



# **Development Trend & Differentiation Construction of Refinery Industry of China**

**Cai Liekui**

**2019.9**

# Present Situation and Development Trend of Oil Refining Industry



# Current status of oil refining industry

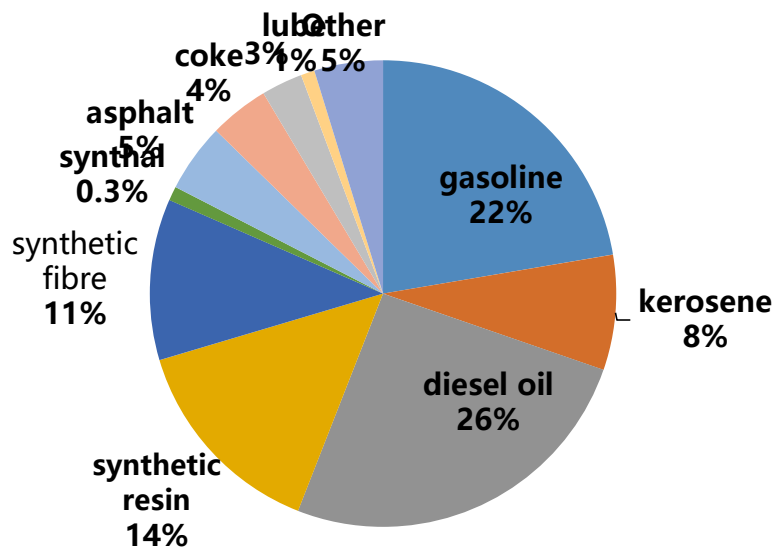


## Overall

Refining capacity: **240** refining enterprises, **19** refining and chemical integration enterprises, **7** major bases

Crude oil processing capacity: **830** million tons per year in 2018, the start-up rate is about **73%**

Crude oil imports: **420** million tons in 2017, **450** million tons in 2018, **230** million tons in 2019 (Jan. to Jun.)



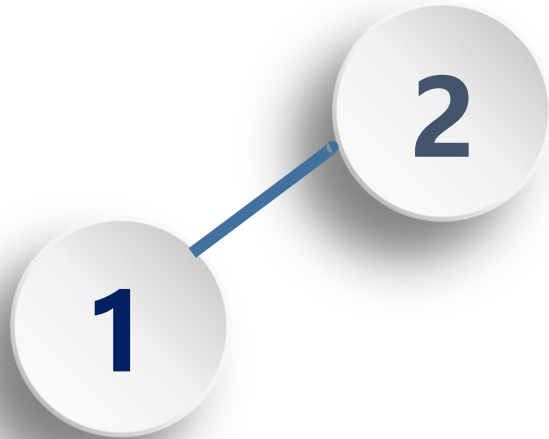
## 1

### Refining Capacity Continuous growth More Prominent of Structural Surplus

Refining capacity added **22.25 million tons** in 2018, with an average refinery scale of **4.12 million t/a**(world scale:**7.59 million t/a**), 19 integrated refining and chemical enterprises with a total capacity of 230 million t/a, and the remaining fuel refineries 600 million t/a.

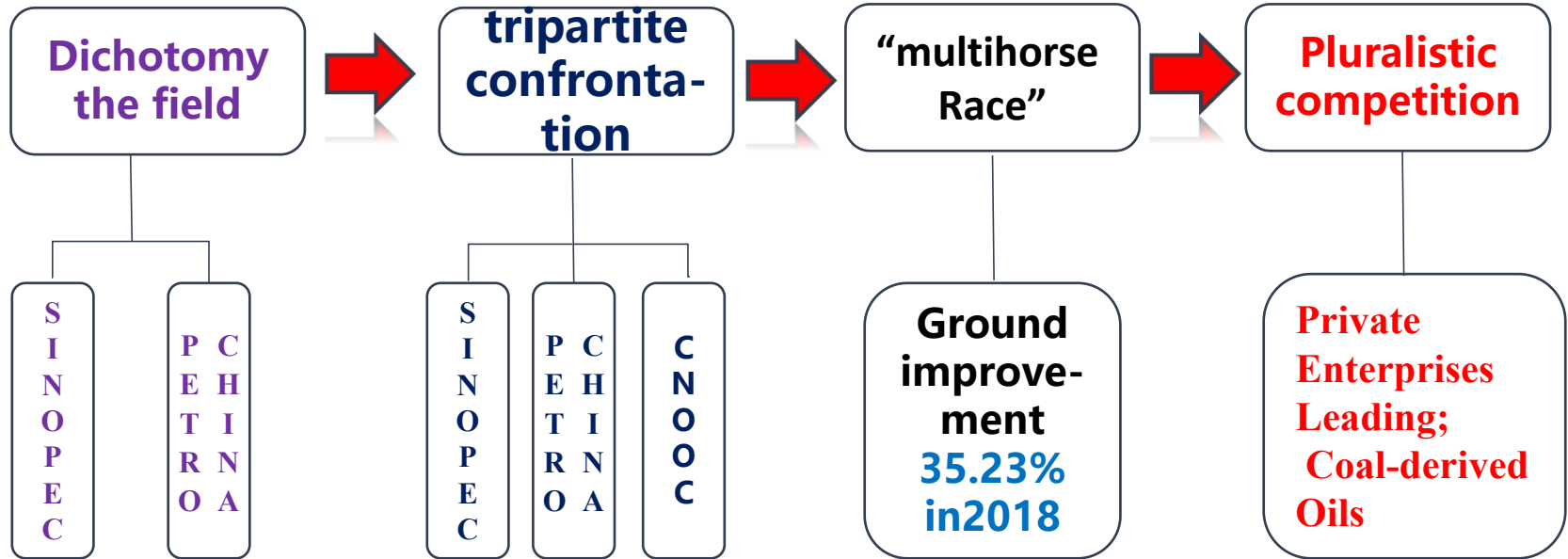
- Technical indicators and equipment levels are uneven
- Overall scale, product quality, energy consumption and integration level, the surplus is more than 0.8 billion tons per year.
- The consumption of gasoline and diesel oil is about 365 million tons per year, and the diesel-to-gasoline ratio is decreasing year by year: 2.27:1 in 2005, 1.27:1 in 2018 and 1.15 in the first half of 2019.

