Ammonia From Coal

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A Changing World …

Growing population & energy density

Fuel sourcing complexity

Increasing environmental requirements

Escalating security concerns

Technology & talent globalization

Heightened investor demands

Everyone under pressure

Traditional Ammonia Manufacturing

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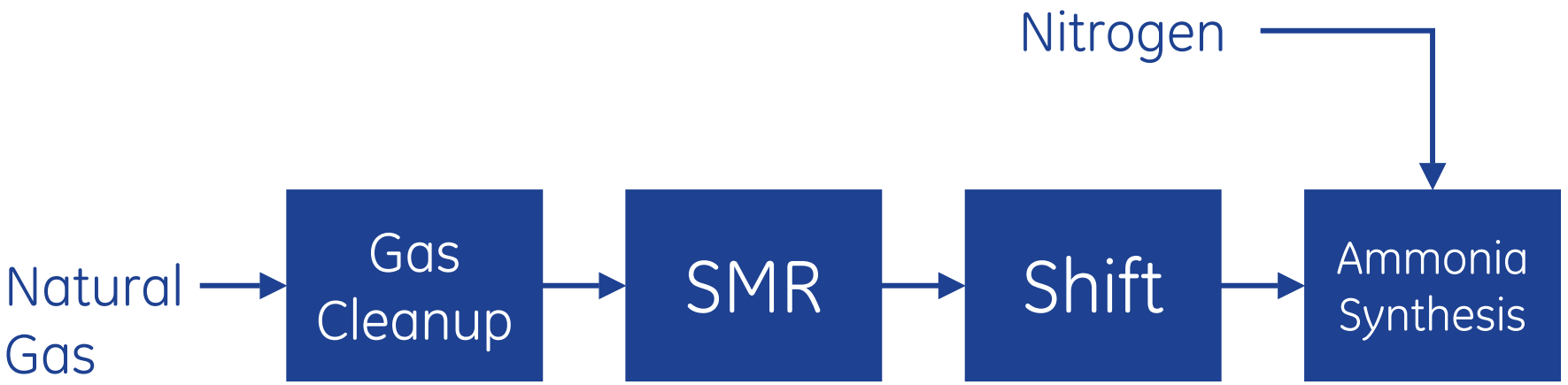
Natural Gas based manufacturing



Natural Gas Challenges

Clean Air Act

- Many gas turbines installed as clean power generation

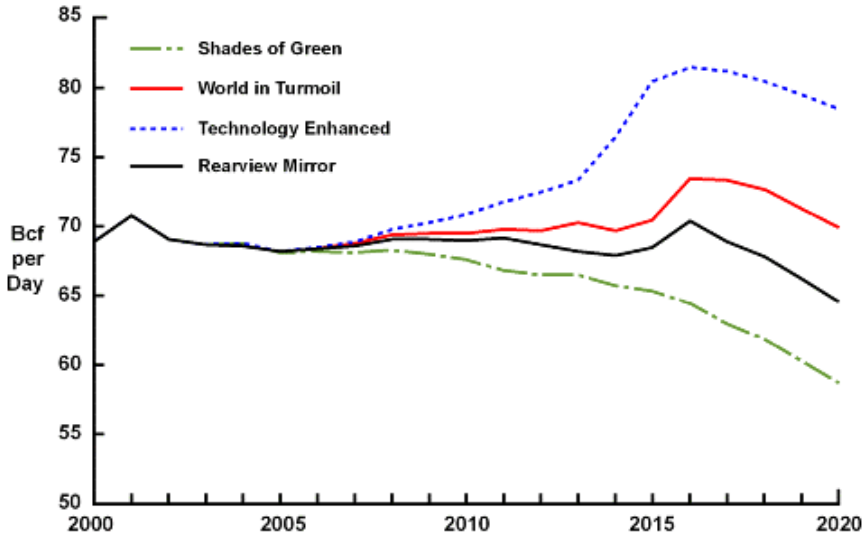
LNG

- Intense NIMBY opposition to LNG terminals
- Increases foreign energy dependency

Canadian Oil Sands

- Reduces or eliminates WCSB natural gas exports from Canada

Projected Natural Gas, N. America Dry Productive Capacity, Henry Hub Pricing



Source: Cambridge Energy Research Associates.
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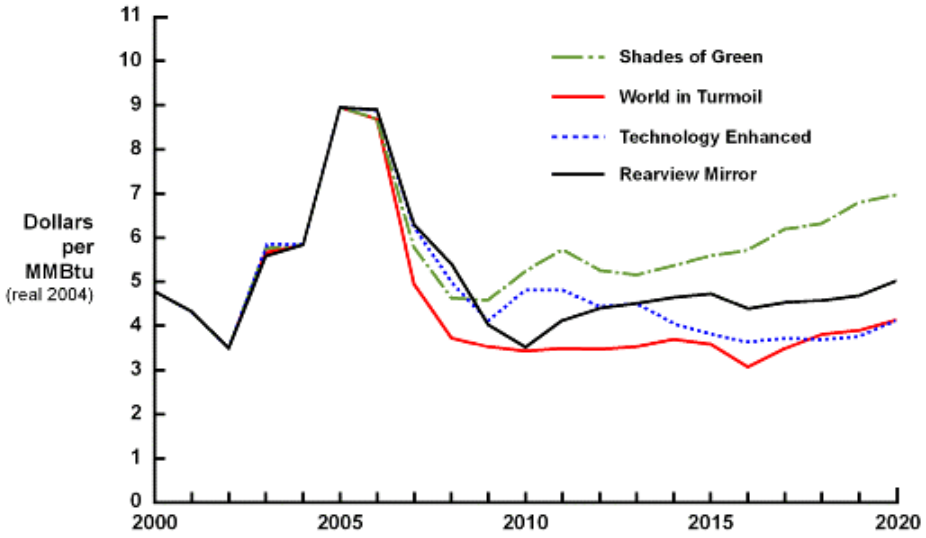

Source: Cambridge Energy Research Associates.
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The solution: Ammonia from coal

