

Special Reports

China's Refining Industry - The Transforming Giant

Table of Contents

A Report by NexantThinking™

Published December 2017

www.nexantthinking.com

Section	Page
1 Executive Summary	1-1
1.1 INTRODUCTION.....	1-1
1.2 BACKGROUND.....	1-1
1.3 Refined Product Demand	1-4
1.3.1 Key Market Drivers.....	1-5
1.4 Refined Product Supply	1-10
1.4.1 Key Market Drivers.....	1-11
1.5 Refined Product Net Trade	1-16
1.6 Refinery Competitiveness	1-17
1.7 Refinery and Petrochemical Integration.....	1-20
1.8 Key Conclusions	1-24
2 Background	2-1
2.1 INTRODUCTION.....	2-1
2.1.1 Macroeconomic Trends.....	2-4
3 China's Refining Industry	3-1
3.1 INTRODUCTION.....	3-1
3.2 Regulatory Framework.....	3-3
3.2.1 Key Regulatory Authorities.....	3-3
3.2.2 Policy and Regulation.....	3-3
3.3 CHINA'S DOMESTIC CRUDE OIL RESERVES & PRODUCTION.....	3-5
3.3.1 Overview	3-5
3.3.2 Regional Production.....	3-8
3.3.3 Quality Considerations	3-12

3.4	CHINESE CRUDE OIL IMPORTS	3-13
3.4.1	Overview	3-13
3.4.2	Quality Considerations	3-13
3.4.3	Import Trends	3-14
3.4.4	Quality Characteristics of Imported Crudes	3-17
4	Refined Product Demand	4-1
4.1	INTRODUCTION	4-1
4.2	VEHICLE FLEET DEVELOPMENTS	4-2
4.2.1	Introduction.....	4-2
4.2.2	Air Quality.....	4-3
4.2.3	National Air Pollution Rules and Standards	4-6
4.2.4	New Energy Vehicle Policy	4-8
4.2.5	Vehicle Analysis by Region and Province.....	4-12
4.2.6	Vehicle Fleet Structure	4-16
4.2.7	Electric Vehicle Fleet Development	4-20
4.2.8	Autonomous Vehicle Development	4-25
4.2.9	Gas-driven Vehicle Fleet Development.....	4-26
4.2.10	Vehicle Fleet Outlook	4-26
4.3	TRANSPORT FUEL DEMAND: SPECIFICATION DEVELOPMENTS.....	4-28
4.3.1	Introduction.....	4-28
4.3.2	Road Transport Fuel Specifications	4-28
4.3.3	Marine Fuel Specifications	4-29
4.4	TRANSPORT FUEL DEMAND: FUEL SUBSTITUTION	4-31
4.4.1	Introduction.....	4-31
4.4.2	Biofuels.....	4-33
4.4.3	Other Blend Stocks in Transport Fuels	4-37
4.5	OTHER FUEL DEMAND: INTRODUCTION	4-38
4.6	OTHER FUEL DEMAND: POWER GENERATION	4-38
4.7	OTHER FUEL DEMAND: COOKING & HEATING	4-40
4.8	PETROCHEMICAL FEEDSTOCK DEMAND.....	4-40
4.8.1	Ethylene Feedstock Demand	4-40
4.8.2	Propylene Feedstock Demand	4-51
4.8.3	Aromatics Feedstock Demand	4-56
4.8.4	Summary	4-63
4.9	REFINED PRODUCT DEMAND FORECAST	4-67
4.9.1	Introduction.....	4-67
4.9.2	LPG	4-69
4.9.3	Naphtha.....	4-74
4.9.4	Gasoline	4-75
4.9.5	Kerosene	4-80

