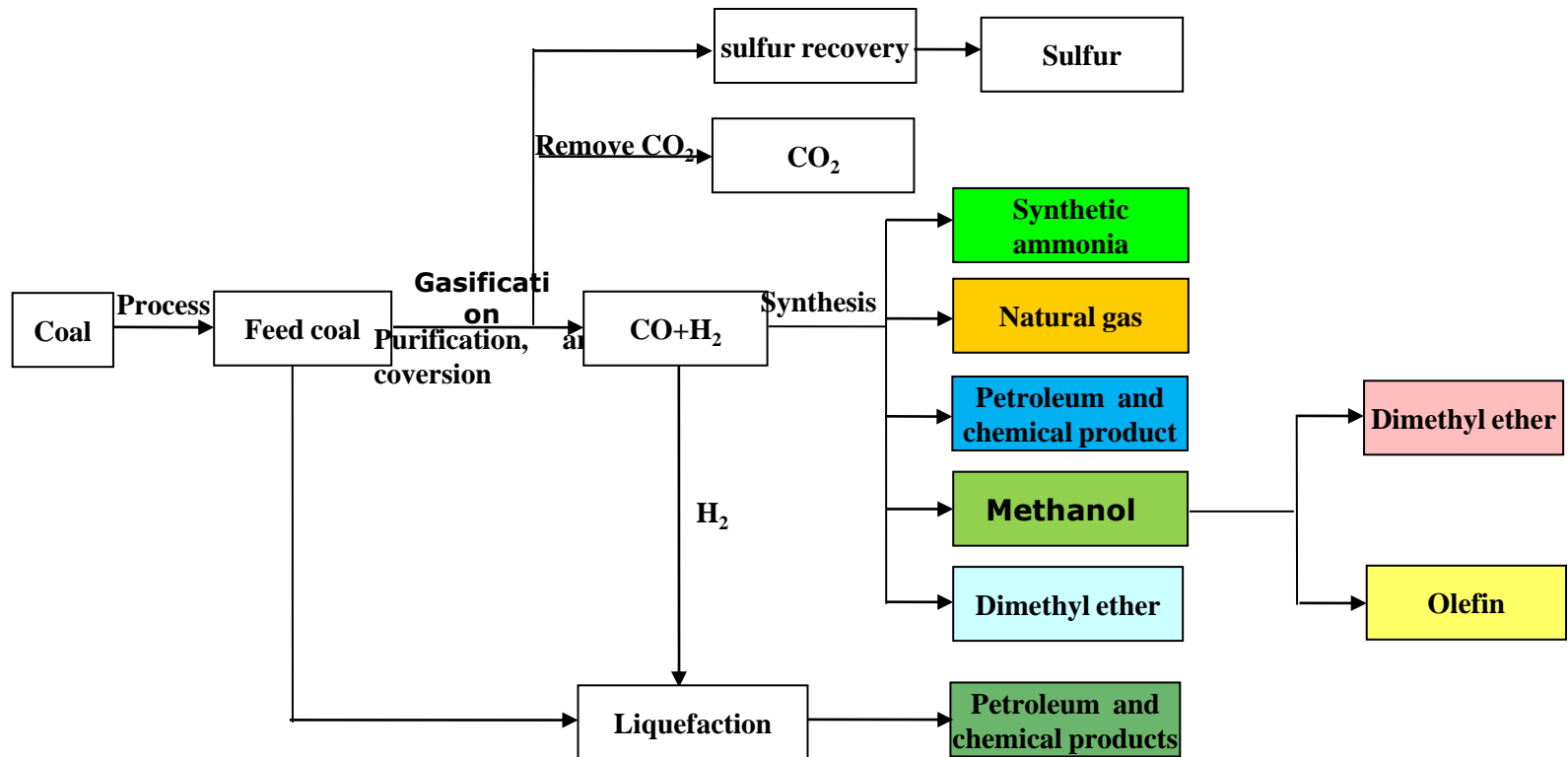

Coal Conversion and CO₂ Utilization

China Coal Research Institute
2011.09

Agenda

- ❑ **Coal Conversion Technologies and CO₂ Emissions**
 - ❑ **Approaches for CO₂ Emissions Reduction and Utilization through Coal Conversion**
 - ❑ **Demonstration Projects of Coal Conversion and CO₂ Utilization demonstration projects**
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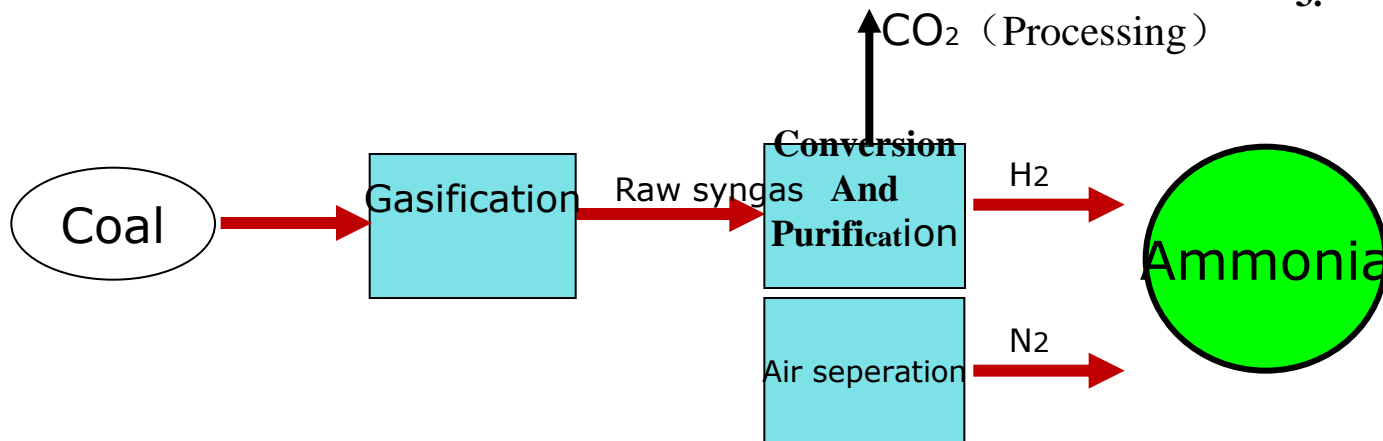
