TRENDS IN CHINA'S OIL REFINING INDUSTRY THROUGH 2015

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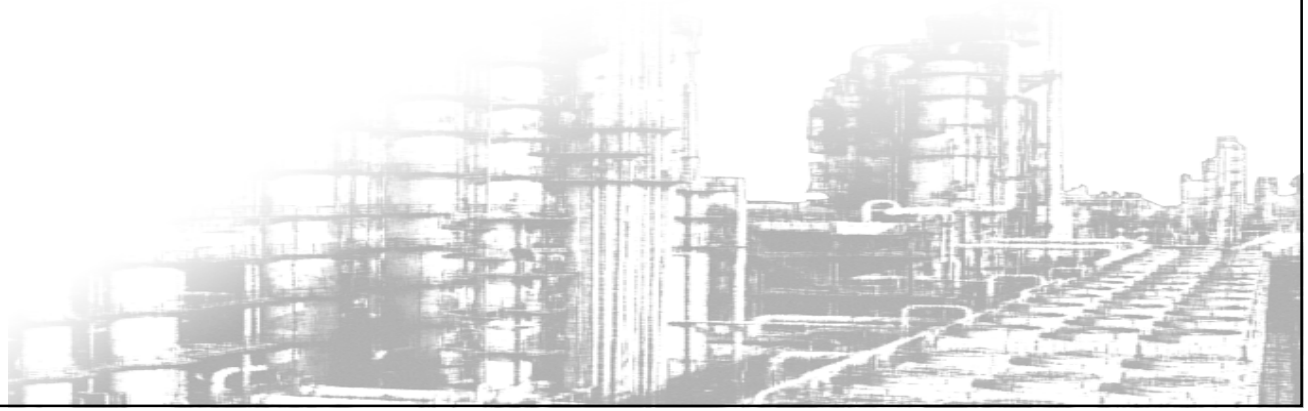
CHINA'S OIL REFINING INDUSTRY

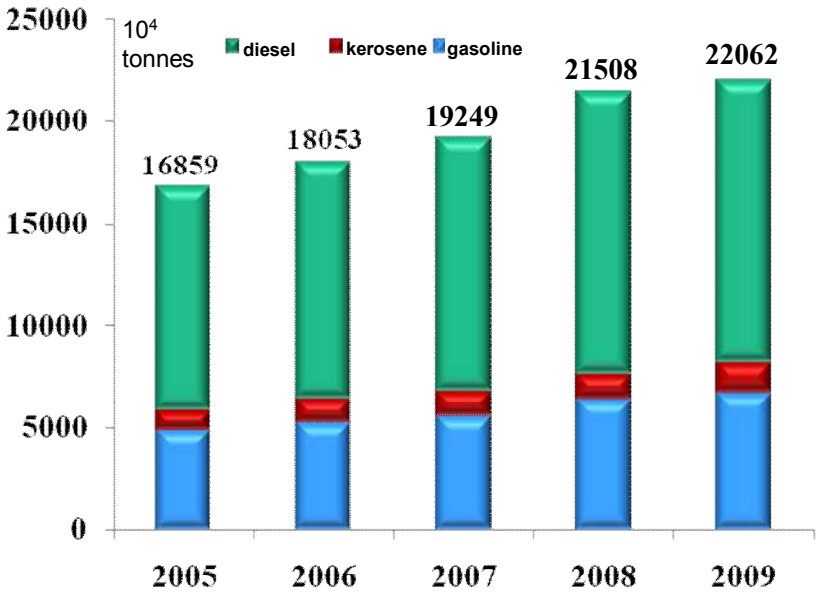
THE PRESENT



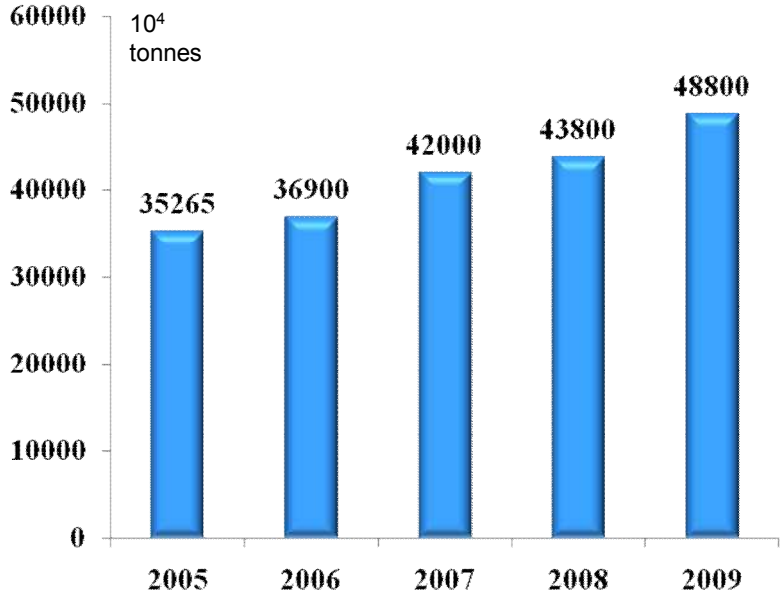
I. China's oil refining industry—the present

1.1 China—world's second largest oil refiner

- **Fast economic development led to increased consumption of refined oil products and refining capacity.**