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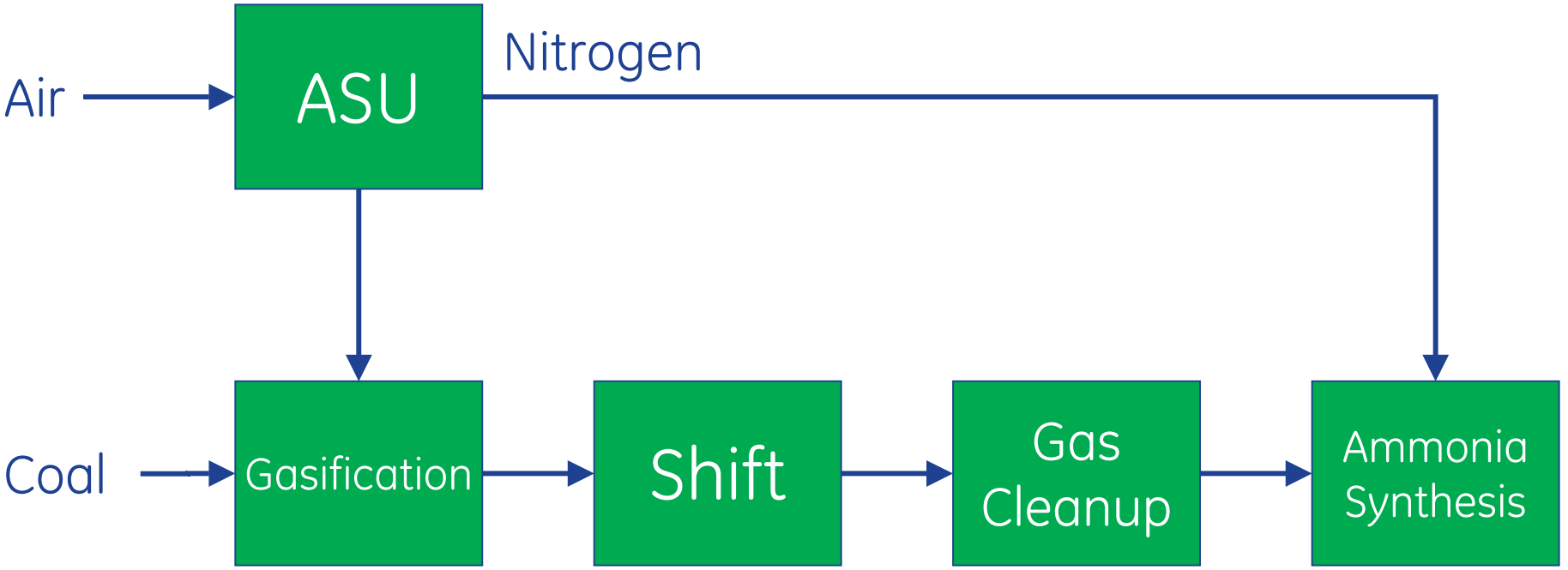
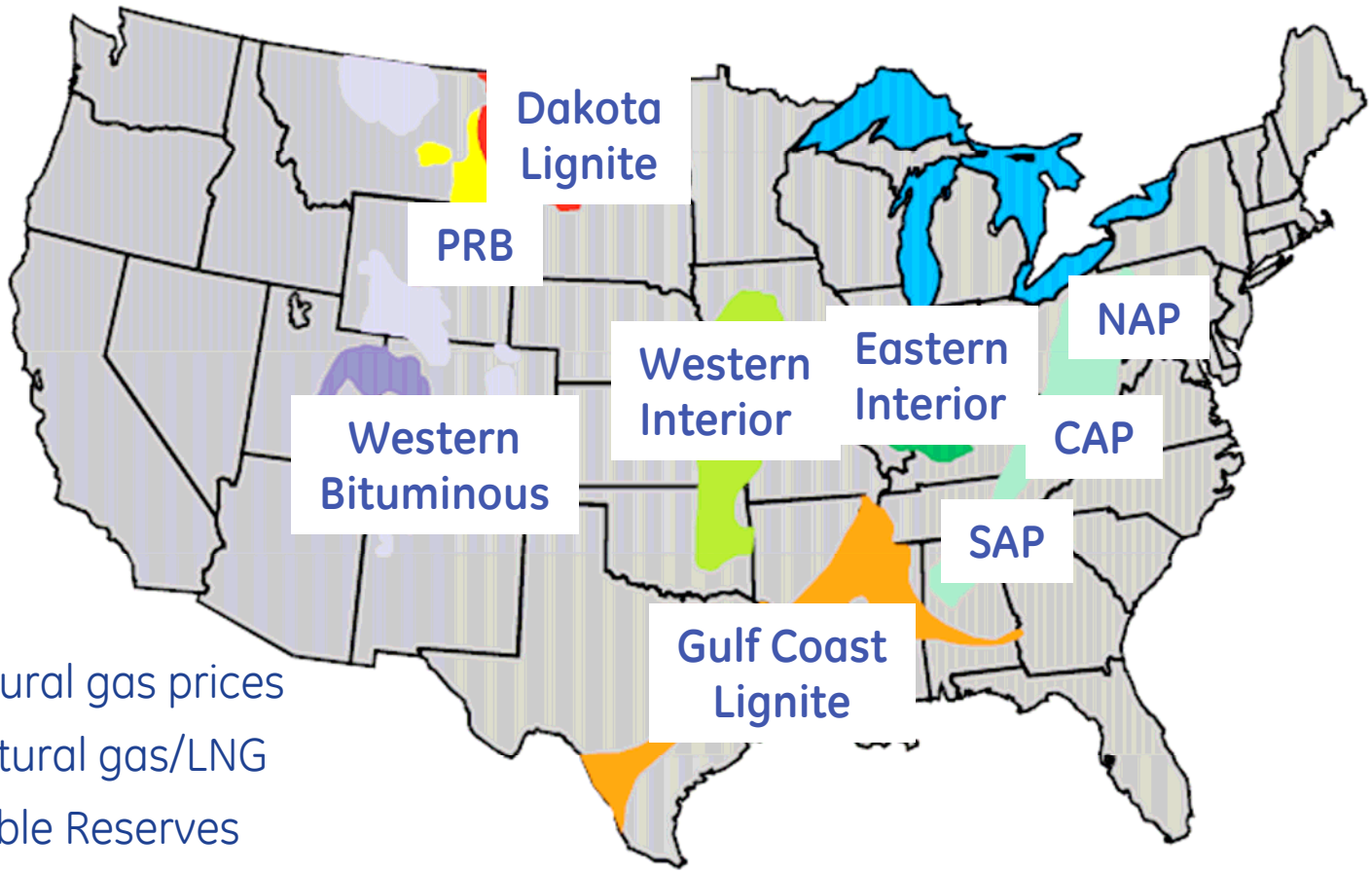
Coal based manufacturing

