



# Summary of Activities

## Coal-to-SNG and Coal-to-Chemicals

August 2009

Dani Petrucci

US Department of Energy  
Office of Sequestration, Hydrogen, and Clean Coal Fuels



# Coal Conversion Processes

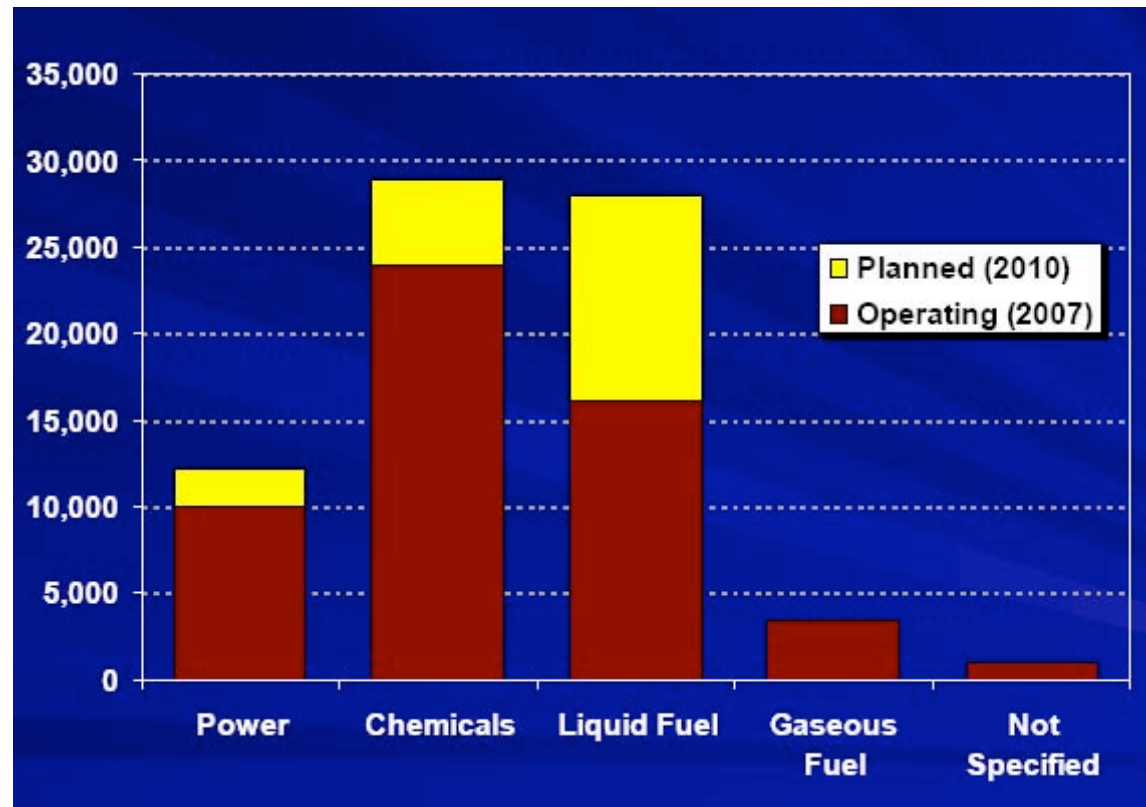
- Carbonation and Pyrolysis
  - Low severity (mild gasification)
  - High temperature
- Direct Liquefaction
  - One-stage reactor technology
  - Two-stage reactor technology
  - Co-processing
  - Hybrid
- Gasification/Synthesis Gas Production
  - Indirect Liquefaction
    - Gas reactors
    - Slurry reactors
  - Methanation/substitute natural gas (SNG)
  - Hydrogen
  - Chemicals



# Gasification

- Gasification is a partial oxidation reaction where raw material containing carbon is reacted with steam and air or oxygen under high temperature and high pressure to produce a syngas composed primarily of hydrogen ( $H_2$ ) and carbon monoxide (CO).
- Gasification can produce:
  - Electric power
  - Substitute natural gas (SNG)
  - Hydrogen
  - Steam
  - Transportation fuels
  - Chemicals and fertilizers

# World Gasification Capacity by Primary Product (MW Thermal Equivalent)



Source: Gasification Technologies Council

According to the Gasification Technologies Council, “world gasification capacity is projected to grow by more than 70% by 2015.”