Apparent consumption of gasoline, kerosene and diesel in 2005-2009



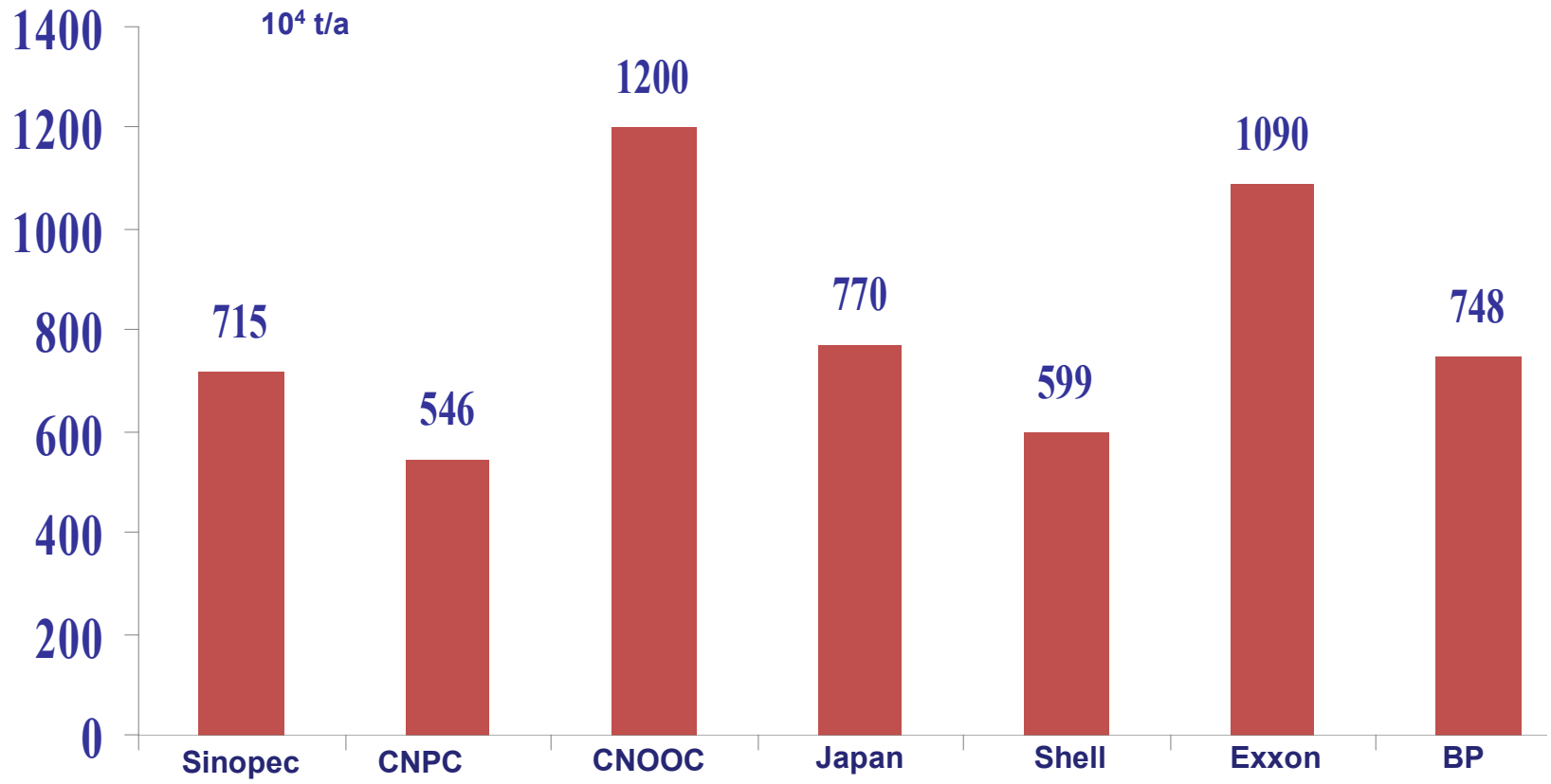
Primary crude distillation capacity in 2005-2009

I. China's oil refining industry—the present

❖ Restructuring accelerated and refining scale expanded.

Eighteen refineries each with over 10 million tonne/a throughput

I. China's oil refining industry—the present

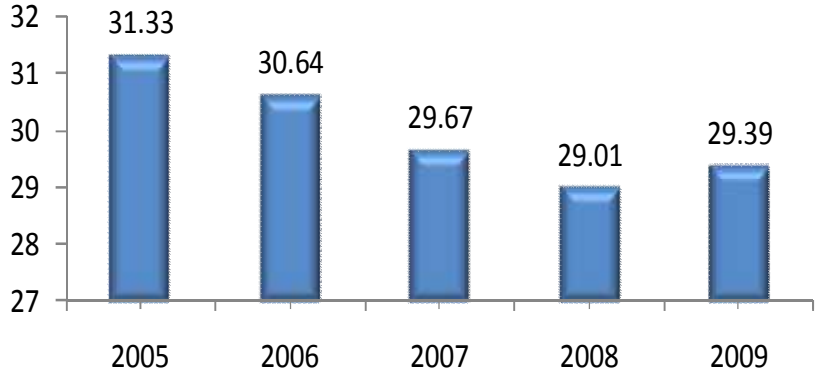


Average refining capacity of world major oil refiners in 2009

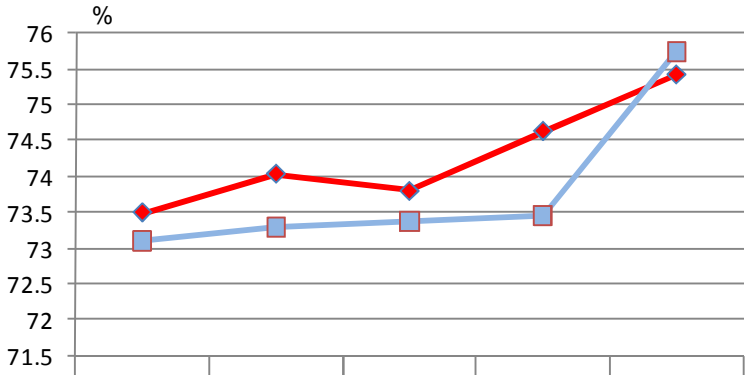
I. China's oil refining industry—the present

