



Shenhua Direct Coal Liquefaction

Process and Project

Li Hongkai, Cui Minli

China Shenhua Coal Liquefaction Corp. Ltd.



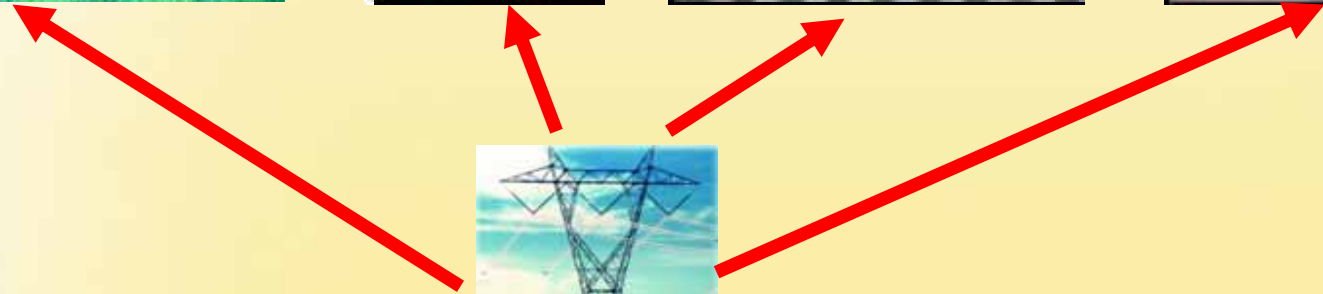
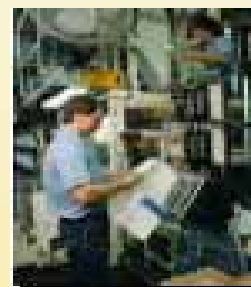
Outline

- 1、 Necessity to Develop Coal-to-Oil Technology**
- 2、 Development History of China Shenhua Coal Liquefaction Process**
- 3、 Shenhua Direct Coal Liquefaction Process and Characteristics**
- 4、 Shenhua Direct Coal Liquefaction Project**



1、Necessity to Develop Coal-to-Oil Technology

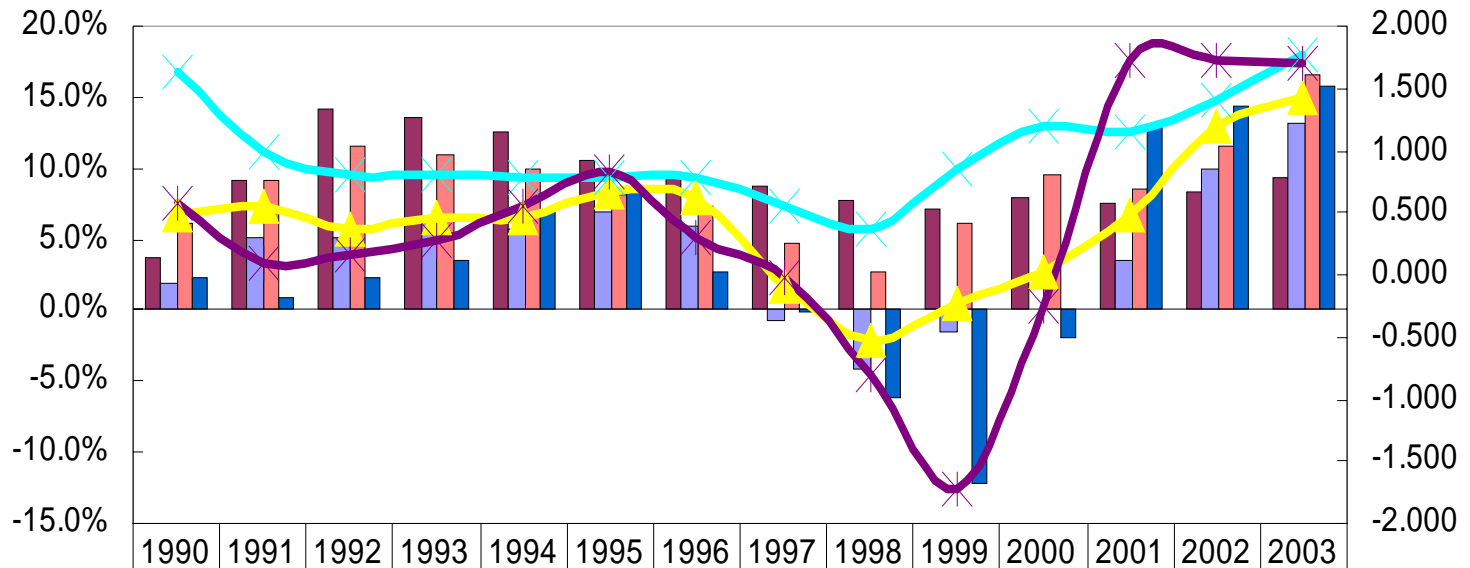
- Energy is essential production factor and material base to human society.