I. Coal Conversion Technology and CO₂ Emissions



Routes of Coal Conversion

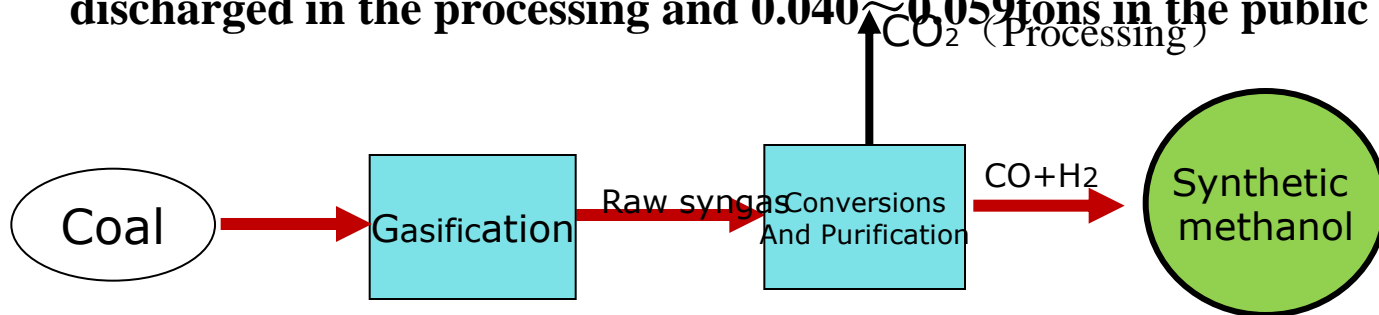
(1) Ammonia and Urea Production from Coal

- The comprehensive coal consumption in ammonia production is 1.3~1.7 tons of standard coal equivalent per ton of NH_3 , a level of below 1.5tce/t NH_3 can be achieved if technology permits.
- Volume of carbon dioxide emissions is about 2 ~ 3t/t NH_3 .