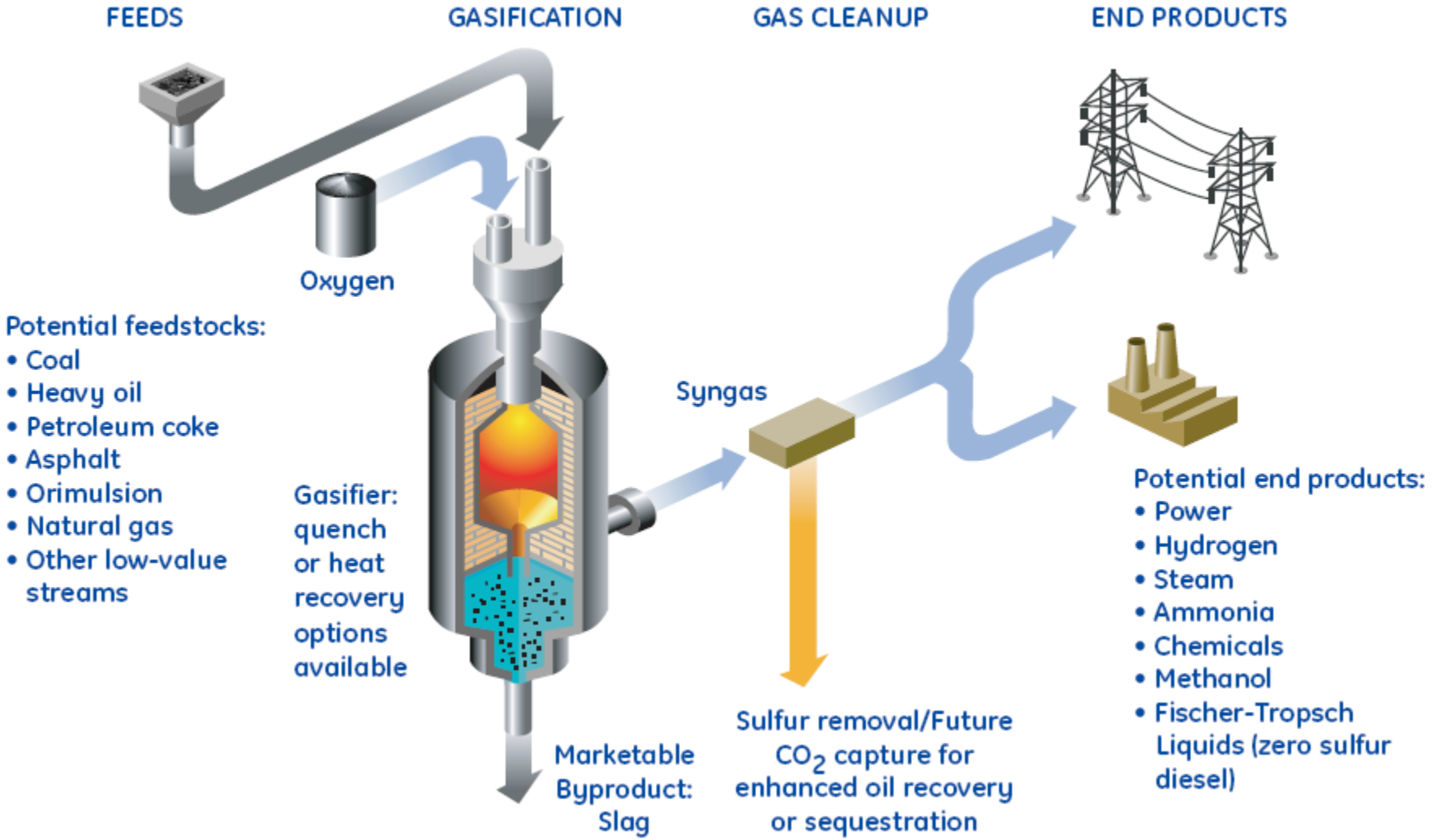


Why Coal?



- High/volatile natural gas prices
- Availability of natural gas/LNG
- Global Recoverable Reserves
  - Oil 40 yrs, NG 70 yrs, Coal 192 yrs
- Need for fuel diversity

GE's Gasification Technology



Feeds (GE's Commercial Experience)

Gas

- Natural Gas
- Refinery Off Gas

Solids

- Petroleum Coke
- Coal

Liquids

- Crude Oil
- Fuel Oil/Heavy Fuel Oil
- Naphtha
- Vacuum Residue
- Asphalt/Deasphalter Residue
- Visbreaker Tar
- Steam Cracked Tar

Gasification makes Syngas

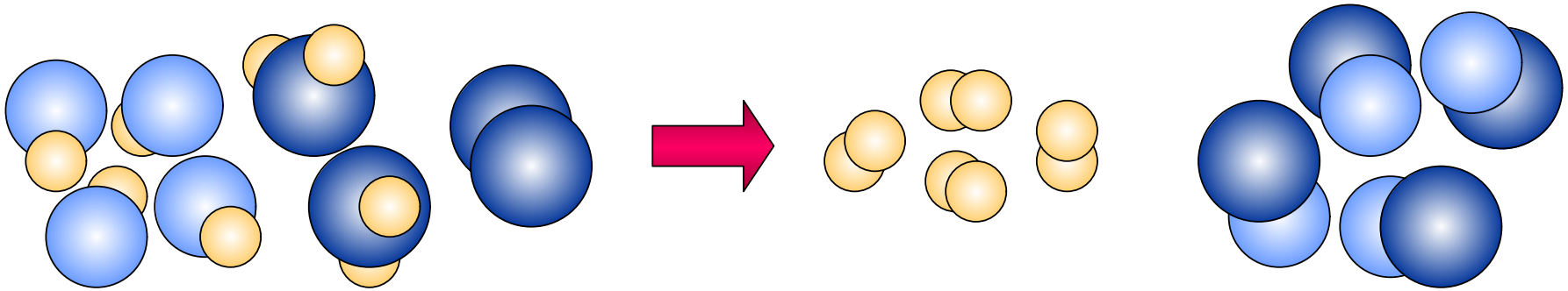
Feed

- Hydrocarbon
- Oxygen
- Water

Syngas

- Hydrogen
- Carbon Monoxide
- Energy

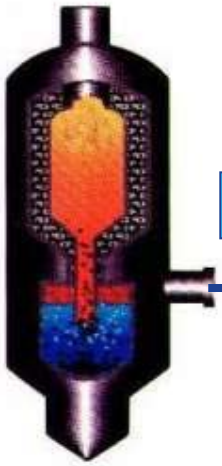
Simplified Chemistry



4 CH + 2 H_2O + O_2 → **4 H_2 + 4 CO**

(Coal) (Water) (Oxygen) (Hydrogen) (Carbon Monoxide)

Gasification – Multiple Cleaner Coal Solutions



Syngas

$(H_2 + CO)$

Gasification Technology

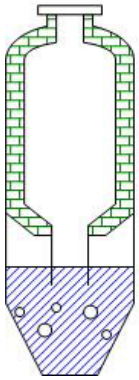
- **Power (IGCC)**
  - Greenfield
  - Polygen
  - Refueling
  - Site Repowering
- **Refineries**
  - Hydrogen
  - Steam
  - Power
- **Chemicals**
  - Methanol
    - Formaldehyde
    - MTBE
    - Acetic acid
    - Amine
    - DME
  - Ammonia
    - Urea
    - Ammonia nitrate/sulfate
  - Oxochemicals: Butanol, Ethylhexanol
- **Coal to Liquids** → Cleaner Diesel