1、Necessity to Develop Coal-to-Oil Technology

- Energy is a bottleneck and standing difficult problem in the process of China's development.



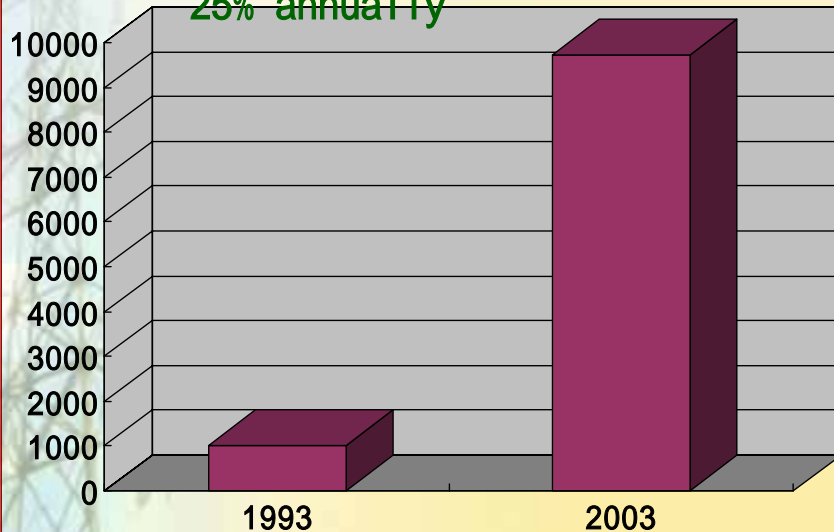
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
■ GDP增长	3.8%	9.2%	14.2%	13.5%	12.6%	10.5%	9.6%	8.8%	7.8%	7.1%	8.0%	7.5%	8.3%	9.3%
■ 能源消费增长	1.8%	5.1%	5.2%	6.3%	5.8%	6.9%	5.9%	-0.8%	-4.1%	-1.6%	0.1%	3.5%	9.9%	13.2%
■ 电力消费增长	6.2%	9.2%	11.5%	11.0%	9.9%	8.2%	7.4%	4.8%	2.8%	6.1%	9.5%	8.6%	11.6%	16.5%
■ 能源生产增长	2.2%	0.9%	2.3%	3.6%	6.9%	8.7%	2.8%	-0.2%	-6.2%	-12.2%	-2.0%	13.0%	14.4%	15.8%
▲ 能源消费弹性	0.474	0.554	0.366	0.467	0.460	0.657	0.615	-0.091	-0.526	-0.223	0.016	0.472	1.193	1.420
◆ 电力消费弹性	1.632	1.000	0.810	0.815	0.786	0.781	0.771	0.545	0.359	0.859	1.188	1.151	1.398	1.774
✱ 能源生产弹性	0.579	0.098	0.162	0.267	0.548	0.829	0.292	-0.023	-0.795	-1.718	-0.244	1.733	1.735	1.703