❖ **Deep processing led to increased light distillate yield**

Crude API 2005-2009

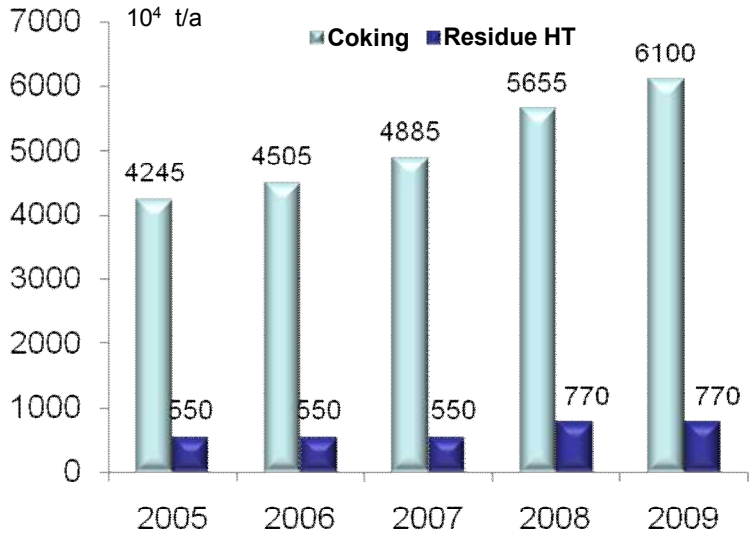


Light distillate yield 2005-2009



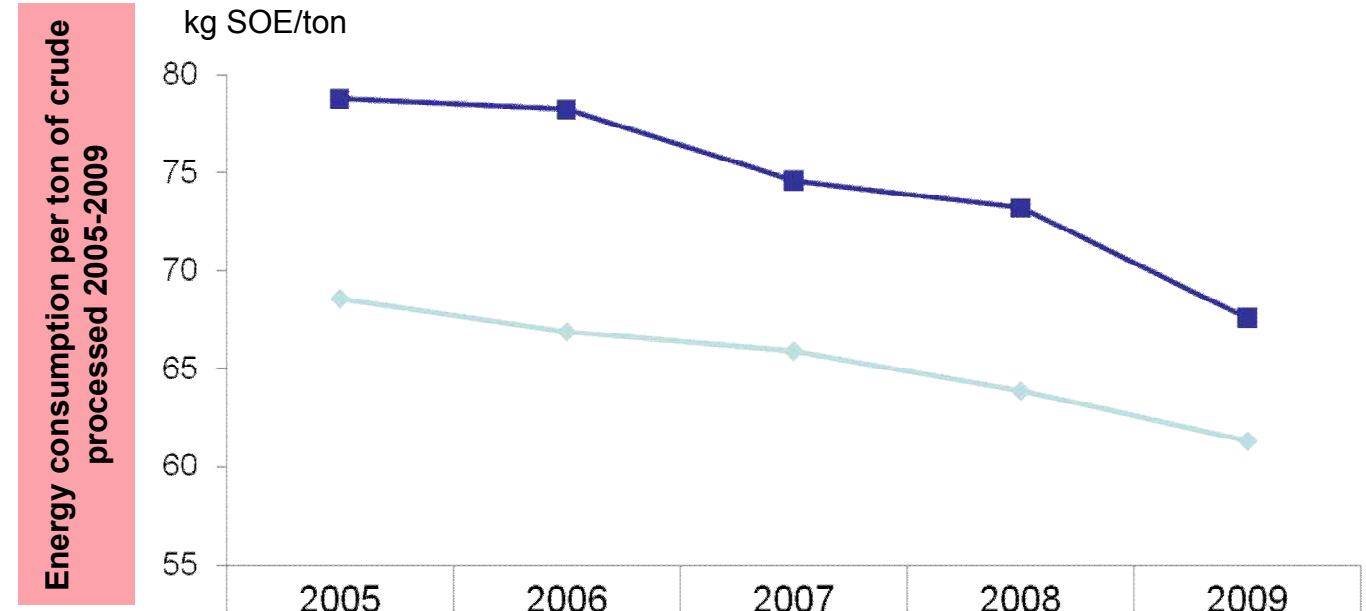
	2005	2006	2007	2008	2009
Sinopec	73.49	74.03	73.79	74.63	75.42
CNPC	73.1	73.29	73.37	73.45	75.74

Combined coking and residue HT capacity of Sinopec and CNPC 2005-2009



I. China's oil refining industry—the present

❖ **Less energy consumption and CO_2 emission in crude processing**



	2005	2006	2007	2008	2009
Sinopec	68.59	66.89	65.91	63.89	61.34
CNPC	78.78	78.22	74.61	73.2	67.62

I. China's oil refining industry—the present

- **IT application in oil refining improved. Supply chain management technology, desktop refinery simulation technology, advanced control technology and refined products online blending technology began to be used in refineries, supportive of the refining process optimization.**

I. China's oil refining industry—the present

❖**Refined products quality improved and environmental protection standards met**

☞Leaded gasoline phased out in 1997. From 1997 to 2010, sulfur content in gasoline down from 2000 ppm to 150 ppm, and sulfur content in light diesel down from 5000 ppm to 2000 ppm.

☞Non-mandatory standards for sulfur content less than 500 ppm in automotive diesel put to effect from 2003. National standard for sulfur content less than 350 ppm to be enforced from 1 July 2012.

☞Standard for sulfur content less than 50 ppm in gasoline and diesel applied in major cities like Beijing, Shanghai and Guangzhou.

I. China's oil refining industry—the present

Changes in national and Beijing local gasoline quality standards

	National standard			Beijing local standard		
	GB17930-1999	GB17930-2006 (automotive gasoline II)	GB17930-2006 (automotive gasoline III)	DB11/238-2004 (enforced since 01/10/2004)	DB11/238-2004 (enforced since 1/7/2005)	DB11/238-2007
S content, ≦m%	0.08	0.05	0.015	0.05	0.015	0.005
Olefins, ≦v%	35	35	30	30	18	25
Aromatics, ≦v%	40	40	40	40	42	
Olefins+aromatics, ≦v%						60
Benzene, ≦v%	2.5	2.5	1	2.5	1	1
O content, ≦v%	2.7	2.7	2.7	2.7	2.7	2.7

Changes in national and Beijing local diesel quality standards

	National standard			Beijing local standard
	GB252-2000	GB/T19147-2003	GB/T19147-2009	DB11/239-2007
S content, ≦m%	0.2	0.05	0.035	0.005
Cetane number, ≧	45	49	51	51
PNA, ≦m%	-	-	11	11
Density (20℃), kg/m^3	Measure	820-860	820-860	820-845

I. China's oil refining industry—the present

1.2 R&D enhanced and refining technologies greatly improved.

- **Developed technologies comparable to international advanced technologies, including:**
  - ✓ **Super-low-pressure continuous catalytic cracking technology**
  - ✓ **Deep-cut technology for crude vacuum distillation**
  - ✓ **MIP-CGP technology**
  - ✓ **Bidirectional combination technology integrating residue HT with FCC**
  - ✓ **Selective HDS of FCC naphtha**
  - ✓ **Deep HDS of diesel in liquid phase circulation**
- **Improved S-Zorb technology for FCC naphtha sulfur removal licensed from ConocoPhillips**
- **Increased Chinese content of oil refining catalysts to 95%. Some catalysts sold at international markets**
- **Applied self-developed technologies and catalysts, to increase light distillate yield, upgrade product quality, and prepare for implementation of GB IV and V gasoline and diesel standards**

I. China's oil refining industry—the present

1.3 China—a big player, but not a strong one yet in the industry

- **Big gap between in-house developed technologies and world advanced technologies like:**
  - ✓ Ebullated-bed residue hydroprocessing
  - ✓ Slurry-bed residue hydroprocessing
- **Performance of some catalysts as good as overseas similar catalysts, but with higher production cost. For example:**
  - ✓ More active metal content in residue hydroprocessing catalysts
- **IT application to be strengthened in refining process**
  - ✓ Desktop refinery simulation, advanced control and oil products online blending applied only in a few refineries
  - ✓ Supply chain management technology to be further improved
- **Technical and economic indicators of refineries below international advanced level**
  - ✓ Energy consumption, processing loss and unit processing cost to be cut down
  - ✓ Yield of high value-added products and profitability per tonne of crude processed to be advanced

I. China's oil refining industry—the present

❖Heavy task to phase out small refineries

✓Difficulties ahead in phasing out small refineries with high materials and energy consumption and low crude utilization rate

✓Roughly 98 small refineries each with crude processing capacity less than 1 mt/a in China