GE's Gasification Technology

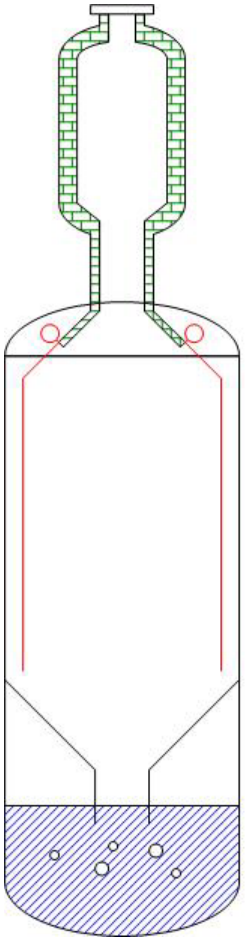
- Developed in the 1940's by Texaco
- Commercialized in the 1950's
- Entrained flow
- Oxygen blown
- Top down
- High pressure
- Short residence time

Two Configurations for Coal/Petroleum Coke

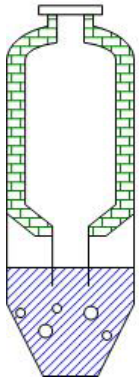
Quench



Radiant Syngas Cooler (RSC)



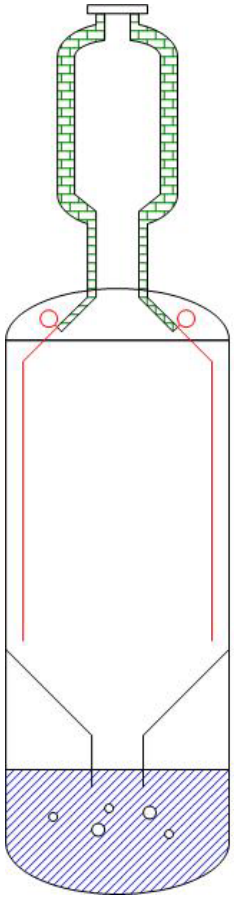
Quench Configuration



- Hot syngas immediately quenched by direct water contact
- Allows pressures up to 1,250 psi
- Lower capital cost
- Lower thermal efficiency
- Shorter construction cycles
- Syngas is warm and saturated with water which is perfect for subsequent shifting
- Proven gasifier sizes up to 900 ft^3

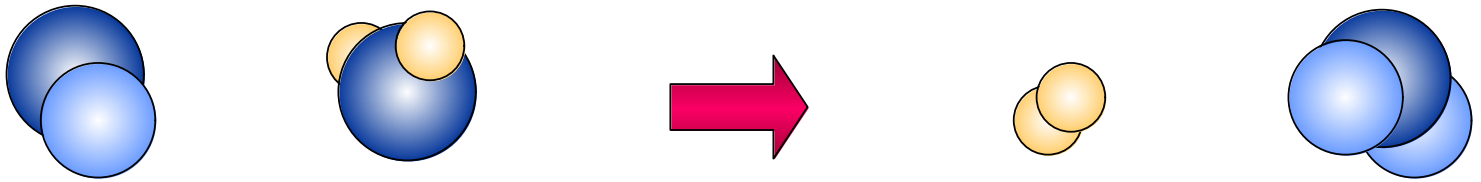
RSC Configuration

- Hot syngas first cooled by generating steam before quenching
- Limits pressures to ~650 psi
- Higher capital cost
- Higher thermal efficiency
- Lower $/kW in power applications
- High pressure steam to 2,000 psi
- Longer construction cycles
- Proven in 1,800 ft^3 size



Sour Water Gas Shift Reaction

GE's syngas has higher hydrogen/carbon monoxide ratio than other gasification technologies making it ideal for applications requiring water gas shift reactions.



CO (Carbon Monoxide in Syngas) + **H_2O** (Water from quench)

H_2 (Hydrogen) + **CO_2** (Carbon Dioxide)

Why Not Consider Gasification?