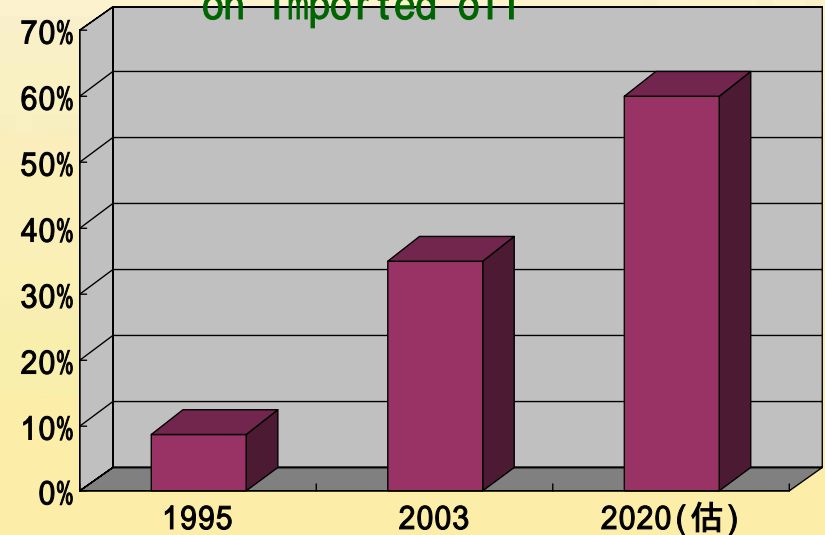
Necessity to Develop Coal-to-Oil Technology

- Petroleum has become a key factor that impacts on China's energy security and national economic development.

Crude oil import volume increase
25% annually



Increased dependence
on imported oil



China's oil security is not so optimistic :

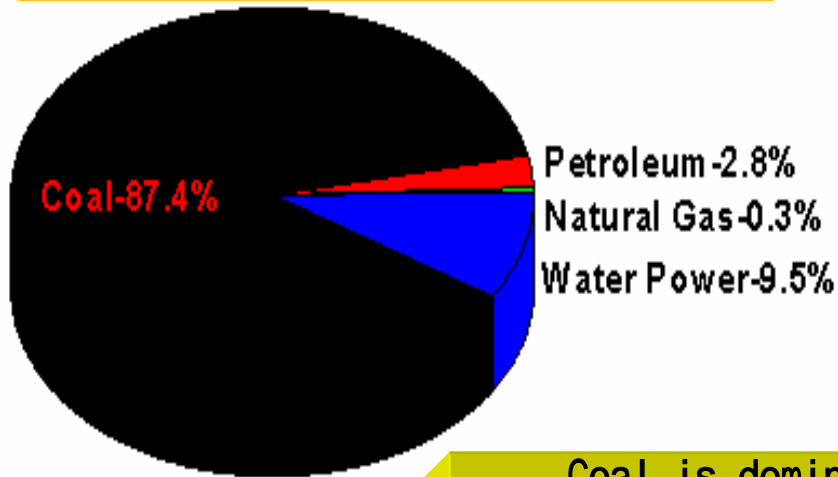
- Relying more and more on international imports, China's oil supply security is full of un-stability.
- Oil supply shortage worldwide, and rise in price.
- Oil & gas exploitation is going to be more and more difficult. Oil & gas supply in China is of uncertainty.



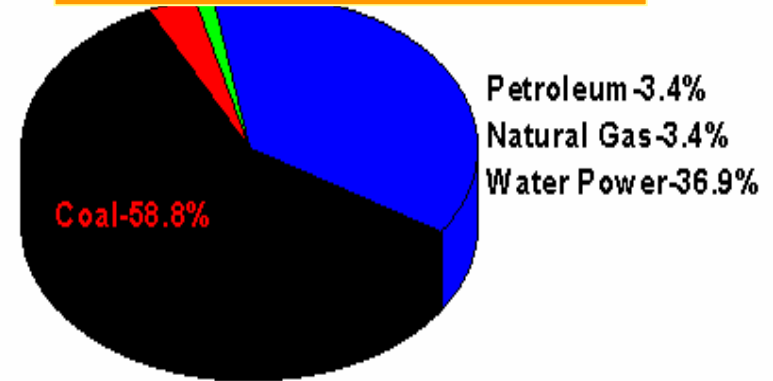
1、Necessity to Develop Coal-to-Oil Technology

- Coal resources is the strategic footstone of China's economic development and energy

Total proven reserves
(exploitable technically)
(823.1 billion Mtce)