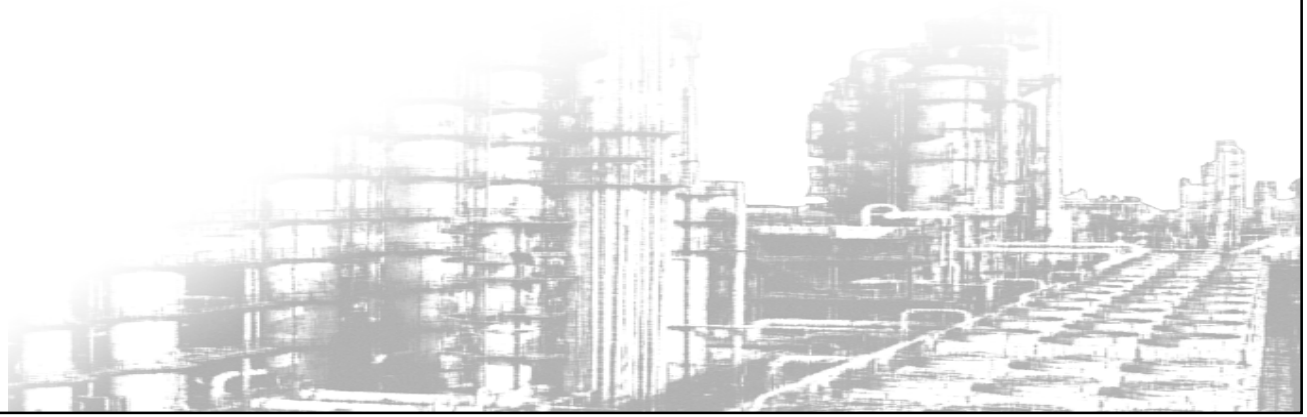
- Total crude throughput 43.64 mt/a
- Average primary processing capacity only 445 kt/a
- Average light distillate yield estimated at about 50%
- Energy consumption more than 90 kg SOE per ton of crude processed

I. China's oil refining industry—the present

❖**Gap in gasoline and diesel quality standards**

- ✓ GB III standards equivalent to Euro III applied in most part of China
- ✓ GB IV standards equivalent to Euro IV applied only in a few regions
- ✓ Standards equivalent to Euro V already enforced in Europe, the US, Japan and Korea

II. TRENDS IN CHINA'S OIL REFINING INDUSTRY THROUGH 2015



2.1 Refining capacity continues to increase, albeit at a slowdown rate

- Energy consumption increases along with GDP growth at certain stages of economic development.
- According to statistics, 16 countries peaked per capita energy consumption with per capita GDP figure ranging from US$10942 to US$23201. China's per capita GDP in 2009 was only US$ 3678, indicating that its per capita energy consumption will continue to grow.

II. Trends in China's Oil Refining Industry through 2015

❖ **In 2009, China's per capita consumption of crude oil, gasoline, diesel and jet fuel was far less than those of USA, major European countries, and Japan and Korea.**

Per capita consumption of crude oil, gasoline, kerosene and diesel in USA, Germany, France, UK, Japan, Korea, and China in 2009（tonne/person）

	oil	gasoline	kerosene	diesel
USA	2.47	1.26	0.21	0.56
Germany	1.27	0.25	0.11	0.62
France	1.24	0.12	0.11	0.75
UK	1.13	0.26	0.26	0.41
Japan	1.43	0.28	0.20	0.32
Korea	1.76	0.16	0.16	0.37
China	0.30	0.05	0.01	0.10

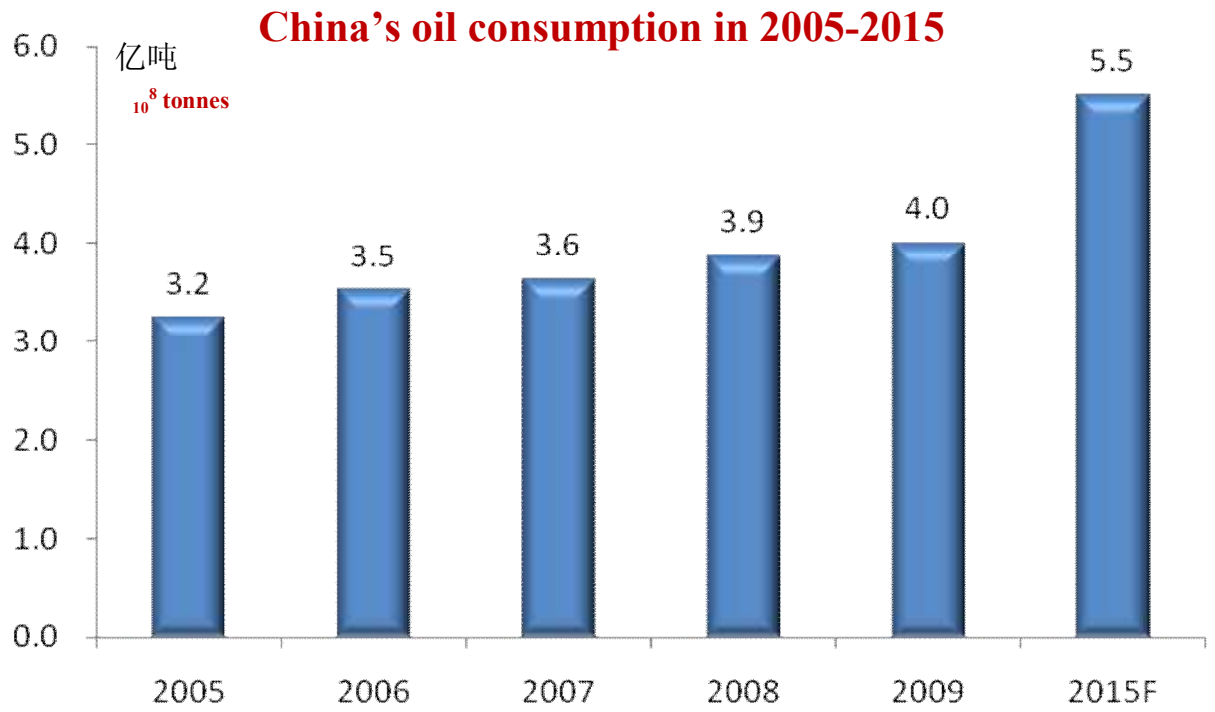
Sources: Data from IEA except China-related consumption data

II. Trends in China's Oil Refining Industry through 2015

- By changing its development mode and economic structure, China's economy will continue to grow steadily, though at a lower rate than the past decade.
- High-speed railways and city underground railways will lead to changes in public transportation structure. More restrictive measures on passenger cars will be taken to ease traffic congestion. To cut CO_2 emissions and contain accelerating energy consumption growth, the government will deepen the reform of energy resources price and taxation, hence slowdown in oil products consumption growth.

II. Trends in China's Oil Refining Industry through 2015

- Oil demand expected to reach 550 million tonnes in 2015.
- Average annual growth projected at 5.4% in 2009-2015.



