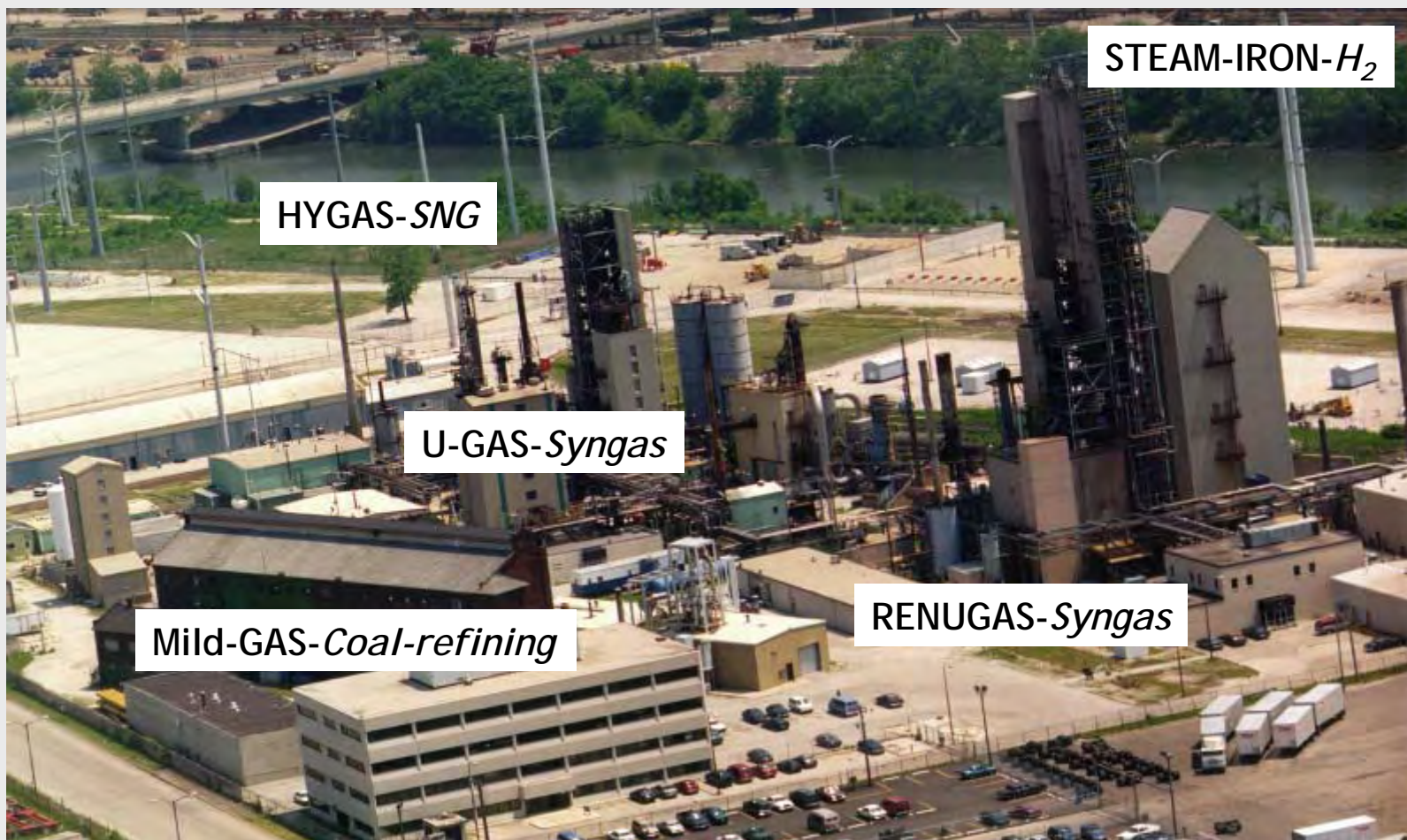


> Integration of syngas production and conversion

> Process simulation and techno-economic evaluations

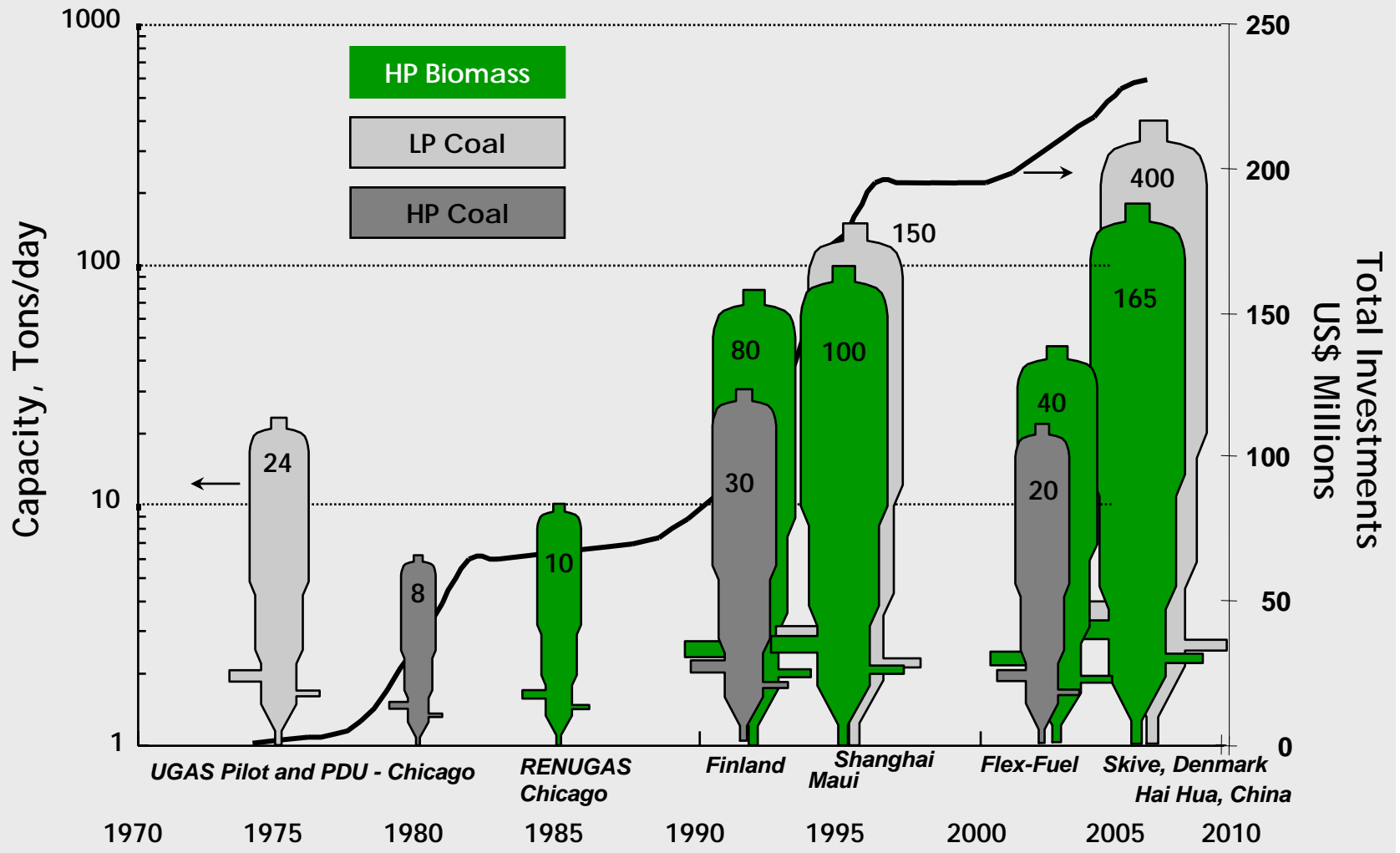
GTI Energy Development Center

1951-1996



Leader of International Energy Agency (IEA) Task 33 - Biomass Gasification since the Task inception in 1989.