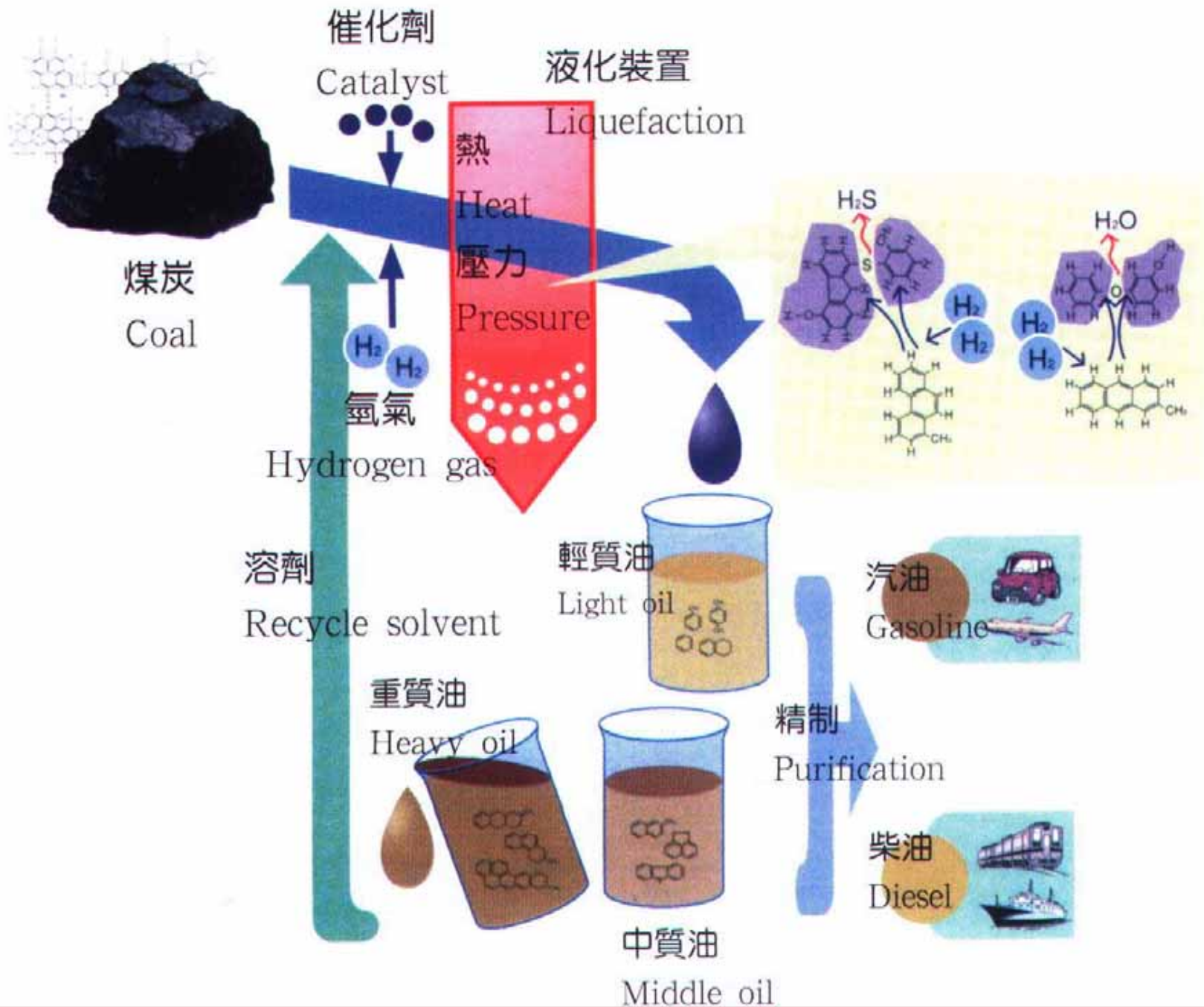


Remaining economic
exploitable reserves



Coal is dominating over China's total remaining exploitable energy reserves. Relatively rich in coal Resources is the strategic footstone of China's economic development and energy.