4.9.6	Diesel/Gasoil	4-85
4.9.7	Fuel Oil	4-91
4.9.8	Petroleum Coke.....	4-96
5	Refined Product Supply.....	5-1
5.1	INTRODUCTION.....	5-1
5.1.1	Contents	5-1
5.2	DEVELOPMENT OF THE CHINESE REFINING SECTOR	5-2
5.2.1	Refining Capacity Development by Region and Ownership	5-2
5.2.2	Recent Trends	5-9
5.2.3	Outlook for Future Capacity Development.....	5-11
5.2.4	Assessment of the Independent Refining Sector.....	5-27
5.3	REFINED PRODUCTS SUPPLY	5-46
5.3.1	LPG	5-51
5.3.2	Naphtha.....	5-54
5.3.3	Gasoline	5-57
5.3.4	Jet Fuel/Kerosene	5-60
5.3.5	Diesel/Gasoil	5-62
5.3.6	Residual Fuel Oil.....	5-65
5.3.7	Petcoke	5-67
6	Refined Product Net Trade.....	6-1
6.1	NET TRADE OVERVIEW.....	6-1
6.2	NET TRADE BALANCES BY PRODUCT	6-3
6.2.1	LPG	6-3
6.2.2	Naphtha.....	6-6
6.2.3	Gasoline	6-9
6.2.4	Kerosene	6-12
6.2.5	Diesel/Gasoil	6-15
6.2.6	Fuel Oil	6-18
6.2.7	Petroleum Coke.....	6-21
7	Refining Competitiveness.....	7-1
7.1	INTRODUCTION.....	7-1
7.2	SIZE AND COMPLEXITY OF REFINERIES.....	7-2
7.2.1	Size.....	7-2
7.2.2	Complexity.....	7-4
7.2.3	Nexant's Size and Complexity Analysis.....	7-6
7.2.4	Competitiveness of Chinese Refineries	7-7
7.2.5	Competitiveness of the Independent Refining Sector in China	7-12
8	Refinery Petrochemical Integration	8-1
8.1	BACKGROUND.....	8-1
8.1	REFINERY PETROCHEMICAL INTEGRATION IN CHINA	8-3

8.1.1	Propylene Production	8-3
8.1.2	Ethylene Production	8-7
8.1.3	Aromatics Production	8-11
8.2	PROFILE OF REFINERY INTEGRATED SITES	8-13
8.2.1	Dushanzi Petrochemical	8-13
8.2.2	Shanghai Petrochemical (Sinopec Jinshanwei)	8-17
8.2.3	Sinopec Zhenhai Refining Company.....	8-20
8.2.4	Qilu Petrochemical Company.....	8-23
8.2.5	Fujian Refinery and Petrochemical Company.....	8-26

		Page
A	Refined Product Demand: Historical Data by Province	A-1
B	Net Refined Product Trade by Region	B-1

Figure	Page
1.1 China Provinces & Regions.....	1-2
1.2 GDP Per Capita by Province – 2005.....	1-3
1.3 GDP Per Capita by Province – 2016.....	1-3
1.4 China Share of Global GDP	1-4
1.5 Refined Product Demand - China	1-5
1.6 Road Transport versus Other Refined Products Demand – China.....	1-6
1.7 Passenger Vehicles per Capita	1-6
1.8 Passenger Vehicle Fleet by Fuel Source	1-7
1.9 Petrochemical Feedstock Demand – China.....	1-8
1.10 Naphtha Petrochemical Feedstock Demand by End-Use – China	1-9
1.11 LPG Petrochemical Feedstock Demand by End-Use – China.....	1-10
1.12 Refined Product Supply – China	1-11
1.13 China Refined Product Supply by Province, 2016	1-12
1.14 Refining Capacity Growth versus Refined Product Demand Growth.....	1-13
1.15 Refining Capacity, 2010-2030 – China	1-14
1.16 Independent Refining Capacity by Province, 2016	1-15
1.17 Refined Products Net Trade – China	1-17
1.18 Size and Complexity of Chinese Refineries	1-18
1.19 Competitiveness of Independent Refiners	1-19
1.20 Refinery Petrochemical Integration Index	1-21
1.21 Propylene Production by Technology and Integration - China.....	1-22
1.22 Ethylene Production by Technology and Integration – China.....	1-23
1.23 <i>para</i> -Xylene Production by Integration – China	1-23
2.1 China's Total Population Compared with Major Economies	2-1
2.2 China Provinces and Regions	2-3
2.3 Population by Region – China.....	2-4
2.4 Population & GDP Growth – China	2-4
2.5 China Share of Global GDP	2-6
2.6 GDP per Capita – China.....	2-6
2.7 GDP Per Capita by Province – 2005.....	2-8
2.8 GDP Per Capita by Province – 2016.....	2-9
2.9 Air Quality Measurement - Beijing.....	2-10
2.10 Carbon Dioxide Emissions – Major Industrial Countries	2-11
2.11 Belt and Road Initiative – Planned Focus	2-14
3.1 Crude Oil Reserves and Production, 2016.....	3-5
3.2 Location of Major Chinese Oilfields.....	3-7
3.3 China Crude Oil Production by Region	3-8
3.4 China Crude Oil Production by Province/Fields	3-8