# Benefits of Gasification

## Environmental

- Lower amounts of criteria air pollutants emitted
- Uses less water
- Generates less waste than most traditional energy technologies

## Economic

- Wide fuel flexibility
- Lower operating costs due to higher efficiencies and a decreased need for back-end pollution control equipment
- Co-production (power generation + hydrogen production, SNG production, CO<sub>2</sub> production)
- Byproducts, such as sulfur and slag, can be sold for profit

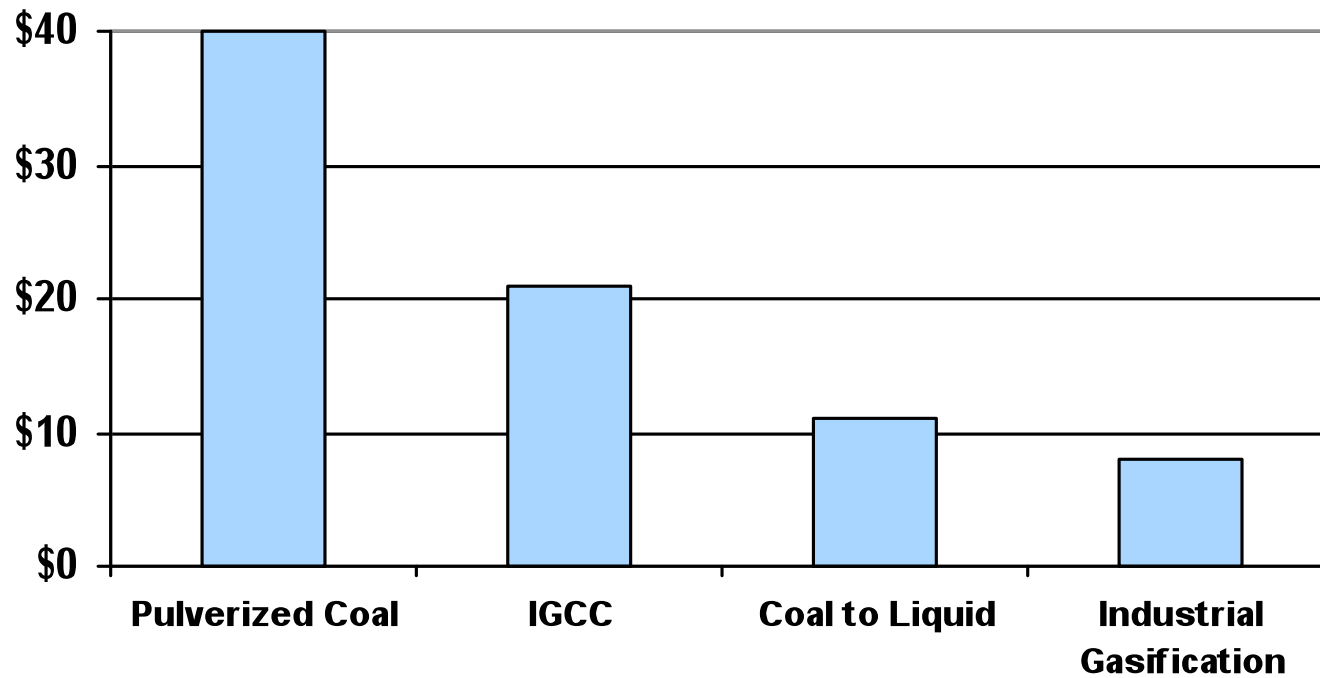


# Gasification and CO<sub>2</sub> Capture

- The carbon dioxide produced can be captured using commercially proven technologies
- If oxygen is injected into the gasifier instead of air, the carbon dioxide is emitted as a concentrated gas stream in the syngas at high pressure
- In this form, it can be captured more easily and more cost-effectively
- The CO<sub>2</sub> can be sequestered or used for:
  - Beneficial reuse
  - Enhanced oil recovery (EOR)
  - Enhanced gas recovery (EGR)