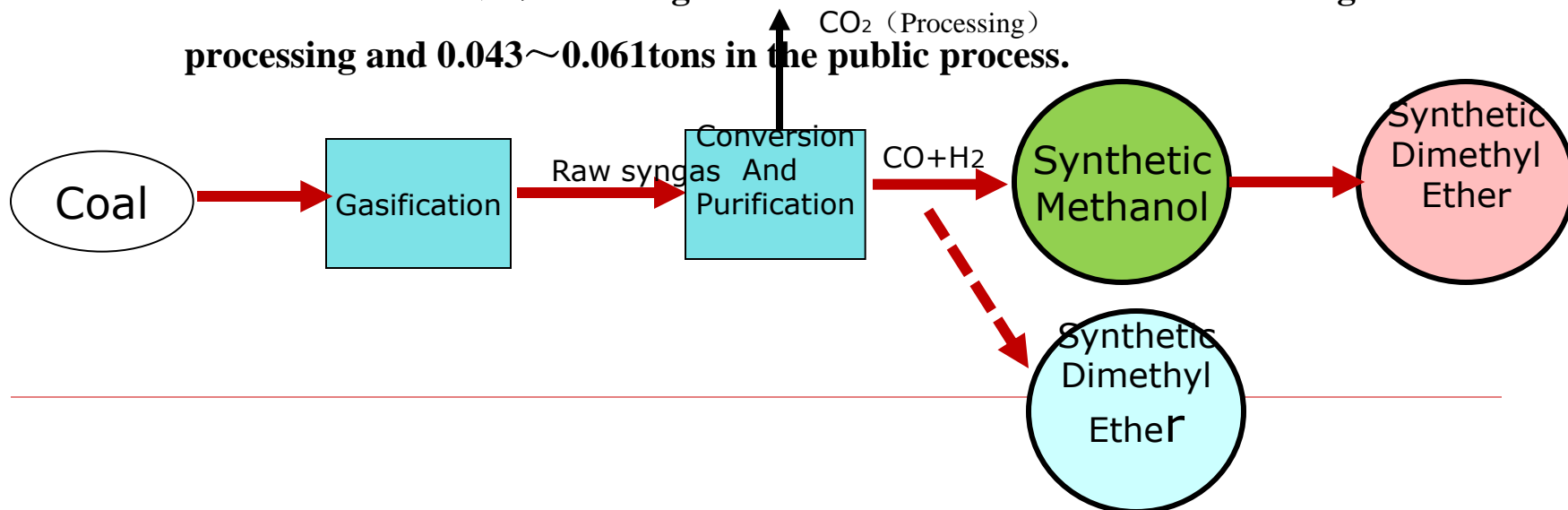
(2) Methanol Production from Coal

- The comprehensive coal consumption in methanol production is 1.42~1.59 tons of standard coal equivalent per ton of methanol. Energy conversion efficiency can reach 43~48% , or even 50% in some large projects.
- CO₂ emissions are 2.37 ~ 3.52tons of carbon dioxide per ton of methanol(0.119 ~ 0.176t/GJ) , among which 0.079 ~ 0.117tons are discharged in the processing and 0.040~0.059tons in the public process.



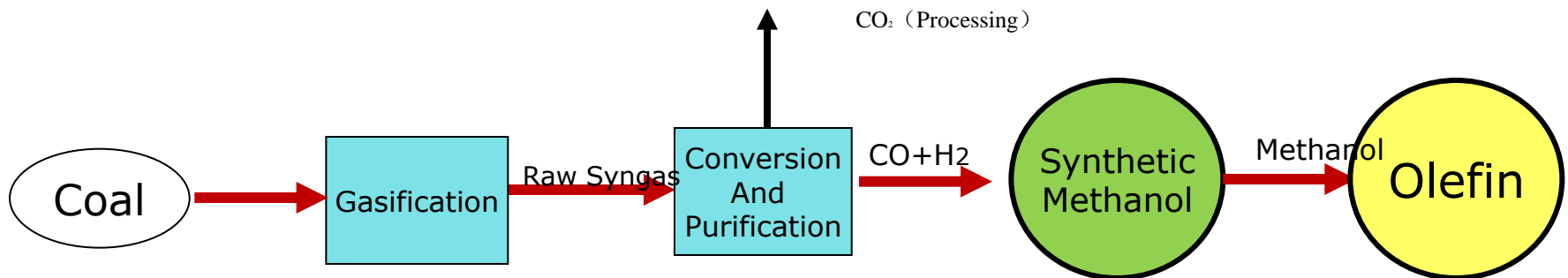
(3) Dimethyl Ether Production from Coal

- The comprehensive coal consumption here is 2.18~2.40 tons of standard coal equivalent per ton of dimethyl ether. Energy conversion efficiency can reach 41~45%.
- CO₂ emissions are 3.8~5.48tons of carbon dioxide per ton of dimethyl ether (or, 0.133~0.190t/GJ) , among which 0.090~0.129tons are discharged in the processing and 0.043~0.061tons in the public process.