Scale-up and Investment History of GTI Gasification Technology



Gasifier Projects



80 ton per day Gasification Pilot Plant in Tampere, Finland using biomass & coal



100 ton per day Bioenergy Demo Plant in Hawaii using bagasse



1000 ton per day U-GAS[®] Industrial fuel gas in Shanghai, China using coal



165 ton per day CHP Plant in Skive, Denmark using wood

GTI's Flex-Fuel Test Facility: A Technology Development and Systems Integration Platform



- > Flexible fuel capability
- > Operational flexibility
- > Plug and play systems integration and testing

Flex-Fuel Test Facility Overview

Features

- Coal - 10 tpd w/air; 20 tpd w/oxygen
- Biomass - 24 tpd w/air; 40 tpd w/oxygen
- Gasification Pressure to 28 atm
- Multi-contaminant Syngas Cleanup
- On-line Syngas Analysis Systems

Process Evaluations

- Hydrogen Production
- SNG Production
- CO₂ Capture Technologies
- Syngas-to-Liquids Production
- Advanced Power Conversion Systems
- Advanced Oxygen Production Systems
- Industrial Syngas End-Use

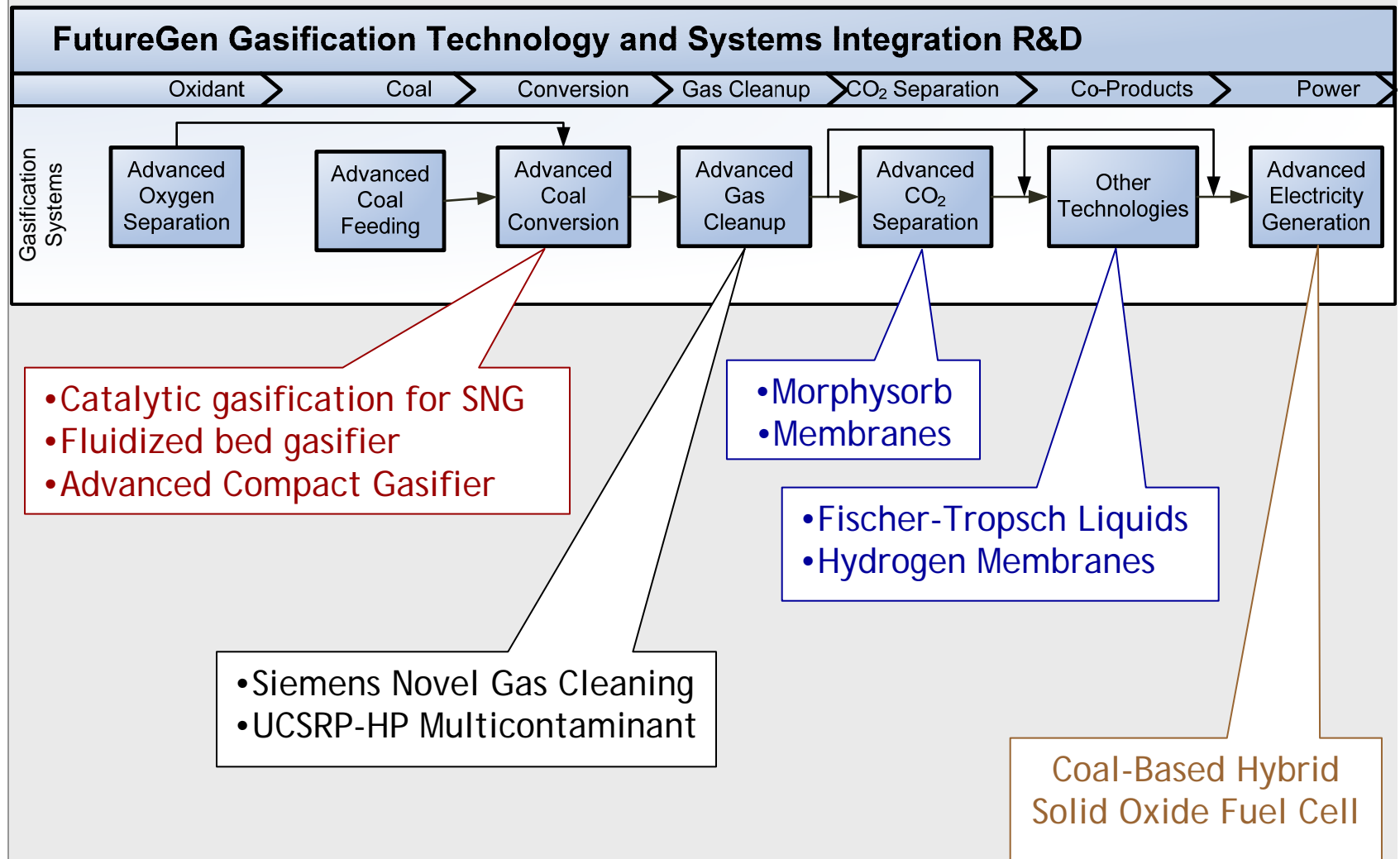
Commercial Operator Training



Industrial Combustion Lab



GTI Projects Relevance to FutureGen



Objectives of Selected Gasification and Gas Processing Projects

GASIFICATION

- > bluegas[®] Catalytic Gasification (GreatPoint Energy): Produce low-cost substitute natural gas (SNG) from coal via catalytic gasification.
- > Advanced Compact Gasifier (Pratt & Whitney Rocketdyne, GTI, DOE): Convert all ranks of coal to power and fuels at high efficiency and economy with an advanced entrained gasifier.*
- > IGCC for India (USAID, Nexant): Support design of U-GAS[®] solution for advanced power production in India.