## Forming and Developing the Pattern of Diversification of Business entities

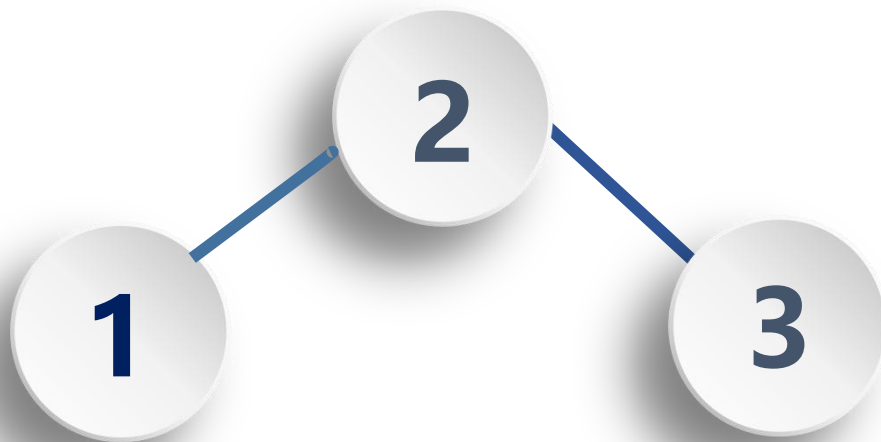


**Refining Capacity**  
**Continuous growth**  
**More Prominent of**  
**Structural Surplus**

# Current status of oil refining industry



## Forming and Developing the Pattern of Diversification of Business entities



**Refining Capacity  
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**Accelerate transformation  
and upgrading of refineries  
in response to changes in  
operating environment**

- **Enhanced pressure on environmental protection and accelerated product quality upgrading**

2018 - "Year of Environmental Storm""2 + 26" cities take the standard VI for gasoline and diesel. Sinopec's 22.9 billion yuan & PetroChina 31 billion yuan in environmental protection in three years.

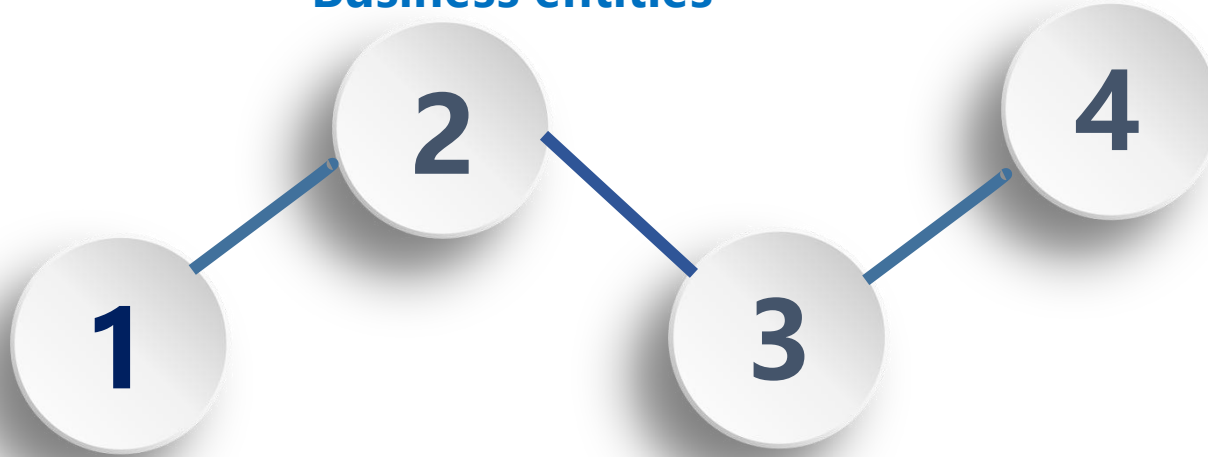
- **Standardize operation and carry out major special rectification**
- **Strengthen supervision of refined oil market**