- Established technologies
- Fuel flexibility
- Addresses environmental issues

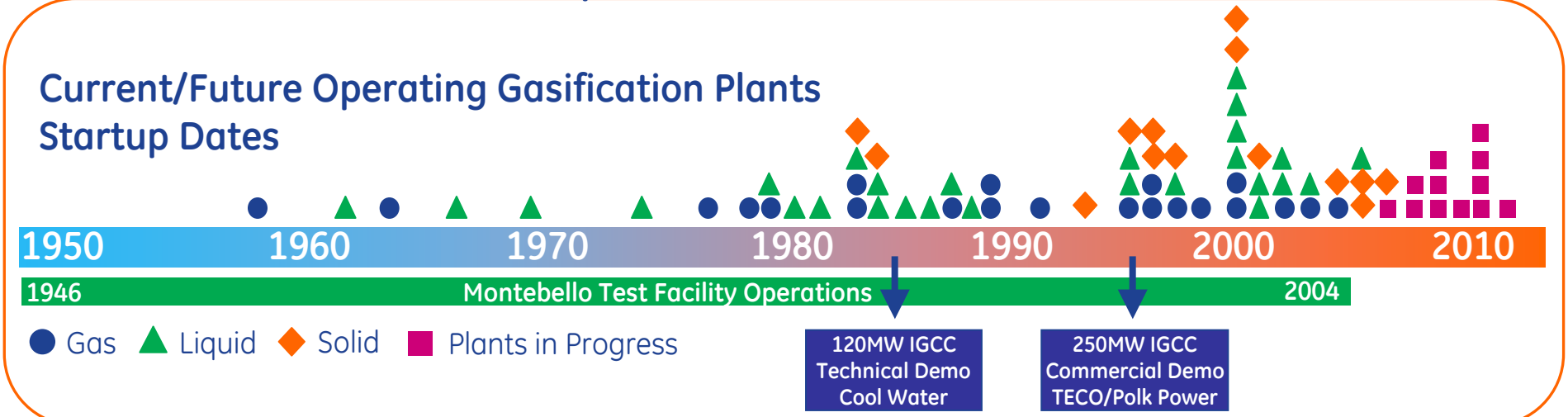
The solution is not new

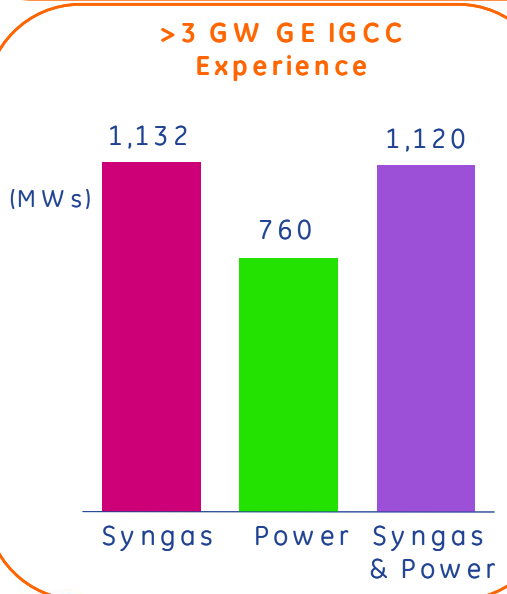
GE Energy Feed and Product Matrix

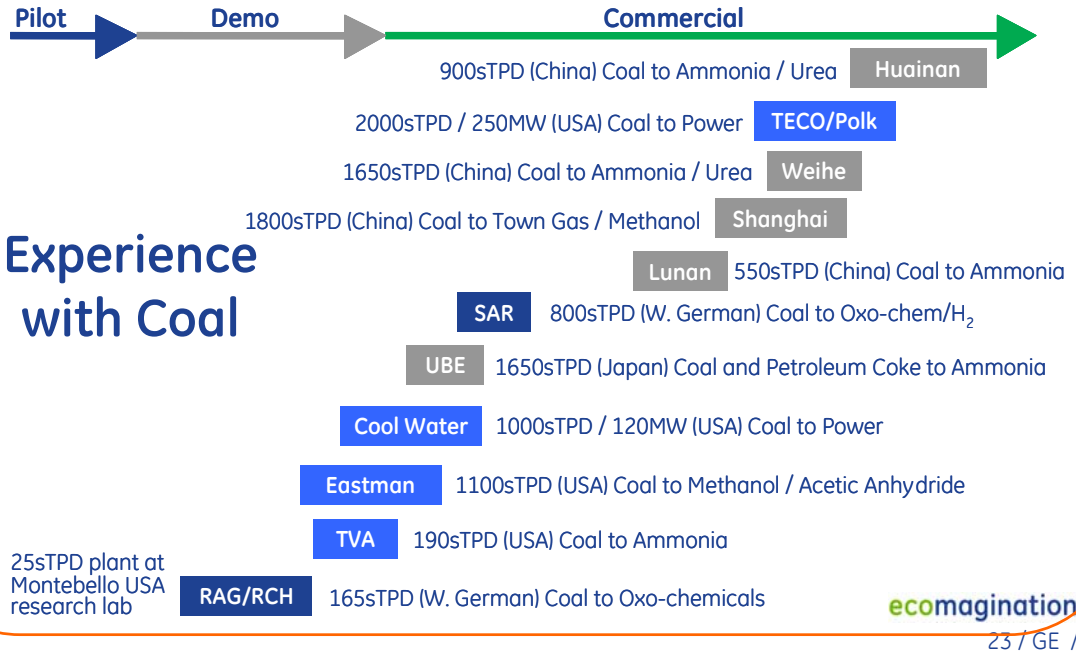
	Gas	Liquids	Solids
Fischer-Tropsch	1950	-	-
Hydrogen	1953	1956	1988
Chemicals	1957	1961	1982
Power	-	2000	1984
Quench	1953	1956	1982
Syngas Cooling	1950	1959	1984

Decades of Experience

Current/Future Operating Gasification Plants Startup Dates







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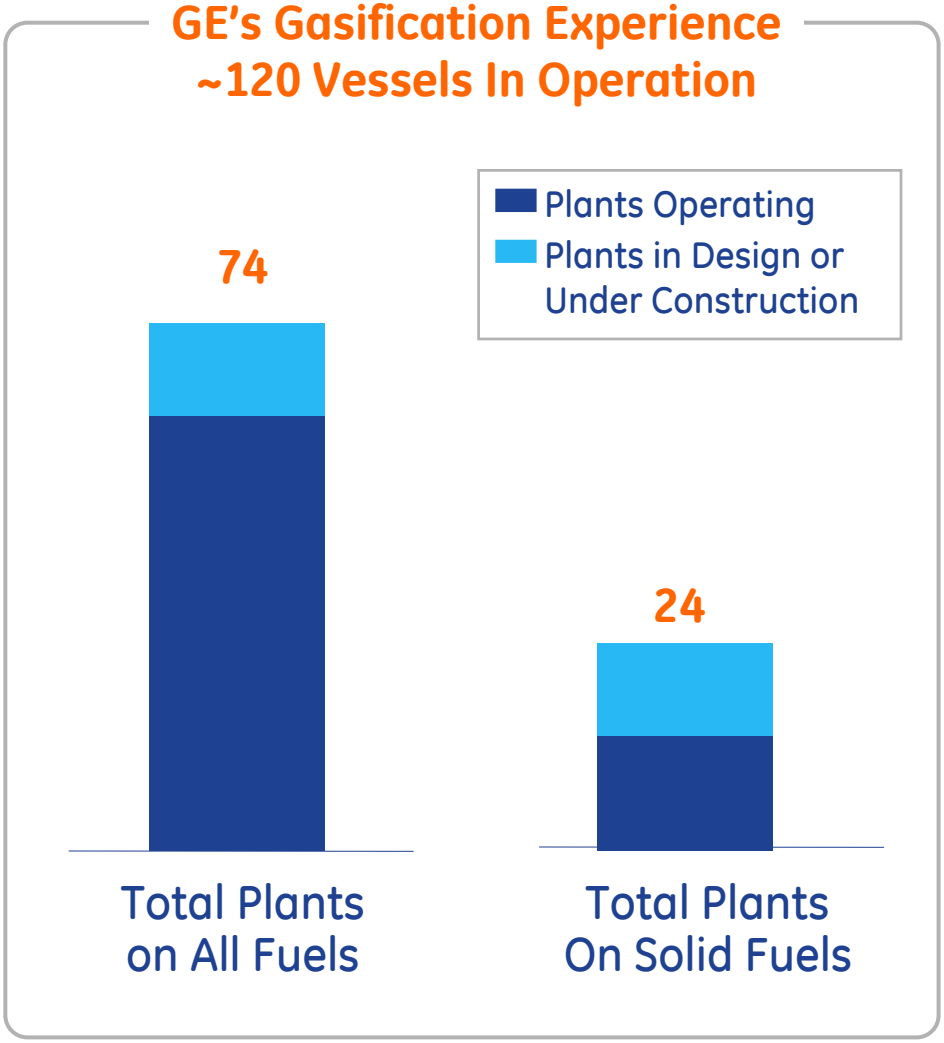
GE Gasification & IGCC Experience Leadership