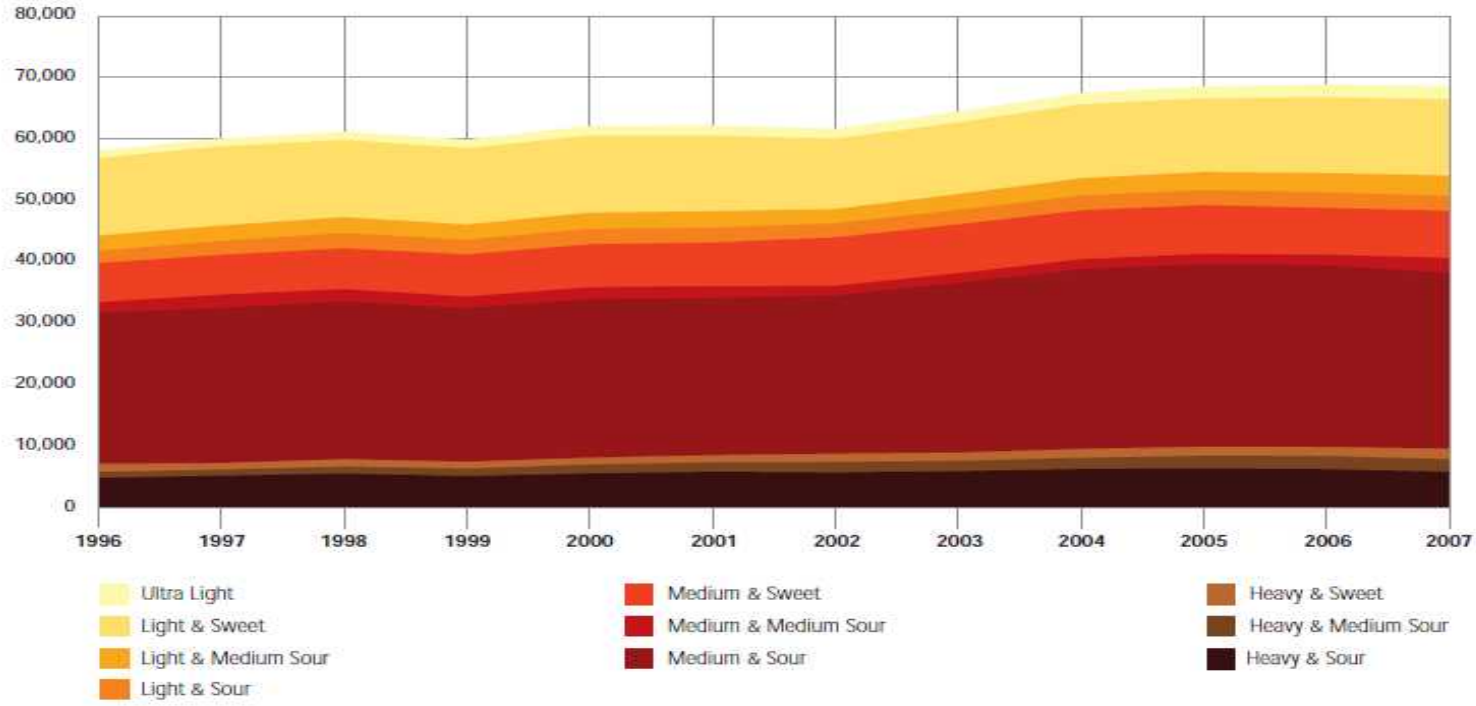
Sources: 2005-2009 data are from "Flash Report on China's Petroleum and Chemical Data". 2015 data are projections.

II. Trends in China's Oil Refining Industry through 2015

2.2 Ratio of oil import increased. Portion of sour, acidic and heavy crude supply to increase.

- China's domestic crude output will be flat and slightly increased to around 200 million tonnes/a.
- Incremental oil consumption will be met mainly by crude from international market. Imported oil could account for 64% of total consumption.
- Globally, incremental crude supply will be mainly sour, acidic and heavy crude.

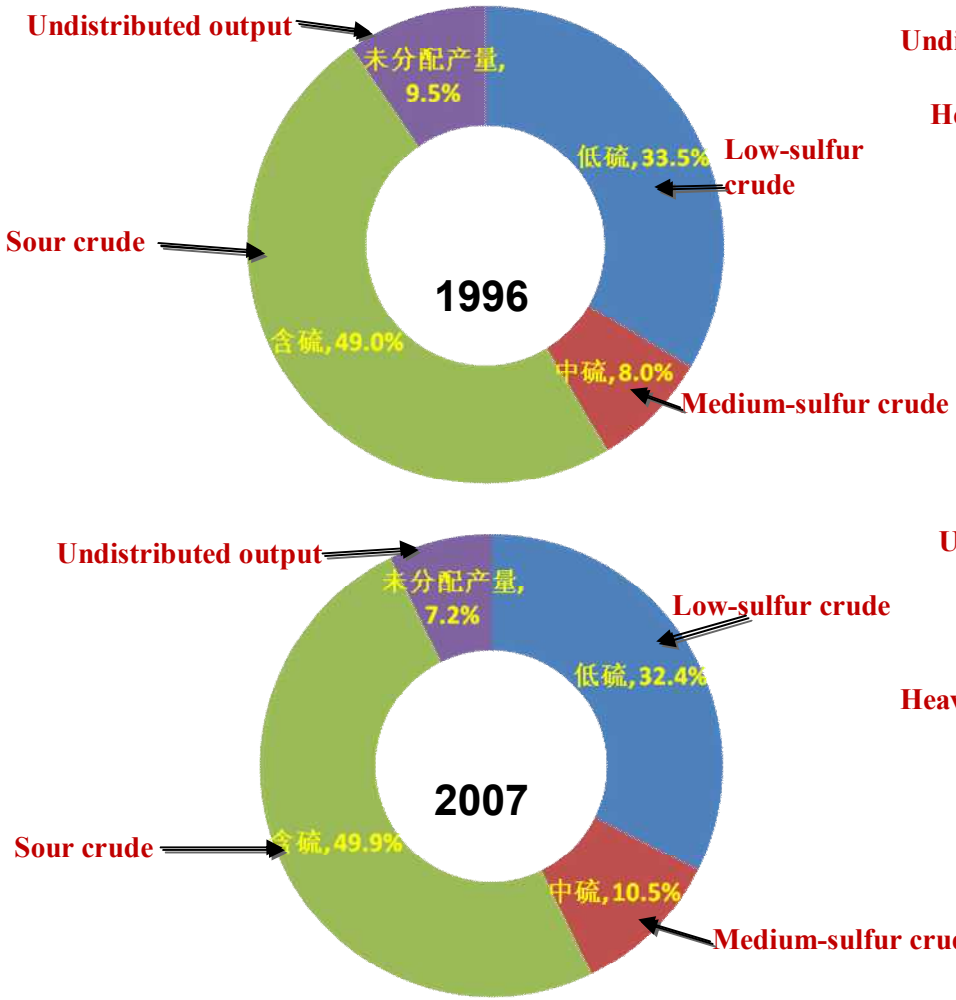
Global crude supply: changes in types, 1996-2007



