

**30<sup>TH</sup> ANNUAL INTERNATIONAL  
PITTSBURGH COAL CONFERENCE**



**Fully Vertically Integrated Coal  
Based Clean Energy Company  
—— The Future of Coal Industry**

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BEIJING, CHINA**

# Outlines

- **Vertical Integration in Shenhua Group**
- **Why Fully Vertical Integration is Needed for Coal Industry ?**
- **New Technologies Promote Vertical Integration of Coal Industrial Chains**
- **Concluding Remarks**

## Part 1:

# Vertical Integration in Shenhua Group

- ✓ Coal exploitation and production,
- ✓ Coal transportation
- ✓ Coal fired power plants
- ✓ Coal to liquids and chemicals

# Vertical Integration in Shenhua



Mining

China's largest Integrated energy company, supplying **6.5%** of electricity and **12%** of primary energy in China.  
The largest coal company in China and the largest coal supplier in the world



Chemical conversion

The businesses covering mining, power, railway, port coal to liquids & chemicals, and renewable energy.



神华集团  
SHENHUA GROUP

**45** subsidiaries (Branches),  
~**270,000** employees  
RMB ~**870** billion total assets



Power



Railway



Port



Renewable energy

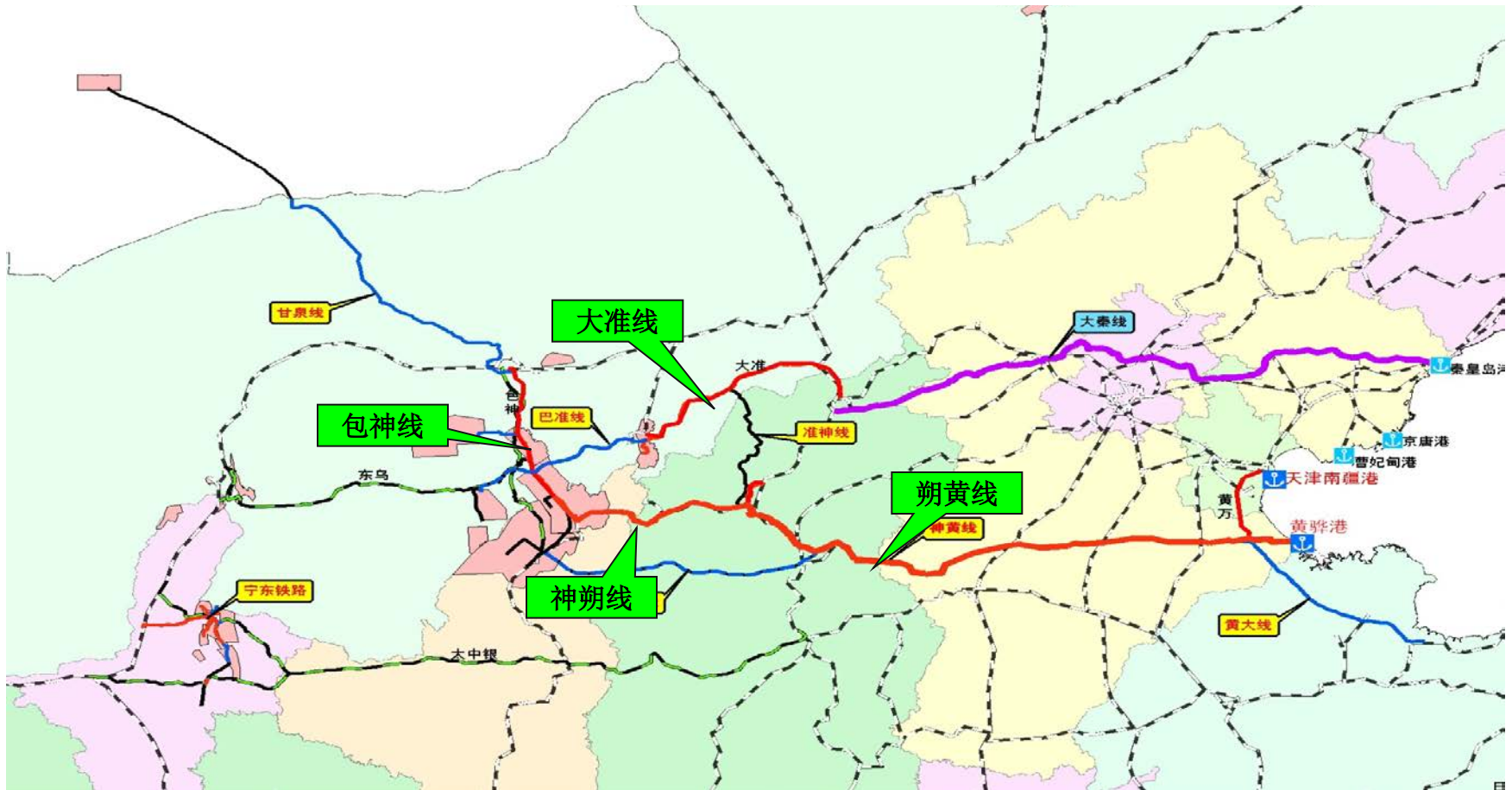
# Coal

There are **8 mining complexes across 5 provinces**: Inner Mongolia, Shaanxi, Shanxi, Ningxia, Xinjiang, etc.



# Railway

Shenhua railway length is **1642 km** , with a capacity of transporting **300 mil. T.** of coal.



# Ports



## Port : 3

■ Huanghua port : seaborne capacity exceeding **100 mil.t/a** and is ranked as the second largest coal port.

■ Tianjing port : seaborne capacity exceeding **45 mil. t/a**

■ Zhuhai Gaolan port: seaborne capacity exceeding **40 mil. t/a**

# Power

By 2012 , the capacity of coal power plants amounted to **63GW** and ranks as the 6th power generation company in China.



Coal fire power plant : **63**



Wind power plant : **33**



PV Station : **2**

Hyro power plant : **5**



# Coal Chemicals

Capacity of coal to liquid & chemicals amount to **10 mil.t/a**

## Coal-to-liquids



World's first industrialized 1 mil. t/a direct liquefaction facility

## CCS



China's first 100,000 t/a CCS demonstration project

## Methanol to olefins (MTO)



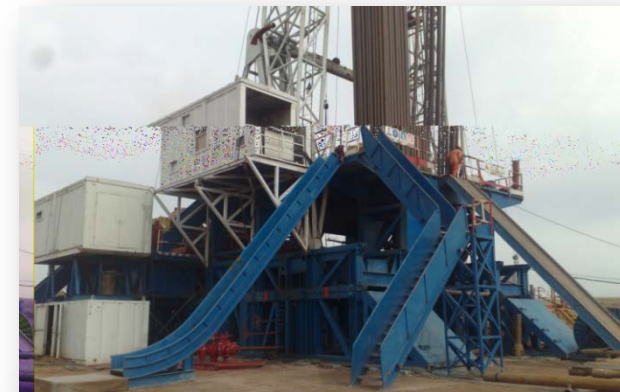
600,000 t/a MTO and 500,000 t/a methanol-to-polyolefins (MTP) demonstration projects

## Coal to SNG



1.73 bn m<sup>3</sup>/a SNG project

# Shenhua CCS Demo Project



Feasibility Study started in 2007, concluded in Nov. 2009; Injecting CO<sub>2</sub> from DCL plant close to the DCL site.

