



Shenhua Coal Conversion Technology and Industry Development

Yuzhuo Zhang

Shenhua Group Corporation Ltd.,
China



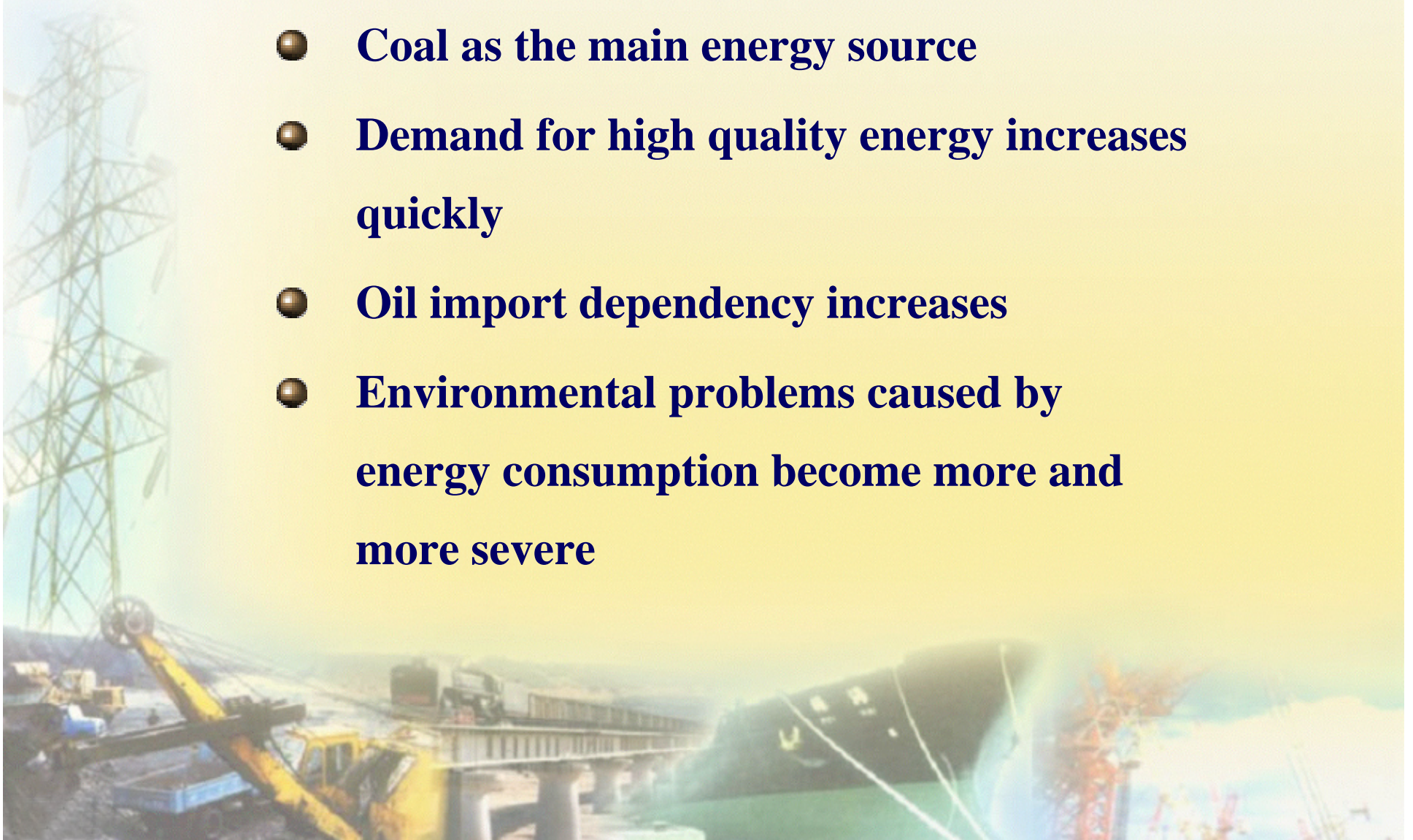
Outline

- 1. Present status of China's energy production and consumption**
- 2. Shenhua's strategies for coal conversion**
- 3. Development of Shenhua coal conversion projects**
- 4. Research and development of Shenhua coal conversion technology**
- 5. Conclusion**



1. Present status of China's energy production and consumption

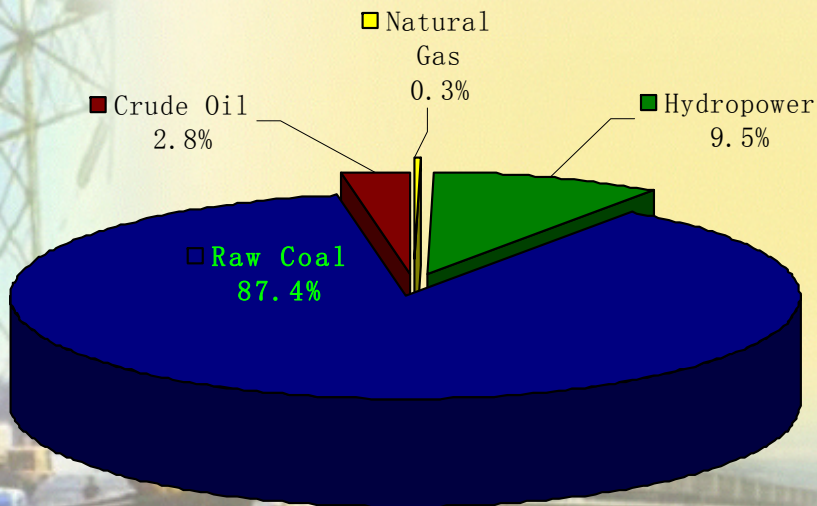
- Coal as the main energy source
- Demand for high quality energy increases quickly
- Oil import dependency increases
- Environmental problems caused by energy consumption become more and more severe



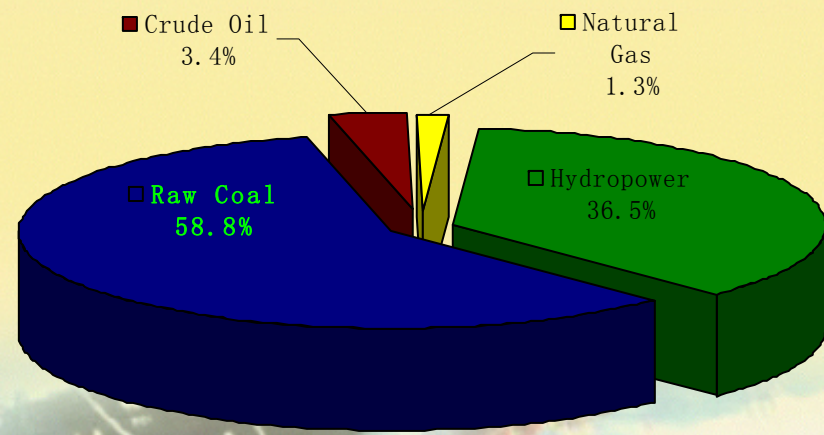


1.1 Coal as the main energy

- China has rich coal resources.
- China's conventional energy reserves higher than 823 billion tce.
- Chinese per capita energy resources only about 51% of the world average.



Energy Reserves Mix



Exploitation Energy Mix



1.1 Coal as the main energy

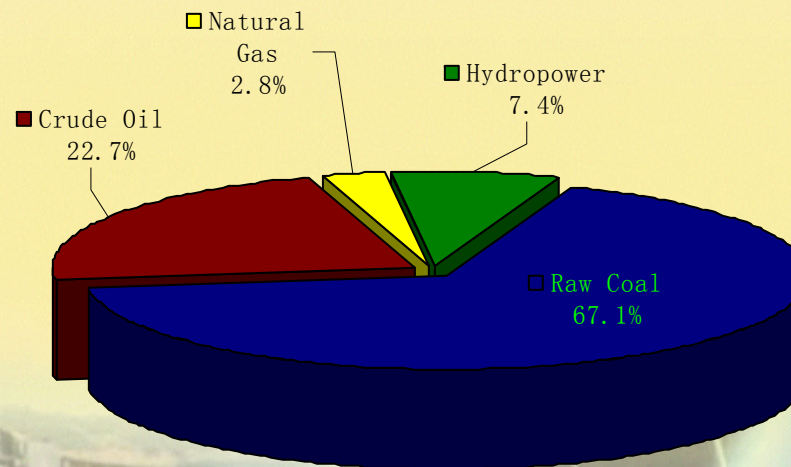
● China's Gross Energy Production and Energy Mix in Recent Years

Year	Energy Production (Mtec)	Energy Mix (%)			
		Raw Coal	Crude Oil	Natural Gas	Hydropower
1980	637.4	69.4	23.8	3	3.8
1990	1039.2	74.2	19	2	4.8
1995	1290.3	75.3	16.6	1.9	6.2
1996	1326.2	75.2	17	2	5.8
1997	1324.1	74.1	17.3	2.1	6.5
1998	1242.5	71.9	18.5	2.5	7.1
1999	1091.3	68.3	21	3.1	7.6
2000	1069.9	66.6	21.8	3.4	8.2
2001	1209.0	68.6	19.4	3.3	8.7
2002	1383.7	71.2	17.3	3.1	8.4
2003	1603.0	74.2	15.2	2.9	7.7



