Producing Liquid Fuels from Coal

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Presentation Content

- What is CTL: History and Current Status
- Why CTL and what are the barriers
- Overview of technology
- General ROM economics
- CTL products
- Worldwide CTL Potential
- GHG issues
- Benefits and next steps

What is CTL?

- Direct Coal Liquefaction
  - Bergius 1900
  - Many demo and pilot projects in 70's and 80's
  - Shenhua Project in China (HTI/Headwaters/Axens)
- Indirect Liquefaction
  - Fischer-Tropsch 1920's
  - Sasol 1 1950's
  - Sasols 2 & 3 1980's
  - Feasibility studies in China

GTL & CTL: Current Status

- Gas to Liquids (GTL) is commercial
  - Approximately $25,000/bbl construction cost
  - Natural gas at $0.50-$1.0/ MM Btus
    - RSP ~ $20-25/BBL
  - Exxon-Mobil, Shell and Sasol plants planned in Qatar and Nigeria
- Coal to Liquids (CTL) technology
  - Sasol 150,000 BPD FT plants in South Africa (last plant built in 1980)
    - China Shenhua Sasol feasibility studies for 2 large FT plants
  - China Shenhua direct liquefaction plant
  - No large scale integrated plants built with advanced technology

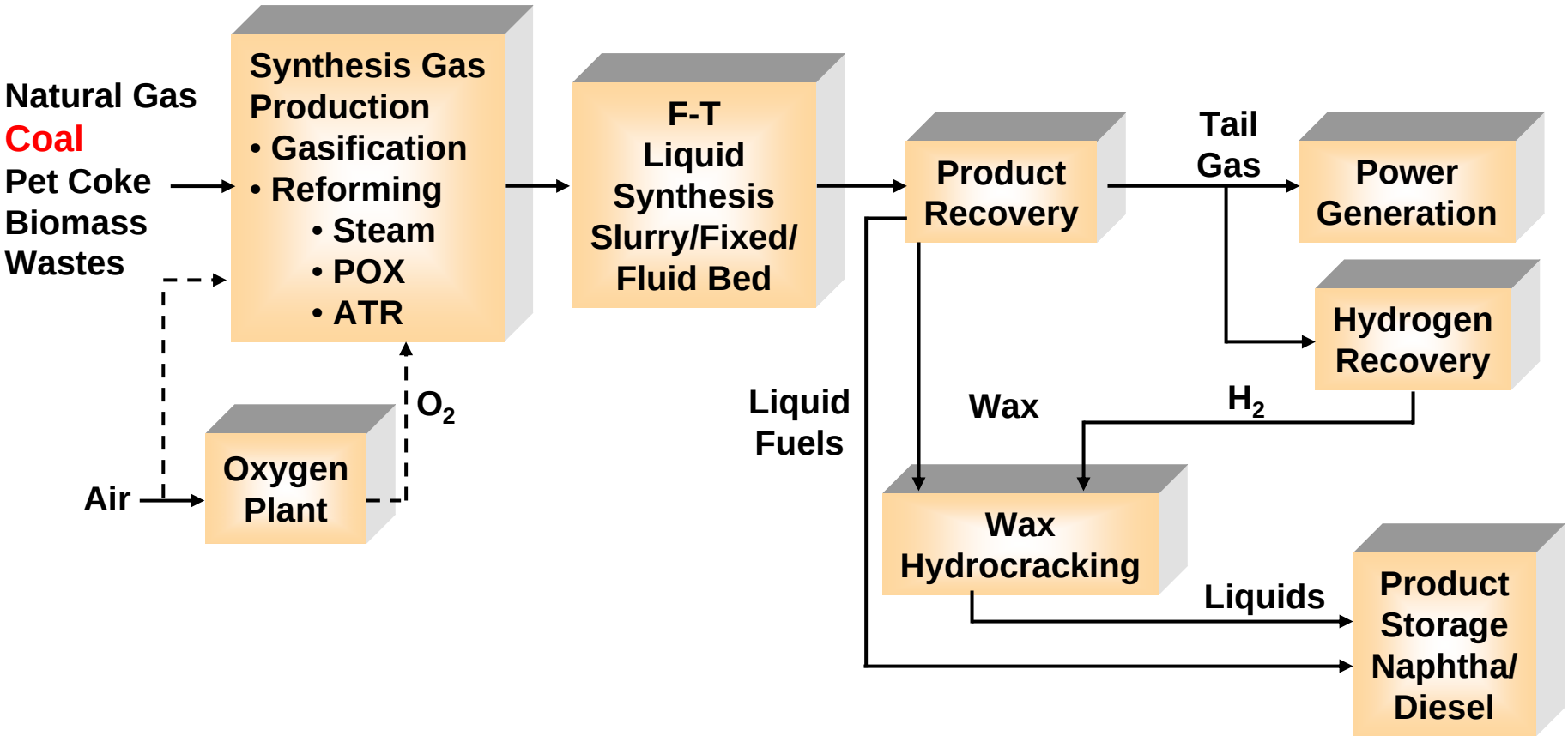
Why CTL?