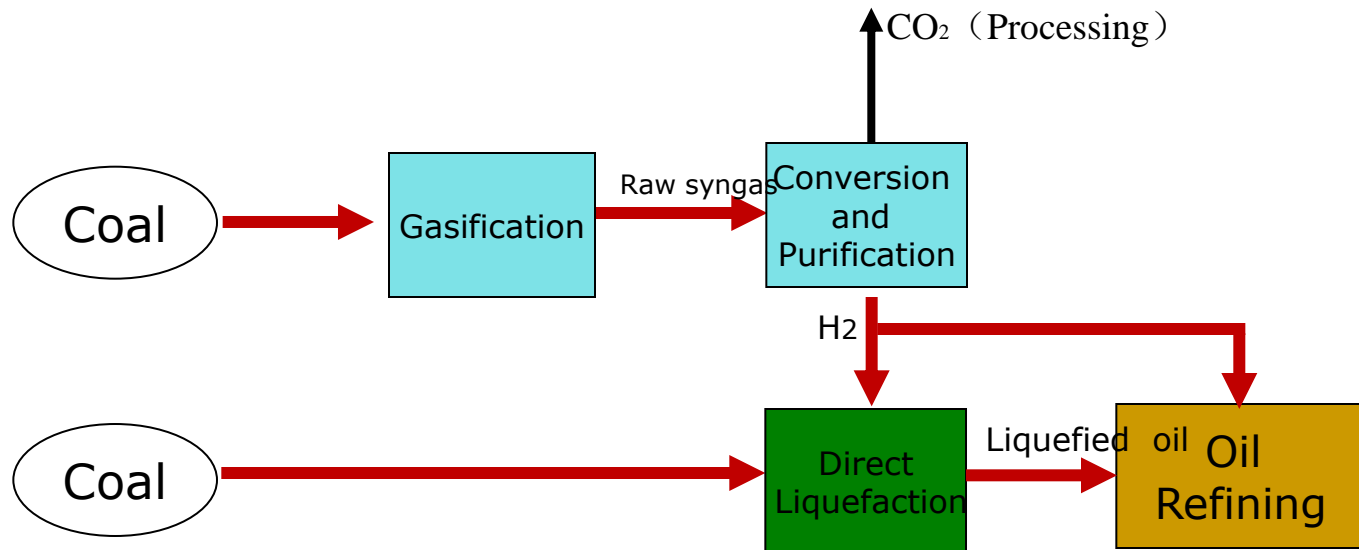
(4) Olefin Production from Coal

- The comprehensive coal consumption is 4.28~5.20 tons of standard coal equivalent per ton of olefin.
- CO₂ emissions are 6.40~9.15tons of carbon dioxide per ton of olefin, among which 4.27~6.10tons are discharged in the processing and 2.13~3.05 tons in the public process.



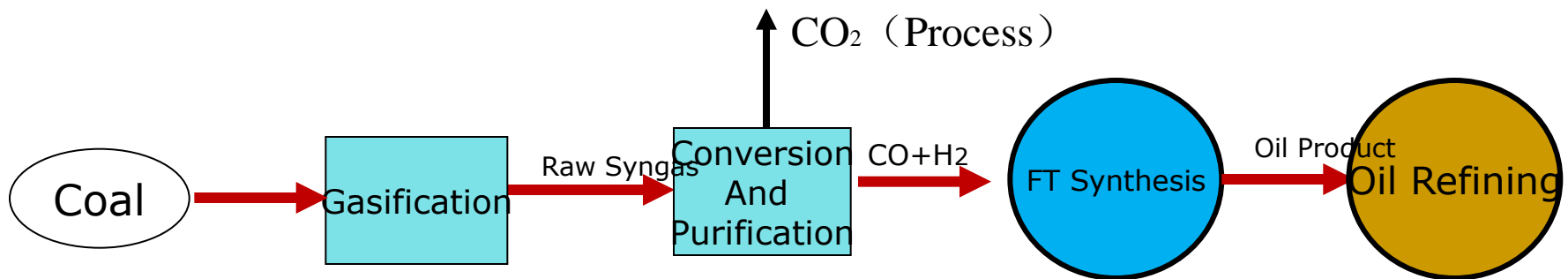
(5) Direct Liquefaction of Coal

- The comprehensive coal consumption is 2.57~3.01 tons of standard coal equivalent per ton of coal in direct liquefaction of coal; energy conversion efficiency stands at 50~58%.
- CO₂ emissions are 4.14~6.85tons per ton of oil product (or, 0.096~0.157t/GJ), among which 0.067~0.110tons are discharged in the processing and 0.029~0.047 tons in the public process.