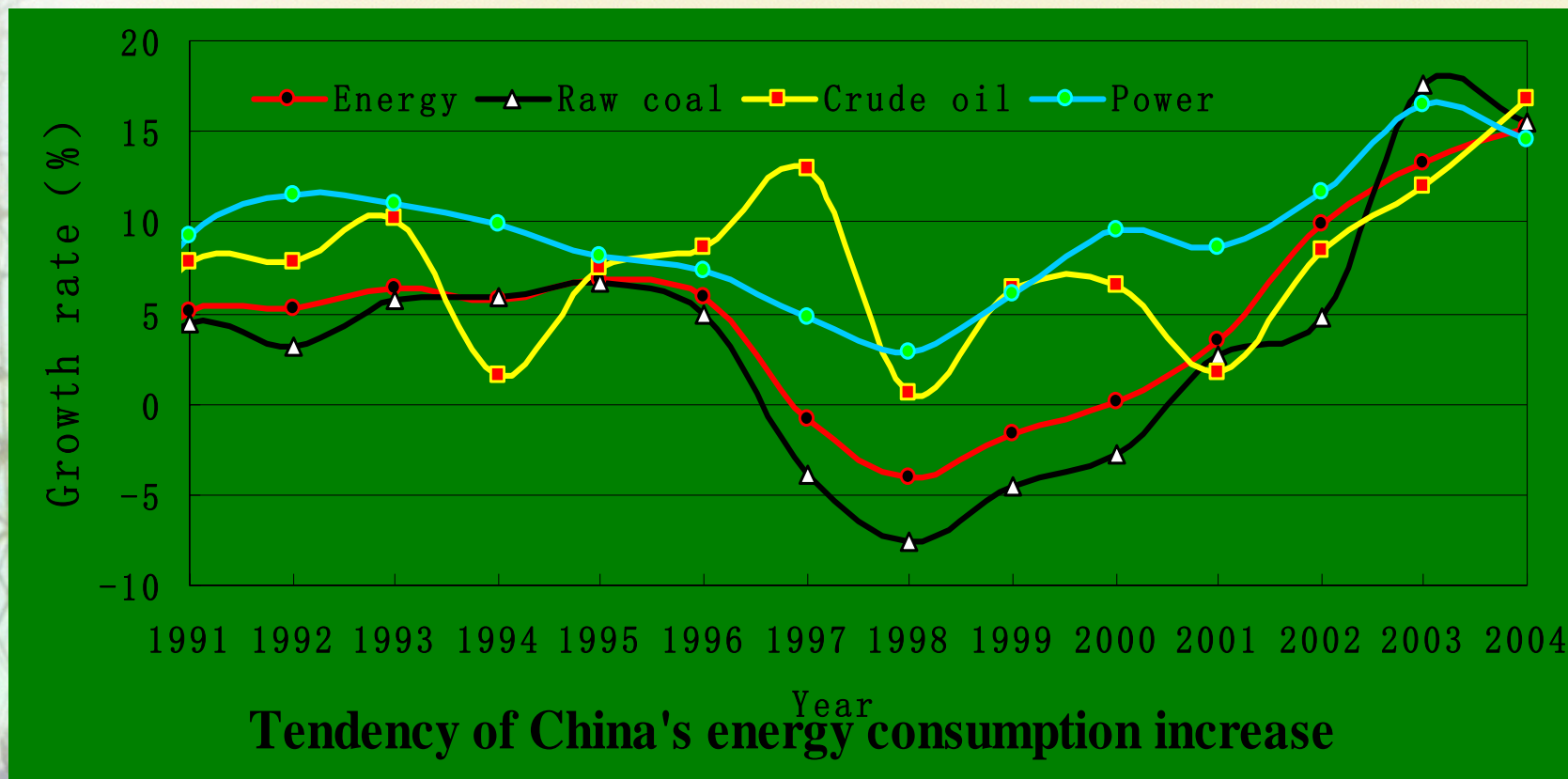
1.1 Coal as the main energy

- Coal consumption in 2004 was 1.87 billion tons.
- The coal dominant energy mix will not change for a considerable long period of time.
- It is estimated that coal will take a 60% share in 2010 and no less than 50% in 2050, still in the prime position.



2003' Energy Consumption Mix

1.2 Demand for high quality energy increases quickly

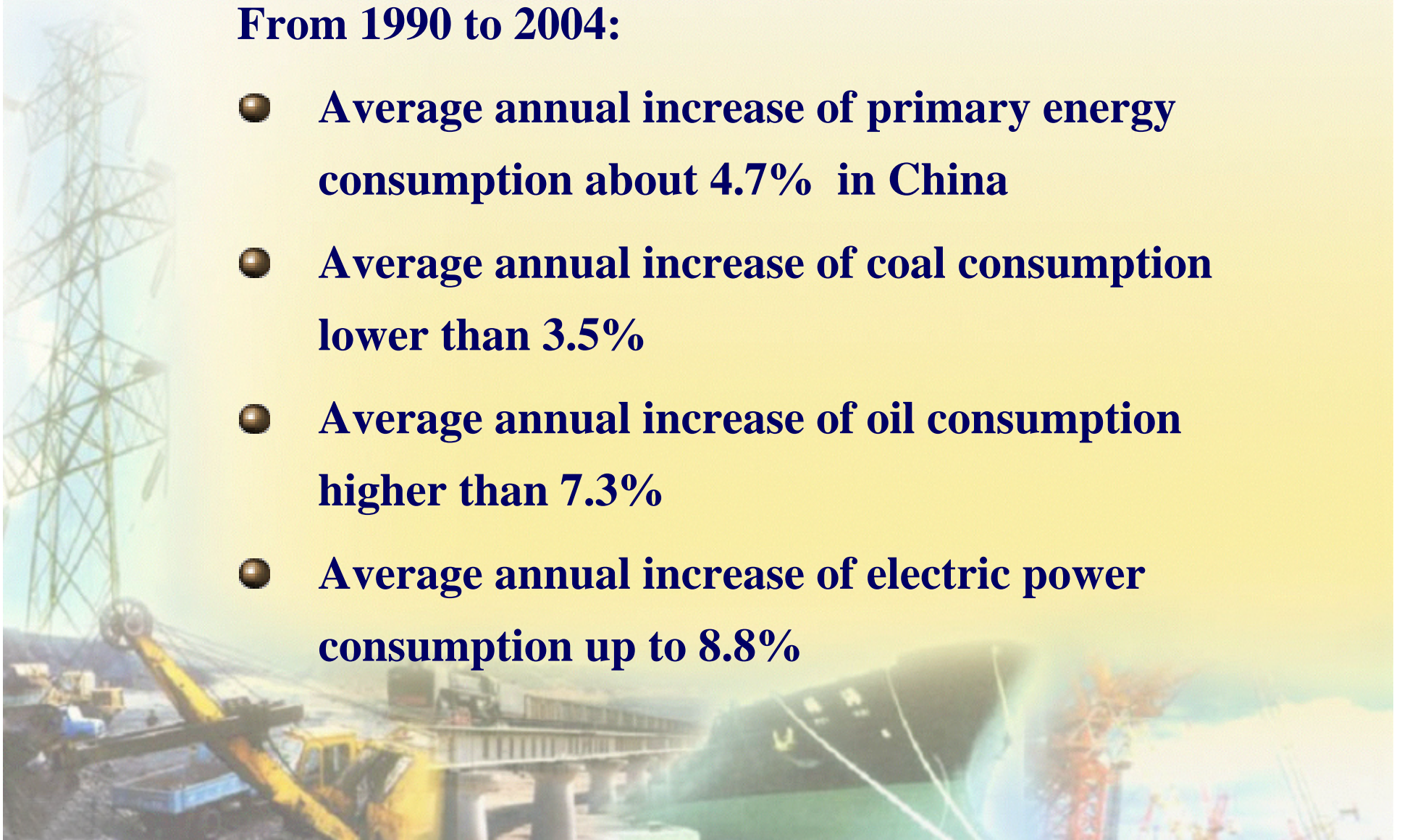




1.2 Demand for high quality energy increases quickly

From 1990 to 2004:

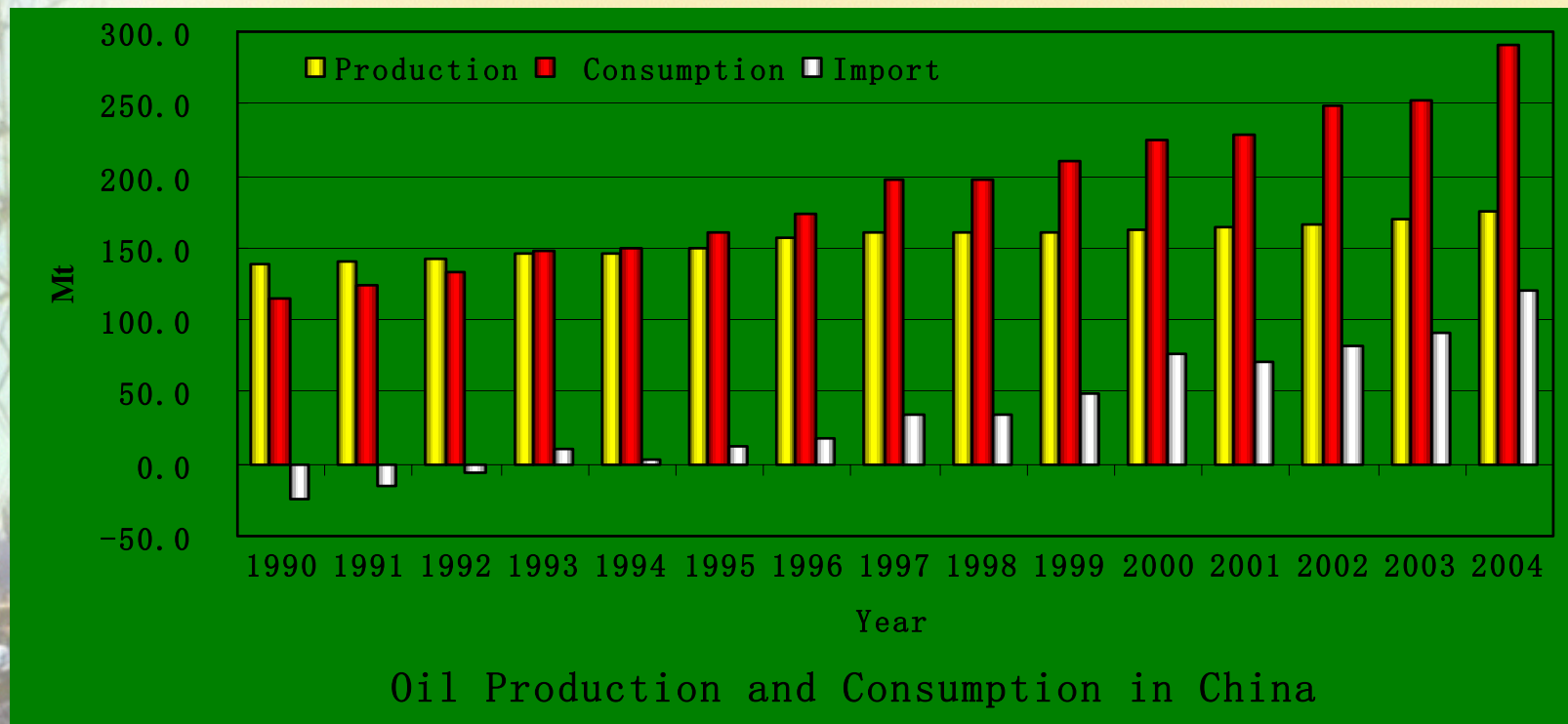
- **Average annual increase of primary energy consumption about 4.7% in China**
- **Average annual increase of coal consumption lower than 3.5%**
- **Average annual increase of oil consumption higher than 7.3%**
- **Average annual increase of electric power consumption up to 8.8%**





1.3 Oil import dependency increases

- China became a net oil import country in 1993.
- Oil product is 175 million tons, consumption up to 290 million tons, oil import up to 120 million tons, and dependency on import up to 38% in 2004.





1.3 Oil import dependency increases

Prediction:

- To 2010, the gap will be up to 150 million tons, and China's oil import dependency will rise to 40%.
- To 2020, China's oil consumption will be no less than 450 million tons, and oil import dependency will possibly reach between 60% and 62%.





1.4 Environmental problems caused by energy consumption become more and more severe

- Increasing of energy consumption, especially the primary energy consumption, increases CO₂ emissions inevitably

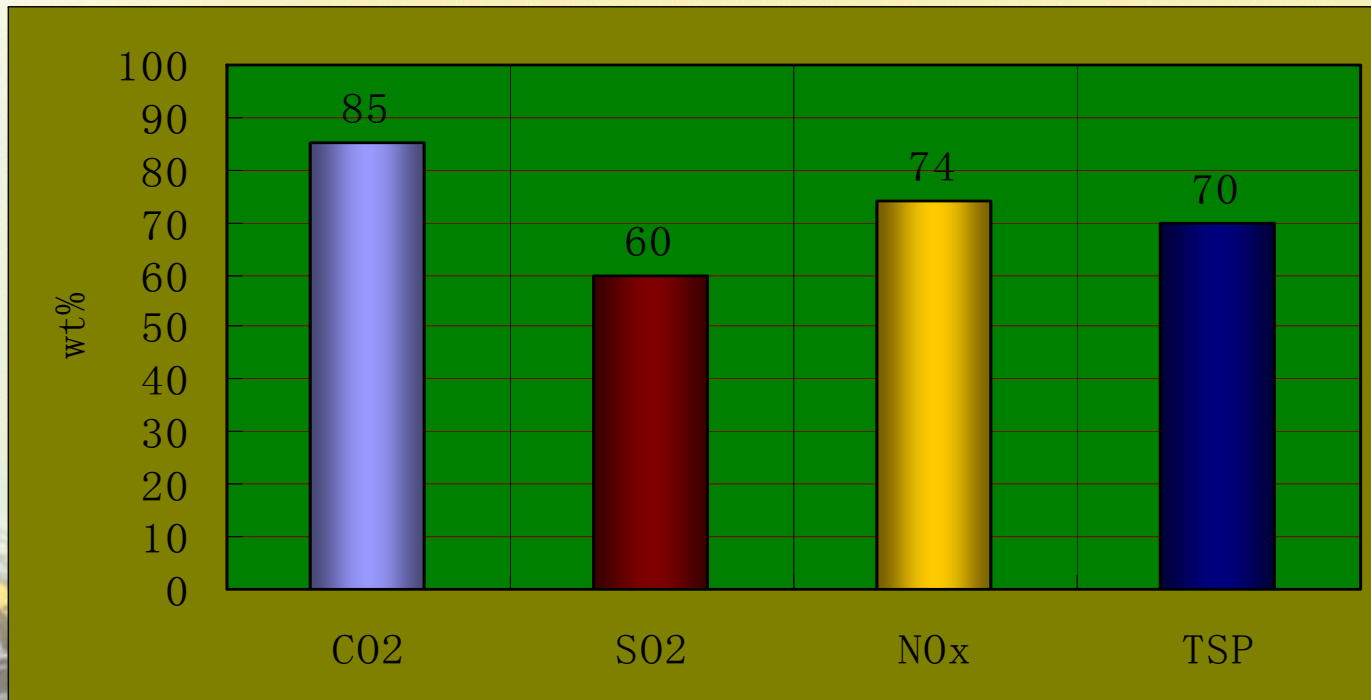
Emissions of China's leading pollution in recent years

Item	Year				
	1999	2000	2001	2002	2003
Industry Gas (billion Nm ³)	12681	13814	16086	17526	19891
SO ₂ (Mt)	18.57	19.95	19.48	19.27	21.59
Dust (Mt)	11.59	11.65	10.7	10.12	10.48



1.4 Environmental problems caused by energy consumption become more and more severe

- The direct coal combustion is of low efficiency and heavy pollution. The economic loss caused by SO_2 pollution and acidic rain due to burning coal is more than 100 billion RMB.
- Environmental problems caused by coal combustion.





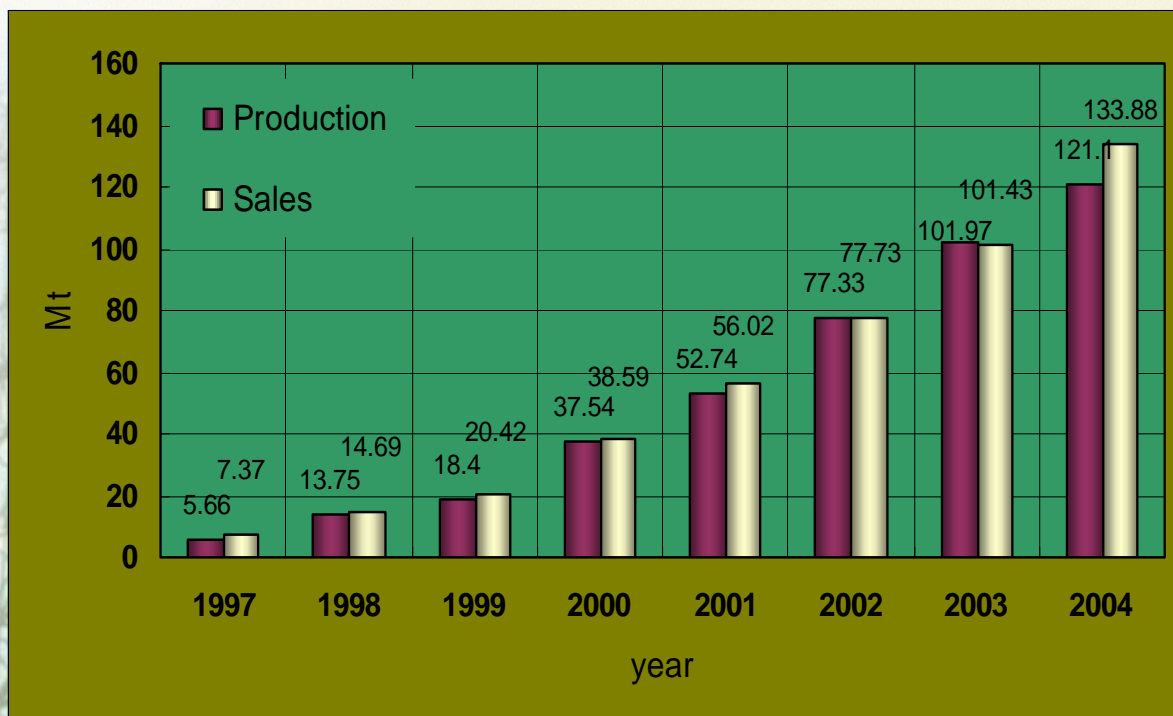
2. Shenhua's Strategy for Coal Conversion