- **Energy Security:**
  - **Large domestic coal resource (250 years supply) could increase domestic transportation fuel production and reduce oil imports**
- **Advances have been made in Gasification through IGCC & chemicals deployment**
- **Advances made in FT Synthesis step through GTL deployment**
- **Fuels produced are like GTL liquids and are compatible with existing liquid fuels infrastructure**
- **Fuels are essentially refined products and no additional refining capacity is necessary**

Barriers to CTL

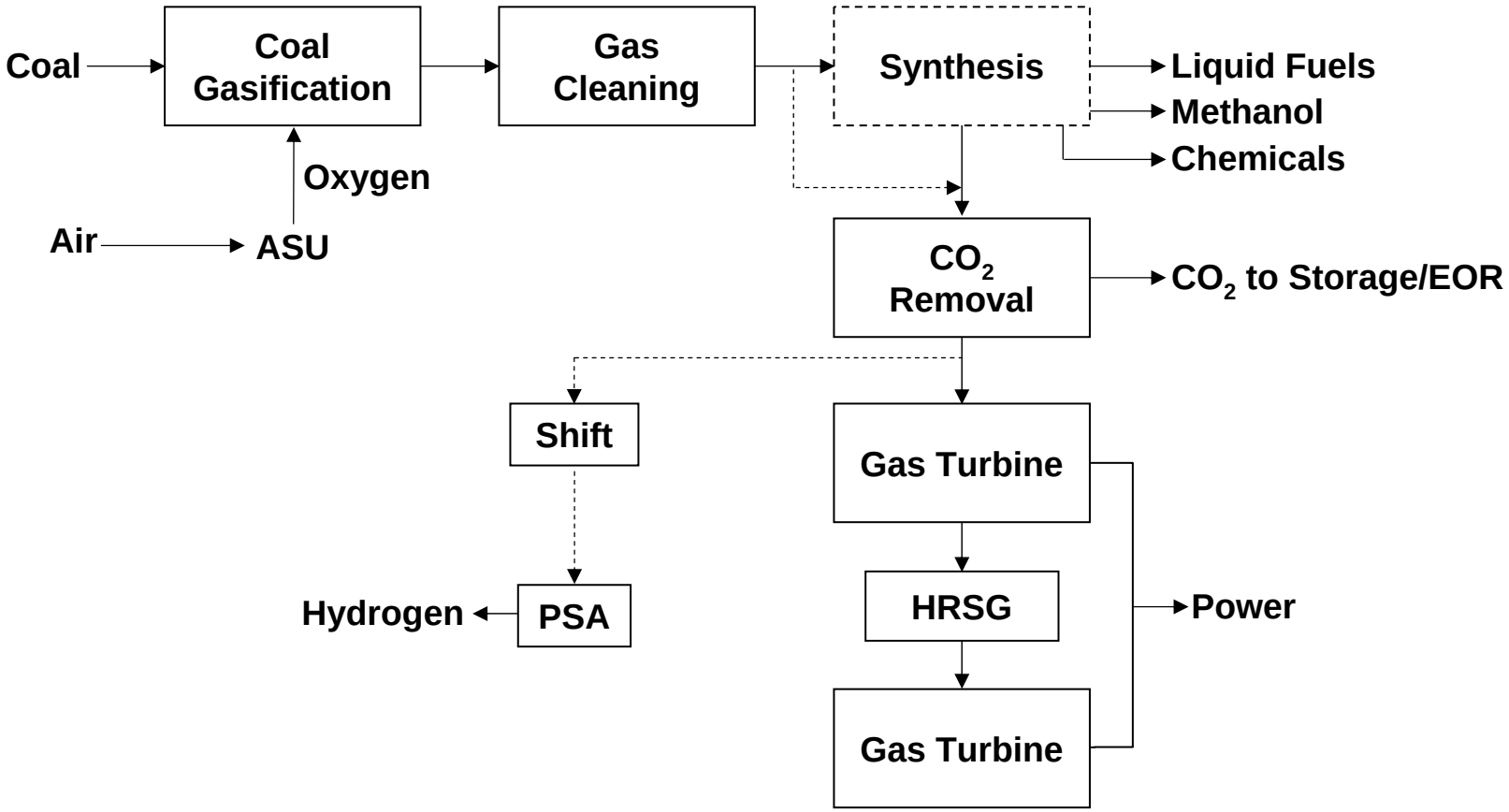
- Technical:
  - Integrated operations of advanced CTL technologies have never been demonstrated
- Economic:
  - Uncertainties about future WOP
  - High Capital and operations costs
  - Investment risks
- Environmental:
  - CO_2 and criteria pollutants emissions
  - Expansion of coal production
- Commercial Deployment:
  - Competition for critical process equipment and engineering skills
    - Who would take the lead in commercial deployment? Part power part liquid fuels
- Social:
  - NIMBY & Public resistance to coal use