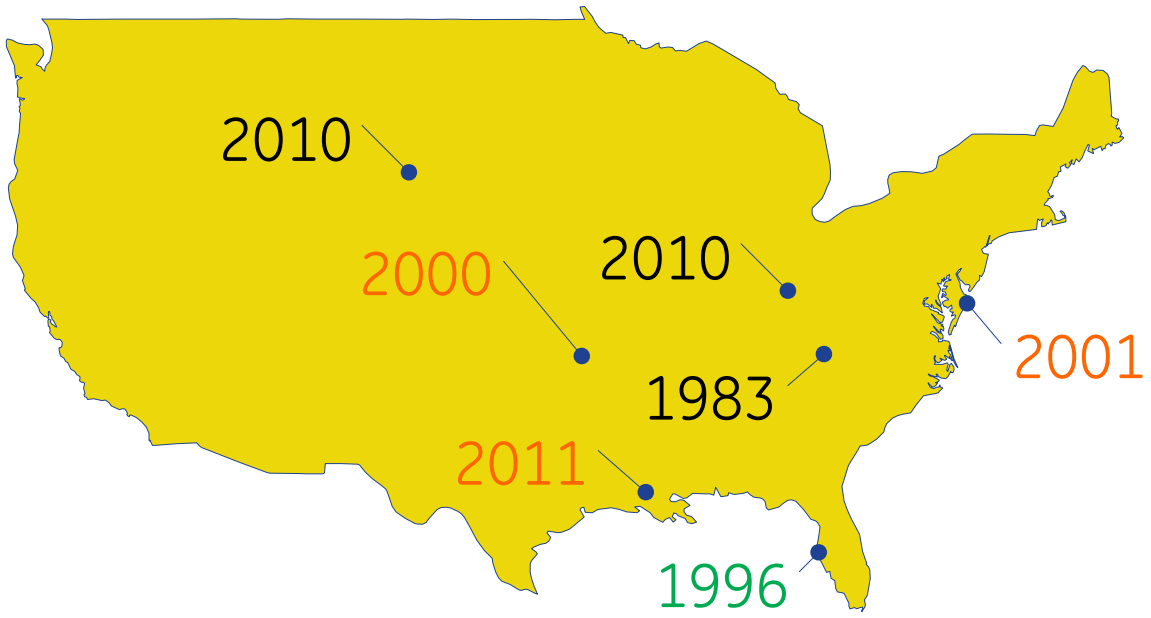
- Gasification leader since 1948 with 62 facilities operating worldwide
- First coal gasification plant in 1978
- 21 gas turbines operating on synthesis gas, 900,000 operating hours
- IGCC leader: >3 GW with GE technologies
- >6 centuries team gasification experience



GE's Solids Gasification Technology

- Developed in the 1970's
- Commercialized in the 1980's
- Coal/Water slurry
- Pump fed
- Fluxant for petroleum coke
- Lockhopper for coarse slag removal
- Syngas train identical to heavy oil gasification