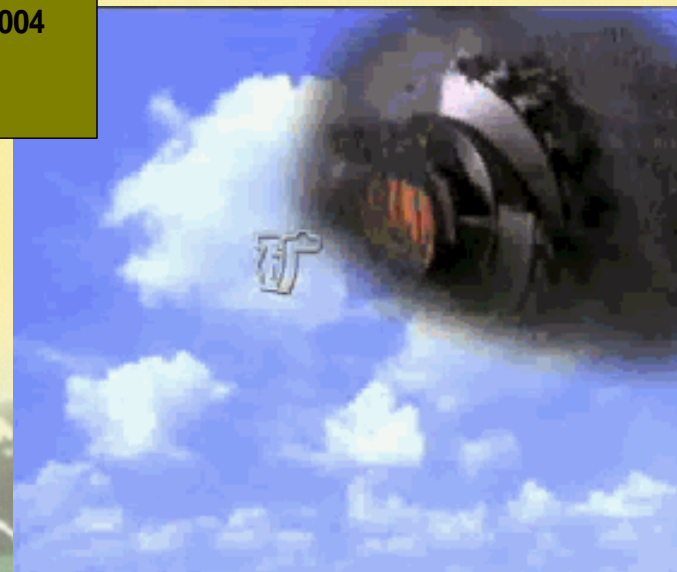
- An energy-based company integrating coal mining, power generation, railway, port and shipping, and becoming a cross-regional, multi-industrial and diversified energy giant.
- The largest coal producing company in China and ranks No. 3 in the world



2. Shenhua's Strategy for Coal Conversion



**Shenhua's Coal Production
and Sales during 1997-2004**





2. Shenhua's Strategy for Coal Conversion

Shenhua coal resources and its characteristics

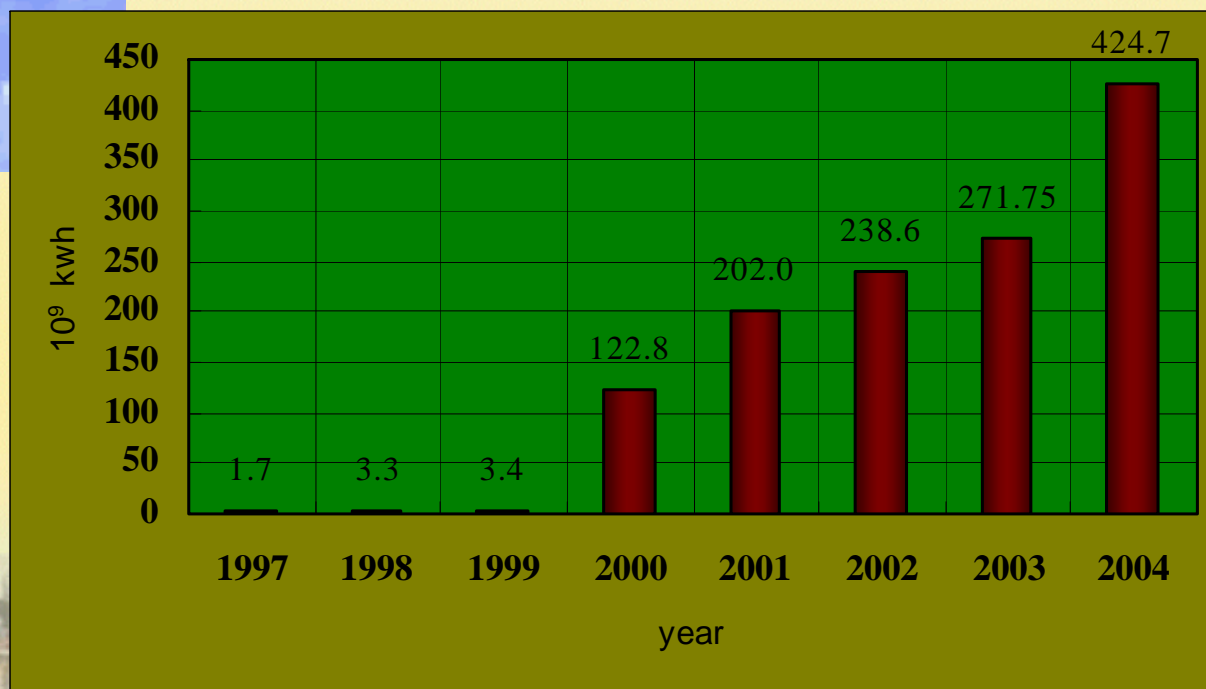
- Shenhua assumes the mission of developing the Shenfu-Dongsheng coalfield, which has proven coal reserves covering an area of 31200 km² and geologic reserves of 223.6 billion tons, ranking No.8 in the world;
- Chemical feedstock coal and steam coal with low ash, low sulfur, low phosphorous, high heat value, high activity;
- High quality coal for gasification
 - low ash fusion point, low ash and high reactivity
 - suitable for slagging gasifier
 - suitable for large capacity entrained-bed gasifier
 - suitable for Texaco, Shell, GSP gasifiers
 - low oxygen consumption, low coal consumption and good comprehensive technical indices
- In the light of Shenhua coal characteristics, to develop the coal conversion industry by utilizing the advanced coal gasification technology is Shenhua's strategic focus.



2. Shenhua's Strategy for Coal Conversion



Shenhua's Electric Power Production during 1997-2004





2. Shenhua's Strategy for Coal Conversion





2. Shenhua's Strategy for Coal Conversion

Coal Tar
In **Wuhai**

Production Capacity: 200 Kt/a

Coal Chemicals
In **Baotou**

- Methanol: 1.8 Mt/a
- MTO: 600 Kt/a

Headquarters
In **Beijing**

Coal Chemicals
In **Yulin**

- Methanol: 3.0 Mt/a
- MTO: 1.0 Mt/a

- Production Capacity: 6 Mt/a
- First Phase: 3 Mt/a
- First Train : 1 Mt/a

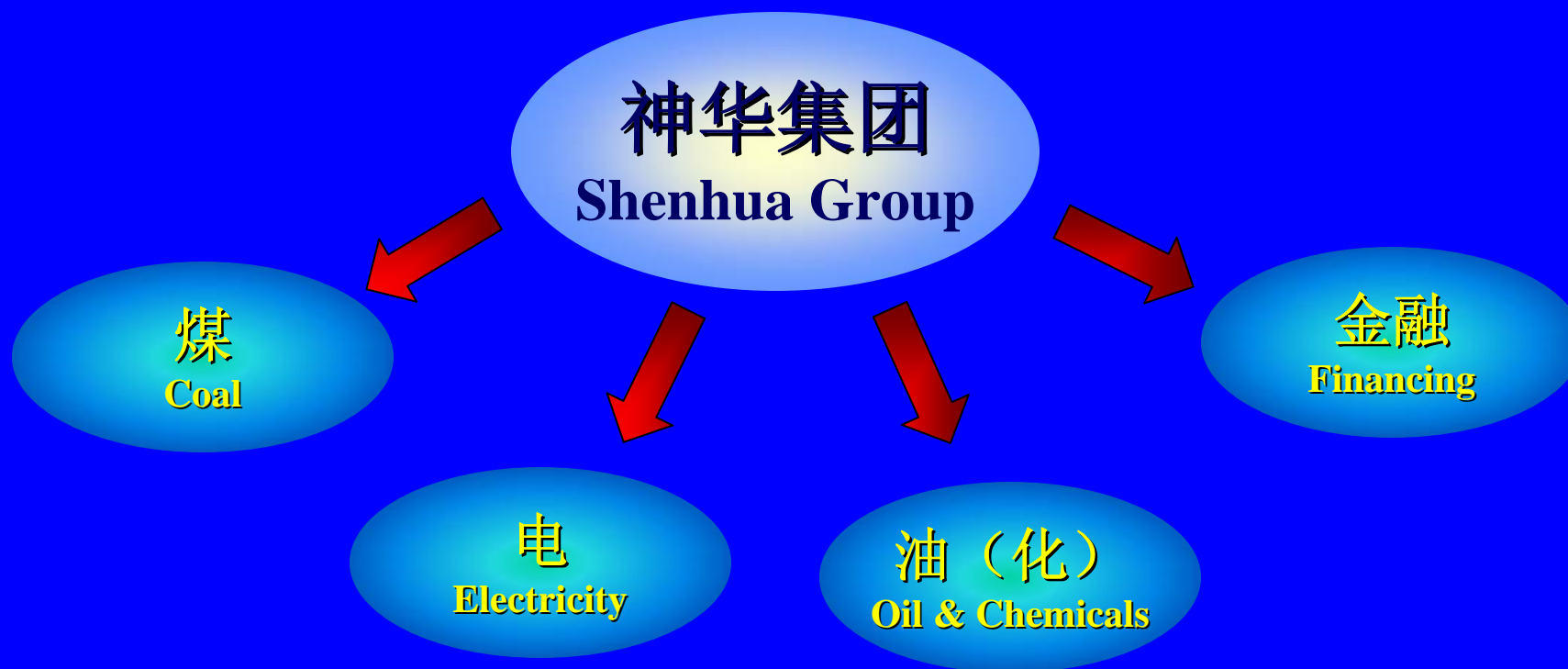
- Production Capacity: 6 Mt/a
- First Phase: 3 Mt/a