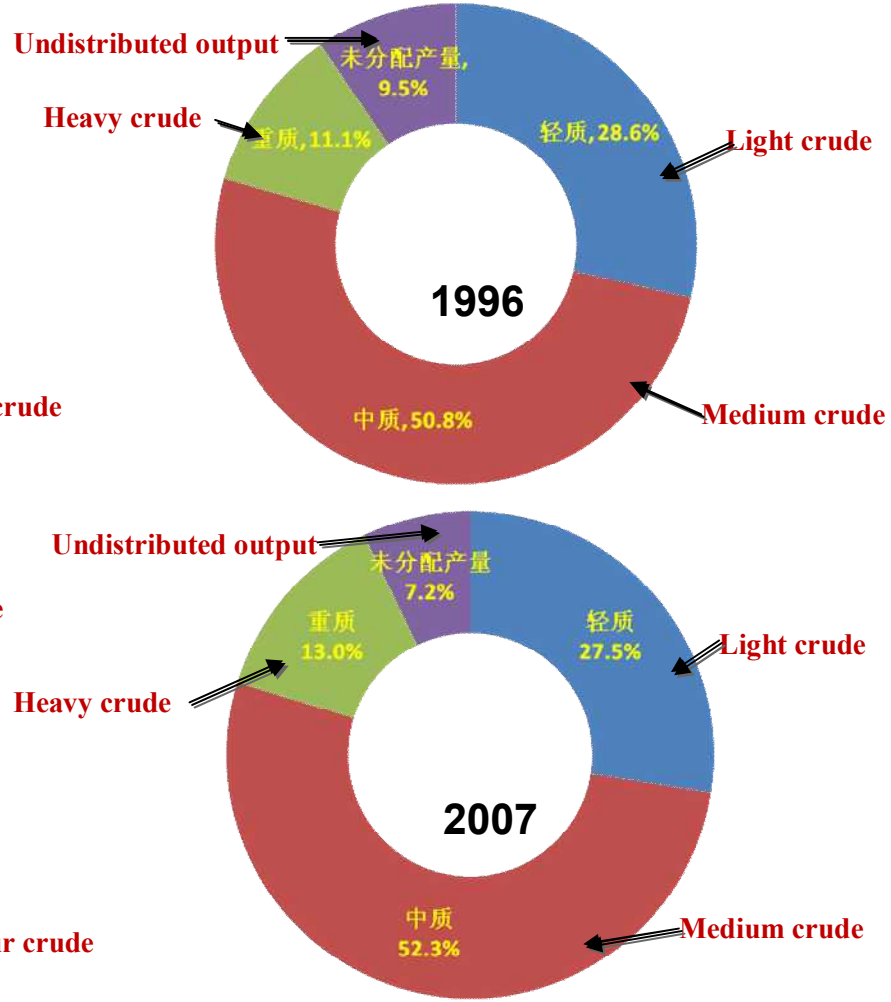
Source: World Oil and Gas Review 2008 (by ENI)

II. Trends in China's Oil Refining Industry through 2015

Changes in sulfur content



Changes in light & heavy crude

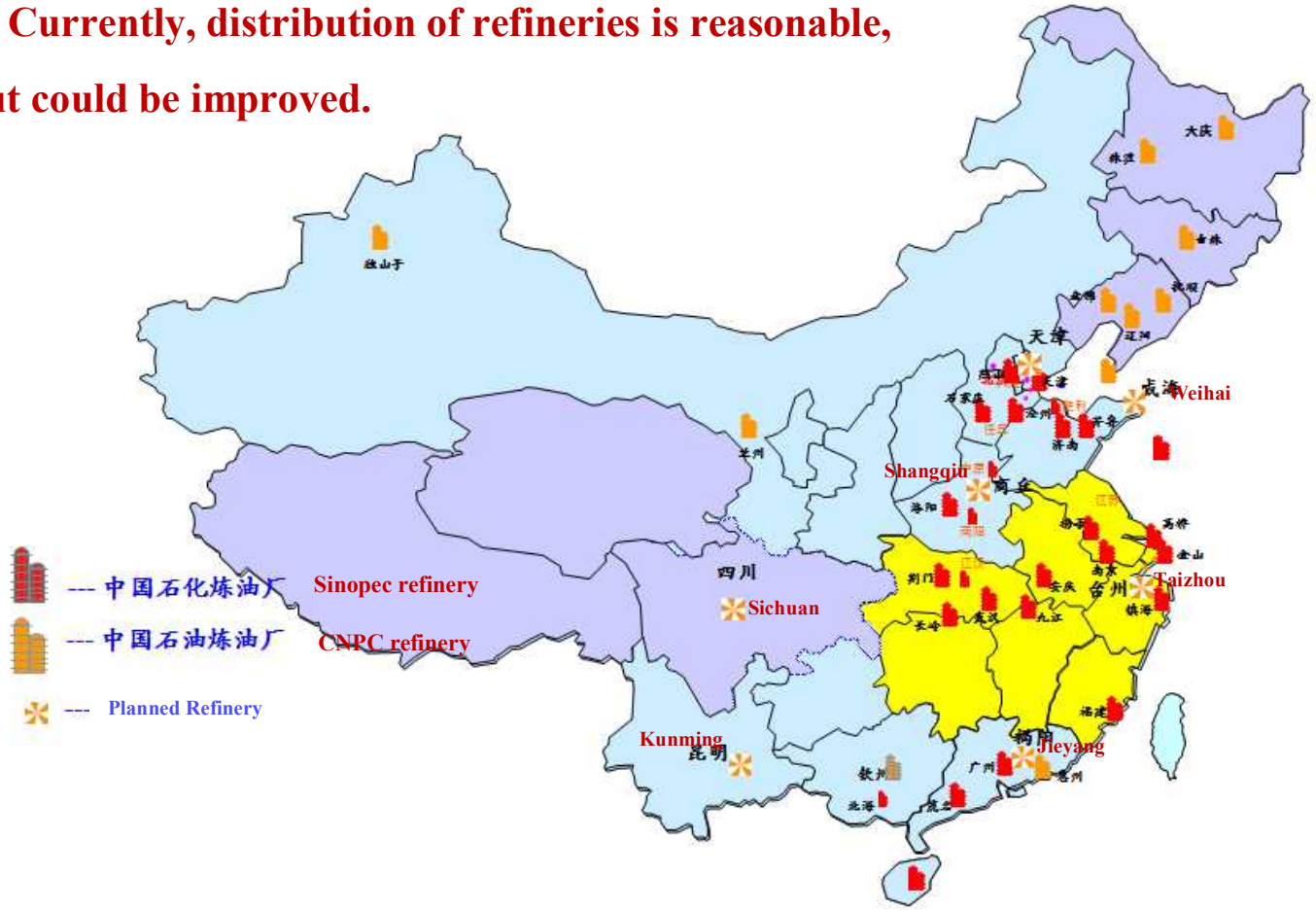


Source: World Oil and Gas Review 2008 (by ENI)

2.3 Partially adjusting distribution of refineries to further increase average scale

❖ **Currently, distribution of refineries is reasonable,**

but could be improved.