Fischer-Tropsch Technology: Overview



Polygeneration Concept

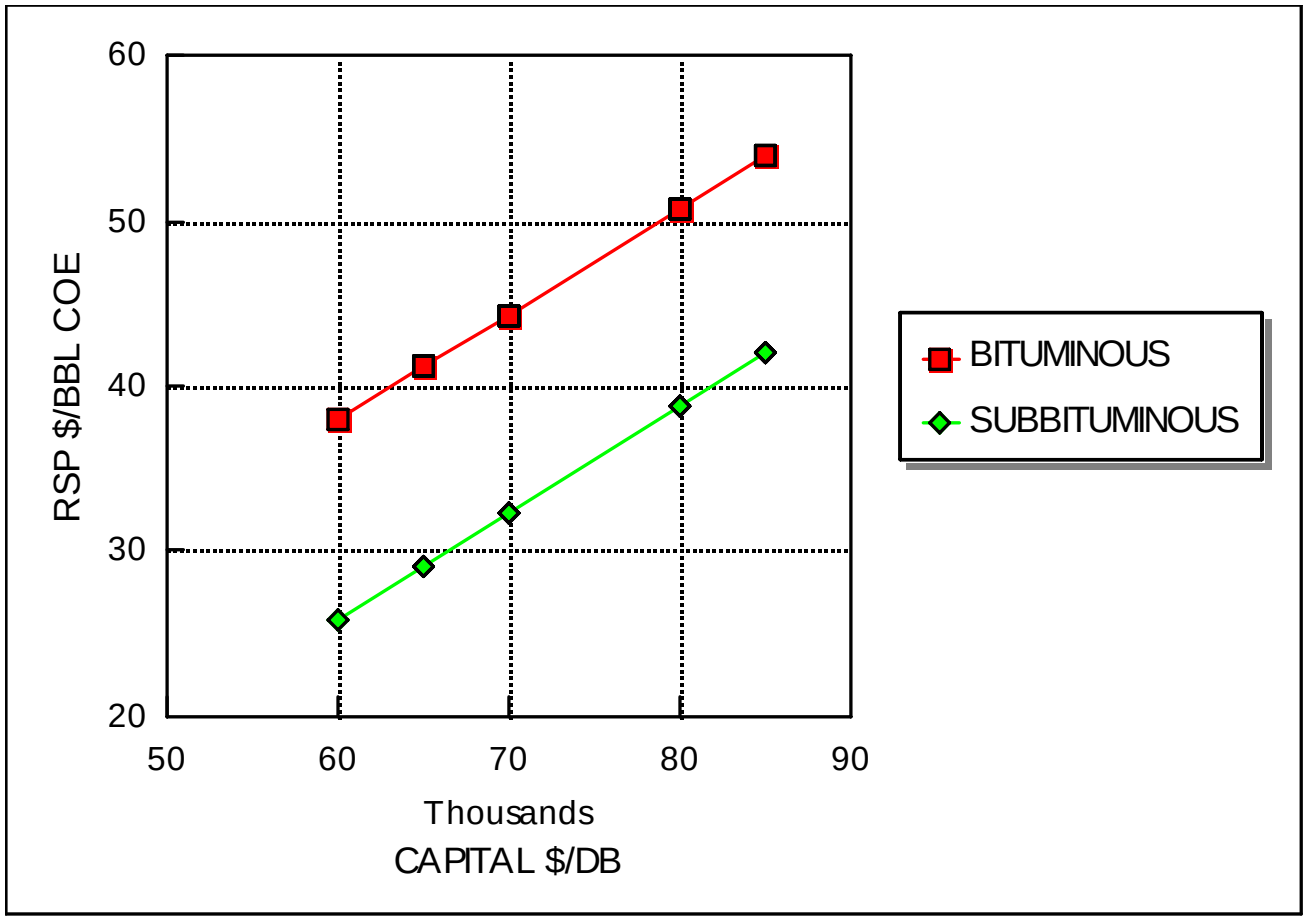
CTL plant configured to produce electric power and liquid fuels can readily be modified to a FutureGen-type plant producing hydrogen.