Direct Coal Liquefaction
In **Majiaata**

Indirect Coal Liquefaction In
Dabaodang



2. Shenhua's Strategy for Coal Conversion



Coal Production

200 Mt

300 Mt

Electric Power

20,000 MW

40,000 MW

Coal Liquefaction

10 Mt

30 Mt

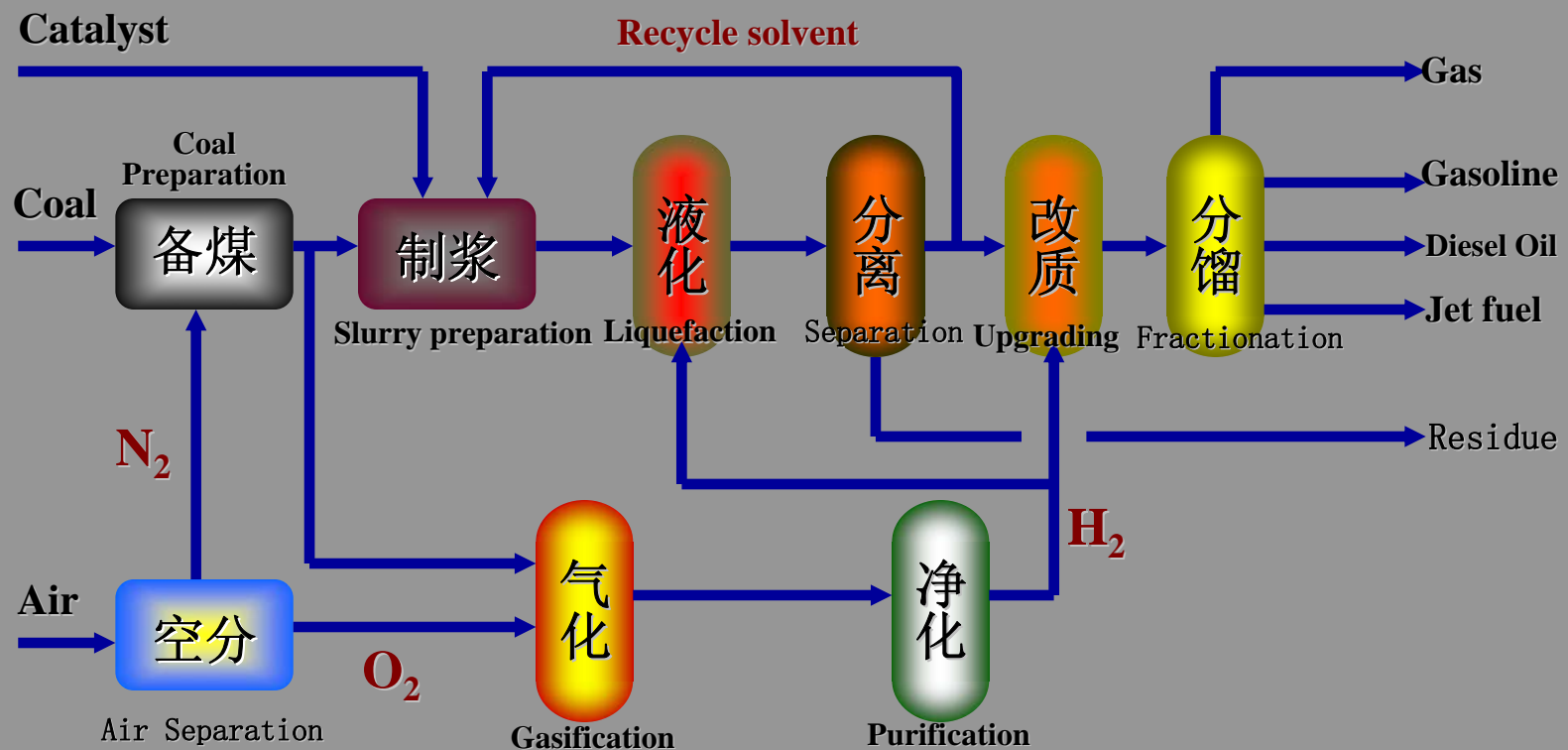
2010

2020



3. Development of Shenhua coal conversion projects

Shenhua Direct Coal Liquefaction Project



- Direct coal liquefaction is actually a process of coal hydrogenation at high temperature and high pressure with the action of catalyst.
- Use of Shenhua direct coal liquefaction process.



3. Development of Shenhua coal conversion projects

Shenhua Direct Coal Liquefaction Project

Main Production Units

- Catalyst Preparation
- Coal Liquefaction
- Solvent Hydrogenation
- Hydro-cracking
- Light-ends Recover & De-sulfur
- Coal Preparation
- Hydrogen production
- ASU
- Sulfur Recovery
- Sour Water Stripping



3. Development of Shenhua coal conversion projects

Shenhua Direct Coal Liquefaction Project

Product Scheme

Product	t/a
● LPG	70, 000
● Naphtha	320, 900
● Diesel Oil	620, 800
● Liquid Ammonia	11, 500
● Sulfur	40, 600
● Phenol	3, 500
● Total	1, 067, 300



3. Development of Shenhua coal conversion projects

Shenhua Direct Coal Liquefaction Project

The Shenhua direct coal liquefaction project has the following characteristics:

- Oversized equipment

Feed coal throughput of the first train 6,000 t/d

Coal based hydrogen production capacity 240,000 Nm³/h

- Advanced coal liquefaction process, mild reaction and operating conditions:

Operating pressure 18MPa

Operating temperature 445~455°C

- New and high-efficiency coal liquefaction catalyst

- The optimized integration of advanced and mature unit processes and technologies has reduced project risks and enhanced the operation reliability and economics.



3. Development of Shenhua coal conversion projects

Shenhua Direct Coal Liquefaction Project

Site Construction Commencement Ceremony





3. Development of Shenhua coal conversion projects

Shenhua Direct Coal Liquefaction Project

Site Leveling





3. Development of Shenhua coal conversion projects

Shenhua Direct Coal Liquefaction Project

Main Road to the Site Area





3. Development of Shenhua coal conversion projects

Shenhua Direct Coal Liquefaction Project

Construction site





3. Development of Shenhua coal conversion projects

Shenhua Direct Coal Liquefaction Project

Construction site





3. Development of Shenhua coal conversion projects

Shenhua Direct Coal Liquefaction Project

Reactors Fabrication Site





3. Development of Shenhua coal conversion projects

Shenhua Direct Coal Liquefaction Project



神华集团煤液化厂鸟瞰图

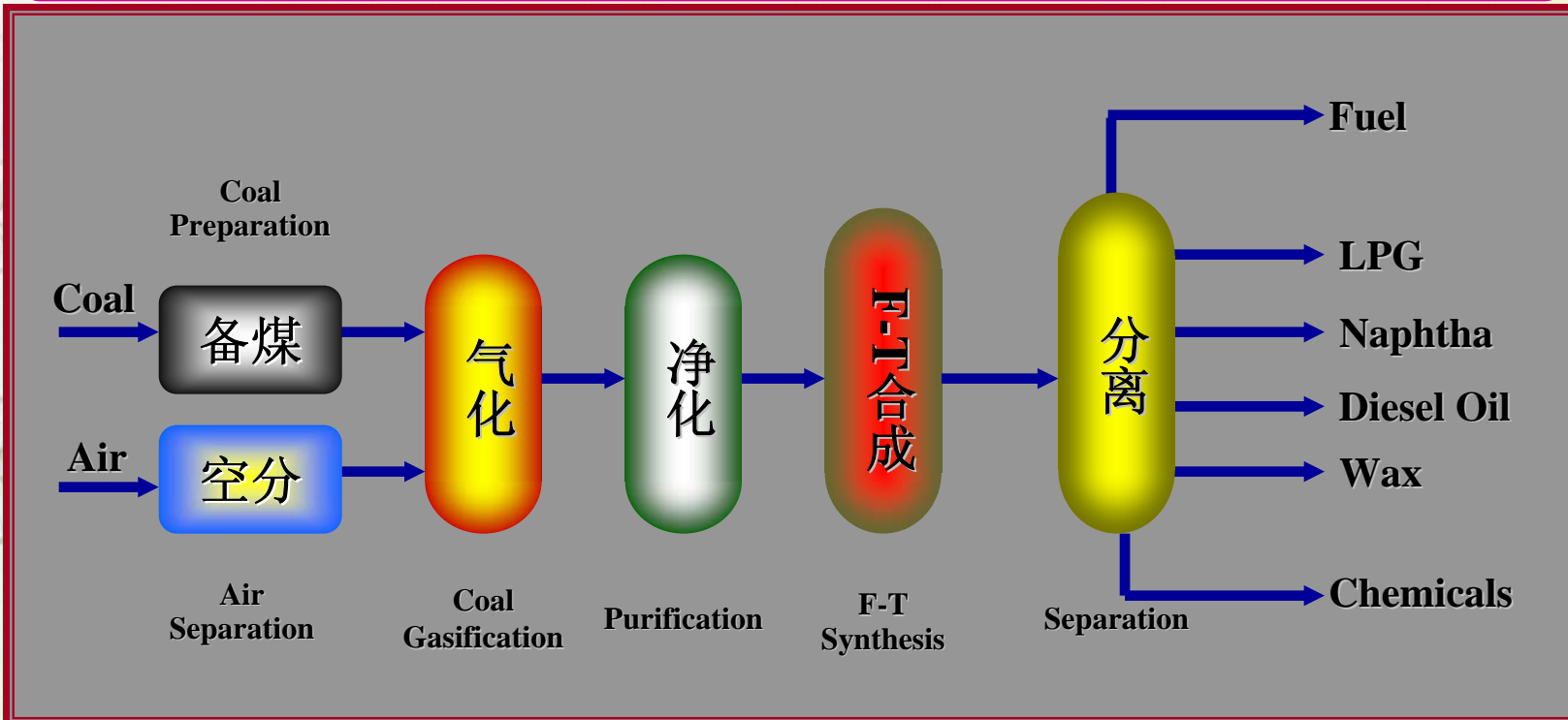
The first train is 1 Mt/a liquids and it will be put into operation in 2007.