SYNGAS PROCESSING

- > Novel Gas Cleaning Process (Siemens Power Generation, DOE): Remove hot syngas contaminants to ultra-clean levels for high-efficiency IGCC (fuel cell) and chemicals applications.*
- > UCSRP-HP Multi-contaminant Process (DOE, ICCI): Develop a new, inexpensive process to remove and recover multiple contaminants in coal-derived syngas.*



* Projects with DOE participation

Objectives of Selected Gasification and Gas Processing Projects (2)

SYNGAS PROCESSING (cont'd)

- > Acid Gas Treatment Pilot Plant (IL DCEO, GTI): Efficiently capture sulfur and CO₂ from syngas for acid gas and carbon management.
- > Engineered Catalyst for In-Situ Elimination of Tar (DOE-EERE, GTI): Create a lower-cost, high-performing catalyst for tar reductions in biomass gasifiers.
- > Hydrogen Production from Biomass Gasification (Xcel): Demonstrate membranes for H₂ separation from biomass-derived syngas.

SYNGAS CONVERSION

- > Coal-Derived High-Hydrogen Content Fischer-Tropsch Liquids (Headwaters, GTI, DOE): Produce Fischer-Tropsch liquids from coal using iron-based catalysts.*
- > Coal-Based Hybrid Solid Oxide Fuel Cell (FuelCell Energy, Versa Power, DOE): Prove feasibility of SOFC for high-efficiency power in the FutureGen concept.*



* Projects with DOE participation

Acid Gas Treatment Pilot Plant

Value: Sulfur and CO₂ capture for low emissions and carbon management

> Sponsor: State of Illinois DCEO, GTI

> Scope

- Refurbish and Reconfigure the Acid Gas Treatment Pilot Plant for syngas application
- Integrate with FFTF for sulfur and CO₂ removal evaluation on syngas