# Carbon Capture and Compression Costs

**Carbon Capture and Compression Costs  
(Dollars Per Metric Ton)**





- Substitute Natural Gas (SNG) is produced from syngas (created by coal gasification) through the process of methanation
- It is nearly identical to conventional natural gas in composition
- Can be shipped in the U.S. natural gas pipeline system
- Used to generate electricity, to heat homes and businesses, or in the automotive industry
- By creating SNG from coal, it is possible to provide a cheap domestic source of natural gas that could be used to meet the increased demand



# Great Plains Synfuels Plant, North Dakota

- The only commercial-scale coal-to-SNG plant in the United States
- Located in Beulah, North Dakota
- Owned by the Dakota Gasification Company
- Began operating in 1984
- Uses 6 million tons of coal per year
- Sasol-Lurgi Gasification Process
- Average daily SNG production is 145 million standard cubic feet (SCF)
- Yearly production is approximately 54 billion SCF
- Approximately half of the total amount of carbon dioxide produced by the plant is captured and pipelined to the Weyburn oilfield in Canada for EOR



# Domestic Coal-to-SNG Projects

#	Plant Owner	Project Name	Location	Feedstock	Status	SNG Capacity	Cost
1	Secure Energy Systems, Siemens SFG	Secure Energy Systems SNG	Decatur, IL	IL Bituminous Coal	Planning – Development; Commissioning 2010	20 Billion SCF*/year	-
2	Peabody Energy, Conoco-Phillips	Kentucky NewGas Energy Center	Central City, KY	Coal	Planning - Development	60-70 Billion SCF/year	-
3	Dakota Gasification Company	Great Plains Synfuels Plant	Beulah, ND	Lignite	Operating since 1984	54 Billion SCF/year	\$2.1 Billion
4	C Change Investments, NC12	-	LA	Coal/pet coke	First phase opening in late 2010	300 Billion SCF/year	\$3.5 Billion
5	Power Holdings, LLC	The Southern Illinois Coal-to-Synthetic Natural Gas Facility	Jefferson County, IL	IL Coal	Planning	65 Billion SCF/year	\$1 Billion
6	GreatPoint Energy	Mayflower Clean Energy Center	Somerset, MA	Various	Feedstock Testing Facility	-	\$37 Million



# Domestic Coal-to-SNG Projects (continued)

#	Plant Owner	Project Name	Location	Feedstock	Status	SNG Capacity	Cost
7	TransGas Development Systems	Scriba Coal Gasification Plant	Scriba, NY	Coal	Fully operational in late 2010, currently on hold (permitting issues/public opposition)	-	\$2 Billion
8	Great Northern Power Development/ Allied Syngas	South Heart Gasification Project	South Heart, ND	Lignite	Construction to begin in late 2009, early 2010	100 Million SCF/day	\$1.4 Billion
9	Cash Creek Generation LLC**	-	Henderson County, KY	Coal	Construction to be completed in 2012	770 MW Coal-Fired IGCC*** Power Plant	-
10	Indiana Gasification LLC	-	Spencer County, IN	Coal	Planning, Expected to be operational by 2011	-	\$2 Billion
11	Christian County Generation, LLC	Taylorville Energy Center (TEC)	Taylorville, IL	Bituminous Coal	Development, now in FEED, construction beginning in 2010, operational in 2014	500 MW Coal-fired IGCC and SNG production	\$3.5 Billion



# International Coal-to-SNG Projects

#	Plant Owner	Project Name	Location	Feedstock	Status	SNG Capacity	Cost
1	Shanghai Pacific Chemical (Group) Co., Ltd.	Wujing Gas Plant No. 2	Wujing, Shanghai, China	Bituminous Coal	Operational since 1994	Syngas for gases	-
2	Shell	Inner Mongolia Chemical Plant	China	Coal	Planning – Development; Commissioning 2010	20 Billion SCF/year	-
3	Shenhua Group, LLC	Shenhua SNG Project	Yijinhuoluo County, Ordos City, Inner Mongolia, China	Coal	Implementation, Operational in 2012	70 Billion SCF/year	\$2 Billion
4	China National Offshore Oil Corp (CNOOC) and Datong Coal Mine Group	Datang Project	Keshiketeng County, Inner Mongolia, China	Coal	Implementation, no date given for completion	140 Billion SCF/year	\$4.39 Billion