GE's Gasification Coal and Petroleum Coke Plants - USA

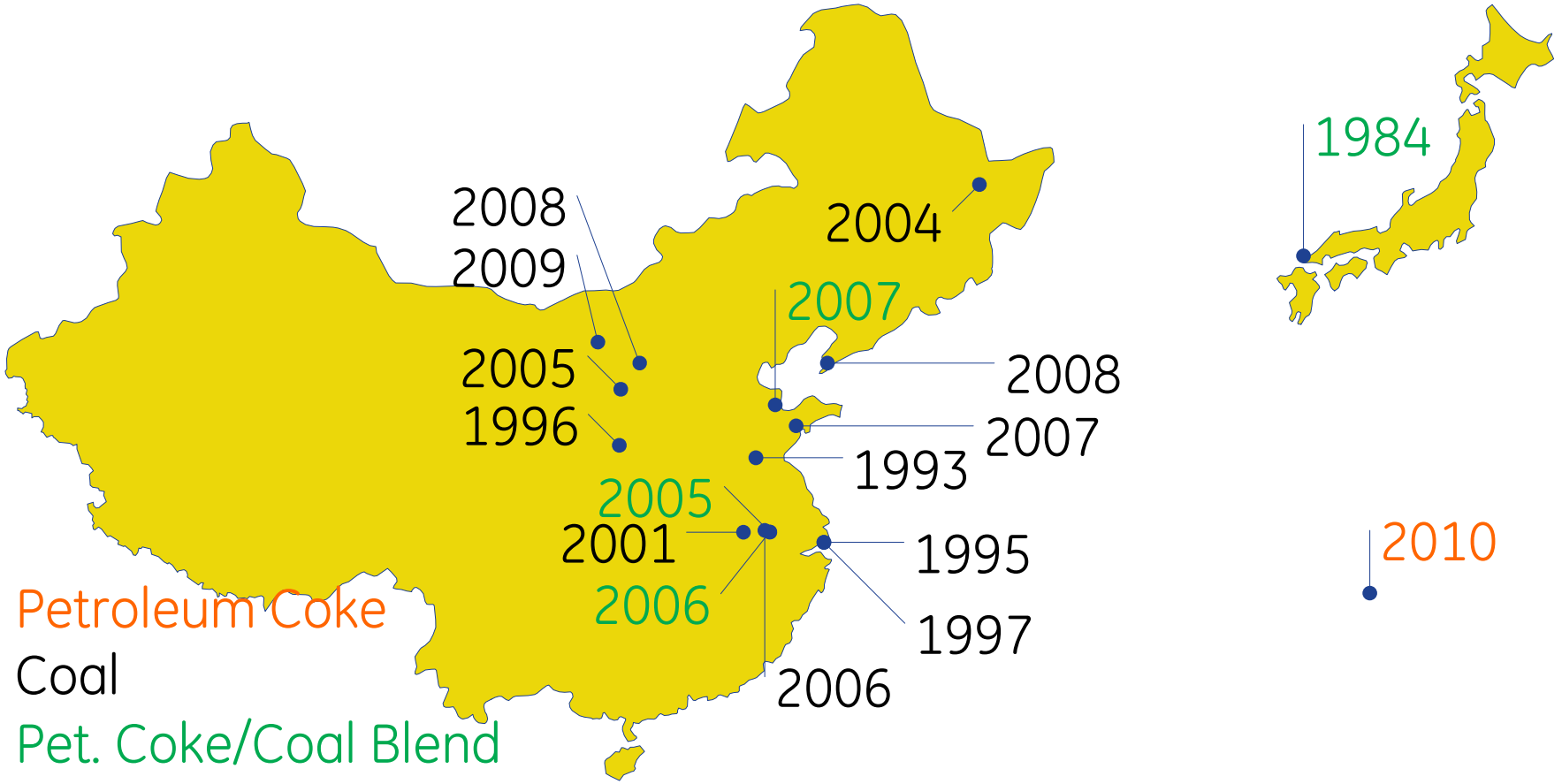


Petroleum Coke

Coal

Pet. Coke/Coal Blend

GE's Gasification Coal and Petroleum Coke Plants – Rest of World



GE Gasification Technology Ammonia Experience

Plants

History

54 built

Today

16 commercial operation

2 engineering/construction

Gasifier Vessels

History

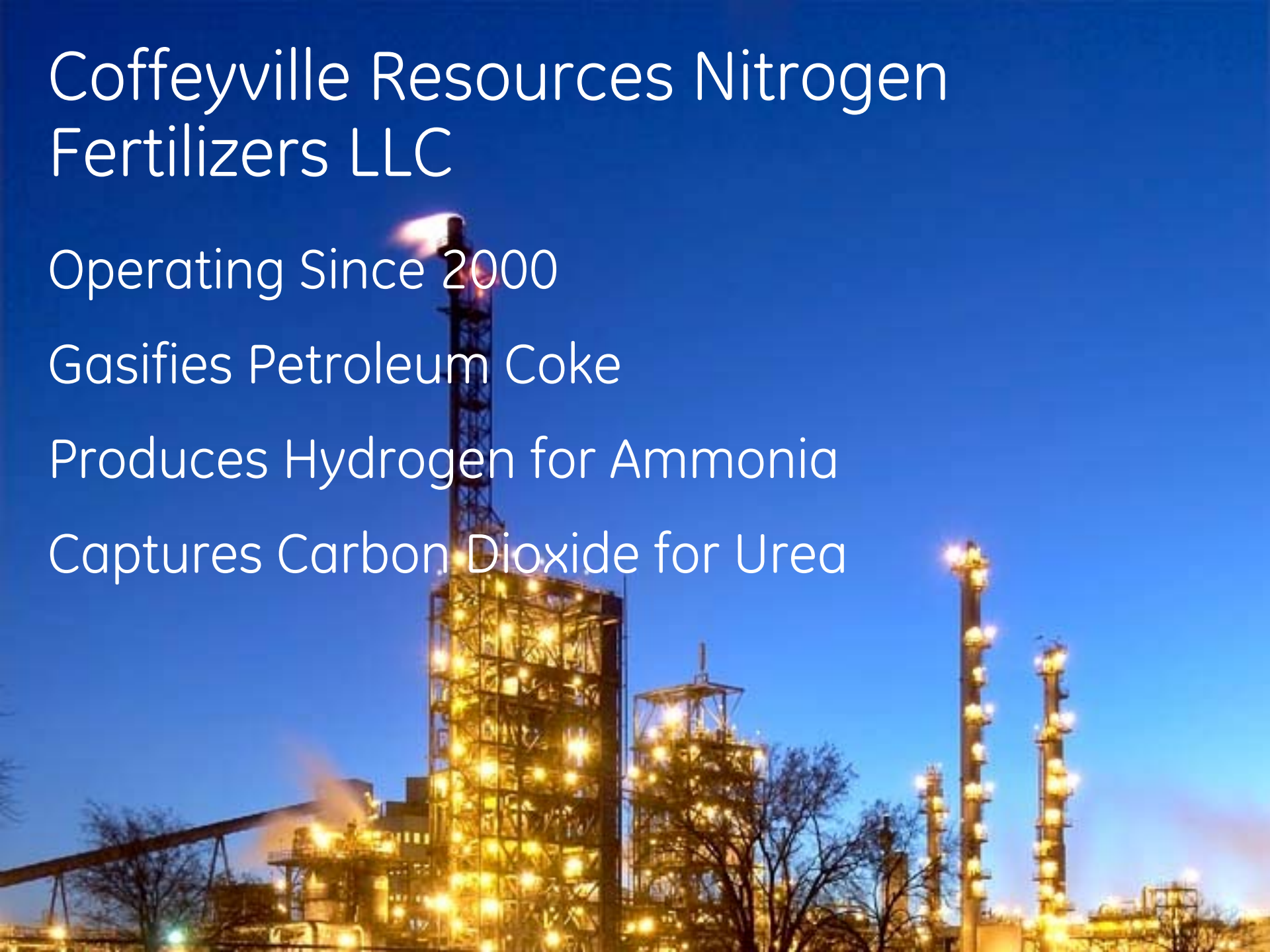
138 built

Today

36 commercial operation

5 engineering/construction

Coffeyville Resources Nitrogen Fertilizers LLC



Operating Since 2000

Gasifies Petroleum Coke

Produces Hydrogen for Ammonia

Captures Carbon Dioxide for Urea

Our commitment to gasification

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GE's Corporate Commitment to Gasification

- GE's 2005/6 Annual Reports
- ecomagination[SM]
- Significant media presence
- Jeff Immelt global city tours
- National TV commercial

The New York Times

npr

FORTUNE

U.S.News & WORLD REPORT

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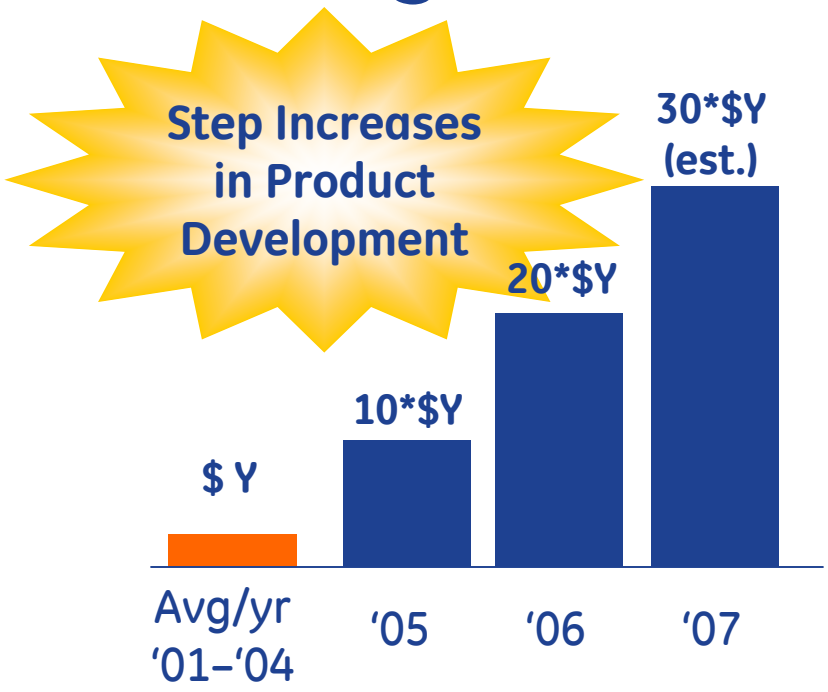
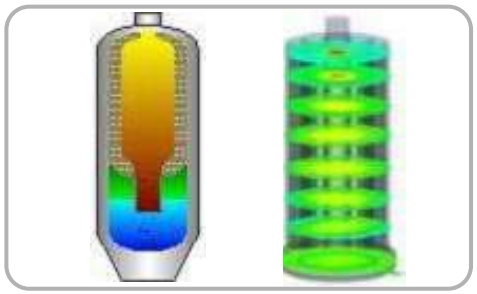
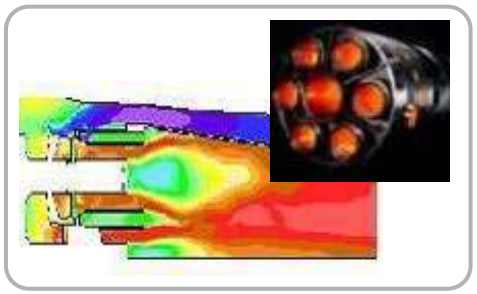
Investing for Success