# Current status of oil refining industry



**Forming and Developing the  
Pattern of Diversification of  
Business entities**

**International capacity  
cooperation is in the  
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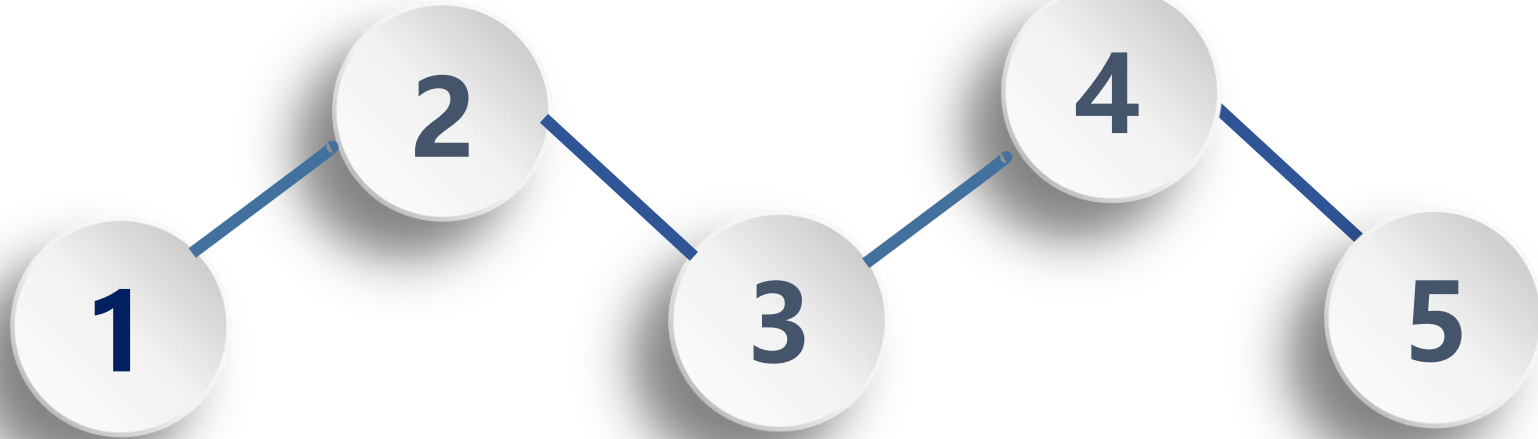
District	Province	Participant
Asia	Zhejiang Hengyi Petrochemical Company SINOPEC Hengyuan petrochemical	Hengyi (Brunei) 8 million tons of integrated refining and chemical projects, total investment of 3.45 billion US\$, followed by 14 million t/a projects. Malaysian Refining and Chemical Integrated Residue Hydrogenation Project Euro IV Upgrading and Renovation Project of Hengyuan Petrochemical Malaysia Refinery
Middle East	SINOPEC	Participation in the construction of a world-class refinery project in Azur, Kuwait, with a total amount of US\$4.2 billion
Central Asia and Russia	PetroChina PetroChina SINOPEC CHINESE CHEMICAL ENGINEERING	Complete the first phase of modernization upgrading and renovation of the Zimkent Refinery in Kazakhstan Construction of Oil Storage, Transportation and Refining Complex Project on the Amur-Heihe Border in Russia US\$2.7 billion in construction contract for aromatics unit and petroleum deep processing unit in Atelau Refinery, Kazakhstan Russian Afekap Hydrocracking Plant Project with a Contract Value of 1.099 billion Euros
Africa	PetroChina	Algeria Algiers Refinery's \$560 million Reconstruction and Extension Project
Other and Intentional Projects	PetroChina SINOPEC SINOPEC	Participation in the Refining Consortium Project in Rio de Janeiro, Brazil Participation in the Refining Project of Indonesian National Oil Company Signing a strategic cooperation agreement with Saudi basic industry will further develop cooperation in the field of petrochemical industry

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**Alternative  
energy share  
increases**

# Current status of oil refining industry



## ✓ Natural gas

Import LNG, shale gas

## ✓ Coal derived oil

Shenhua, Yitai, Lu'an, etc.

## ✓ Ethanol for vehicles

11 provinces increased their pilot projects to 26 provinces.

## ✓ New energy vehicles

In 2018, the total number of vehicles was 2.8 million (instead of 2 million tons).

Time	natural gas (cubic metres)	Fuel methanol(*)	Biodiesel (*)	Coal oil (*)	Fuel ethanol(*)	Electric vehicles	total (*)
2015 (P)	248	650	300	132	200	45	-
2015 (S)	2020 (*)	292.5	300	132	120	36 (*)	2900.5
2016 (P)	268	700	200	150	200	90	-
2016 (S)	2183 (*)	315	200	150	120	75 (*)	3043
2017 (P)	292	700	200	450	280	150	
2017 (S)	2377 (*)	315	200	450	168	120 (*)	3630
2018 (P)	316	770	200	500	330	280	
2018 (S)	2572 (*)	340	200	500	198	200 (*)	4010
2020 (P)	363	900	200	700	200	500	-
2020 (S)	2957 (*)	405	200	700	120	403 (*)	4785

**P: Physical quantity, S:Substitution quantity, \*:10 thousand tons**  
**In 2018, the total amount of alternative fuel oil was 40.1 million tons, accounting for 10.1% of vehicle fuel.**



## ◆ Sustainable Promotion of Green Low Carbon Development

Under the increasingly stringent national security and environmental protection requirements, domestic smelters will continue to make every effort to promote standard emission reduction and pollution control, and adhere to the green and low-carbon development path with the concept of "green production of clean energy".

- Domestic will fully supply national VI diesel fuel in 2019
- Accelerate the promotion of ethanol gasoline and achieve full coverage of ethanol gasoline by 2020
- speed up the adjustment of the overall plant process and gasoline product plan, and speed up the conversion of etherified raw materials.