3.5 Chinese Marketable Crude Oil Production by Grade	3-12
3.6 Comparison of Feedstock Qualities	3-13
3.7 China Crude Oil Imports by Region	3-15
3.8 China Crude Oil Imports by Region	3-15
3.9 China Crude Oil Imports by Country – Top 10 Suppliers.....	3-16
3.10 Average API & Sulfur Content of China's Imported Crude	3-17
4.1 Road transport versus Other Refined Products Demand – China	4-1
4.2 Vehicle Fleet Development	4-2
4.3 Passenger Vehicle Fleet Growth versus GDP Growth – China	4-3
4.4 Air Quality in January 2017	4-5
4.5 PM 2.5 Concentration in Representative Cities in North, East and South China	4-6
4.6 Passenger Vehicles per Capita – China, United States, Germany, Japan.....	4-12
4.7 Passenger Vehicle Ownership by Province	4-13
4.8 Truck Fleet by Province.....	4-15
4.9 Vehicle Fleet by Type – China	4-16
4.10 Passenger Vehicle Fleet versus Truck Fleet Growth – China	4-17
4.11 Passenger Vehicles by Fuel Source – China.....	4-18
4.12 Four Wheeled Passenger Vehicles by Fuel Source – China	4-19
4.13 Total Powered Vehicles by Fuel Source – China.....	4-19
4.14 Electric Vehicle Fleet by Type	4-20
4.15 Electric Vehicles by Type	4-21
4.16 Chinese-Made Battery Electric Vehicle (BEV)	4-21
4.17 Chinese-Made Plug-In Hybrid Electric Vehicle (PHEV)	4-22
4.18 Chinese-Made Low Speed Electric Vehicle (LSEV).....	4-22
4.19 Chinese-Made Electric Assisted Bicycle	4-22
4.20 Chinese-Made E-Scooter	4-23
4.21 Chinese-Made E-Motorcycle	4-23
4.22 Passenger Vehicle Fleet* by Fuel Source.....	4-27
4.23 Gasoline Pool Breakdown – China	4-29
4.24 Ethanol Demand – China	4-34
4.25 Biodiesel Demand – China.....	4-35
4.26 Electricity Generation by Source – China	4-39
4.27 Refined Product Demand for Power Generation – China	4-39
4.28 Refined Product Demand for Heating and Cooking	4-40
4.29 Chinese Ethylene Capacity Development.....	4-42
4.30 Location of Ethylene Plants in China	4-43
4.31 China Ethylene Production by Feedstock	4-44
4.32 China Ethylene Production by Process	4-45
4.33 Chinese Naphtha Demand as Steam Cracker Feedstock by Region	4-46
4.34 Chinese Ethane Demand as Steam Cracker Feedstock by Region	4-47

4.35 Chinese LPG Demand as Steam Cracker Feedstock by Region	4-48
4.36 Chinese Coal Price Evolution.....	4-50
4.37 Chinese Ethylene Production Cost, Q1 2017.....	4-50
4.38 China Propylene Production by Feedstock	4-52
4.39 China Propylene Production by Process.....	4-52
4.40 Location of Propylene Plants in China	4-53
4.41 Location of Propylene Plants in Shandong, Hebei, Beijing, Liaoning, Tianjin Provinces	4-54
4.42 Major Global Propane Importers	4-55
4.43 Chinese Propane Demand as PDH Feedstock by Region	4-55
4.44 Chinese Naphtha Feedstock Demand for Aromatics Production by Region	4-57
4.45 China Benzene Production by Process.....	4-58
4.46 Location of Benzene Plants in China	4-59
4.47 China <i>para</i> -Xylene Production by Process	4-61
4.48 Location of <i>para</i> -Xylene Plants in China	4-62
4.49 Chinese Naphtha Petrochemical Feedstock Demand by Region	4-63
4.50 Chinese Naphtha Petrochemical Feedstock Demand by End-Use	4-64
4.51 Chinese LPG Petrochemical Feedstock Demand by Region	4-65
4.52 Chinese LPG Petrochemical Feedstock Demand by End-Use.....	4-65
4.53 Propane Consumption for Chemicals versus Imports, 2016.....	4-66
4.54 Chinese Ethane Petrochemical Feedstock Demand by Region	4-66
4.55 Refined Product Demand - China	4-68
4.56 Demand Growth, Residential & Commercial vs GDP – LPG	4-69
4.57 Demand by Sector – LPG	4-70
4.58 Demand Per Capita by Province – LPG.....	4-71
4.59 Petrochemical Demand Per Capita by Province – LPG.....	4-72
4.60 Demand by Region – LPG	4-73
4.61 Demand – Naphtha	4-74
4.62 Demand Per Capita by Province – Gasoline.....	4-77
4.63 Demand by Region – Gasoline	4-79
4.64 Passenger Vehicles Per Capita by Region	4-80
4.65 Demand Per Capita by Province – Kerosene	4-82
4.66 Demand by Region – Kerosene	4-83
4.67 Demand by Use – Kerosene	4-84
4.68 Demand per Capita by Region – Aviation Kerosene	4-84
4.69 Automotive Demand by Region – Diesel/Gasoil	4-85
4.70 Demand by Use – Diesel/Gasoil	4-86
4.71 Other Demand by Use – Diesel/Gasoil	4-87
4.72 Marine Bunker Demand by Region – Diesel/Gasoil.....	4-88
4.73 Demand Per Capita by Province – Diesel/Gasoil.....	4-89
4.74 Demand by Region – Diesel/Gasoil	4-90