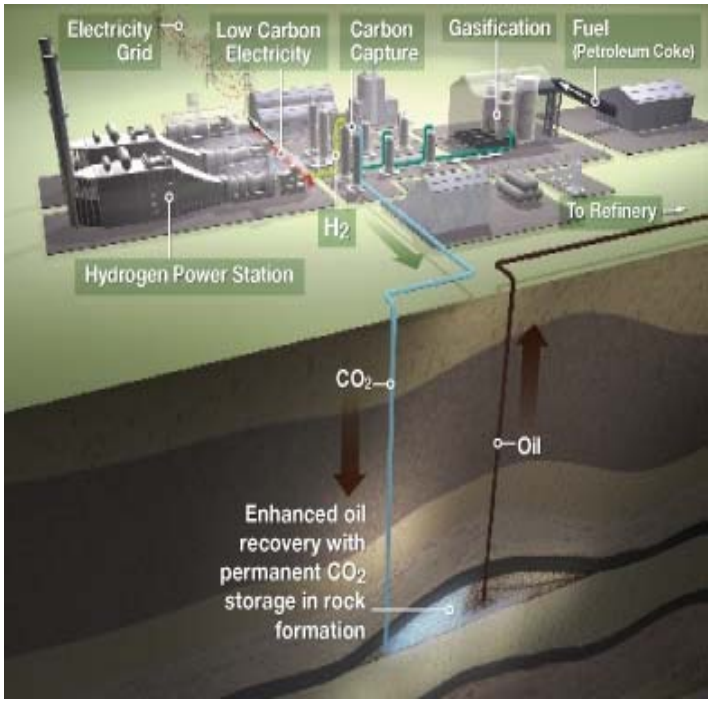
Gasification Technology

Power Generation Technology



Advanced Technologies

GE and BP Signed HOA To Accelerate Use of Low Carbon Power Generation



Carson Hydrogen Power Project

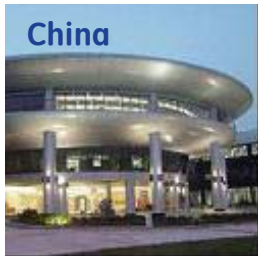
Hydrogen Power Projects

- Utilize advantaged fossil fuels (coal, petcoke)
- Produce high H2 fuel gas to burn in gas turbines
- Capture CO_2 (~90%)
- Utilize CO_2 for Enhanced Oil Recovery (EOR)
- Future storage in Saline Aquifers

Value Through Collaboration

- Combine technology company with an operations company
- Leaders in gasification, power and CCS
- 10 – 15 projects over next decade
- Carson, CA is first gasification project

Leveraging The "Bigger GE"



Global Technology Team

Houston, TX – Process & Product Design & IGCC Experience

Niskayuna, NY – Materials, Design, System Analysis

Shanghai, China – Materials, Chemistry, Instrumentation

Schenectady, NY/ Salem, VA – Controls, Simulation

Bangalore, India – Computational, Experimental

Greenville, SC – Design, Adv Materials & Manufacturing

Irvine, CA– Gasification Modeling & Experimental Experts

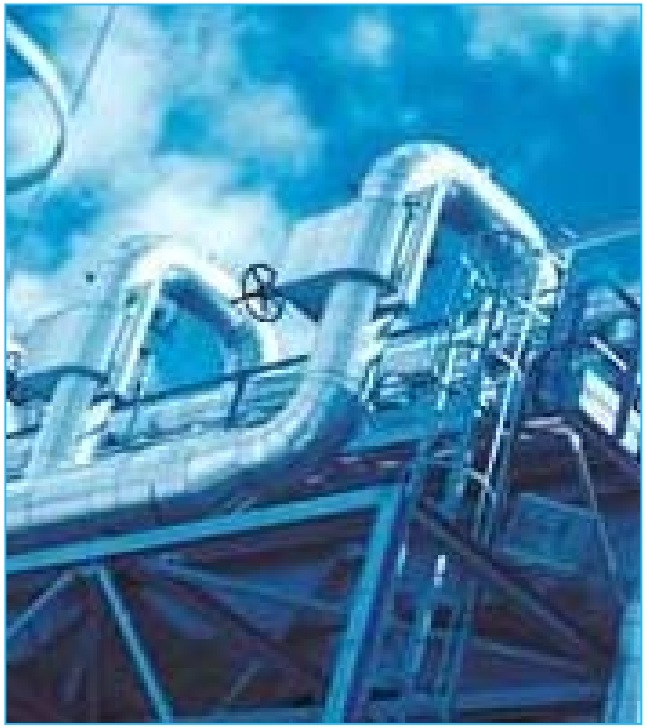
300 Engineers & Scientists

Business Model

Screening	Feasibility	FEED	EPC	Operations
Screening Study (Optional)	Paid Feasibility Study (Optional)	Process Design Package	Technical Services	Startup Support
Block Level Detail	Major Equipment Level Detail	Preliminary Engineering Detail	Critical Equipment Supply	Technical Services
±30% Factored Cost Estimate	±20% Cost Estimate (by Owners Engineer)	±10% Detailed Cost Estimate (by EPC)		Users Conferences

Why Gasification Makes Sense

- Proven technology - commercial operation today
- Fuel flexibility – lower cost fuels than natural gas
- Energy security – domestic coal supplies
- Public acceptance – competitive cleaner coal alternative



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