## ◆ RGRC(Rapidly Growing Refining Capacity) & FDD(Further Developing Diversification ) Of Business Entities

## ◆ Transformation and Upgrading(TU) accelerated, Regionalization 、 Refining and Chemical Integration(R&RCI) Trend is obvious



# Trends—RGRC & FDD Of Business Entities



- Promoted by the central and private enterprises, China's total refining capacity will reach **873 million tons per year in 2019** and 10 million tons refineries will reach **29**. By **2024**, expected about 10 new 10 million tons, and the refining capacity will increase by nearly **210 million tons per year**
- Oversupply of finished oil, export becomes an important way of adjustment.

Enterprise Name	Production time	Group	Productivity change	New capacity	Remarks
Jingmen	2019	SINOPEC	550→1000	450	EIA
Zhoushan (I)	2019	Zhejiang petrochemical	0→2000	2000	under construction
Huajin	2020	CNIGC	600→1000	400	Established
Quanzhou	2020	SINOCHEM	1200→1500	300	under construction
Gure (II)	2020	SINOPEC	0→1600	1600	EIA
Qingyang	2020	PetroChina	300→600	300	Extension
Daxie	2020	CNOOC	800→1400	600	Extension
Zhongke	2020	SINOPEC	0→1000	1000	under construction
Luoyang	2020	PetroChina	800→1800	1000	Extension
Zhenhai	2020	SINOPEC	2300→3800	1500	Established
Shenghong	2021	Shenghong Petrochemical	0→1600	1600	under construction
Guangdong	2021	PetroChina	0→2000	2000	Newly build
Zhejiang (II)	2021	Rongsheng petrochemical	2000→4000	2000	Extension
Xuyang	2022	Xuyang Petrochemical	0→1500	1500	EIA
Yulong (I)	2022	Yulong petrochemical	0→2000	2000	EIA
Yanshan	2022	SINOPEC	0→1200	1200	Established
Hua Jin AMI	2024	CNIGC、saudi aramco、Xincheng petrochemical	0→1500	1500	Proposed

## ➤ Basification、 Regionalization 、 Park

Dominated by “**Two Continents and One Bay**” and follows the principle of being close to the market.

Most of the newly refineries after 2020 belong to the seven major petrochemical industrial parks such as Zhejiang Petrochemical, Gulei Petrochemical etc.

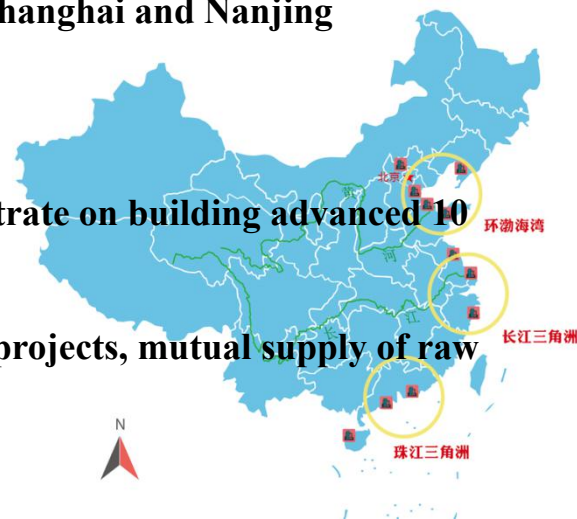
**SINOPEC** -- Four world-class refining bases in Maozhan, Zhenhai, Shanghai and Nanjing

**PetroChina** --Two 10-million-ton refineries in the Southwest

**CNOOC** --Two petrochemical bases in Huizhou and Ningbo Daxie。

**Shandong**--Transformation of old and new kinetic energy and concentrate on building advanced 10 million tons refineries.

More provinces and cities set up petrochemical parks to share public projects, mutual supply of raw materials, and resource sharing in the park.