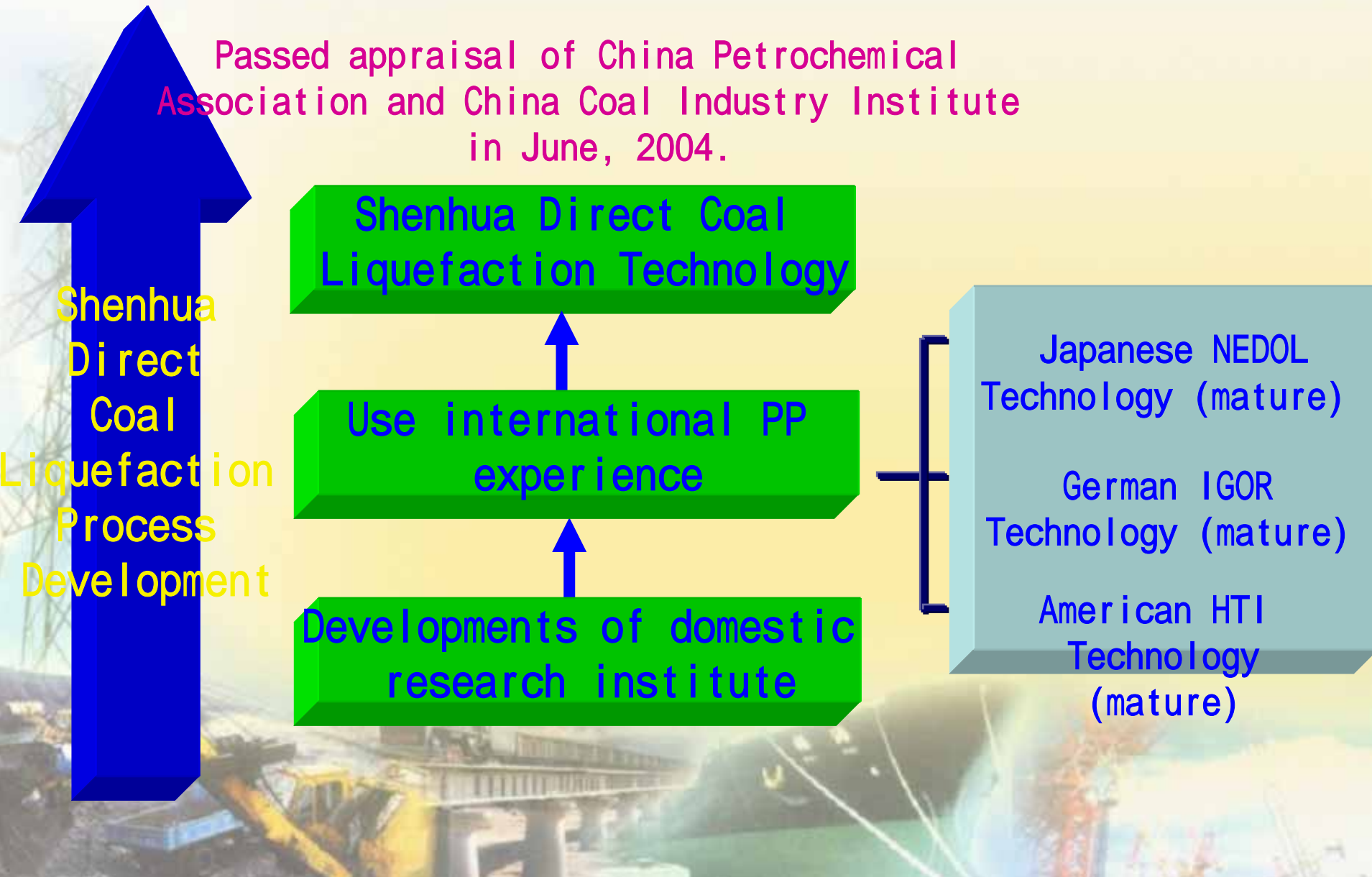
煤炭直接液化示意圖





2. History of Development on China Shenhua Coal Liquefaction Process

Passed appraisal of China Petrochemical Association and China Coal Industry Institute in June, 2004.





2、 History of Development on China Shenhua Coal Liquefaction Process



PDU

Shenhua and Enterprise twice tests

Plant scale-up, process optimization, operation support

863 Catalyst

Shenhua and Research institute Twice long-term tests

Simple process, stable operation, low cost

**Equip
ment**

Shenhua and University One- meter- diameter Cold module test

Reasonable equipment structure

BSU

Shenhua and research institute 10times 249days

High yields of oil product
Good product mix



3、Shenhua Direct Coal Liquefaction Process and Characteristics

● Development process of “863” synthetic high-activity catalyst



Lab (module test)