Generic ROM CTL Economics: Sub-bituminous Coal

Capital	75,000	$/DB
Size	120,000	BPD
CRF	0.12	
Capacity	330	DPA
Coal Cost	5	$/T
Efficiency	0.49	
Coal BTU	8,516	BTU/#
FT MMBTU/B	5.264	
BFT/Ton	1.59	
Plant Capital		$9,000/MM
Bituminous		
Capital	$1,080	
O&M	450	
Coal	125	
Annual Review Required	$1,655	
NAP Credit	$238	
Power Credit	$3.80	
	$1,413	
RSP Diesel	$44.62	
Premium	$9.10	
RSP (COE)	$35.52	
		TPA
Annual Coal Input	$24,978,000	

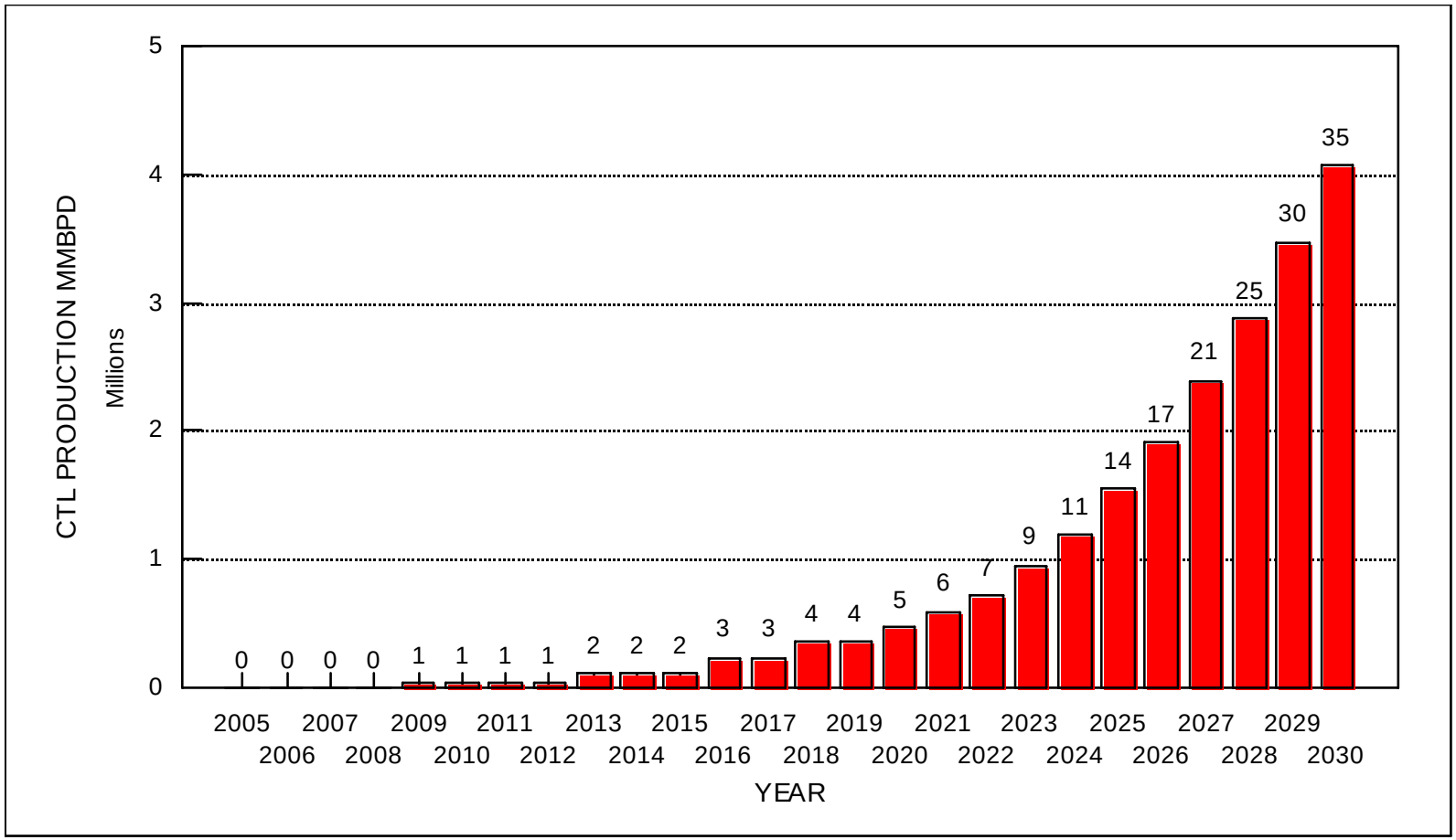
General Economics



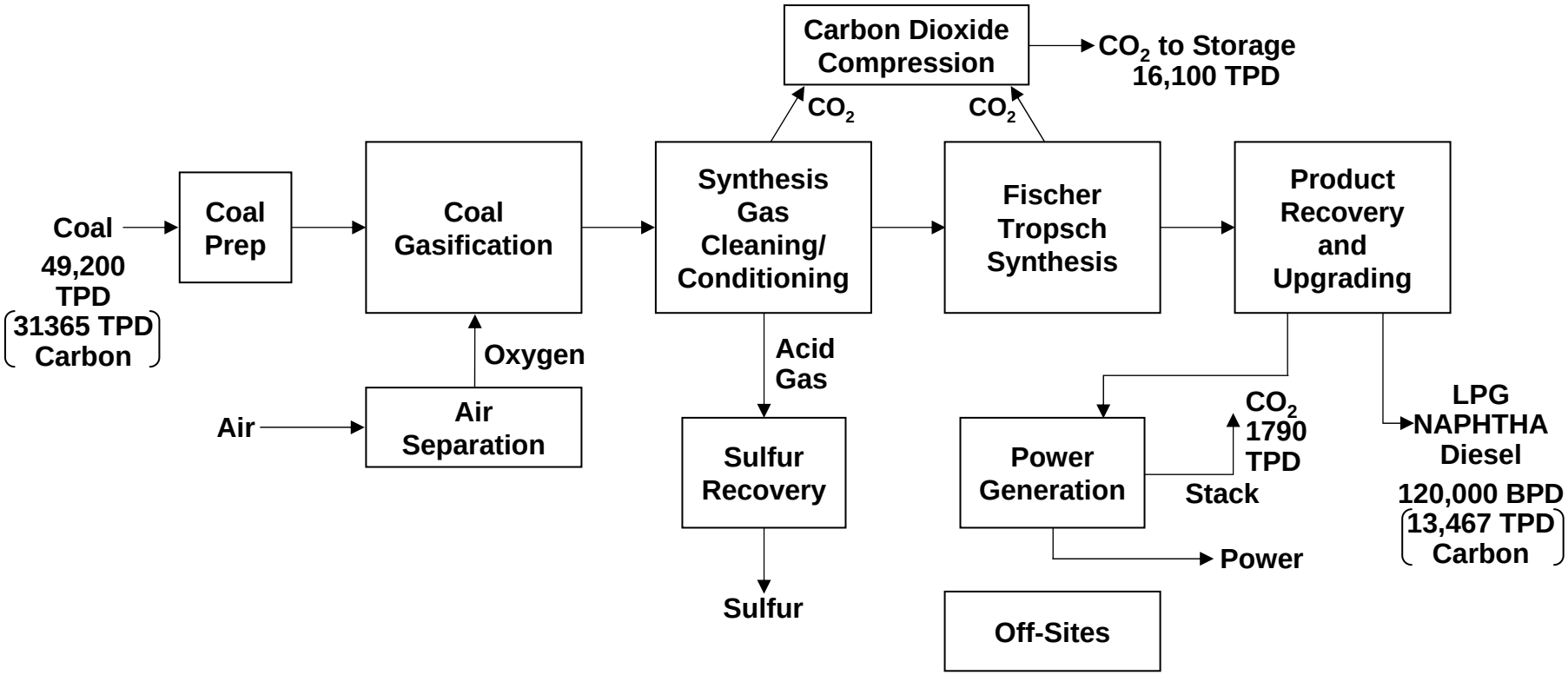
FT Products

- Ultra clean zero sulfur liquid fuels
  - Fungible with current infrastructure
  - Diesel fraction has high cetane number
  - Naphtha low octane but excellent cracker feed & HCCI fuel
  - Waxes can be hydroisomerized to high quality lubes
  - Clean burning compared to petroleum fuels

Worldwide CTL Potential?



What Would a Large CTL Plant Look Like?



GHG Issues: Approximate CO2 Emissions

- Petroleum