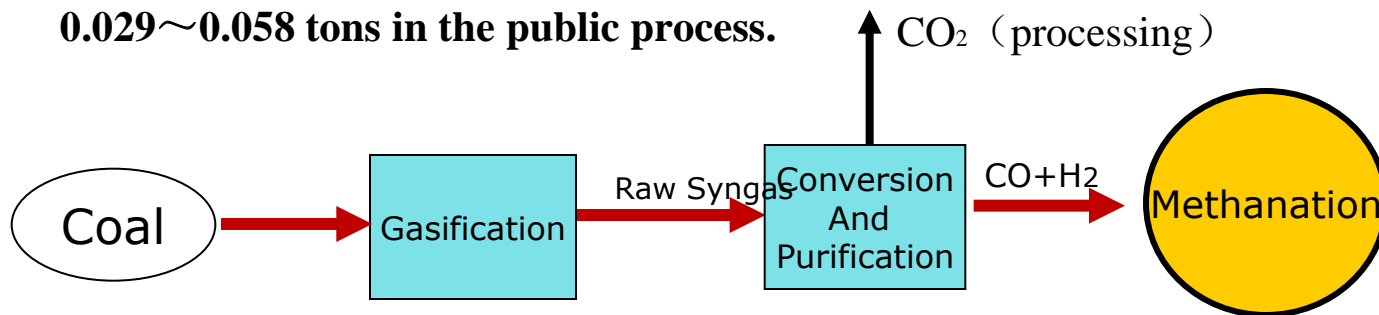
(6) Indirect Liquefaction of Coal

- The comprehensive coal consumption is 3.24~3.87 tons of standard coal equivalent per ton of coal in indirect liquefaction of coal; energy conversion efficiency stands at 38~43%.
- CO₂ emissions are 5.52~8.49tons per ton of oil product (or, 0.128~0.197t/GJ), among which 0.085~0.131 tons are discharged in the processing and 0.043~0.066 tons in the public process.



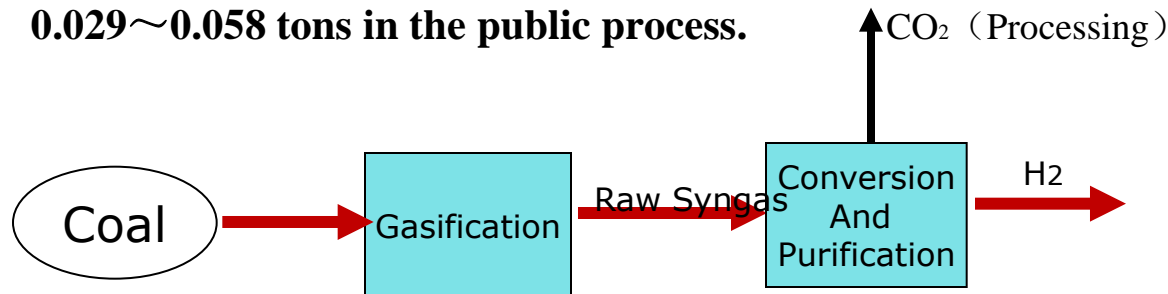
(7) Natural Gas from Coal

- The comprehensive coal consumption is 1.97~2.25 tons of standard coal equivalent per cubic kilometers of natural gas; energy conversion efficiency stands at 55~63%.
- CO₂ emissions are 3.2~5 tons per cubic kilometers of natural gas (or, 0.086~0.145t/GJ), among 0.057~0.097 tons are discharged in the processing and 0.029~0.058 tons in the public process.