BSU



Scale-up Test



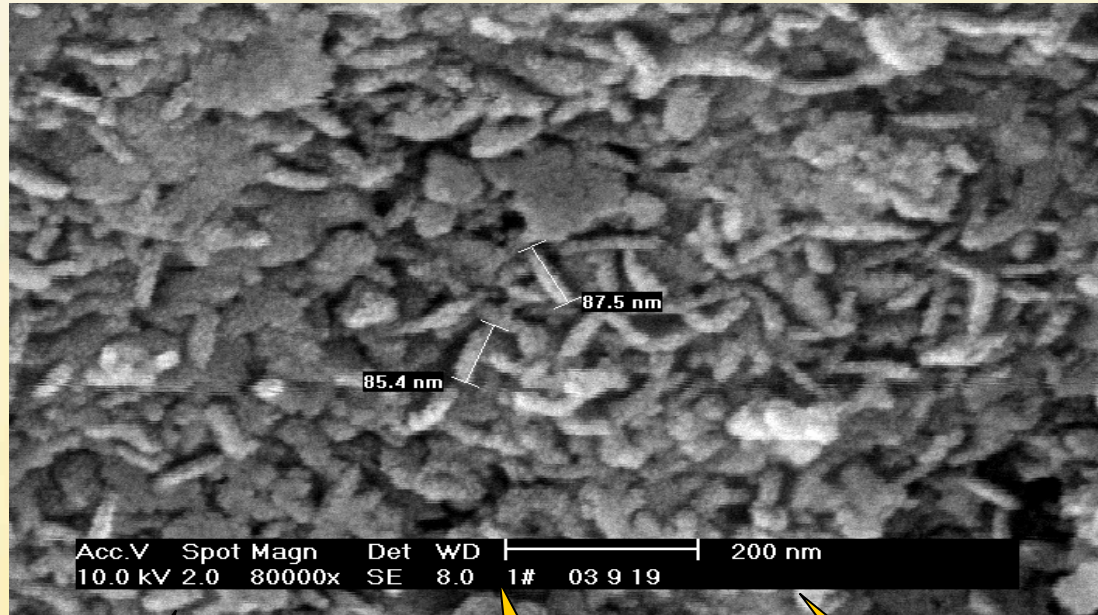
PDU





3、Shenhua Direct Coal Liquefaction Process and Characteristics

- The new “863” catalyst is of the following characteristics:



Low cost

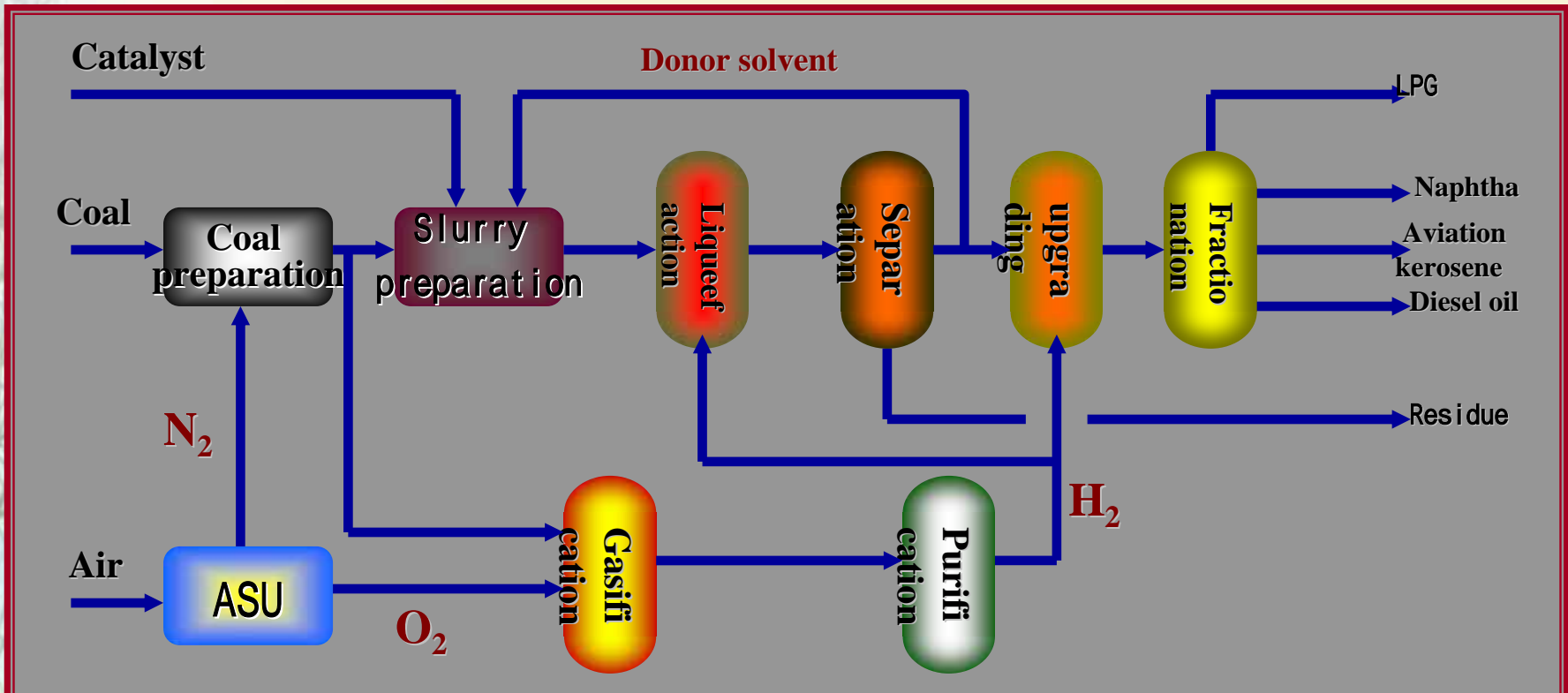
Easy preparation and good repetition

High activity



3、Shenhua Direct Coal Liquefaction Process and Characteristics

● Shenhua Direct Coal Liquefaction Process Flow Diagram



Coal : <0.15mm

450-470 °C

380-390 °C

Catalyst: Fe-S

17-30 MPa

15-18 MPa



3、Shenhua Direct Coal Liquefaction Process and Characteristics

- Pictures of Shenhua PDU and its products





3、 Shenhua Direct Coal Liquefaction Process and Characteristics

- **Shenhua coal liquefaction process has the following main characteristics:**

- Adopt cycle donor solvent in coal slurry preparation
- Use two forced-circulating suspension bed reactors
- Apply vacuum distillation to remove asphalt and solids
- Use forced-circulating suspension bed reactors for hydrogenation of cycle solvent and product





3. Shenhua Direct Coal Liquefaction Process and Characteristics

● Liquefaction results of Shenhua direct coal liquefaction process

	Adopt "863" Catalyst
Conversion rate, % maf	91.22%
Oil yield, % maf	57.17%
Gas yield, % maf	13.11%
Water yield, % maf	12.51%
Organic residue, % maf	23.99%
Total, % maf	106.78%
H ₂ consumption, % maf	5.65%



3、Shenhua Direct Coal Liquefaction Process and Characteristics

Shenhua PDU is operated continuously for 412hours (nearly 18days)





4. Shenhua Direct Coal Liquefaction Project

- **Construction Location : Shangwan, Erdos, Inner Mongolia**
- **Plant scale : 5Mt/a (a first-of-a-kind direct coal liquefaction commercialized demonstration plant in the world)**
- **Construction Period (By phases) : Phase-I, 3Mt/a**
Design capacity of the first train (early-stage engineering):1Mt/a, construction was commenced in August, 2004, it is planned to put into operation in 2007.





4. Shenhua Direct Coal Liquefaction Project

Main Production Units

- Catalyst Preparation
- Liquefaction Unit
- Solvent Hydrogenation
- Hydro-upgrading
- Light Ends Recovery & Desulphurization
- Coal Preparation
- Hydrogen Manufacturing
- Air Separation Unit
- Sulfur Recovery
- Waste Water Treatment





