Coal to Fluid Hydrocarbons

• Framework
  – Energy Security
  – Technologies
  – Environment
  – Economics

• Current Development
  – Commercial Units
  – Projects
  – International Co-operation
Coal Conversion

Energy Security
A Growing Demand in Oil, whatever IEA scenario

Source: IEA’s World Energy Outlook 2009

Oil consumption forecast (Mt/year)

Reference scenario

450 ppm scenario

Source: IEA’s World Energy Outlook 2009
Oil, Gas and Coal: Reserves

BP Statistics - 2010 Annual Report

Source: BP Statistical Review 2010
Coal reserves modified for China, Indonesia, Mongolia
Oil, Gas and Coal: Reserves + 10% of Resources

2010 Annual Report (BGR)

Source: BGR Annual report (2010)
A major energy security stake

![Graph showing years of consumption for different regions and energy sources.](source: BP Statistical Review 2010, Coal reserves modified for China, Indonesia, Mongolia)
Coal Conversion

Technology
Technologies: conventional conversion routes

**Indirect routes**
- Synthetic gas - CO+H2
- Gasification: Surface/Underground
- Coal
- Methanol
- Fischer-Tropsch
- Methanation
- Refining
- Methanol To Gasoline
- Methanol To Olefins
- Great Plains, ND (USA)
- Petrochemicals
- Liquid Fuels
- Natural Gas

**Direct route**
- Dissolution
- Liquefaction
- Hydrotreatment
- Refining
- Liquid Fuels
- Majiata (Inner Mongolia)
- Jang (Shanxi, China)
- Secunda (RSA)
- Yitai (China)
- Baotou (I. Mongolia)

Majiata (Inner Mongolia)
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**Indirect routes**

- Gasification: Surface/Underground
- Fischer-Tropsch
- Synthetic gas - CO+H2
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- Liquid Fuels

Projects:
- Secunda (RSA)
- Lu’An (China)
- Yitai (China)
Technologies: conventional conversion routes

Indirect routes

Gasification
  Surface/Underground

Synthetic gas - CO+H2

Coal

Methanol

Methanol To Gasoline

Jang (Shanxi, China)

Liquid Fuels
Technologies: conventional conversion routes

**Indirect routes**

- Coal
  - Gasification
    - Surface/Underground
  - Synthetic gas - CO+H2
  - Methanol
    - Methanol To Olefins
    - Petrochemicals

Baotou (I. Mongolia)
Technologies: conventional conversion routes

**Indirect routes**

1. **Coal**
2. **Gasification**
   - Surface/Underground
3. **Synthetic gas - CO+H2**
4. **Methanation**
5. **Natural Gas**

Great Plains, ND (USA)
Technologies: conventional conversion routes

**Indirect routes**

1. Gasification
   - Surface/Underground
2. Synthetic gas - CO+H2

**Direct route**

1. Coal
2. Dissolution
3. Liquefaction
   - Majiata (Inner Mongolia)
4. Hydrotreatment
5. Refining
6. Liquid Fuels
Technologies: conventional conversion routes

**Indirect routes**
- Synthetic gas - CO+H2
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- Methanol To Gasoline
- Methanol To Olefins
Environment: Coal is most controversial

March 2, 2009, Washington DC (Reuters)

« Coal is My Worst Nightmare »
Steven Chu, Nobel physicist, U.S. Energy Secretary

March 26, 2009, World CTL Conference

Coal Takes Lives
Renewable Energy NOW!
Three steps:

• Coal mining: need for a responsible sourcing

• Conversion itself
  – Need for water: 1 to 2 m3 per barrel: an issue in several regions
  – Ashes, gaseous and liquid noxious emissions: managed through classical chemical processes

• Combustion: synthetic fuels are purer than from conventional fuels.

Source: Idaho National Laboratory (2007)
Global Issue: GreenHouse Gas Emissions

Case 1: Diesel produces from coal without CCS (Carbon Capture & Storage)

Well to Wheels emissions (grams of CO2 equivalent per mile):

Sources: Idaho National Laboratory (2007) and U.S. DOE (2009) (marked *)
Global Issue: CCS & Biomass are CTL’s best allies

Case 2: Diesel produced from coal with CCS:

- CCS reduces by 90-95% the CO2 emissions within the CTL plant
- CCS is now included in most CTL projects.

Well to Wheels emissions (grams of CO2 equivalent per mile):

Sources: Idaho National Laboratory (2007) and U.S. DOE (2009) (marked *)
CCS: Cost Breakdown

Capture
$25-75 per tonne CO₂

Transport
$1-5 per tonne CO₂/100 km

Injection
$1-2 Per tonne CO₂

Source: IPCC - Intergovernmental Panel on Climate Change - 2005

In a CTL plant, CO2 is already captured
Coal Conversion

Economics
At Present Barrel Price, a Profitable Activity

$/bbl - Crude Oil Equivalent

Technology providers
Sensitivity Analysis

Variation of the Return on Investment in % for +/-25% variation of...

Other parameters: CO2 impact, subsidies, discount rate,…

Source: U.S. DOE 2007
A Capital Intensive Industry (40-50,000 bpd unit)

Reported Capital Expenditure - 40-50,000 bpd unit
Many Projects, Several Demonstration Plants

4.3 Mm3/d
Great Plans, ND

Fox Creek

Leuna

Serafimovskiy

Irkutsk

Assam

Tata Sasol

Jindal

Posco

Bumi & Sasol

JAMG

Ordos

Yitai

Lu’an

Ormos

600,000 tpa

4,000 bpd

3,000 bpd

20,000 bpd

160,000 bpd

4,000 bpd

600,000 tpa

160,000 bpd

Great Plans, ND

SNG

Operations
Forecasts published in
• the U.S.A.
• the P.R. China


Source: China Coal Information Institute (2009) and Shenhua (2010)
World CTL, a European Initiative to Boost Co-operations

Presentations, networking, appraisal
Conclusion

- **Coal** is fully available.
- The predominant role of conversion is **energy security**.
- **Environment is a key issue.** Technology, CCS and Biomass are the best allies of CTL.
- **Several Demonstration Plants** are now in operation.
- **CTL is highly competitive** at current energy prices, although **capital intensive**.
- **China** has taken the lead.
- **International Co-Operation** keeps developing.
Thank you.

Our next events:

Gasification Asia Pacific 2011
Beijing, June 8-9, 2011

World CTL 2012
Delhi, January 18-20, 2012

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