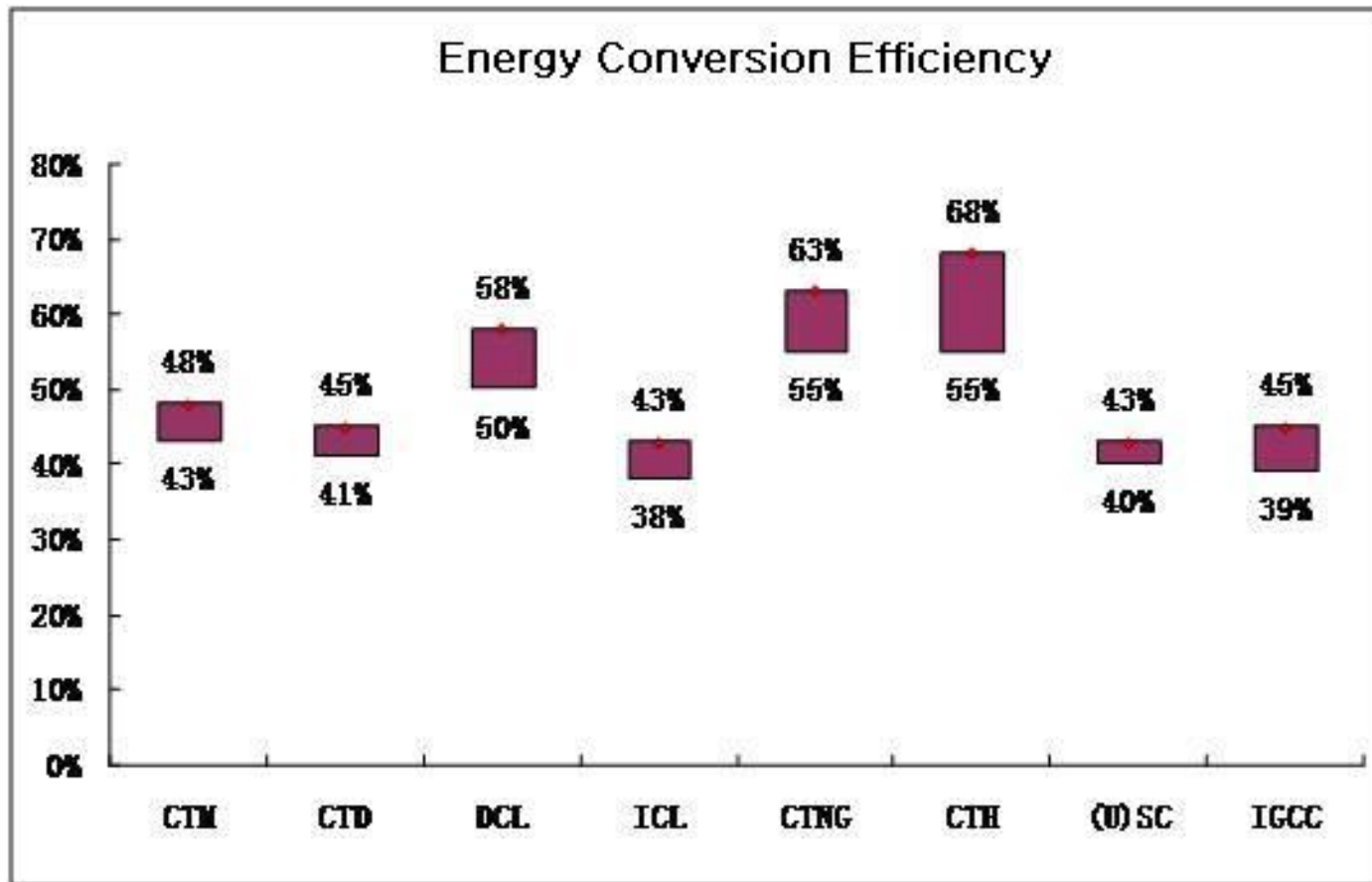


(8) Hydrogen Production from Coal

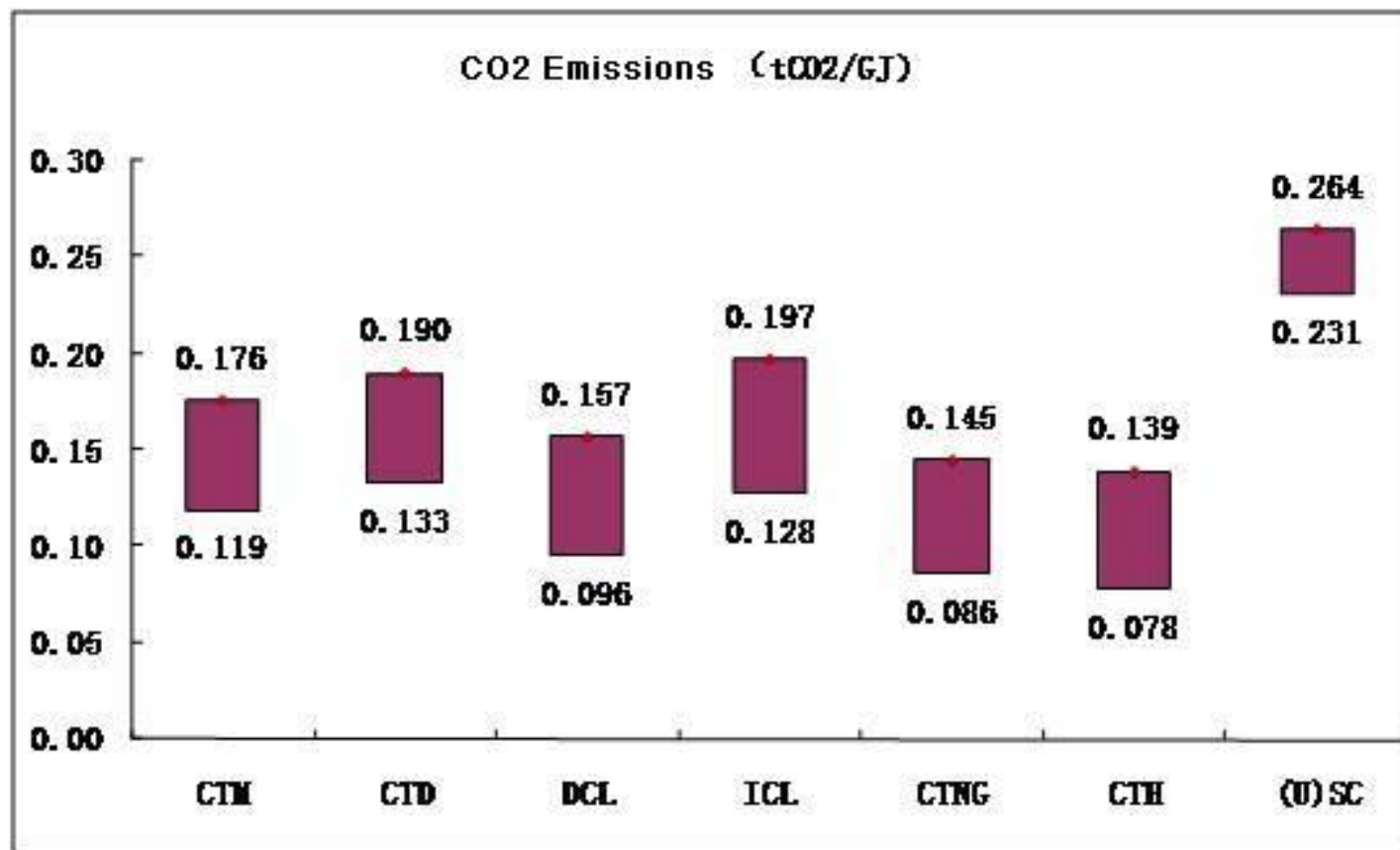
- The comprehensive coal consumption is 0.64~0.79 tons of standard coal equivalent per cubic kilometers of hydrogen; energy conversion efficiency stands at 55~68%.
- CO₂ emissions are 1.02~1.82 tons per cubic kilometers of hydrogen (or, 0.078~0.139t/GJ),, among 0.057~0.097 tons are discharged in the processing and 0.029~0.058 tons in the public process.