100 KTA CCS pilot plant successfully injected supercritical CO<sub>2</sub> into the saline aquifer with a depth of 2,243.6m on Jan 2nd, 2011.

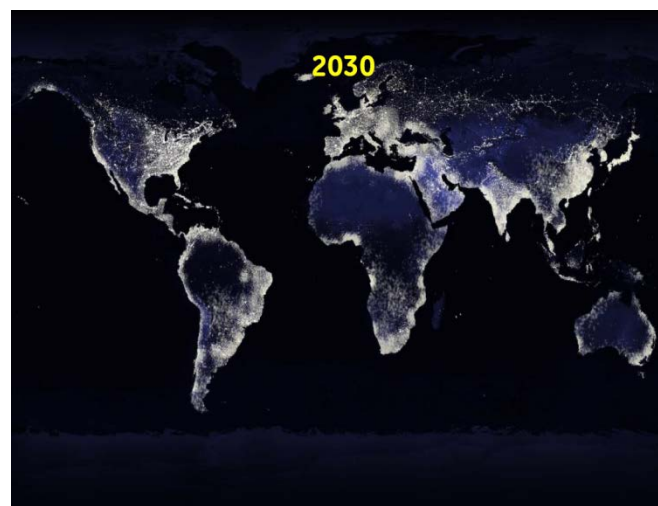
## Part 2:

# Why Vertical Integration ?

- ✓ **The demands of CO<sub>2</sub> and other emission reduction**
- ✓ **Lessons learned from oil industry**
- ✓ **Life cycle analysis**
- ✓ **Benefits of an integrated coal industrial chain (higher energy efficiency leads to less emissions, risk mitigation, revenue & profit growth, etc.)**

# Higher Energy Demand — A Matter of Fact

- Total global energy consumption was 12.48 billion ton oil equivalent in 2012
- This demand will grow by 40% by 2030 forecasted by IEA
- The current energy production and utilization faces grave challenges ahead



# Carbon Emission – A Dilemma between the Right to Survive and the Right to Develop



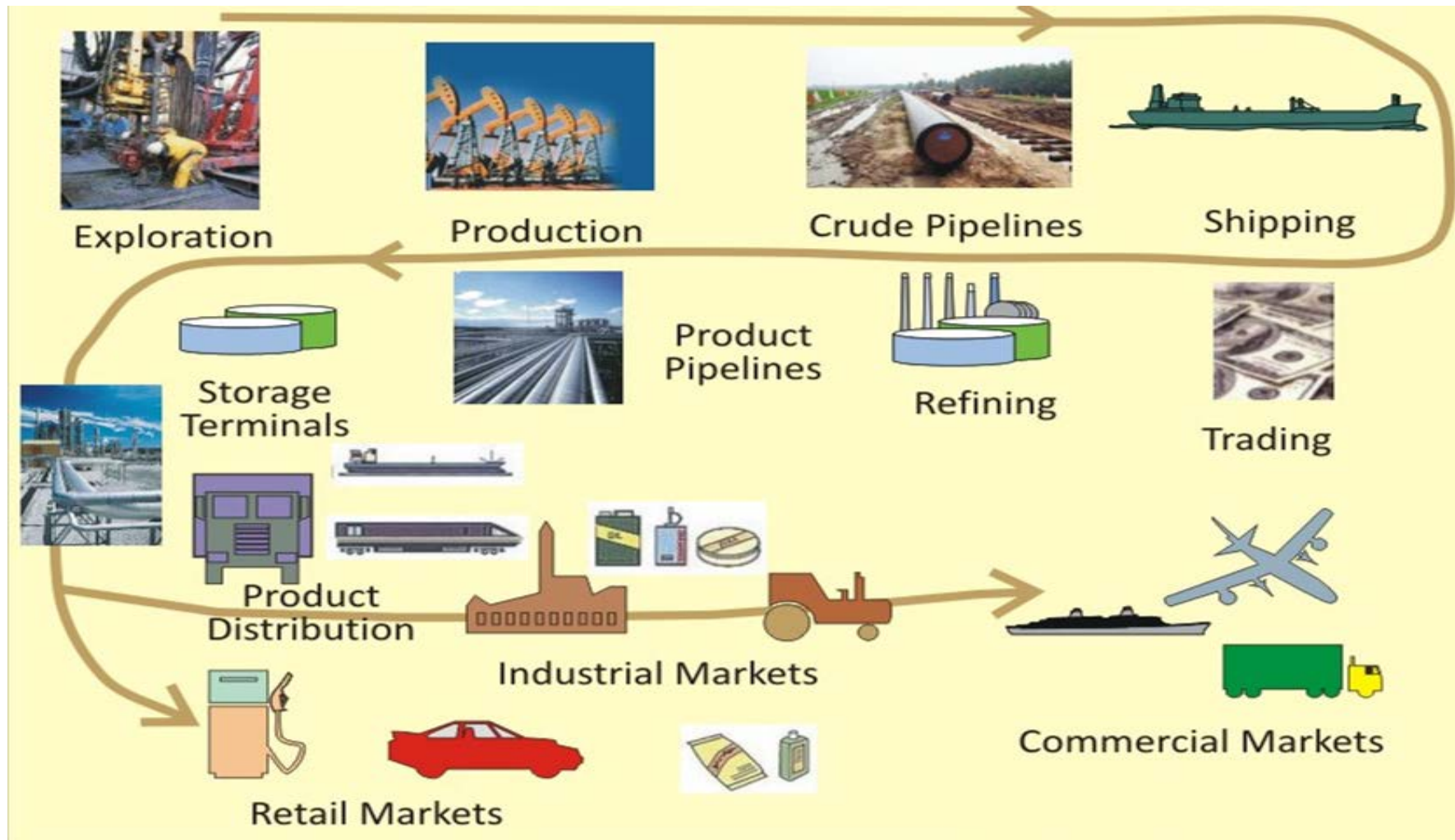
- Global warming caused by carbon emission is fundamentally changing earth's climate
- Fossil-energy-based emerging countries will account 80% of the increased energy consumption!
- How to balance the right to survive and the right to develop for human beings?