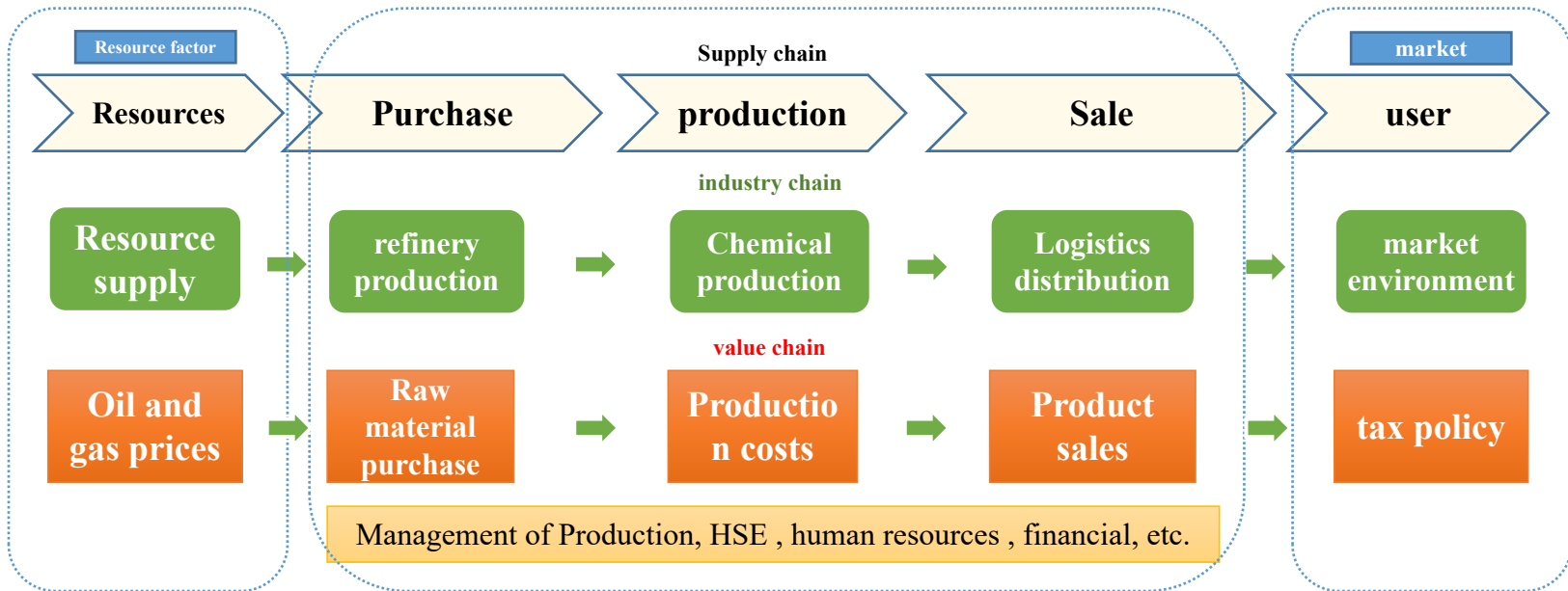


# Transformation and Upgrading accelerated, R&RCI Trend is obvious



## ➤ Intelligence, informatization

"Automation + Intelligence", promoting refinery production and operation upgrade. The collaborative optimization of "supply chain", "industrial chain" and "value chain" is realized by it.



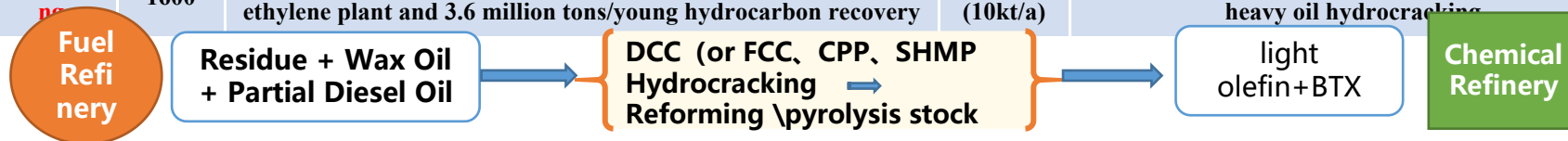
# Transformation and Upgrading accelerated, R&RCI Trend is obvious



## ➤ Increasing Unit Scale, Process Level and Integration of Refining and Chemical Industry

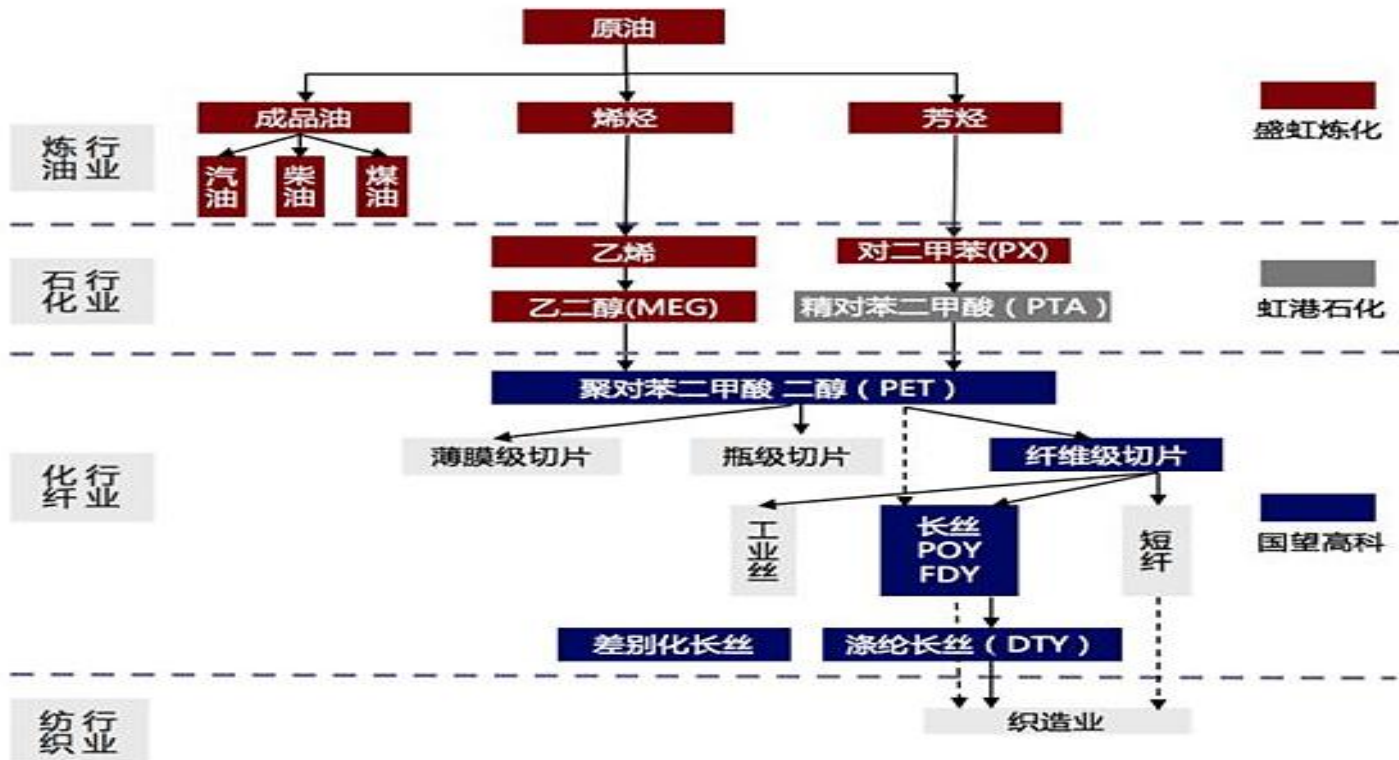
After 2020, the processing capacity of chemical plants accounted for more than **45%** of the primary processing capacity, and the processing scale of heavy oil conversion units was large.