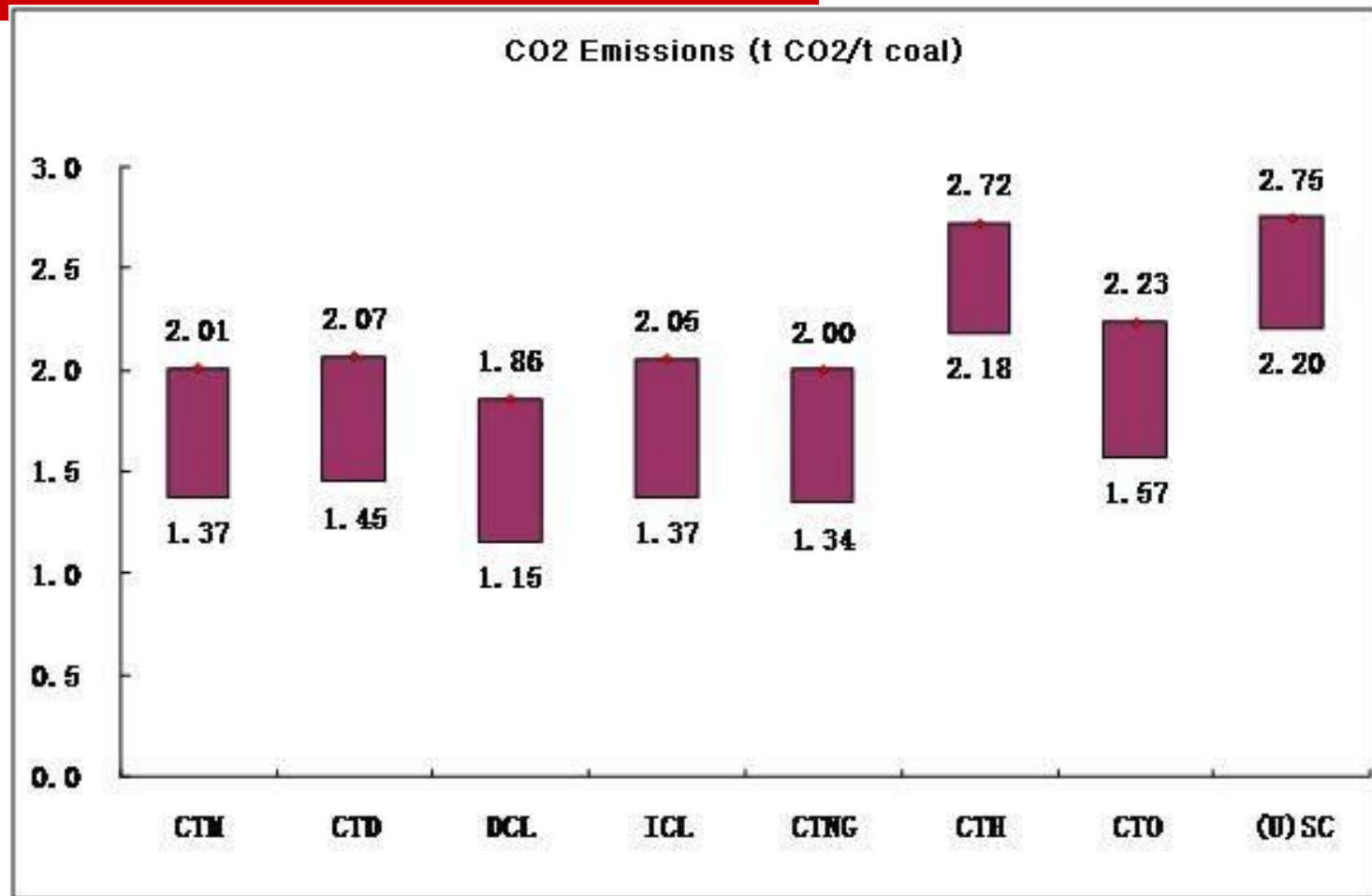
Energy Efficiencies of Conversion Technologies, %



Carbon Dioxide Emissions of Conversion Technologies, tCO₂/GJ



Carbon Dioxide Emissions of Conversion Technologies, tCO₂/t coal



II. Approaches for CO₂ Emissions Reduction and Utilization through Coal Conversion

□ Approaches for CO₂ Emissions Reduction

- **Choosing the right direction for product development**
 - **Improving technology**
 - **Raising coal conversion efficiency**
 - **Raising the efficiency of catalysts**
 - **Improving the efficiency of pumps**
 - **Recycling waste heat**
 - **Rationalizing the process flow**
 - **Developing coal poly-generation technology**
-

□ Approaches for CO₂ Utilization

➤ Producing chemical products as raw materials

- Since CO₂ produced in the coal chemical processing are of high concentration and high pressure, it's helpful for capture and utilization; Priority can be given to deploying capture and storage technologies in the coal chemical industry and IGCC power plants.
- Producing urea while making coal-ammonia; emissions can be decreased to 0.71t/t.
- Producing chemical products such as K₂CO₃, acetic acid
- Underground fire extinguishing

➤ Raising oil-gas recovery

□ EOR, ECBM

III. Demonstration Projects of CO₂ Utilization in Coal Conversion

Shenhua Group CCS Demo. Project

**100,000t/a, in operation,
deep aquifer
sequestration**

**Yankuang Cathay Coal Chemicals CO., Ltd. (YCCC),
Yancon Lunan Chemical Fertilizer Plant**

**Producing Urea ,Acetic
acid,potassium carbonate; CO₂
emissions were reduced by 3.6
million tons.**

**ENN Group Algae Carbon Sequestration
Biological Energy**

**320,000t/a,
under
construction,**

**New Materials Preparation with CO₂,
ZHONGKEJINLONG Chemical**

**22,000t/a CO₂resin,
in operation**

**Degradable Plastic Preparation with CO₂
China National Offshore Oil Corporation (CNOOC)**

2100t/a

□ Possibility of being used for EOR

**CO₂EOR Research and Demonstration,
Jilin Oilfield, PetroChina**

**0.8-1 Mt/a; Phase I is
completed; Phase II is
under construction;
EOR**

**CO₂ EOR for Coal-bed Gas
China United Coalbed Gas Holding Limited**

**40t/d, pilot
project**

**CCS and Oil Displacement Demo. Project
Shengli Oil Field, SINOPEC Corp**

**8000t/a, in
operation, EOR**

**Thank
you!**
