Coal Conversion

• **Framework**
  – Why Converting Coal?
  – Technologies
  – Environment
  – Economics

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

Why Converting Coal?
A Regional Security Issue

Reserves of Conventional Fossil Fuels (Reserves/Consumption)

Source: BP Statistical Review 2012
Coal reserves modified for China, Indonesia, Mongolia
Limited Logistic Capacities

Logistic capacities:
- capital intensive
- often congested
Revenues compared to power

US dollars / Ton of coal equivalent

Sources: China: Asiachem (2012) – Xinjiang based prices
USA: Siemens (2013)
Indirect routes

Gasification
Surface/Underground

Coal

Synthetic Gas - CO+H2

Methanation

Natural Gas

USA, China 29 years
Technologies: Main Conversion Routes

**Indirect routes**

- **Gasification**
  - Surface/Underground

- **Synthetic Gas - CO+H2**

- **Fischer-Tropsch**
  - South Africa, China
  - 33 years

- **Methanation**
  - USA, China
  - 29 years

- **Refining**
  - Liquid Fuels
Technologies: Main Conversion Routes

**Indirect routes**

- **Gasification**
  - Surface/Underground
  - Synthetic Gas - CO+H2
  - Fischer-Tropsch
  - Methanol
  - Methanol To Gasoline
  - Methanol To Chemicals

- **Methanation**
  - USA, China 29 years
  - Natural Gas

- **Refining**
  - South Africa, China 33 years
  - Liquid Fuels

- **Methanol To Gasoline**
  - China 3 years
  - Liquid Fuels

- **Methanol To Chemicals**
  - South Africa, China 15 years
  - Petrochemicals
Technologies: Main Conversion Routes

**Indirect routes**

- **Gasification**
  - Surface/Underground
  - Synthetic Gas - CO+H2
  - Fischer-Tropsch
  - Methanol
  - Hydrogen

- **Methanation**
  - USA, China 29 years
  - South Africa, China 33 years

- **Refining**
  - Liquid Fuels
  - China 3 years

- **Methanol To Gasoline**
  - Liquid Fuels
  - South Africa, China 15 years

- **Methanol To Chemicals**
  - Petrochemicals
  - India, USA, China 31 years

- **NH3 Synthesis**
  - NH3 - Urea

- **Natural Gas**
  - USA, China 29 years
  - South Africa, China 33 years
  - China 3 years
  - South Africa, China 15 years
  - India, USA, China 31 years
Technologies: Main Conversion Routes

**Indirect routes**

- Synthetic Gas - CO+H2
  - Methanation
    - Natural Gas
      - USA, China 29 years
  - Fischer-Tropsch
    - Refining
      - Liquid Fuels
        - South Africa, China 33 years
  - Methanol
    - Methanol To Gasoline
      - Liquid Fuels
        - China 3 years
    - Methanol To Chemicals
      - Petrochemicals
        - South Africa, China 15 years
  - Hydrogen
    - NH3 Synthesis
      - NH3 - Urea
        - India, USA, China 31 years

**Direct route**

- Dissolution
  - Liquefaction
    - Hydrotreatment
      - Refining
        - Liquid Fuels
          - China 4 years
Environment
Three steps:

- Coal extraction by the mining industry
- Conversion itself
  - Need for water: 1 to 2 m$^3$ per barrel: an issue in several regions
    - Major research in this field
  - Ashes, gaseous and liquid noxious emissions: managed through classical chemical processes
- Combustion: synthetic fuels are purer than from conventional fuels.
Coal Conversion features **two drawbacks:**
- [Carbon]/[Hydrogen] high ratio of coal
- Energy consumption of the Conversion process

Source: Princeton Environmental Institute (2013)
CCS Cost Breakdown

Capture
$25-75 per tonne CO\textsubscript{2}

Transport
$1-5 per tonne CO\textsubscript{2}/100 km

Injection
$1-2 Per tonne CO\textsubscript{2}

Source: IPCC - Intergovernmental Panel on Climate Change - 2005

In a CTL plant, CO2 is already captured
Environment: Coal is most controversial

March 2, 2009, Washington DC (Reuters)

March 26, 2009, World CTL Conference

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

US dollars / Ton of coal equivalent

Sources: China: Asiachem (2012) – Xinjiang based prices
USA: Siemens (2013)
Capital Expenditure

Reported Capex - 40-50,000 bpd unit

Source: World CTX
Coal Conversion

Current Developments
Projects and Operations

* In 2011 and 2012, Yitai, Lu’An, JAMG and Shenhua have announced large extensions
Coal To Olefins projections: China

Chinese Coal To Olefins Capacity (mt/a)

Source: Asiachem 2013
CTL projections: International Energy Agency

India (World CTL’12)
JSPL: 80,000
Tata Sasol: 80,000
NFL/Coal India: 5,000
RIL: 80,000

Volumes remain low, but increase is significant.

Sources: IEA – World Energy Outlook 2011
International Co-operations and World CTX

Presentations, networking, appraisal
Conclusion

• Coal Conversion answers **energy security concerns, logistics issues** and **search for better coal monetization**.

• **Environment is a key issue.** Solutions exist: technological improvements, CCS and combination with biomass.

• Processes are operated **commercially**.

• **Conversion is competitive** at current energy prices, although capital intensive.

• It is expanding **fast** but will remain a secondary energy route.

• **China** has taken the lead.

• **International Co-Operations** keep developing.

• **World CTX** is committed to support this trend.
Thank you.

Welcome in **Beijing** on March 25-28, 2014