3. Development of Shenhua coal conversion projects

Shenhua Indirect Coal Liquefaction Project



● The technology of indirect coal liquefaction is that: the coal is gasified into syngas, which is further synthesized into fuel oil and chemicals. The core technology of the indirect coal liquefaction is F-T synthesis .



3. Development of Shenhua coal conversion projects

Shenhua Indirect Coal Liquefaction Project

F-T synthetic products include:

- Oil phase product:

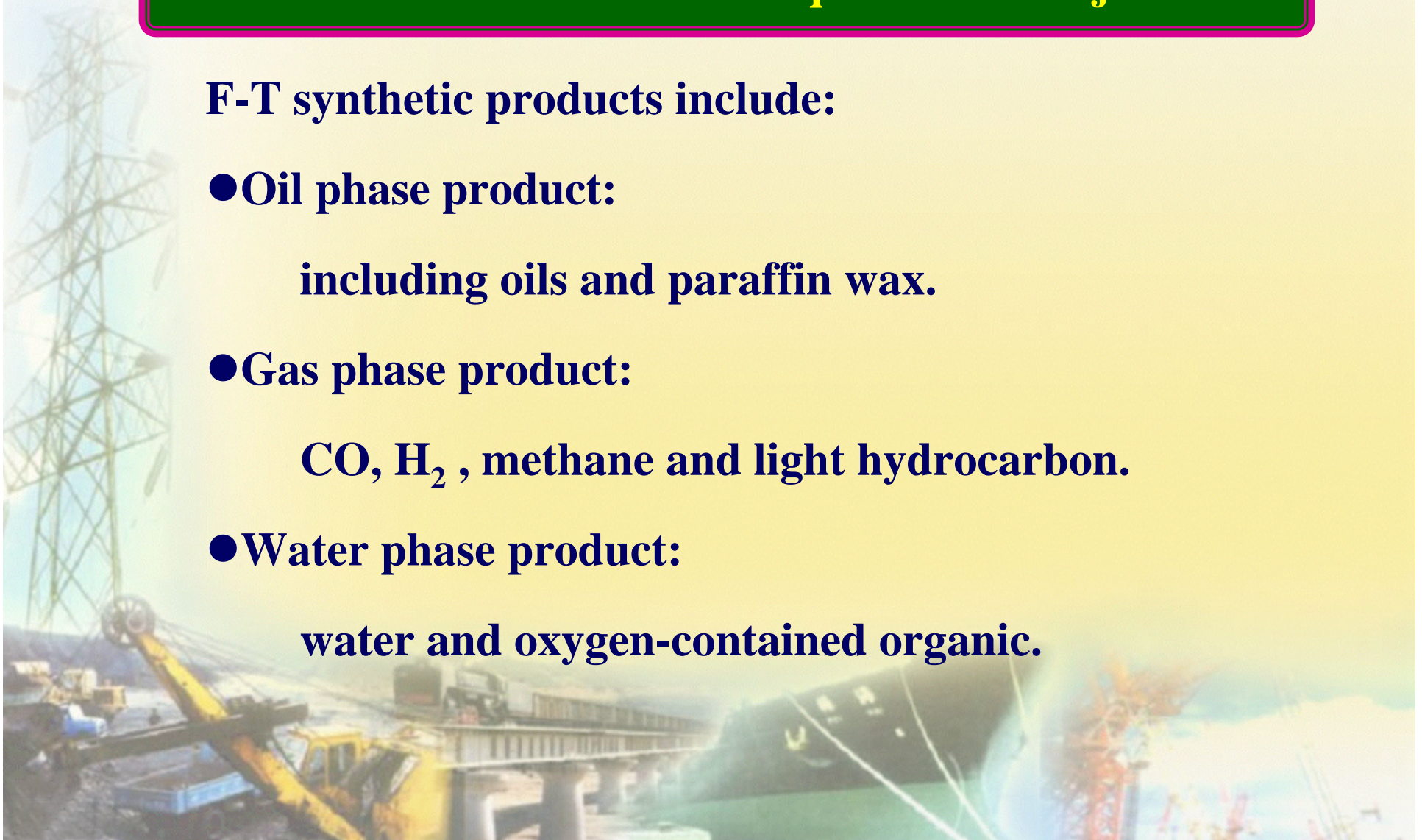
including oils and paraffin wax.

- Gas phase product:

CO, H₂, methane and light hydrocarbon.

- Water phase product:

water and oxygen-contained organic.





3. Development of Shenhua coal conversion projects

Shenhua Indirect Coal Liquefaction Project

- Key technology scheme primarily adopt the integration of advanced and matured coal gasification and advanced F-T synthesis technologies.
- Product slate will consider the combination of oil products and chemical products.
- At present, projects comparison and selection of different technology routes and feasibility study are undertaking.

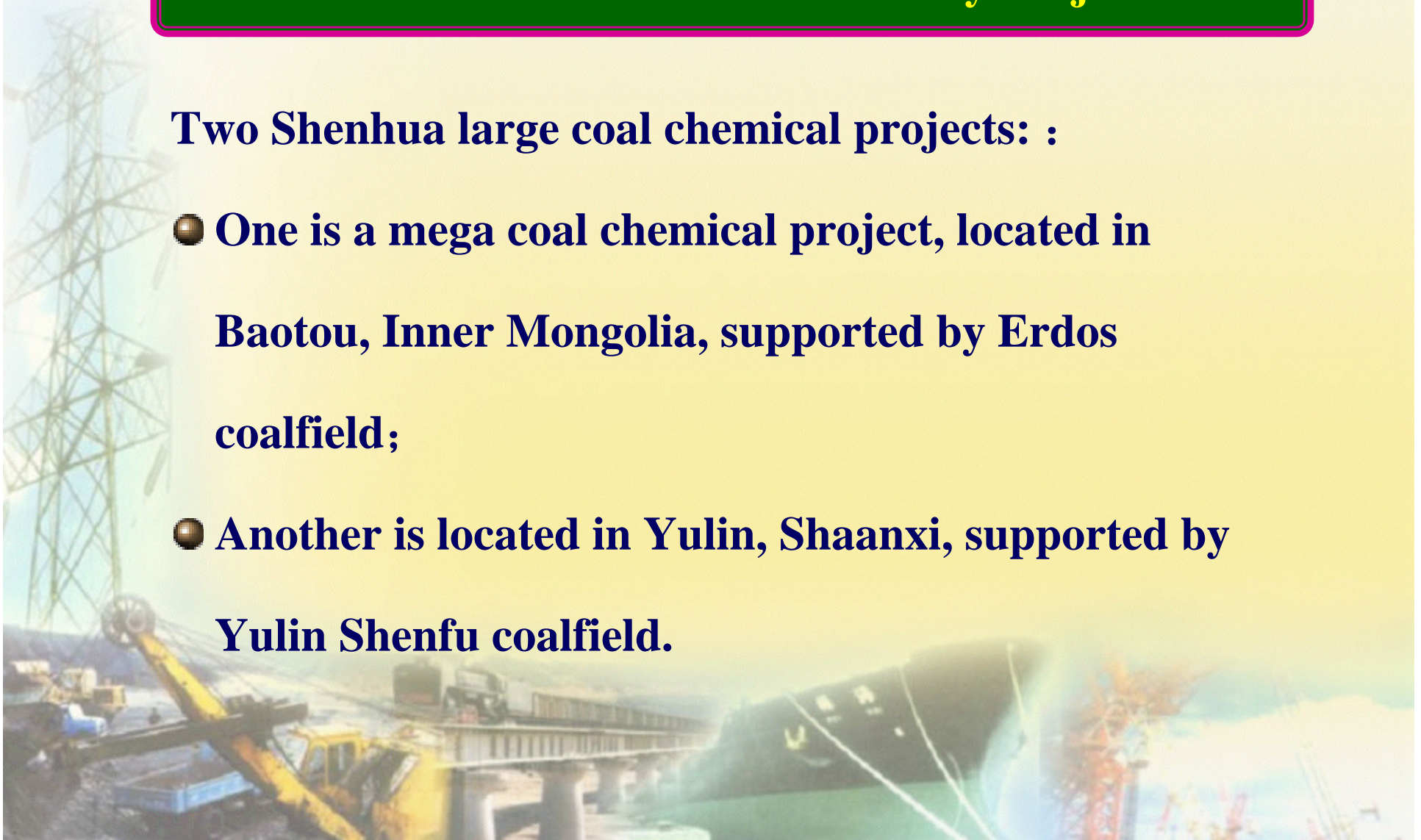


3. Development of Shenhua coal conversion projects

Shenhua Coal Chemical Industry Project

Two Shenhua large coal chemical projects: :