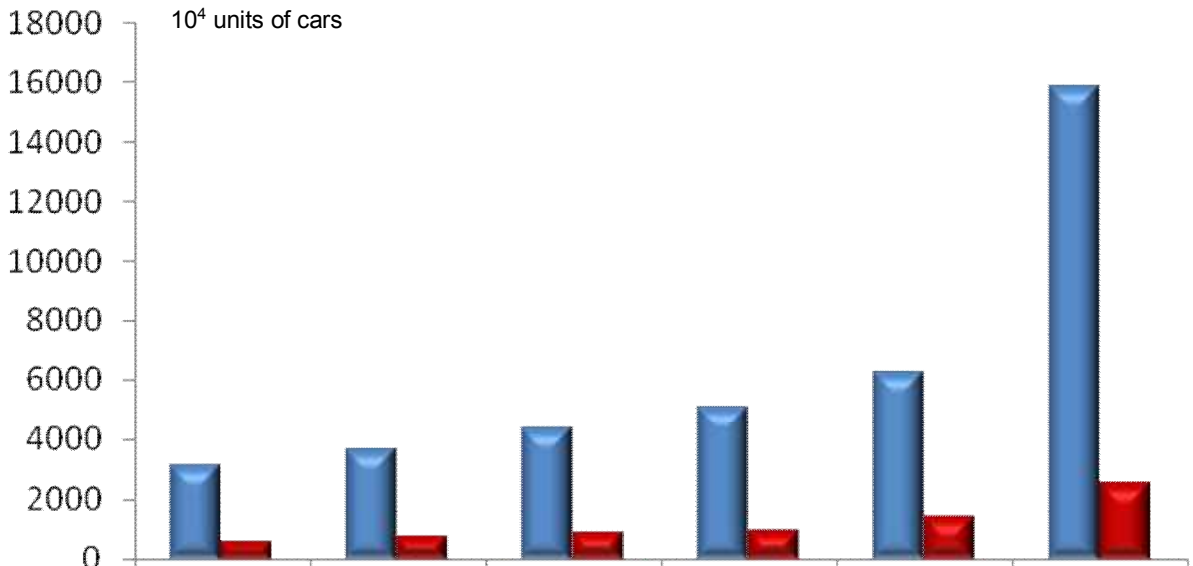


II. Trends in China's Oil Refining Industry through 2015

- By 2015, oil import will further increase, and delivery to refineries will be mainly through sea shipments because of limited handling capacity of the three onshore oil pipelines.
- Some refineries will be constructed close to the import channels or in regions with import channels but short of refined oil products supply. But the numbers will not be big.
- Expansion of existing refineries will be the main theme through 2015. The capacity of some refineries may reach 20 million tonne/a, while certain refineries may reach 40 million tonne/a or more.
- Some small refineries may be expanded, while some others may be shut down.
- Average capacity of refineries will increase further.

2.4 Changes in consumption pattern of oil products will lead to a gradual drop of diesel/gasoline ratio

❖**Booming of auto industry and increased ownership of passenger cars will trigger increase in gasoline consumption.**



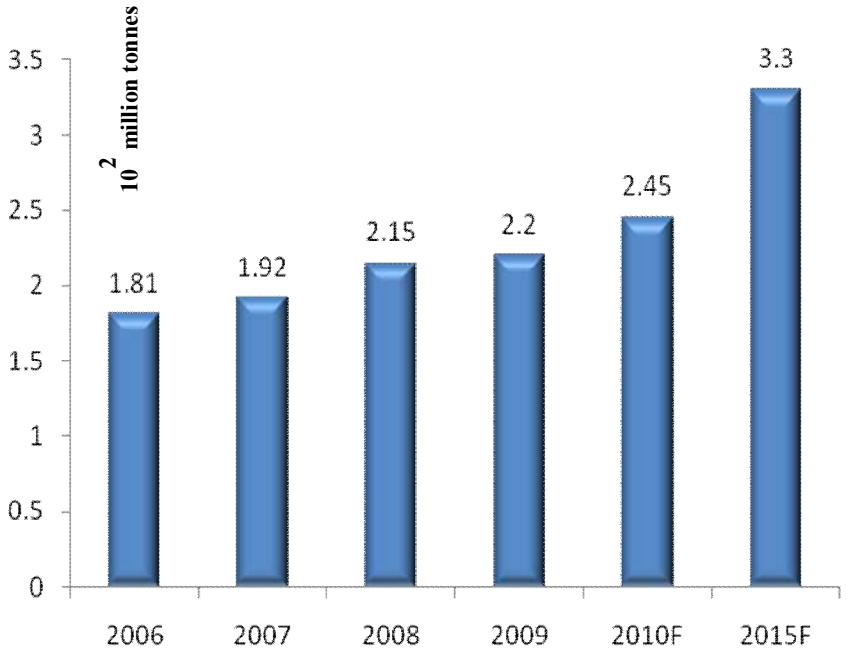
		2005	2006	2007	2008	2009	2015F
Car population	保有量	3160	3697	4358	5100	6288	15893
Car production	产量	581	704	848	910	1368	2500

II. Trends in China's Oil Refining Industry through 2015

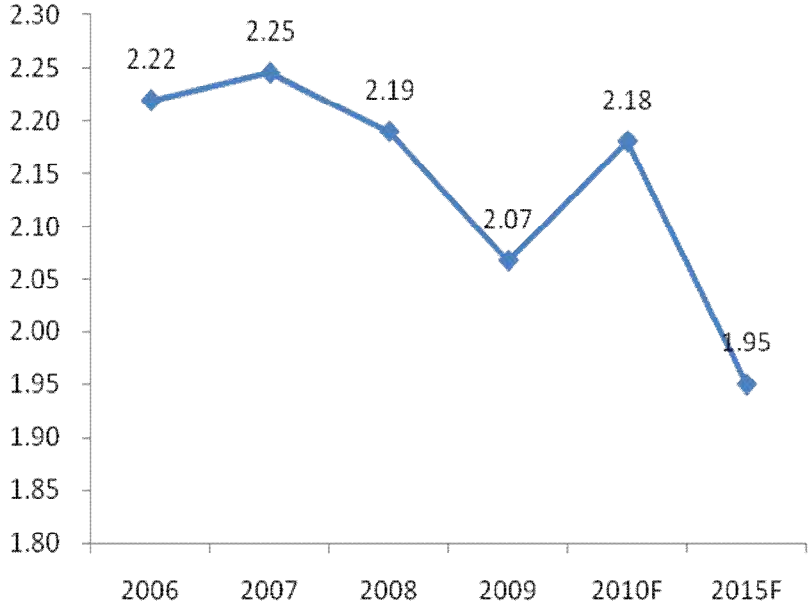
- Unprecedented development of air transport will spur increased consumption of jet fuel.
- Phenomenal development of high-speed rail transport may result in reduced consumption of diesel for railway locomotives.
- By 2012, China's railway network will reach more than 110 thousand km, and over 120 thousand km by 2020. By then, high-speed passenger railway network will be accessible to more than 90% of the total population.
- By 2012, high-speed railway will total 13 thousand km, and reach 18 thousand km by 2020.