> Status

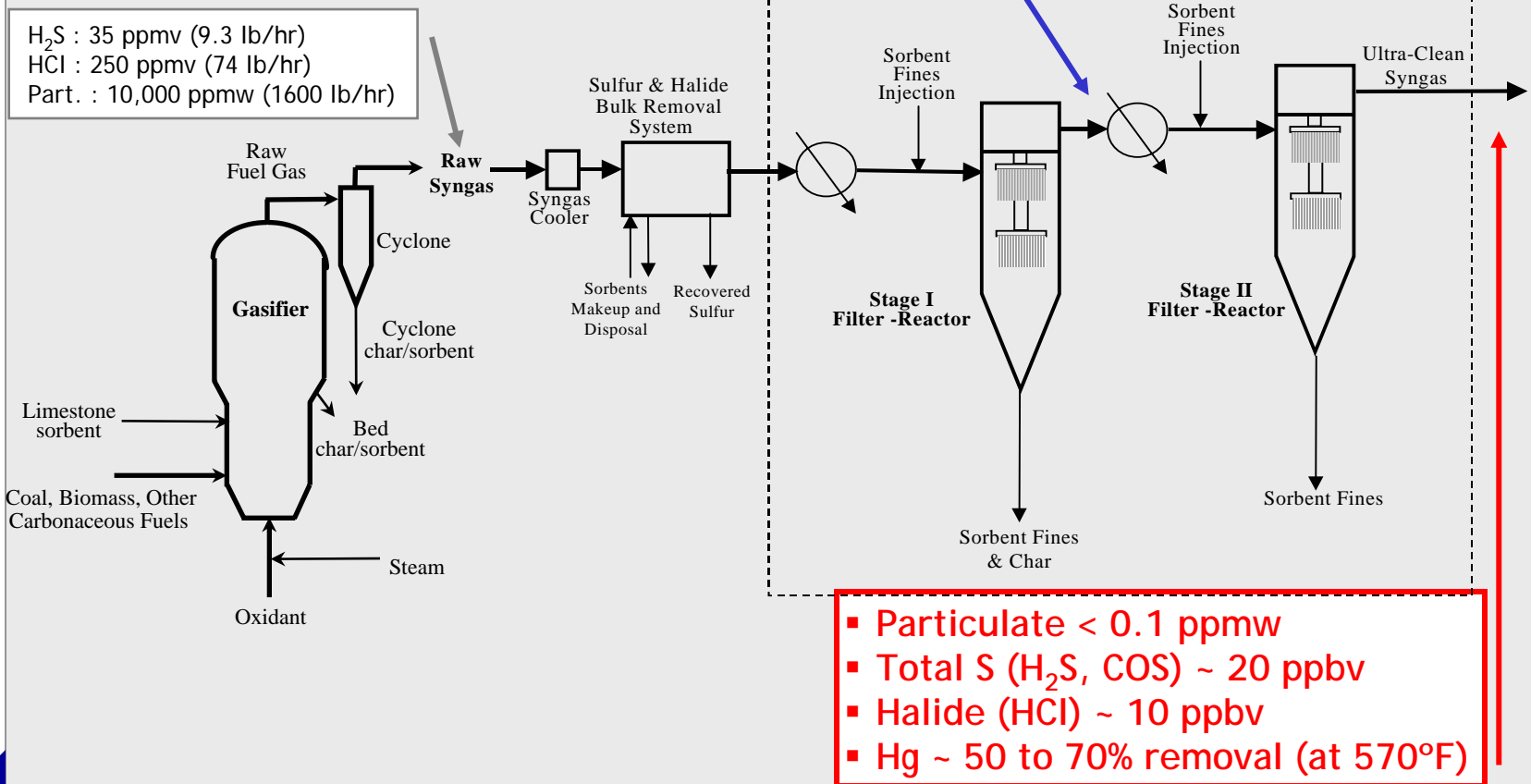
- Equipment installed at FFTF in 2006



Ultra-Clean Syngas Process

Value: Syngas contaminant removal for high-efficiency IGCC (fuel cell) and methanol plants.

- Particulate < 0.1 ppmw
- Total S (H_2S , COS) ~ 1 to 5 ppmv
- Halide (HCl) ~ 1 to 5 ppmv



bluegas[®] Catalytic Gasification

Value: Production of low-cost substitute natural gas (SNG) from coal.

> Sponsor: GreatPoint Energy

> Scope

- Evaluate catalytic gasification for production of SNG from two potential fuels
- Laboratory tests followed by pilot-scale tests in Flex-Fuel Test Facility

> Schedule

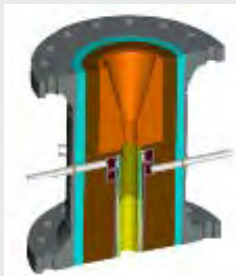
- 18+ month program, started Jan 06

Pratt & Whitney Rocketdyne (PWR) Compact Gasification System

Value: High-efficiency, low-cost advanced gasifier to convert all coals to power and fuels.