CO2 Emitters: IEA Ref. Case

	2005		2015		2030	
	<i>Gt</i>	<i>rank</i>	<i>Gt</i>	<i>rank</i>	<i>Gt</i>	<i>rank</i>
US	5.8	1	6.4	2	6.9	2
China	5.1	2	8.6	1	11.4	1
Russia	1.5	3	1.8	4	2.0	4
Japan	1.2	4	1.3	5	1.2	5
India	1.1	5	1.8	3	3.3	3

# A model by petroleum industry: A vertically integrated industry system

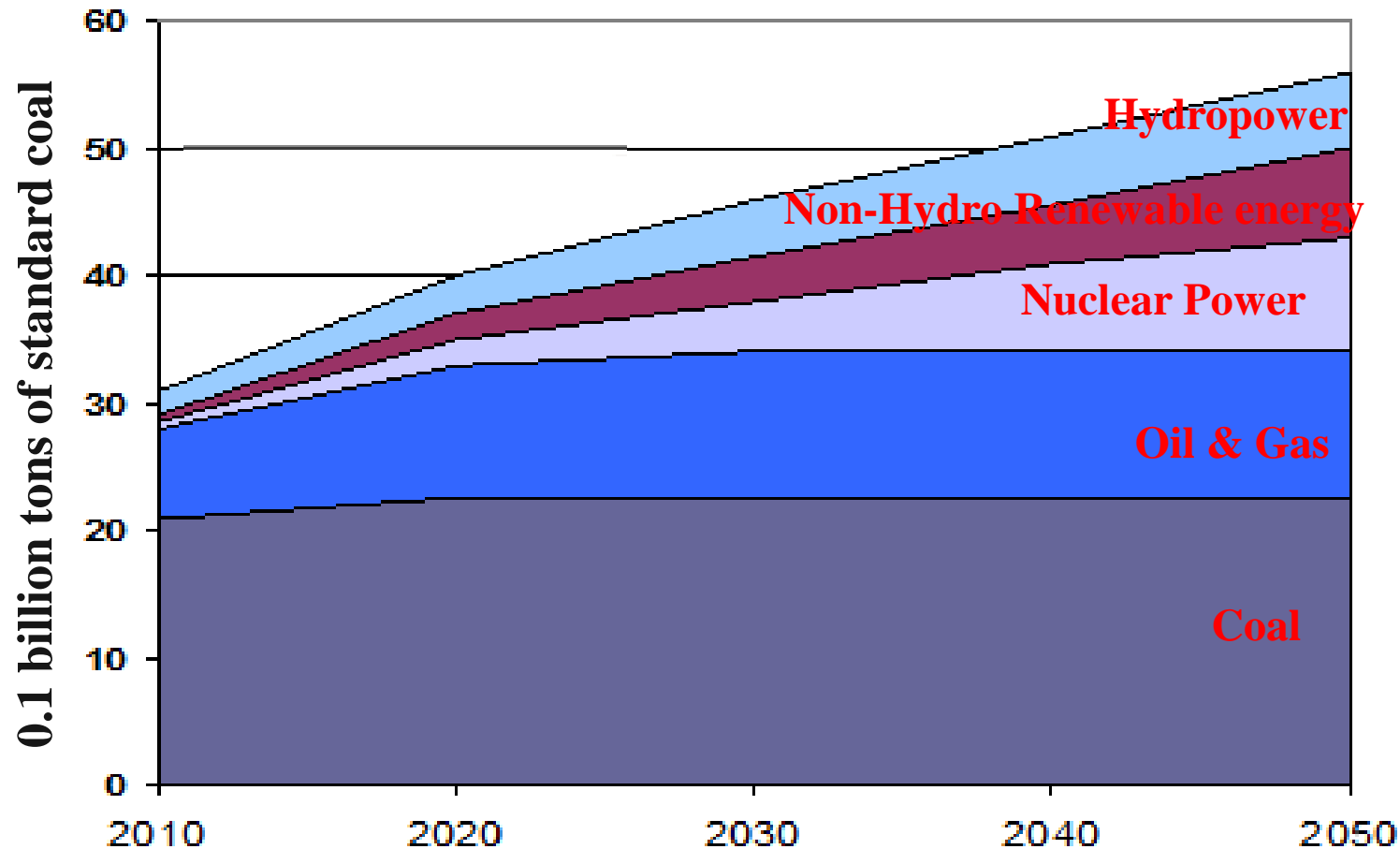
Huge petroleum companies, e.g., BP, Chevron, ExxonMobil, Shell, CNOOC, CNPC, always have an integrated industrial chain:



# Coal plays a dominant role — An energy reality in China

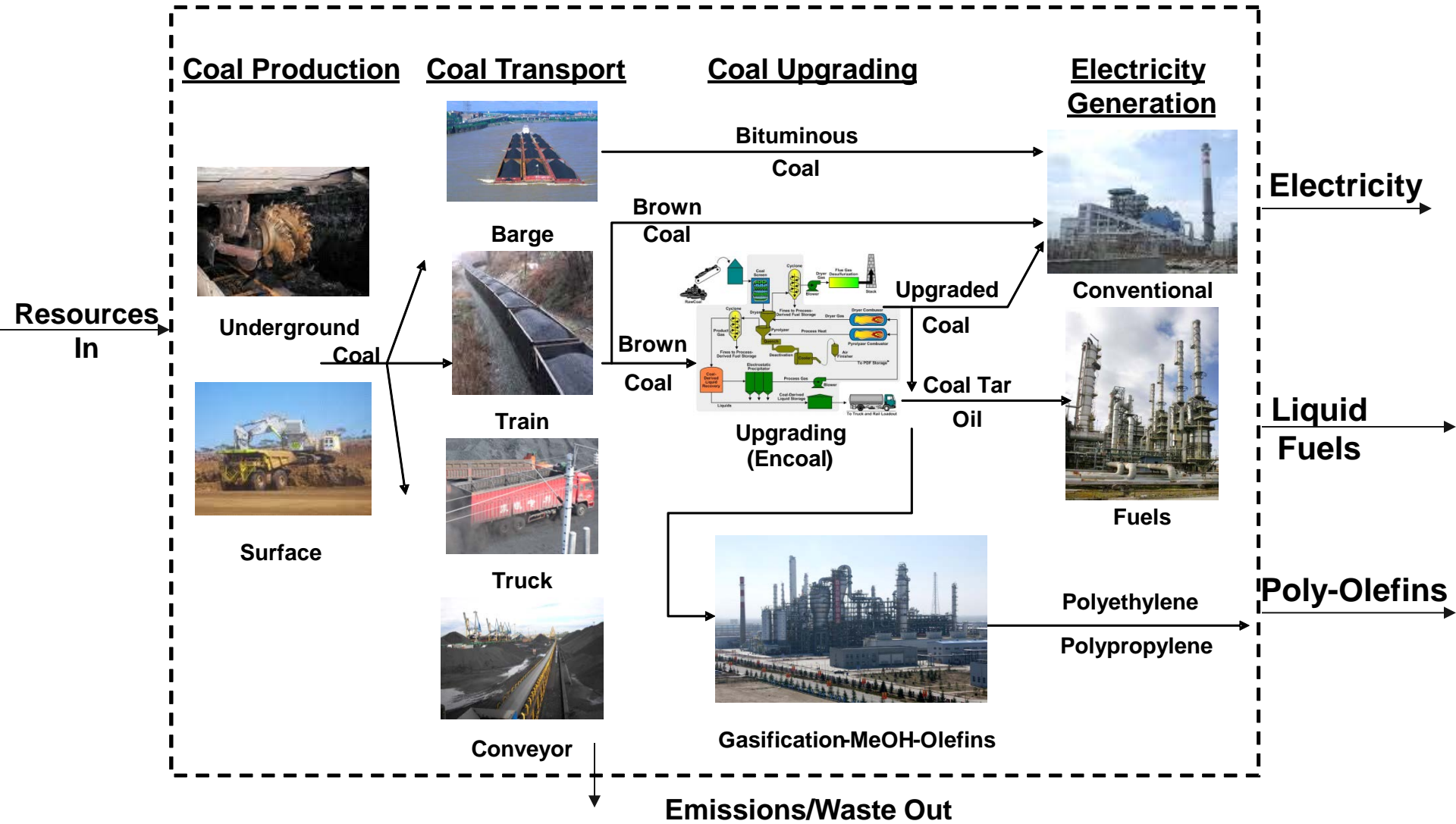


Safe, green, clean, highly-efficient development and utilization of coal is a pressing issue of fundamental values in China!



CAE: National strategy study on medium-and long-term energy development

# Vertical Integration: Coal Industry Life Cycle System





# CO<sub>2</sub> Reduction within Vertical Integration



CO <sub>2</sub> Emission Reduction (Million tons)	By 1% Improved Efficiency in Coal –Chain Industries <sup>a)</sup>	By Solar & Wind's Displacing Coal <sup>b)</sup>
Global	325	91
US	49	18
China	152	13

- Increased efficiency of coal utilization -- the most cost effective approach for CO<sub>2</sub> reduction in the foreseeable future.
- Co-processing & utilization of biomass with coal will reduce CO<sub>2</sub> emission further.

a) The calculations are based on 2009 data, the current efficiency estimated as 35%;  
b) CO<sub>2</sub> emission factors are 3.96, 3.07 and 2.35 ton-CO<sub>2</sub>/toe for Coal, Oil and Natural Gas, respectively, from BP Statistical Review of World Energy, 2010.

# Benefits offered by a vertically integrated coal industry



- **Improve the overall energy efficiency**
- **Reduce emissions and pollutions**
- **Strengthen risk mitigations**
- **Lead to revenue & profit growth**
- **Advance the clean coal technologies**
- **Enhance the stature of coal industries**

## Part 3:

# New Technologies Promote the Vertical Integration of Coal Industry

- ✓ Coal production technologies
- ✓ Coal conversion & coal refining technology
- ✓ Coal power generation and energy storage  
... etc.

# Shenhua Tech. Innovation System



北京低碳清洁能源研究所  
National Institute of  
Clean & Low-carbon  
Energy (NICE)

科技发展公司  
Science &  
Technology  
Development Corp.

**Five in  
One**

国际煤炭战略研究所  
International  
Institute of Coal  
Strategy

神华研究院  
Shenhua R&D  
Institute

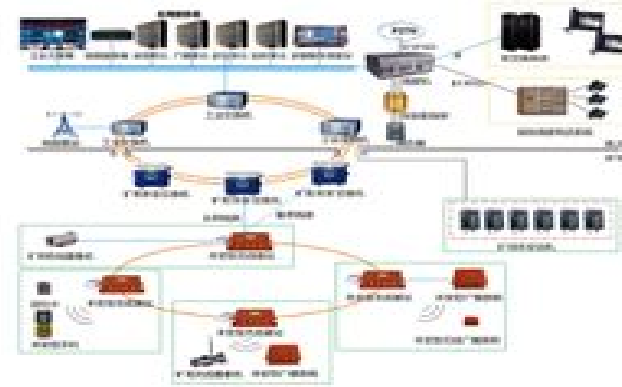
神华管理学院  
Shenhua  
Institute of  
Management



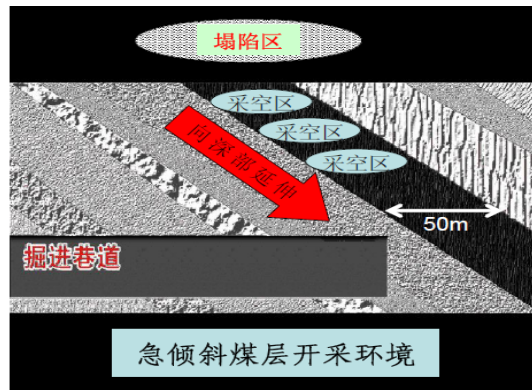
# Shenhua's Coal Production Technology Development



Technologies in effective water use and pollution-controls.