New project	Scale 10kt/a	Main Chemical Plant and Scale	Total capacity	Heavy Oil Conversion Unit and Scale
Zhejiang (I)	2000	5.2 million tons/year aromatics, 1.4 million tons/year ethylene and other chemical plants	660 (10kt/a)	5 million tons/year residue hydrogenation unit and FCC combined unit
KPC	1000	1.8 million tons/year continuous reforming, 2 million tons/young hydrocarbon recovery unit and 800,000 tons/year ethylene unit	460 (10kt/a)	4.2 million tons/year catalytic cracking and 4.4 million tons/year residue hydrotreating
Hengli	2000	Three sets of 3.2 million tons/year reforming unit and 1.3 million tons/year mixed dehydrogenation unit	1090 (10kt/a)	11.5 million tons/year heavy oil hydrogenation
Xinhua Union	2000	3.2 million t/a continuous reforming, 1.3 million t/a continuous aromatization unit, 3.8 million t/a continuous reforming unit and 1.2 million t/a continuous aromatization unit	950 (10kt/a)	3.3 million tons residue hydrodesulfurization, 3.1 million t/a FCC, 3 million t/a delayed coking, 1.6 million t/a FCC
Shengho	1600	2 sets of 3.2 million tons continuous reforming, 1.1 million t/a ethylene plant and 3.6 million tons/young hydrocarbon recovery	750 (10kt/a)	2 million tons/year coking and 9 million tons/year heavy oil hydrocracking





## Distribution of Industrial Chain of Dongfang Shenghong



## ➤ Refining and Chemical Integration :

Refining-Aromatics, Refining-Olefins-Aromatics, Refining-Power Generation Steam

Problems:

- High energy consumption
- The newly 10 million tons built are basically integrated in refining and chemical industry, will face fierce competition
- Resources (characteristics), cost (low cost), market (general-purpose, high-end products), science and technology (independent R&D and improvement capabilities)

## ➤ Differentiation 、 Characterization

While large refineries integrate refining and chemical industry, **small and medium-sized refineries** implement the strategy of **differentiation and specialization**. Some fuel refineries turn to semi-chemical and material refineries to produce asphalt, carbon materials, resins and so on. Some refineries give full play to the characteristics of crude oil and produce characteristic lubricants, asphalt and other products.