Component Development & Pilot Plant

2004 - 2009



Component Development



Pilot Plant Gasifier & Test Facility



Commercial Demonstrations (400 & 3000 TPD Gasifiers)

2007 - 2010

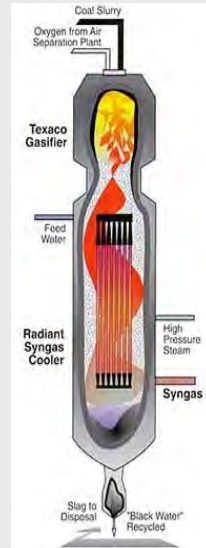


Commercial Gasification Plant

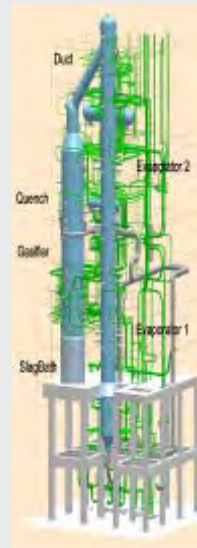
15% to 20% Lower End Product Cost from Improved Efficiency, Cost and Availability

Gasifier Comparison

GE Gasifier



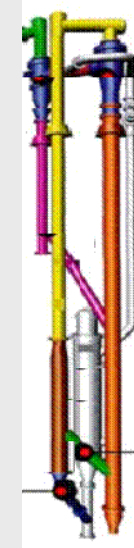
Shell Gasifier



Conoco Phillips Gasifier



Transport Gasifier



PWR Gasifier



90% Size Reduction Provides Significant Advantages

• Capital Cost	Base	>Base	Base	Base	<50%
• Availability*	0.90	0.85 ↑	0.82 ↑	?	0.99
• Cold Gas Efficiency*	0.77	0.83	0.83	0.75	0.85
• Fuel Flexibility	Fair	Good	Fair	Poor	Good
• Product Flexibility	Good	Fair	Fair	Poor	Good

Fischer-Tropsch Process Development Unit

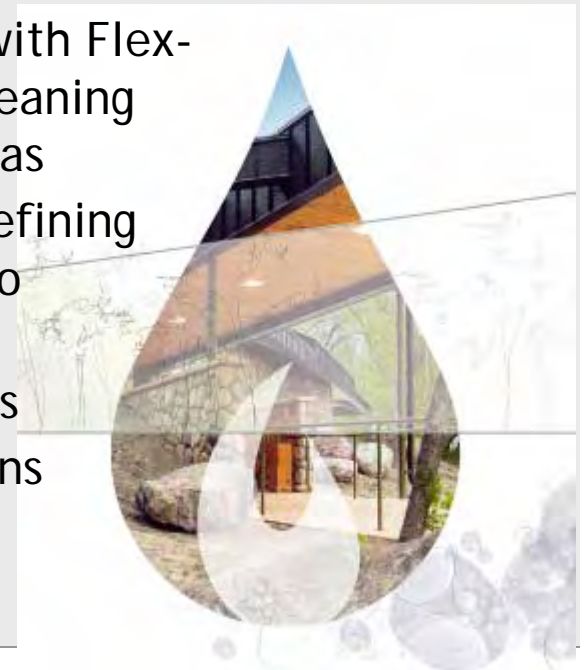
Value: Coal-to-liquids from Illinois basin coal.