Digital mining technologies

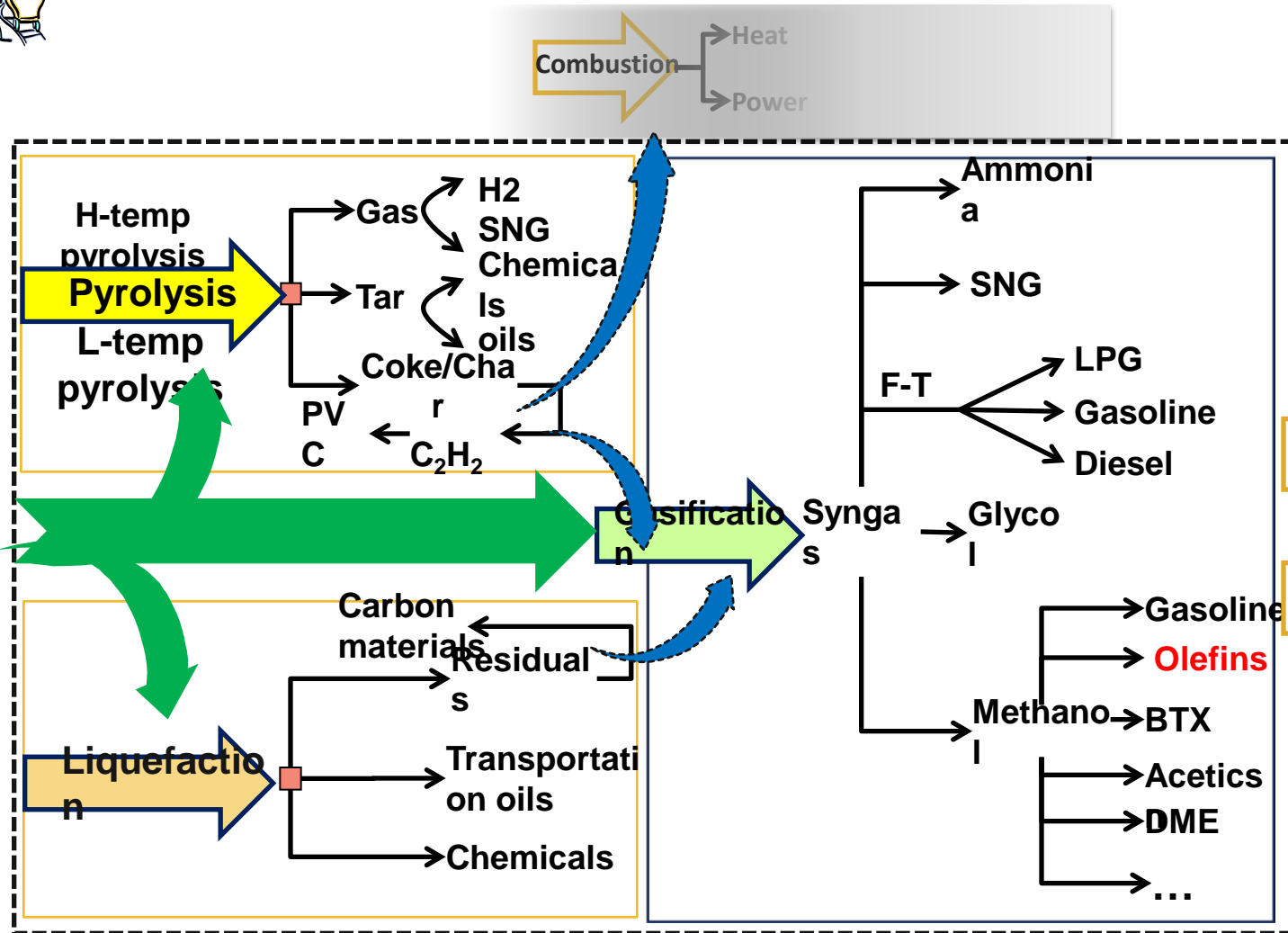


Techniques to prevent hazards in shallow pitching veins



TBM techniques used in long-distance and steep-sloped coal mines


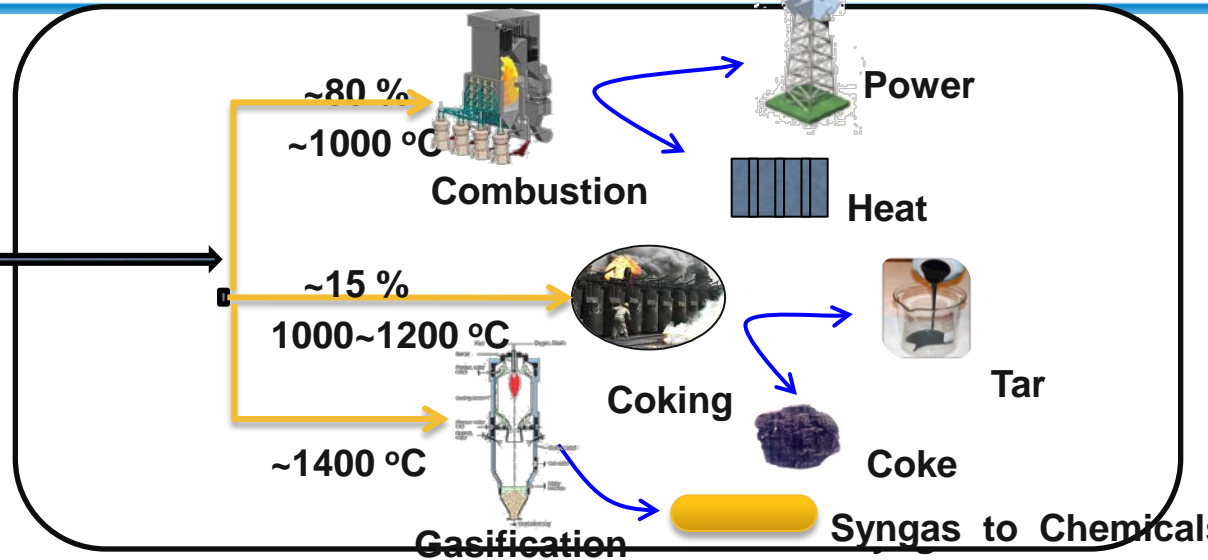
# Clean Coal Conversion



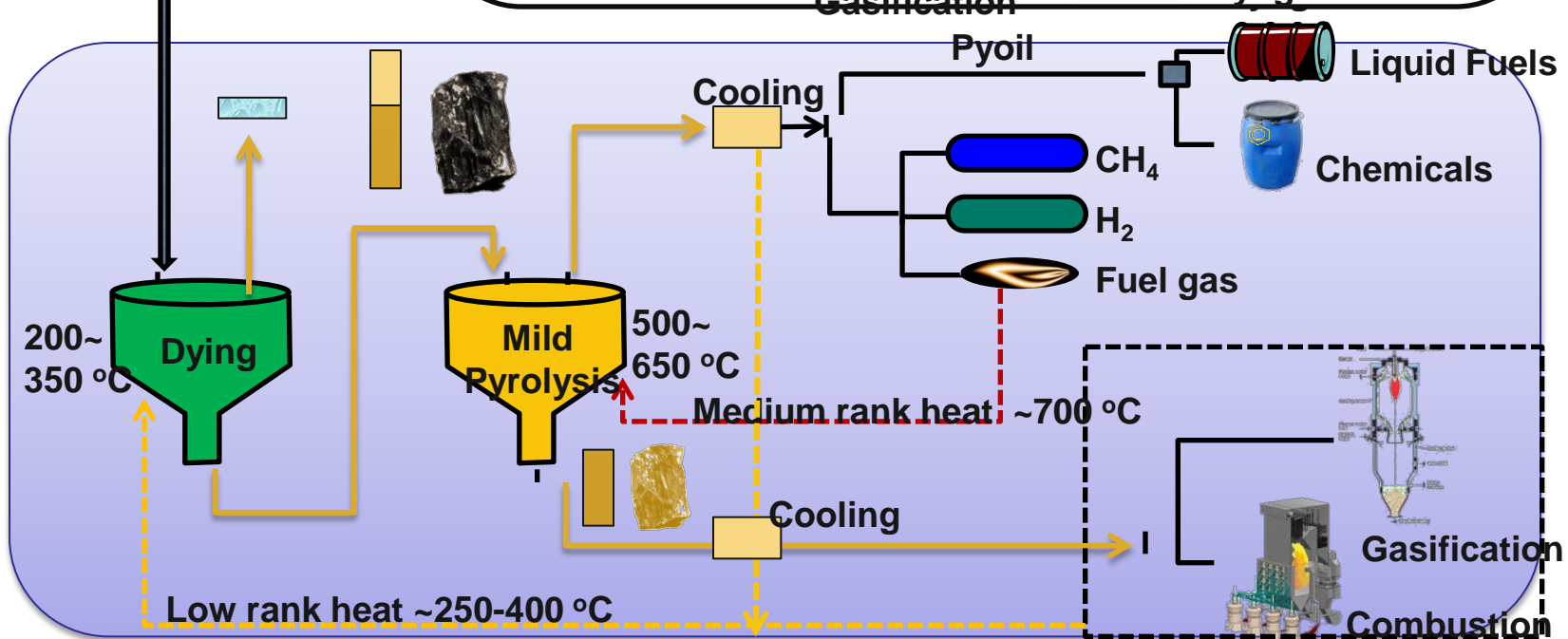
# Coal Refining – New Approach of Coal Utilization