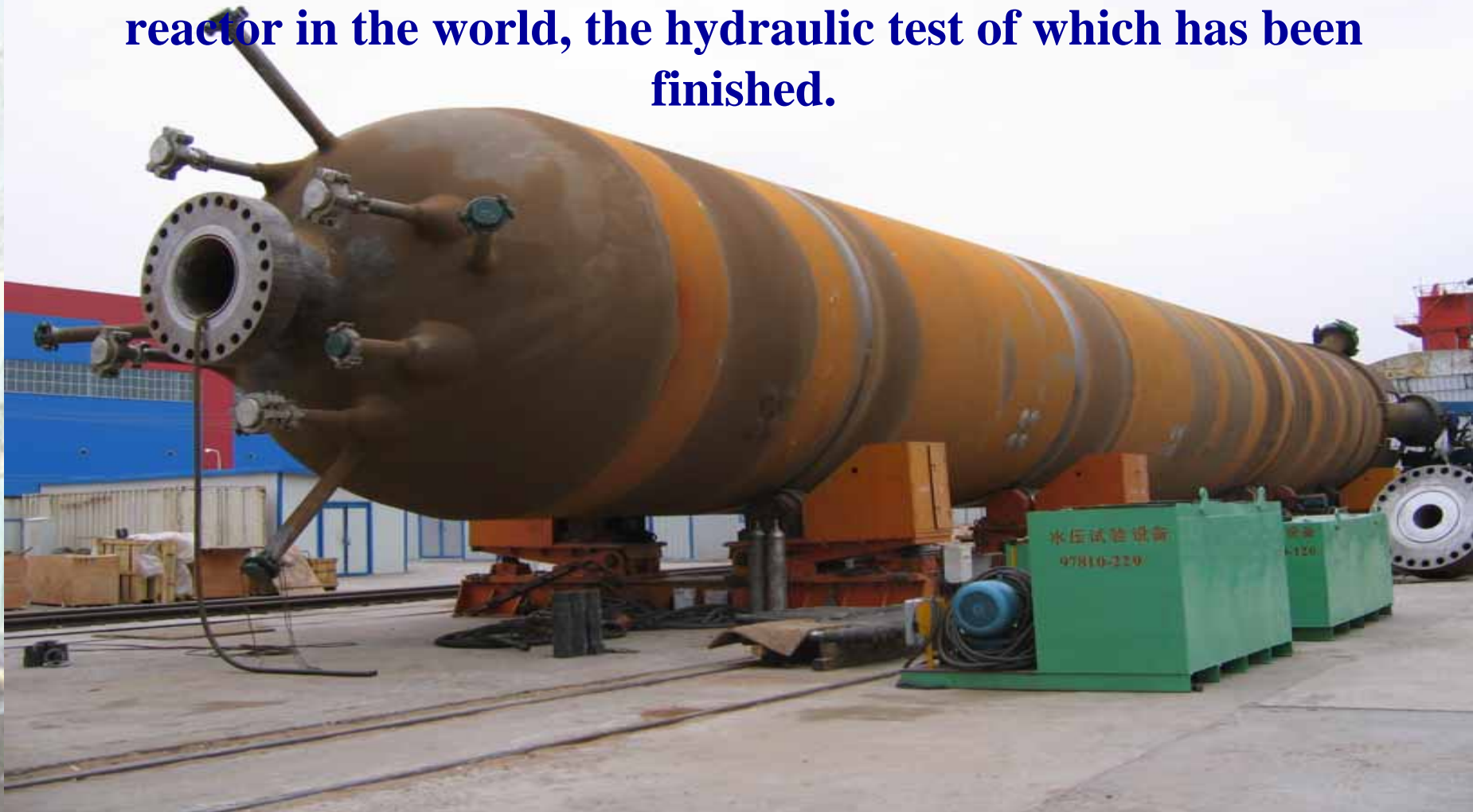
4、 Shenhua Direct Coal Liquefaction Project

Panorama of Project Site





This is the first and heaviest (2250t/set) coal liquefaction reactor in the world, the hydraulic test of which has been finished.



Site Reactor Assembly





Heavy-Duty Equipment Assembly & Welding Workshop



Coal-to-Hydrogen Unit, the weight of single gasifier is 1600t.



Equipment Installation, ASU



Shenhua Direct Coal Liquefaction Project



Product Scheme

Product	10,000t/a
• LPG	7.00
• Naphtha	32.09
• Diesel Oil	62.08
• Liquid Ammonia	1.15
• Sulfur	4.06
• Phenol	0.35
• Total	106.73

Estimated Economic Benefits of Early-stage Engineering

Oil price (international market) (US dollar/barrel)	30	40	50
IRR (Before tax , whole investment)	10.70%	16.73%	21.79%
IRR (After tax , whole investment)	6.96%	11.67%	15.66%



4、Shenhua Direct Coal Liquefaction Project

Up to May 31, 2006

- ◆ Project overall schedule: complete 44.9%
- ◆ Design schedule: complete 86.3%
- ◆ Procurement schedule: (including long-lead equipment)
complete 42.73%
- ◆ Construction schedule: complete 29.18%

Thank You!