  - 248# carbon per barrel = 6#/gal = 0.81#CO2/mile
- CTL (90% capture)
  - 1 Bbl FT = 233# C = 543# coal C
    C not in product = 310#
    C emitted = 31#
    Total C emitted = 31+233=264#=6.28#/gal
    =0.85#CO2/mile

Next Steps and What Else is Needed

Commercial Scale Production

- The government could provide: (1) floor price guarantees for the products to ensure an acceptable rate of return for the project or (2) loan guarantees to allow private financing to be obtained under reasonable terms or (3) tax incentives such as investment tax credits, fuel excise tax exemptions or accelerated depreciation could be used.
- Concurrent with these activities the government could sponsor R&D to improve the technology performance and reduce costs.

Potential Benefits to U.S. Economy

- Establish domestic industry (jobs)
- Enhanced energy security by reducing oil imports
- Reduce balance of payments
- *Clean* domestic liquid fuel production (environment)
- Demonstrate CO2 recovery
- Electric power by product

Conclusions

- It will be necessary in the future to develop alternatives to conventional petroleum when world demand outstrips supply and GTL and CTL could be used as petroleum alternatives
- GTL and CTL produce ultra clean liquid fuels and would use existing transportation infrastructure.
- Cost of production of clean liquid fuels from coal is estimated to be in the range of $30-50/BBL COE depending on coal type and actual Capex.
- Continued high world oil prices above $50/BBL would make CTL an economically viable option in the U.S and worldwide.
- Countries with large coal reserves and little domestic petroleum are candidates for using CTL to provide fuels to supplement conventional petroleum (China, India, US, Australia)
- Continued R&D and GTL & CTL deployment will improve the economics nevertheless government incentives will probably be necessary for FOAK CTL plants to reduce risks for investors and thus accelerate commercial deployment.

Thought for the Future