# Coal-to-Chemicals

- Gasification and the production of syngas is the most common method used to create chemicals from coal
- Primary chemicals produced from coal gasification:
  - Ethanol
  - Methanol
  - Ethylene
  - Propylene
  - Acrylic acid
  - Methyl methacrylate
  - Acetic acid
  - Acetic anhydride
  - Vinyl acetate



# Coal-to-Chemicals

- Modern gasification has been used in the chemical industry since the 1950s
- The chemical industry uses gasification to produce methanol as well as chemicals, such as ammonia and urea, which form the foundation of nitrogen-based fertilizers
- The majority of the operating gasification plants worldwide produce chemicals and fertilizers



# Kingsport Integrated Gasification Facility, Tennessee

- First commercial scale coal-to-chemicals plant in the US
- Located in Kingsport, TN
- Run by a partnership between Eastman Chemical Company and Air Products and Chemicals, Inc.
- Began operations in 1983
- Was a part of DOE's Clean Coal Technology Demonstration Program (CCTDP)
- DOE funded 43% of the project (\$92.7 million of the total \$213.7 million)
- 1,300 tons of coal per day
- Produces methanol, which is then converted to acetic acid and other chemicals
- 100% of Eastman's acetyl demand is met through coal gasification



# Domestic Coal-to-Chemicals Projects

#	Plant Owner	Project Name	Location	Feedstock	Status	Product/ Capacity	Cost
1	Eastman Chemical Co.	Kingsport Integrated Coal Gasification Facility	Kingsport, TN	High-sulfur Bituminous Coal	Operational since 1983	Acetic Anhydride – 680 mt/d	\$214 Million
2	Eastman Chemical Co.	Faustina Hydrogen Products LLC	St. James Parish, LA	Coal	2010	Ammonia – 4000 t/d Methanol – 600 t/d	\$1.6 Billion
3	Eastman Chemical Co.	Beaumont Chemical Facility	Beaumont, TX	Coal	Commercial in 2011-2012, now in FEED	Methanol, ammonia	\$1.6 Billion



# International Coal-to-Chemicals Projects



**Legislation**  
**Loan Guarantees**  
**Tax Incentives**  
**Studies and Reports**



# Legislation

## H.R. 2454 – American Clean Energy and Security (ACES) Act of 2009

- Introduced on May 15, 2009 by representatives Henry Waxman and Edward Markey
- Amends several existing laws related to energy and the environment
- Goals of the bill:
  - Create clean energy jobs
  - Achieve energy independence
  - Reduce global warming pollution
  - Transition to a clean energy economy
- Title III, Reducing Global Warming Pollution
  - Sets economy-wide reduction goals for greenhouse gas (GHG) emissions
  - Proposes a cap-and-trade system to achieve reductions that ultimately lead to a goal of an 80% reduction of GHG emissions compared to a 2005 baseline
- Impact on coal conversion to fuels and chemicals
  - Facilities that convert coal into a liquid or gaseous fuel are covered entities
  - Additionally, the fuel produced, provided it has a carbon-content, is also covered
- Coal-to-liquids (CTL) and coal-to-gas (e.g. hydrogen or substitute natural gas (SNG)) plants do not receive any emissions allowances under Title III, but coal-to-gas plants could be considered for emissions allowances for the commercial deployment of carbon capture and sequestration technologies under Title 1, Clean Energy (Subtitle B, Carbon Capture and Sequestration, Section 115)



# Loan Guarantees

## EPAct 2005 Section 1703 – Loan Guarantee

- The Energy Policy Act of 2005 (EPAct), Title XVII, authorizes DOE to issue loan guarantees to eligible projects that “avoid, reduce, or sequester air pollutants or anthropogenic emissions of greenhouse gases” and “employ new or significantly improved technologies as compared to technologies in service in the United States at the time the guarantee is issued”
- Includes fossil, renewable, transmission, and nuclear technologies
- Coal to SNG, chemicals, hydrogen, and liquid fuels facilities are eligible to apply
- February 2007 – DOE was awarded \$4 billion in loan guarantee authority
- Three Fossil Energy (FE) projects were invited to submit full applications
  - All three met the November 19, 2008 deadline
- The House Energy and Water Appropriations Committee report on H.R. 2764, the Consolidated Appropriations Act of 2008, provided authority for \$38.5 billion in loan guarantees
  - \$8 billion for coal technologies
  - \$6 billion of the total \$8 billion required carbon capture and storage (CCS) or the beneficial reuse of CO<sub>2</sub>
  - The remaining \$2 billion was for advanced coal gasification
  - The loan guarantees apply to all advanced coal technologies (at least 50% coal), power, and industrial gasification
  - The Loan Guarantee Solicitation for coal technologies was issued on September 22, 2008