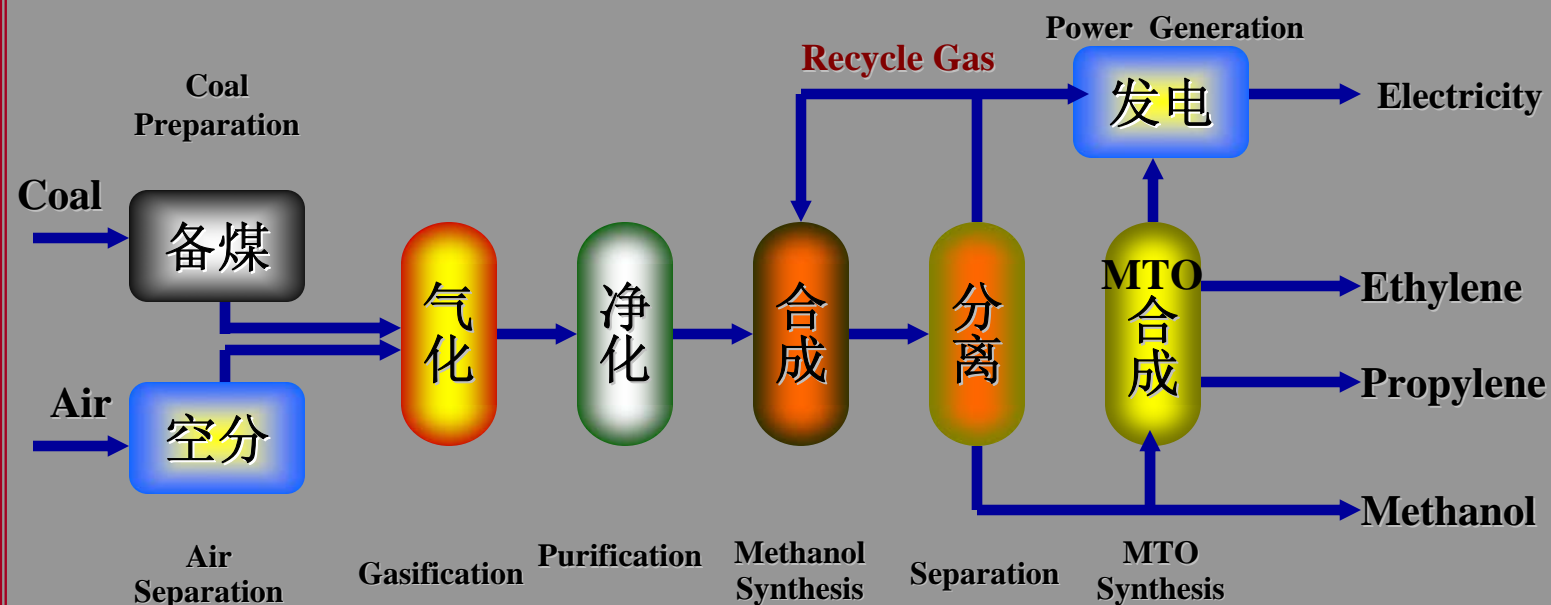
- **One is a mega coal chemical project, located in Baotou, Inner Mongolia, supported by Erdos coalfield;**
- **Another is located in Yulin, Shaanxi, supported by Yulin Shenfu coalfield.**





3. Development of Shenhua coal conversion projects

Shenhua Coal Chemical Industry Project



Key technology is coal to olefin, combination of coal to methanol and methanol to olefin.



3. Development of Shenhua coal conversion projects

Shenhua Coal Chemicals Project

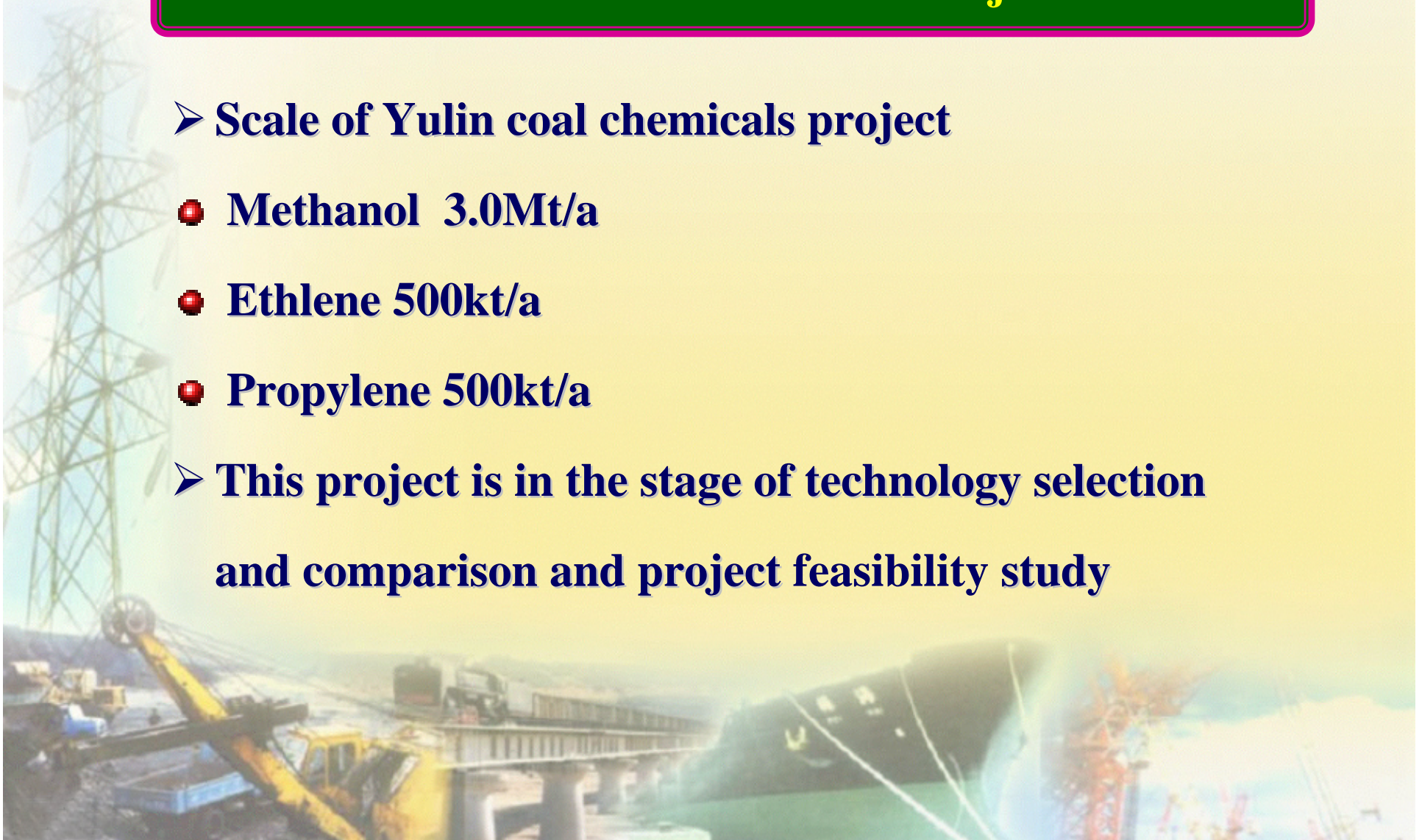
- Scale of Baotou coal chemicals project:
 - Methanol 1.8Mt/a
 - Ethylene 300kt/a
 - Propylene 300kt/a
- Having finished evaluation of feasibility study report, and in the stage of project engineering technology selection and inviting public bidding.
- The plant will be put into operation in 2008.