Sponsors: USDOE-Fossil Energy, Headwaters Energy Systems, GTI

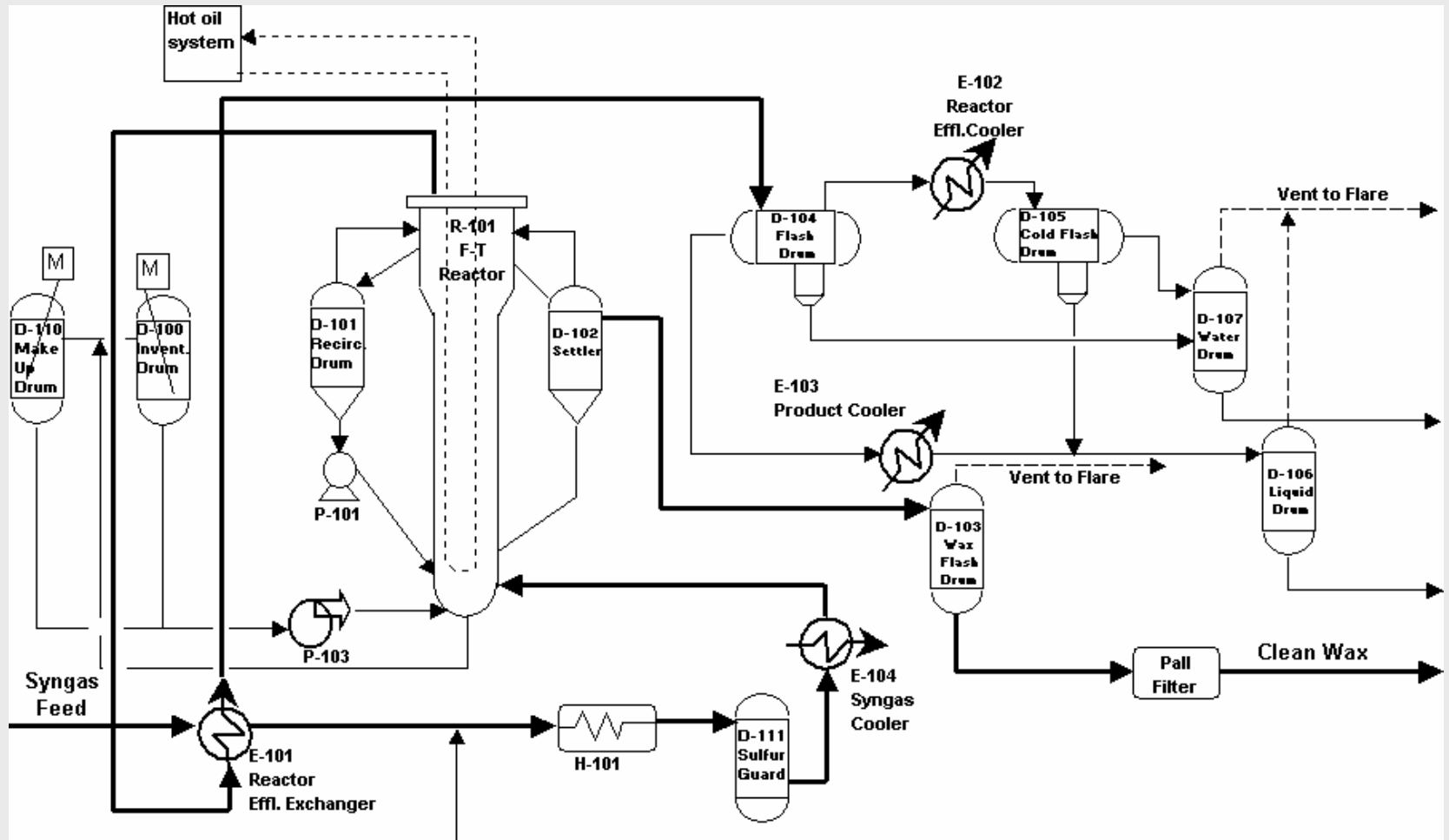
Participants: Headwaters, GTI, Nexant, Argonne National Laboratory, DOE National Energy Technology Laboratory, Department of Defense/Air Force

Scope:

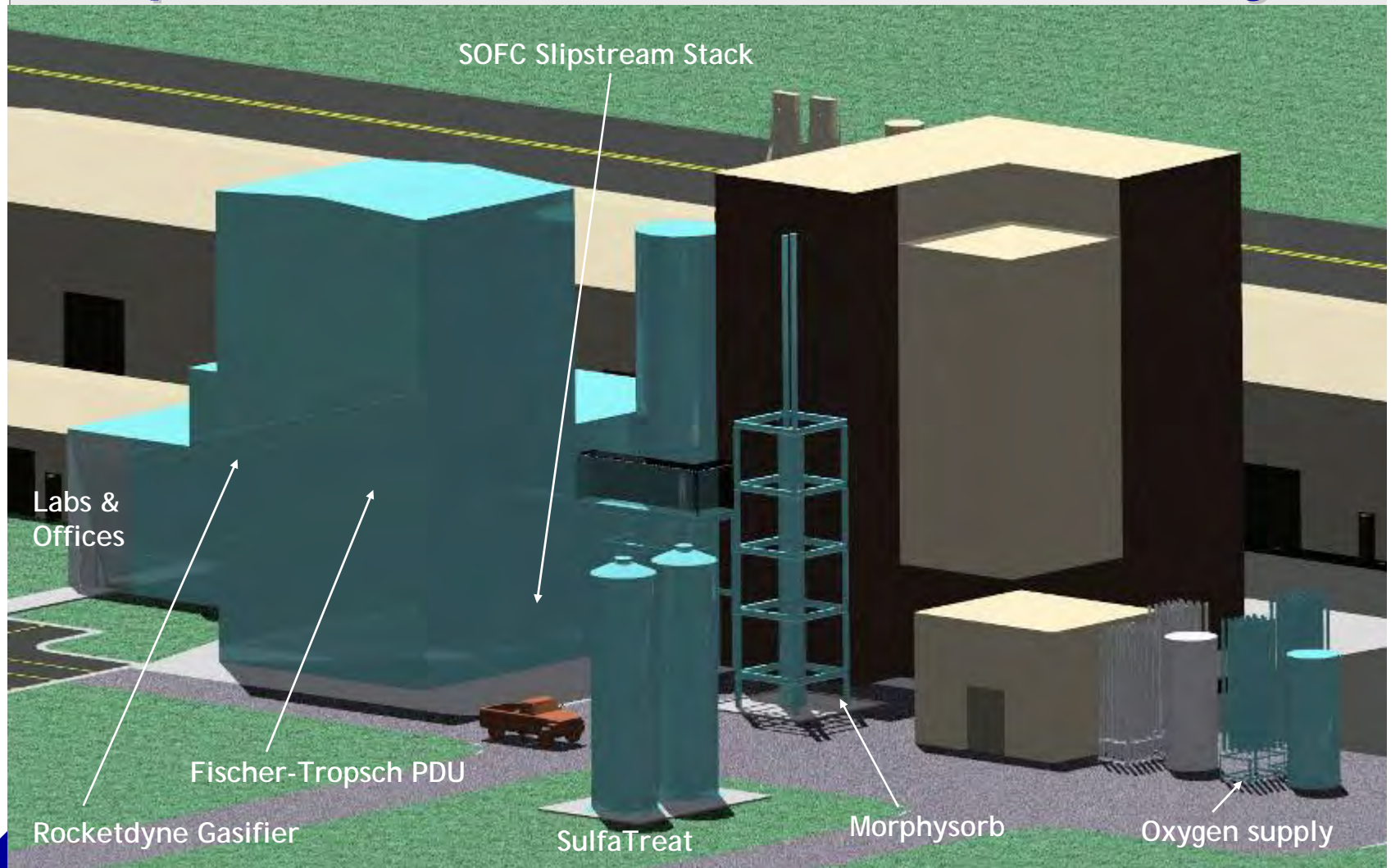
- Design and build pilot-scale PDU to integrate with Flex-Fuel Test Facility - use existing gasifier, gas cleaning and conditioning systems to pre-treat the syngas
- Produce F-T liquids and wax for downstream refining and evaluation (5-10 bpd) (DOE and DOD/AF to evaluate)
 - Compare medium- and high-alpha catalysts
 - Compare slurry and fluidized bed operations
 - Test with syngas from various coals
- Train operating staff



Fischer Tropsch PDU Simplified Flow Diagram - Syngas Feed from FFTF



Conceptual Plan for Expanded Gasification Test Facility



Advantages of GTI Location

- > Fast-track by integrating with existing facilities
- > Existing gasifier for long-duration operation
- > Flexibility in handling different fuels with air or oxygen as oxidant
- > Existing gas cleaning and conditioning systems
- > Facility already permitted
- > Experienced scientists, engineers, and operators