# 2

## DIFFERENTIAL REFINERY CONSTRUCTION

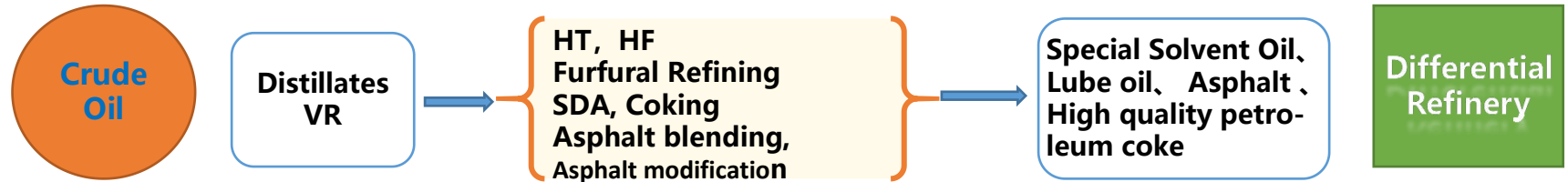


# Refinery Scheme for Processing Naphthenic Crude Oil



## ➤ Lubricating oil, Asphalt, Special Products

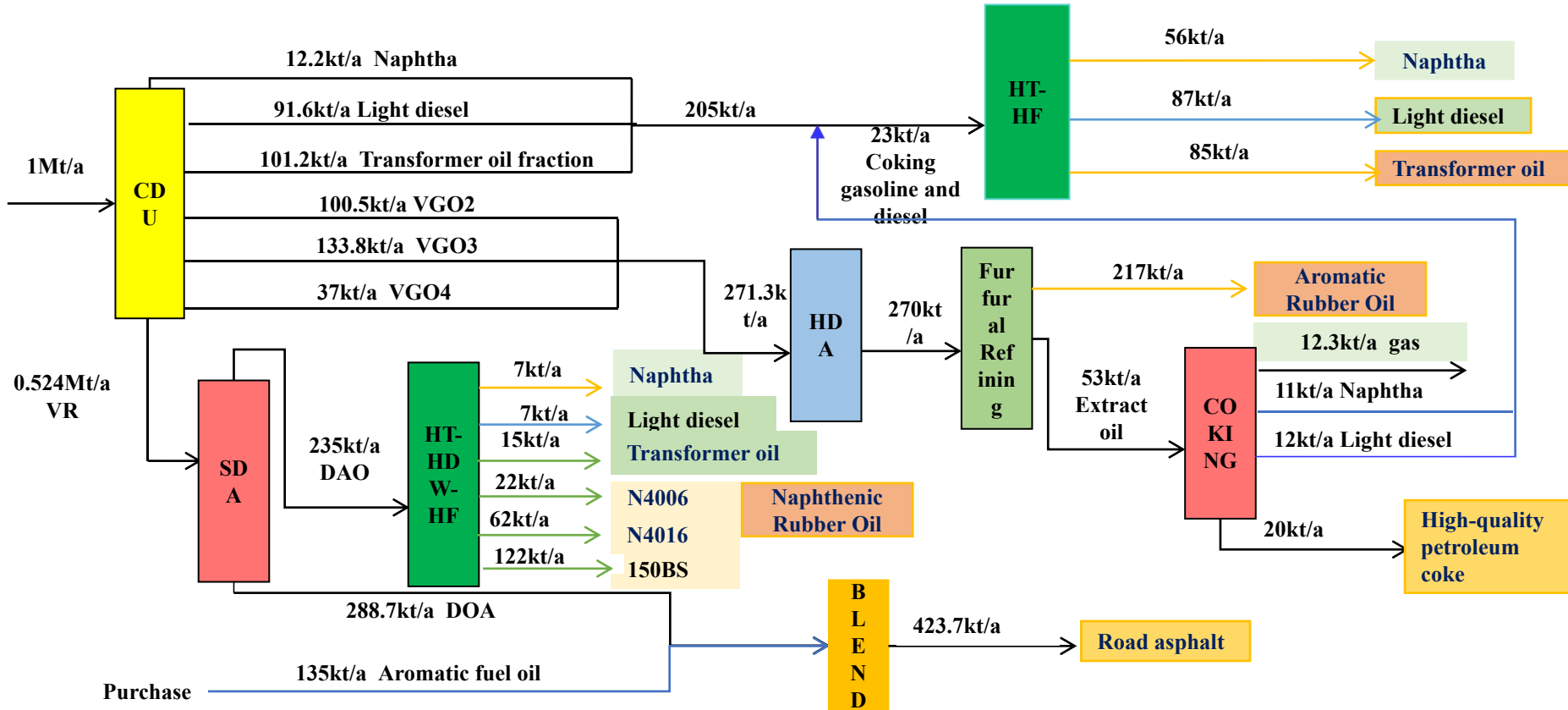
In China, there are seven refineries using domestic naphthenic crude oil as raw material to produce products separately: PetroChina Karamay Petrochemical Company, PetroChina Liaohe Petrochemical Company, CNOOC Petrochemical Refining Co., Ltd. and its subsidiaries (Zhongli, Yingkou, Sichuan and Taizhou) .



## ➤ Differentiated products

Taking the processing of 1 million t/a naphthenic crude oil of a CNOOC as an example, it is necessary to build 250 kt/a high-pressure hydrogenation equipment, 300 kt/a medium-pressure hydrodesulfurization equipment, 300 kt/a furfural refining equipment, 60 kt/a high-quality petroleum coking equipment, 500 kt/a solvent deasphalting equipment and 300 kt/a solvent deasphalting equipment. Lubricating oil high pressure hydrogenation equipment set, 15 kNm<sup>3</sup>/h hydrogen production equipment set, 400 kt/a asphalt mixing equipment set, and the corresponding sewage steam mention sulfur recovery equipment set. Compared with crude oil, the total amount of differentiated products accounted for more than **83%**, the consumption tax-free products accounted for more than **78%**, and the estimated net profit per ton of oil was more than **100 dollars** .

# Refinery Scheme for Processing Naphthenic Crude Oil



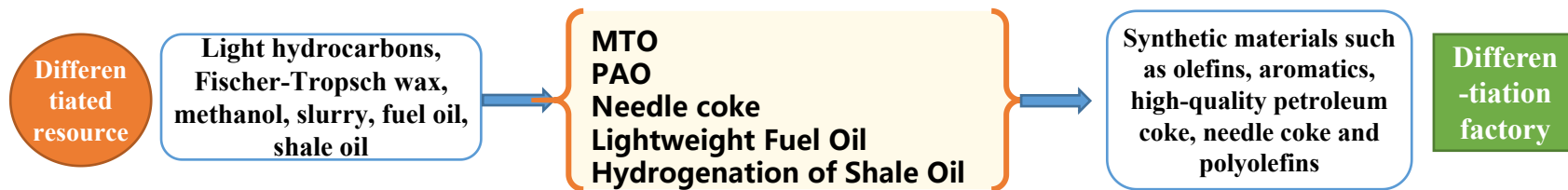
# Refinery Scheme for Processing Naphthenic Crude Oil