3. Development of Shenhua coal conversion projects

Shenhua Coal Chemicals Project

- Scale of Yulin coal chemicals project
 - Methanol 3.0Mt/a
 - Ethylene 500kt/a
 - Propylene 500kt/a
- This project is in the stage of technology selection and comparison and project feasibility study



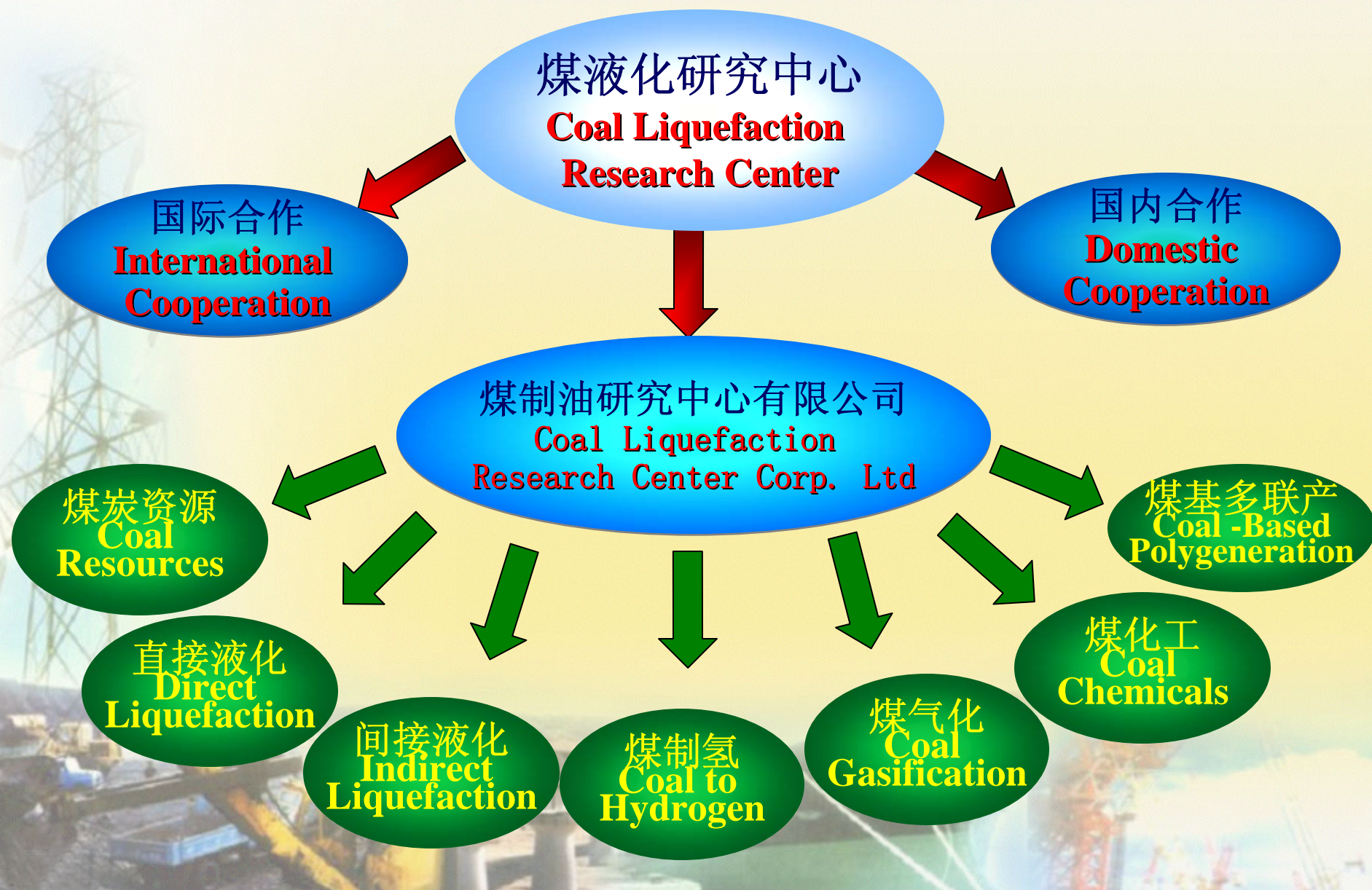


4. Research and development of Shenhua coal conversion technology





4. Research and development of Shenhua coal conversion technology





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4. Research and development of Shenhua coal conversion technology

Technical development to support Shenhua DCL project:

- Development of a new type of coal liquefaction process;
- Development of a new type of catalyst with high efficiency;
- Coal petrographic study for liquefaction;
- Study on basic physical properties of DCL;
- Study on effluent water treatment of DCL;
- Study on comprehensive utilization of coal liquefaction residue;
- Studies on key equipment for coal treatment, coal slurry preparation, liquefaction reactor, coal slurry feed pump and recycle pump, coal liquefied oil processing;
- Study on influences of coal liquefaction on the regional environment, economics and community.



4. Research and development of Shenhua coal conversion technology

Combined with Shenhua coal conversion projects, the following technologies are developed:

- **F-T synthesis technology;**
- **Configuration, design, processing and manufacture technologies of synthesis reactor;**
- **F-T synthesis catalyst technology and catalyst-wax separation;**
- **System integration and control and operation technology of large-scale coal chemical system;**
- **Deep processing technology of coal liquefaction product**
- **Technology of large-scale coal gasification, coal to hydrogen, coal-based poly-generation.**



4. Research and development of Shenhua coal conversion technology

● Shenhua coal conversion projects are mainly built in the west of China, where it has ample environmental capability, yet with weakly defendable environment.

● At the same time, Shenhua group pays more attention to construction of ecological environment.

Shenhua will study the influences of project construction on local communities and surrounding areas, resources, economy and ecological environment.



4. Research and development of Shenhua coal conversion technology

The results of technical and economical analysis of domestic researchers for different coal conversion processes show:

- direct coal liquefaction technology has an energy efficiency of about 60%;
- about 14~18% higher than other coal conversion technologies;
- with the best environmental effects , such as CO₂ emission; the lowest resources consumption and the lowest investment for per unit product.



4. Research and development of Shenhua coal conversion technology

Overall comparison of coal conversion technologies						
Item		Unit	Direct Liquefaction	Indirect Liquefaction		Methanol
				High Temp.	Low Temp.	
Technical	Efficiency	%	59.75	41.56	41.26	45.64
	Products Recovery	%daf	55.15	38.09	43.2	100.35
Resource use	Water use	t/GJ	0.16	0.25	0.26	0.31
		t/t	7	11.21	11.96	7.05
	Coal use	tce/GJ	0.061	0.075	0.076	0.068
Economic	Investment	RMB/t	7260	9110.07	8414.82	3295.08
		RMB/GJ	169.76	200.05	183.01	144.12
	Cost per ton	RMB/t	1771.06	2191.11	1845.89	1083.97
		RMB/GJ	41.41	48.12	40.15	47.41
	IRR	%	10.16	14.96	9.64	14.53
Environ	CO ₂	kg-C/GJ	20.09	34.72	35.61	29.22
	SO ₂	kg/GJ	0.01	0.004	0.004	0.003
	NO _x	kg/GJ	0.09	0.133	0.186	0.17
	Dust	kg/GJ	0.01	0.01	0.013	0.02
	Water	kg/GJ	6.87	6.29	6.46	5.58
	Residue	kg/GJ	3.36	9.92	10.29	8.86



4. Research and development of Shenhua coal conversion technology

● At present, Shenhua group Ltd. is undertaking construction of the first large-scale direct coal liquefaction demonstration project in the world. Advantages and bright prospects of direct coal liquefaction technology on investment, environment and efficiency are important considerations.





4. Research and development of Shenhua coal conversion technology

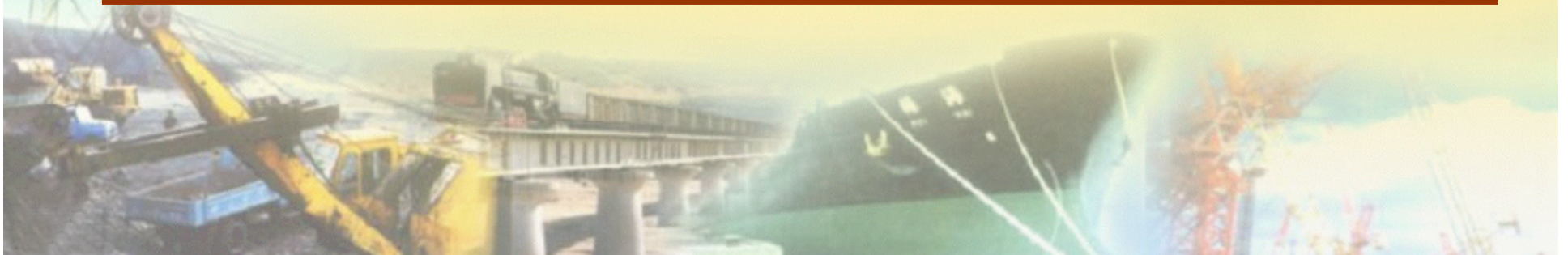
● Shenhua direct coal liquefaction demonstration project involves the integration and intercrossing of coal processing, chemical engineering, petroleum engineering, mechanical manufacture, material, control, special engineering thermodynamics calculation, software engineering etc. Systemic technical optimization and integration are needed. Once this demonstration project succeeds, it will give far-reaching effect on coal-to-oil industry of China and the world.

5. Conclusions

- With the development of world economy, the imbalanced oil supply and demand will be intensified. Coal will still be the best substitute for oil and natural gas.
- Clean coal conversion and high-efficiency utilization will be the approach for future world energy mix readjustment and guarantee of energy demand of high-speed economic development.

5. Conclusions

● China is a country with scarce oil but rich coal resources. Coal liquefaction, coal-to-oil, CCT development and high-efficiency utilization, maintaining environmental friendly are the basic national policies to ensure the long-term energy security.



5. Conclusions

●Shenhua deeply feels the importance of technical innovation and equipment to an enterprise. Combining with the self development, Shenhua will increase the input on technology R&D and provide support to the processes, technologies and equipment with good developing prospects in the area of CCT conversion. We are looking forward to the extensive cooperation with domestic and foreign partners.

谢谢！

Thank
you !