## Current Paths of Coal Utilization

Moisture  
Volatile  
Fixed Carbon / Ash

## Coal Refining



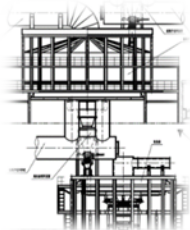
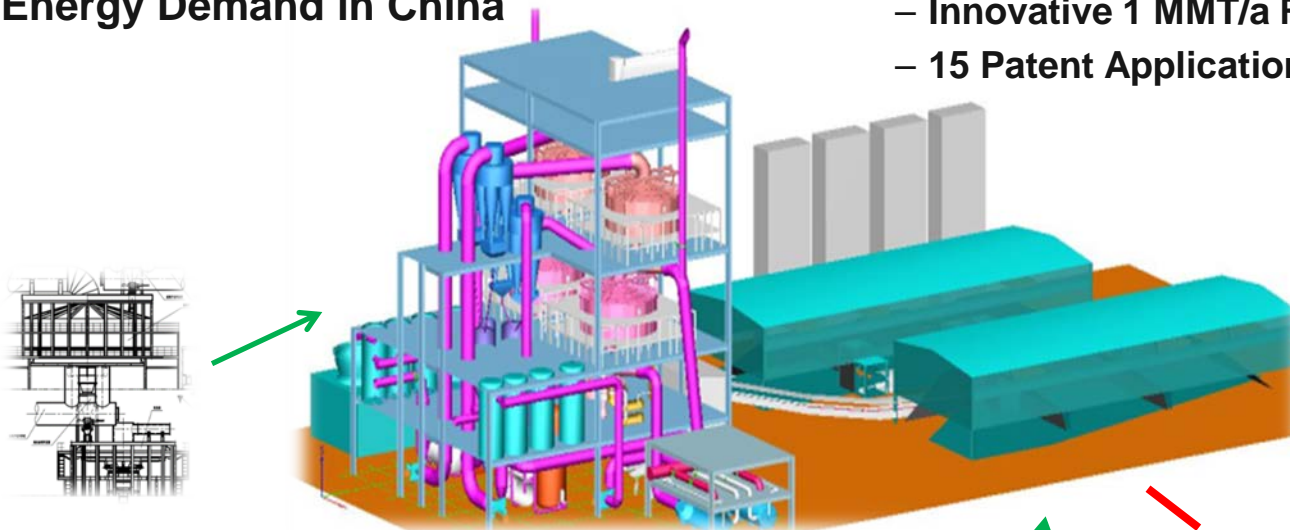
# Low Rank Coal Refining Technology Development

## Objectives and Impacts

- Clean & Efficient Utilization of LRC
- Meet Energy Demand in China

## Achievements

- Pyrolysis Tests for Typical Shenhua Coals
- Feasibility Study of a 10 MMT/a Project
- Innovative 1 MMT/a Reactor Design
- 15 Patent Applications on coal pyrolysis



Critical Equipment Design



Coal Pyrolysis Lab Test Platform

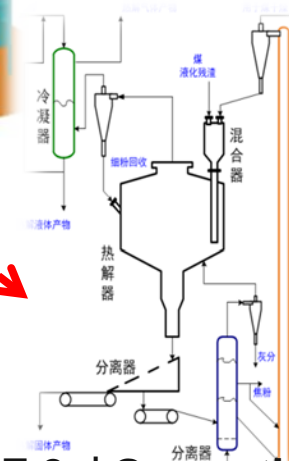


Sample Preparation Unit (SPU)

NICE 1<sup>st</sup> Generation CoalRef<sup>®</sup> Technology (1 MMT/a)



0.3 MMT/a Encoal Demo. Plant



NICE 2<sup>nd</sup> Generation Technology  
In R&D Stage;

Sponsored by MOST (52 MM RMB) and Shenhua Group (60 MM RMB)



# Shenhua Clean Coal Conversion Blueprint during 12<sup>th</sup> Five-Year Plan Period



Capacity by the end of the 12<sup>th</sup> Five-Year Plan period:

**CTL: 10MMTA**

**Coal-to-Methanol: 10.85MMTA (including methanol from MTO plant)**

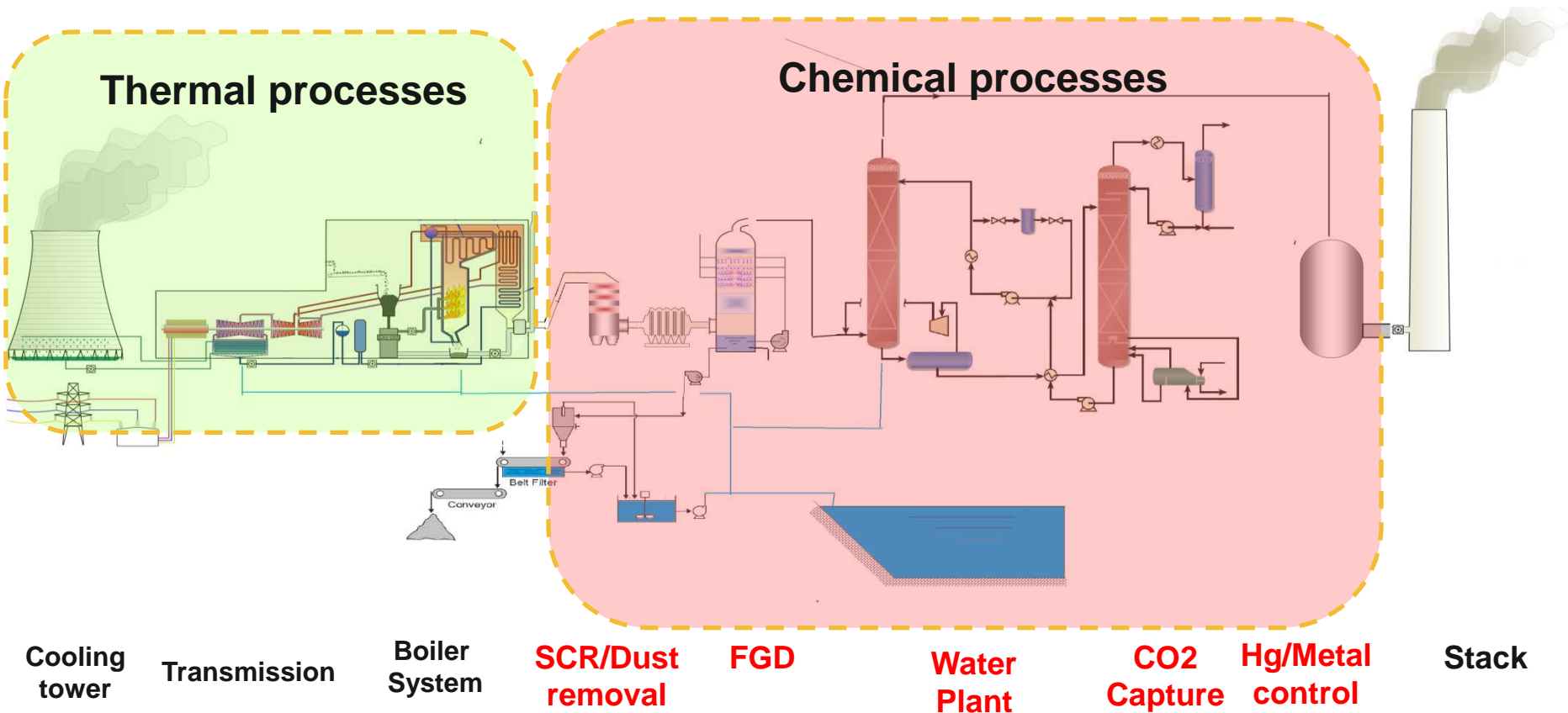
**Coal-to-Olefins: 3.8MMTA**

**SNG: 1.7 billion Nm<sup>3</sup>/yr**

**Total investment: over 100 billion RMB (excluding capital contribution from partners)**

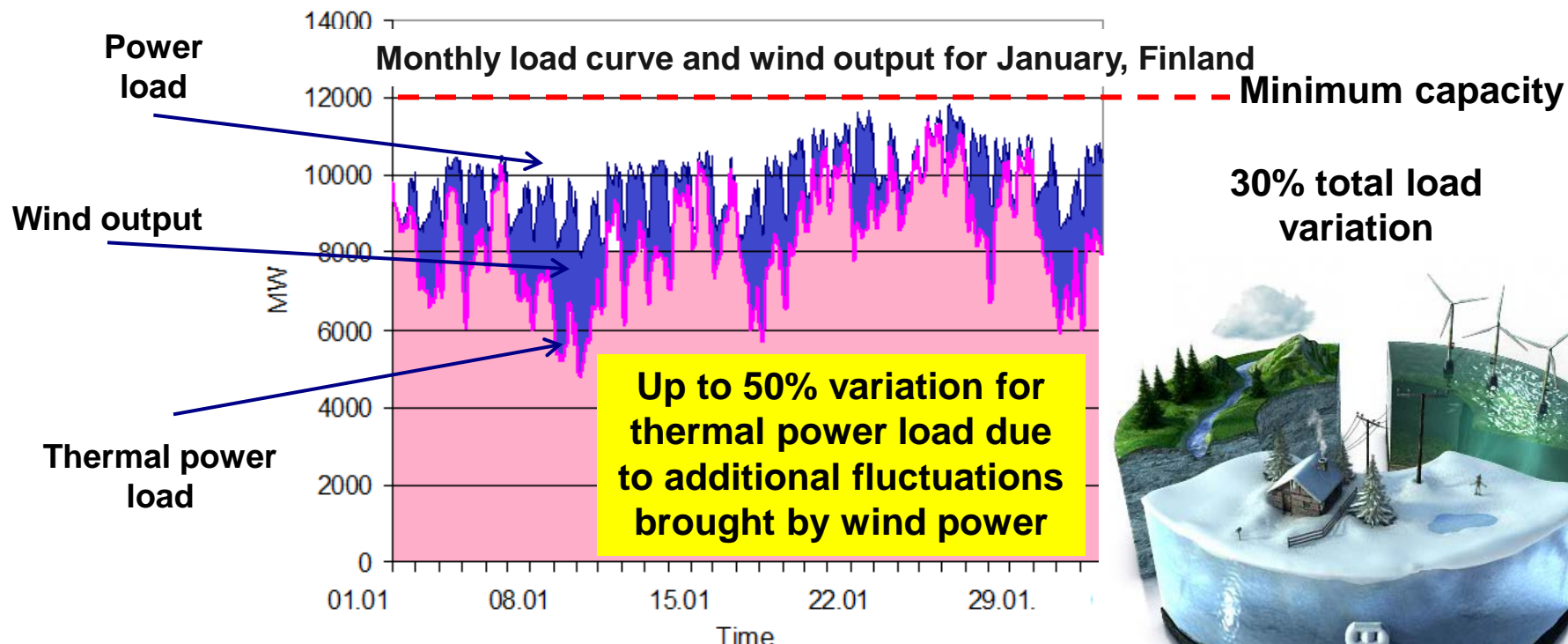
# Emission Reduction of Coal Power Plants, IGCC & Energy Storage

- Increasing importance of Chemical processes in modern coal-fired power plants
- Energy Storage for Integration with Wind/Solar



# Dynamic vs. Steady - A Paradox For Power Demand & Supply

- Chemical process: steady operation, slow respond
- Power load: dynamic change, trend predictable
- Renewable power (wind/solar): largely random, unpredictable fluctuations



\* Ref. DOE report NREL/CP-440-22868, and Rte -France website

In China, 30~50% of wind power not able to connect to grid  
中国30~50%的风力发电不能上网

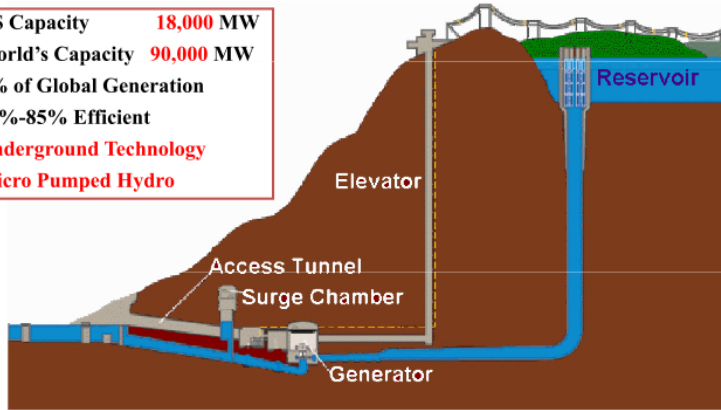
Massive Energy Storage  
For Electric Power Industry Needed

# Energy Storage

## Pumped Storage Facility

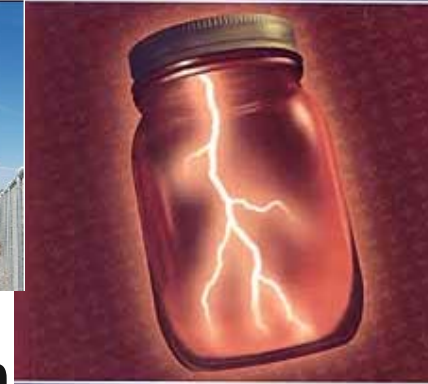
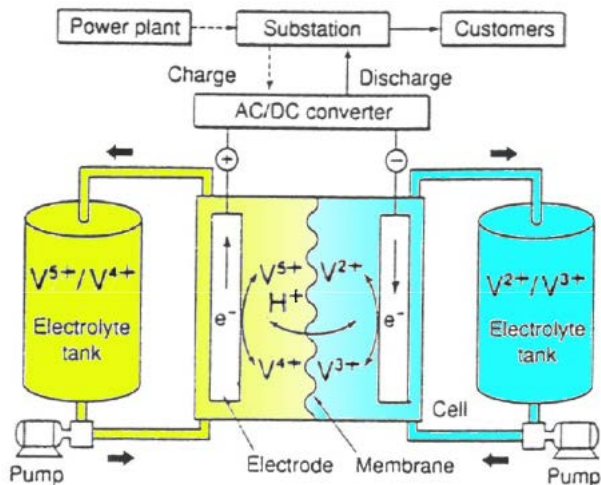