II. Trends in China's Oil Refining Industry through 2015

❖Consumed diesel/gasoline ratio will continue to drop



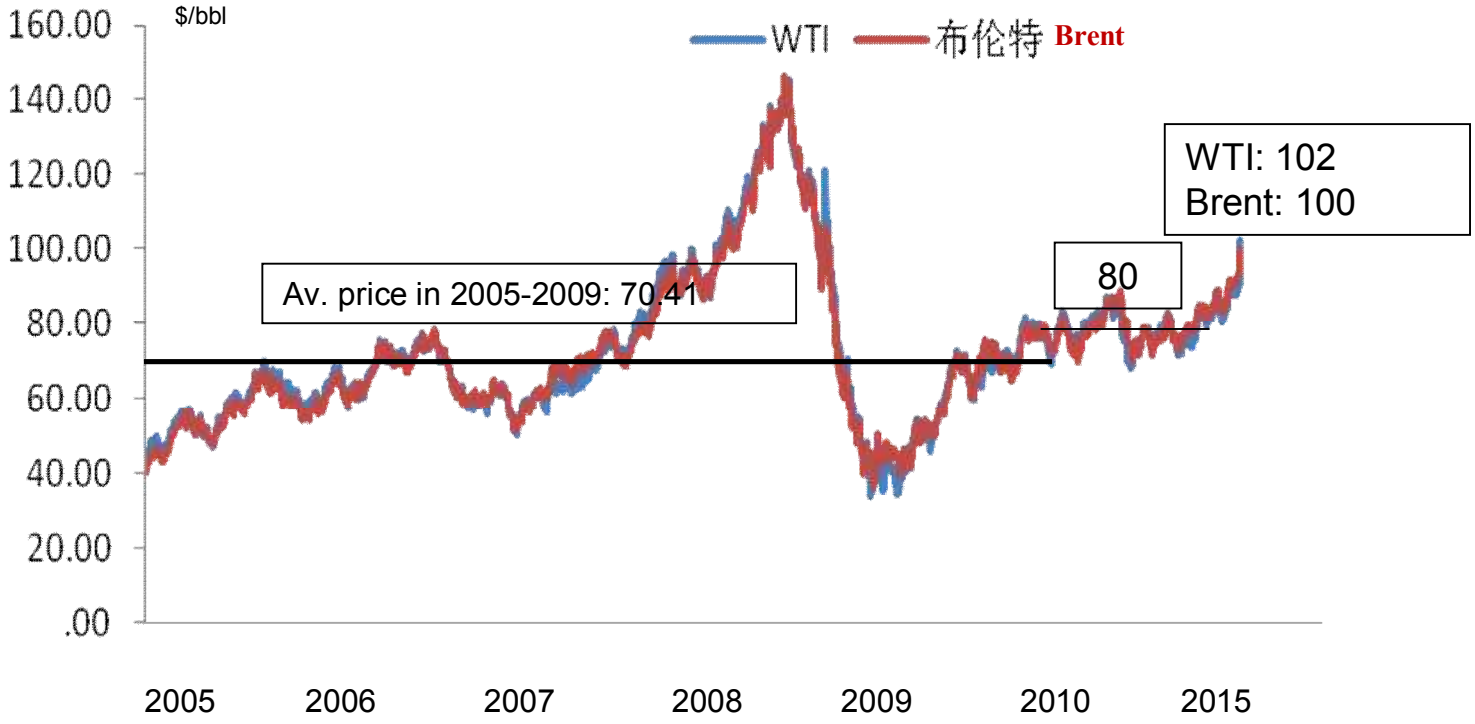
Apparent consumption of gasoline, diesel & kerosene in 2006-2015



Consumed diesel/gasoline ratio in 2006-2015

2.5 Increased crude processing depth will lead to fast increase of gasoil/residue hydrotreating capacity

❖ **An era of high oil price**



II. Trends in China's Oil Refining Industry through 2015

- **Deep processing: crucial to improve profit under skyrocketing oil price.**
- **Reducing sulfur content in oil products and clean production process can contribute to increased gasoil/residue hydrotreating capacity.**
- **Hydrotreating of sour gasoil can improve the quality of FCC feed and reduce FCC flue gas emissions.**
- **Light distillate yield obtained after residue hydrotreating is higher than that achieved by delayed coking. In addition, sour residue hydrotreating does not produce sour petroleum coke which is formed during delayed coking.**
- **Residue hydrotreating capacity will increase quickly whereas residue coking will increase slowly.**
- **Hydrogen production from coal and petroleum coke will develop to meet increasing demand for hydrogen by hydroprocessing units.**

2.6 Newly added refining capacity will be mainly for refined oil products. Past pattern of refining and chemical integration might be changed.

- Methanol-to-olefin and methanol-to-propylene processes will be in commercial operation and proved technically mature.
- Coal-based olefin projects will be economically viable when coal price is competitive.
- Steam cracking of distillates for olefin production will not be competitive over coal-based olefin production at high oil price and low utilization of C_4 byproducts.
- Coal-to-olefin (CTO) process can extend the value chain and increase income for coal companies. It gives coal companies incentive and good profit to develop CTO programmes when coal is sold at its production cost and oil price is high.

II. Trends in China's Oil Refining Industry through 2015

- CTO could lead to enlarged coal industry scale, drive local economic growth, and increase local fiscal revenue, hence welcomed by local governments.
- Compared to CTL, CTO is relatively mature in terms of technology, and can easily achieve economy of scale, producing equivalent result of coal replacing oil.
- Water resources and CO_2 emissions are constraints for CTO, other coal-based chemicals projects or CTL.
- In summary, CTO will develop fast and pose challenges to the pattern of refining and petrochemical integration. Newly added refining capacity will be mainly for production of gasoline, kerosene and diesel.

2.7 Oil products quality standards will be tightened with the enforcement of GB IV standards

- Fast growth in car population will lead to increased share of urban air pollutants caused by automotive exhaust gas.
- Environmental awareness of the public will increase, and the national and local authorities will accelerate upgrading of oil products quality.
- By 2014 and 2015, the GB IV emission standards for automotive gasoline and diesel might be enforced, respectively so as to control the fuels' sulfur content below 50 ppm.

2.8 Saving energy and pursuing clean production will be the solution

- The Chinese government's commitment: cutting 40% to 50% CO_2 emissions per unit GDP by 2020. Reducing fossil fuel consumption is the most important measure. Refineries shoulder the responsibility in energy conservation.
- Energy conservation may need additional investment, but it can bring about good payoff along with increased energy resources prices.
- Tightening environmental regulations and enhanced supervision approaches will press refineries to focus on clean production and emission reduction.
- Energy conservation and clean production can help improve corporate image and bring about social benefits. Therefore, refineries will proactively pursue energy conservation and environmental protection instead of passively following administrative regulations.

2.9 IT applications will elevate refineries management

- Refining process optimization is most important in improving bottom line.
- Process optimization could be realized only through establishment of a comprehensive information system.
- Deeper understanding and application of IT will further elevate the management of the refineries.

2.10 Aiming high: China will make more input in refining technology and speed up the pace of R&D progress

- Key in transition from big player to strong player: leading refining technologies.
- Edge-cutting technologies needed: processing harsh crude, increasing resource utilization and high added-value products yield, improving product specs, saving energy and reducing emission.

THANK YOU!