Item	Name	Quantity/(kt/a)	Unit price without consumption tax/ (Y/t)	total/(MY/a)
Raw materials	Crude Oil	1000	2725	2725.0
	Aromatic fuel oil	135	3000	405.0
	Natural gas	25.2	4800	120.96
	<b>total</b>	<b>1160.2</b>	<b>-</b>	<b>3250.96</b>
Products	Gas	12.3	3500	43.05
	Naphtha	63	3800	239.4
	Light diesel	94	4200	394.8
	Transformer oil	100	5200	520.0
	Aromatic Rubber Oil	217	5200	1123.2
	Naphthenic Rubber Oil	84	4900	411.6
	150Bright Stock	122	7500	915.0
	High-quality petroleum cok	20	7500	150.0
	Road asphalt	423.7	2900	1228.73
<b>total</b>	<b>1135</b>	<b>-</b>	<b>5025.78</b>	

## ➤ Diversification of resources

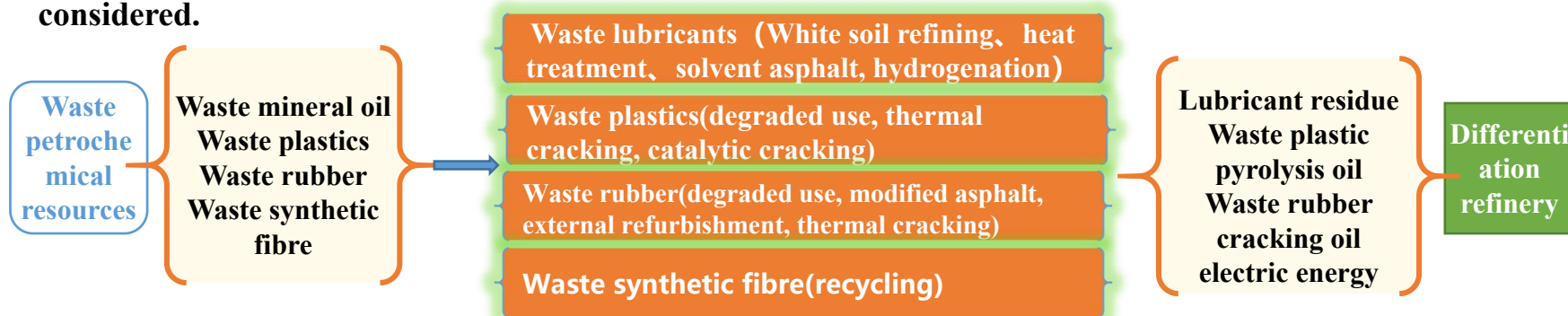
With the development of unconventional oil and gas resources & coal liquefaction products, the increase of light hydrocarbon imports, and the improvement of resource utilization level such as slurry thrown out of large refineries, the production of differentiated special products with differentiated resources as raw materials has a certain competitiveness.



- ? At the same time of resource diversification, can we combine with existing refineries to form an integrated refinery with diversified resources instead of operating several production units independently? For example, whether shale oil can enter the existing refinery system according to its raw material characteristics, hydrogen utilization of alkane dehydrogenation, residue of slurry treatment and light fraction of by-product after coking.
- ? For alkane dehydrogenation and light hydrocarbon aromatization units, the byproduct of hydrogen is more, and the excess hydrogen can also be considered in combination with the hydrogen energy industry, for example, as a hydrogen source for hydrogen energy vehicles.

## ➤ Waste Petrochemical Resources (**Molecular economics**)

From the perspective of molecular composition, only less than 10 % of the molecules of waste petrochemical products have changed, and the decay of this very small number of molecules has led to the continued use of products that can not meet the needs of the original function; From a molecular point of view, more than 90 % of resources can be reused. If the separation or selective modification of 10 % of the decayed molecules from the raw materials is technically difficult to achieve, conversion must be considered.



**Waste mineral oil(including waste lubricants):** about 30 million t/a; Waste lubricants: around 5 million t/a

**Waste plastics:** about 35 million t/a, recycling utilization rate less than 50 %, remaining basic combustion power generation, thermal cracking or liquefied hydrocarbons 7 %(Japan)

**Waste rubber:** 15 million tons per year or more, of which only waste tyres reached about 13 million tons per year in 2017, and about 6.4 million tons per year of regeneration

**Waste synthetic fiber:** basically no report of recycling



## ➤ Thermodynamic concepts

High-grade heat is the most efficient when transforming thermal work, assuming all of them are reversible work. In the case of ambient temperature of 25°C and 720°C the highest efficiency is 70.5%; in the case of 450°C the highest efficiency is 60.5%; in the case of 150°C the highest efficiency is only 33.8%, but in the actual process. Its efficiency is lower. It is difficult to make good use of low temperature heat below 150 in refineries.

## ➤ Refining and Chemical Integration

In the production of olefins, aromatics and other products, a large number of high-grade heat (500-700) are needed, such as ethylbenzene dehydrogenation, reaction temperature 600-650, reforming reaction 500, propane dehydrogenation 550-650°C . At present, it is generally provided by heating furnace.

## ➤ RFCC ( High temperature heat 720°C and above )

RFCC is used as a high temperature heat source for alkane dehydrogenation, ethylbenzene dehydrogenation, aromatization and other devices. Heat comes mainly from the combustion of coke deposits.



# Thanks!

Thank for the  
information provided by  
Zhuochuang.