US Capacity **18,000 MW**  
 World's Capacity **90,000 MW**  
 3% of Global Generation  
 70%-85% Efficient  
 Underground Technology  
 Micro Pumped Hydro



High Capacity - Low Cost - Special Site Requirement - Slow response

## Flow Battery



NICE: Portfolio approach on energy storage technologies

## Thermal Storage Systems (热能储存系统)



# Selecting Strategic Direction Of Coal Conversion Process

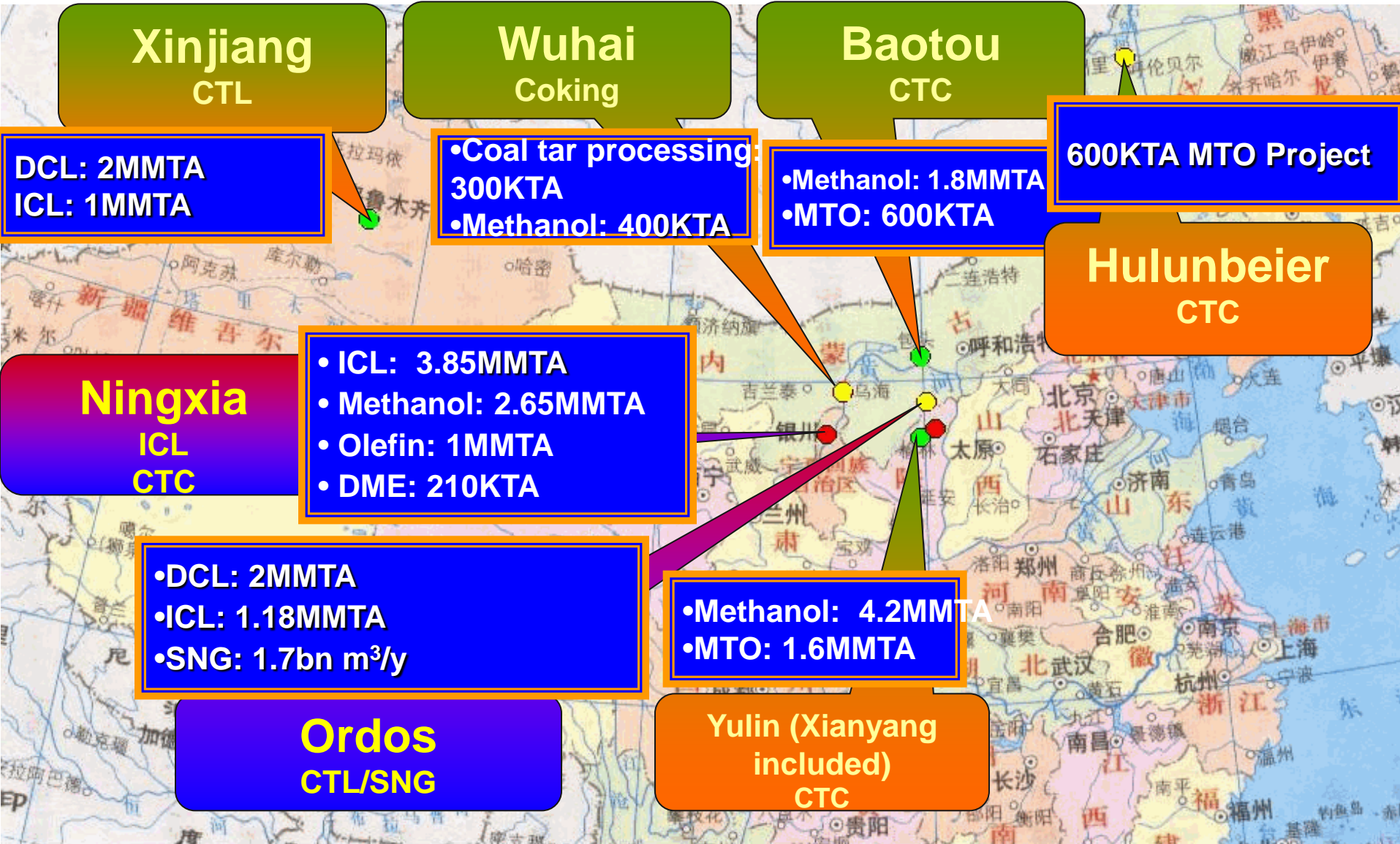


## Life Cycle Coal For Oil Factors In Modern Coal Conversion Processes

Coal conversion processes		DCTL	Indirect CTL	Olefin	NG	H2	Methanol	DME	IGCC
Coal conversion		Fuel for car	Fuel for car	plastics	Fuel for car	Fuel cell	Fuel for car	Fuel for car	Power driven car
Oil conversion		Diesel	Diesel	olefin	gasoline	gasoline H2	gasoline	Diesel	gasoline Diesel
Coal for oil factor	tce /toe	2.45	3.0	2.45	2.15	0.83 1.50	2.54	3.37	1.08 1.50

**Note:** The coal for oil factor is the ratio between the coal equivalent number and the oil equivalent number when producing the same mass or energy products.

# Shenhua Clean Coal Conv. Projects to be executed during 12<sup>th</sup> Five-Year Plan Period



# R&D on Clean Coal Conversion Technologies

**Improvement, optimization and upgrade of the process used in the existing demo plants**



**e.g., DMTO-II process development lead to methanol-to-olefins ratio from 3:1 (ton/ton) to 2.7:1**  
**A 10,000 t/a pilot plant was built in 2009 and all the tests were completed in 2010, showing that the technology is ready to be commercialized.**



# R&D on Clean Coal Conversion Technologies



- **MTA (Methanol-to-Aromatics):** The process has passed bench scale test and is ready for scale-up.
- **Synthetic mixture of lower alcohols**
- **Optimization of clean coal conversion process:** maximize the overall efficiency;
- **Major & critical equipment manufacturing by domestic vendors:** Domestic vendors need to produce those equipment for lower cost.



# Concluding Remarks

- Fully vertical integration of coal industry would increase the overall energy efficiency, reduce emissions, strengthen risk mitigation, and improve the economics.
- Shenhua group has built an integrated coal chain. However, it is still needed to promote the coal chain integration by new technologies.
- Shenhua group has invested a lot of projects to develop new clean coal conversion technologies. The development of new technologies is a key to achieve a fully integrated coal based energy company.

**Questions ? Thank You!**

**Yuzhuo Zhang, Ph.D.**  
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