# Tax Incentives

## EPACT 2005 Section 1307 – Tax Incentives

- Section 1307 of the Energy Policy Act of 2005 (EPAct) authorized \$1.65 billion in tax credits for clean coal projects
- Coal to SNG, chemicals, hydrogen, and liquid fuels projects qualify for these incentives
- Funds are allocated as follows:
  - \$800 million of credits to support Integrated Gasification Combined Cycle (IGCC) projects for electricity generation
  - \$500 million to support advanced coal electricity generation projects that utilize innovative technologies other than IGCC
  - \$350 million to gasification projects that support activities other than electricity generation, such as the production of gases used in chemical production
- Allows for multiple solicitations to be run, as well as redistribution of credits to be performed until all authorized credits are exhausted
- The Energy Improvement and Extension Act of 2008 authorized an additional \$1.5 billion in tax credits for clean coal technologies under sections 48A and 48B of the tax code as follows:
  - \$1.25 billion for advanced coal-based generation technology projects that include equipment which separates and sequesters at least 65% of carbon dioxide emissions
  - \$0.25 billion for gasification projects that sequester at least 75% of their total carbon dioxide emissions



# Tax Incentives (continued)

## Qualified Projects – Section 48B

- Gasification technology eligible under this section includes any process that converts solid or liquid products from coal, petroleum residue, biomass or other materials which are recovered for their energy or feedstock value into a synthesis gas
- The incentives authorized under the 2008 legislation require capture and sequestration of 75% of total CO<sub>2</sub> emissions

## Status of Projects

- In Round One, the following SNG/chemicals projects were selected under the “Gasification” category:
  - Carson Hydrogen Power, LLC - Carson Hydrogen Power Project, Carson, CA
  - TX Energy, LLC - Longview Gasification and Refueling Project, Longview, TX
- Round Two focused on carbon capture and storage projects
- Round Three focused on IGCC projects
- On April 6, 2009, the IRS issued Round Four Notices for both the 48A and 48B tax credits under the Energy Improvement and Extension Act authorization
  - Applications are due to DOE on November 2, 2009 and to the IRS by March 1, 2010



# Studies and Reports

## *Polygeneration of SNG, Hydrogen, Power, and Carbon Dioxide from Texas Lignite*

- NETL
- December 2004
- Studied the feasibility of constructing a coal conversion plant in Texas at the mine mouth of the Wilcox lignite deposit
- The plant would produce at least three products - electric power, hydrogen or substitute natural gas (SNG), and carbon dioxide
- Concluded it would be economically feasible in a time of high natural gas prices



# Studies and Reports

## *Industrial Size Gasification for Syngas, Substitute Natural Gas, and Power Production*

- NETL
- April 2007
- Feasibility study to evaluate the technical and economic viability of coal-derived syngas and substitute natural gas (SNG) refueling of U.S. industries
- Included the following tasks:
  - Develop an energy demand profile for potential industrial customers
  - Perform research on potential fuel sources and process byproducts for the project system
  - Develop a base gasification and gas clean-up design
  - Develop a Design Requirements Document
  - Perform conceptual design and cost estimates for reference plants for the production of syngas from coal gasification, production of SNG, and combustion turbine combined cycle refueling with syngas and SNG
  - Investigate potential environmental impact and applicable environmental regulations



# Studies and Reports

## *Chemical Feedstocks from Coal*

- NETL
- February 2008
- The report analyzed the concept of how to cost effectively produce hydrogen from coal gasification
- Currently, the cost is too high for this process to be commercially viable
- Selling the additional products (chemicals) from coal gasification would reduce the costs associated with hydrogen production
- The report concluded that chemicals can be economically produced from coal if the average coal price remains under \$26/ton, oil remains over \$40/bbl, and gas remains over \$6.20/thousand cubic feet (all prices are in year 2000 dollars)
- These conditions currently exist and are expected to persist until at least 2020