4.75 Demand Per Capita by Province – Fuel Oil	4-92
4.76 Demand by Region – Fuel Oil	4-94
4.77 Demand by Use – Fuel Oil	4-95
4.78 International Marine Bunker Demand – Fuel Oil	4-95
4.79 Demand – Petroleum Coke	4-96
5.1 Growth of Chinese Refining Capacity, 2010-2016	5-3
5.2 Chinese Refining Capacity Share by Region, 2016	5-3
5.3 Share of Refining Capacity Additions by Region, 2010-2016	5-4
5.4 Refining Capacity by Province, 2016	5-6
5.5 Chinese Refinery Ownership by Company, 2016	5-7
5.6 Chinese Refinery Capacity Additions by Company, 2010-2016	5-8
5.7 Chinese Refining Capacity Growth versus Refined Product Demand Growth, 2011-2016 ...	5-10
5.8 Growth of Chinese Refining Capacity, 2010-2030	5-12
5.9 Share of Refining Capacity Additions by Region, 2017-2030	5-13
5.10 Refining Capacity by Province, 2030	5-14
5.11 Chinese Refining Capacity Growth versus Refined Product Demand Growth, 2017-2025 ...	5-15
5.12 Share of Firm Refining Capacity Additions by Company, 2017 onwards	5-15
5.13 CNOOC Huizhou	5-17
5.14 PetroChina Yunnan	5-18
5.15 Sinopec Zhanjiang.....	5-20
5.16 PetroChina Jieyang	5-22
5.17 Hengli Petrochemical	5-24
5.18 Zhejiang Petrochemical.....	5-25
5.19 Independent Refining Capacity by Province, 2016	5-28
5.20 Shandong Dongming Petrochemical.....	5-32
5.21 Chinese Residual Fuel Oil Imports by Country of Origin	5-33
5.22 China Refined Product Supply, 2010-2030.....	5-47
5.23 China Refinery Operating Rates, 2010-2030	5-48
5.24 China Refined Product Supply by Region, 2010-2030	5-50
5.25 China Refined Product Supply by Province, 2016	5-50
5.26 China LPG Supply, 2010-2030.....	5-52
5.27 China LPG Supply by Province, 2016	5-53
5.28 China Naphtha Supply, 2010-2030	5-55
5.29 China Naphtha Supply by Province, 2016	5-56
5.30 China Gasoline Supply, 2010-2030	5-58
5.31 China Gasoline Supply by Province, 2016	5-59
5.32 China Jet Fuel/Kerosene Supply, 2010-2030	5-61
5.33 China Jet Fuel/Kerosene Supply by Province, 2016.....	5-61
5.34 China Diesel/Gasoil Supply, 2010-2030	5-63
5.35 China Diesel/Gasoil Supply by Province, 2016.....	5-64

5.36	China Residual Fuel Oil Supply, 2010-2030	5-65
5.37	China Residual Fuel Oil Supply by Province, 2016	5-66
6.1	Refined Products Net Trade – China	6-2
6.2	LPG Net Trade – China.....	6-3
6.3	Regional Trade Balances and Flows – LPG	6-4
6.4	Regional Net Trade Balance – LPG	6-5
6.5	Naphtha Net Trade – China	6-6
6.6	Regional Trade Balances and Flows – Naphtha.....	6-7
6.7	Regional Net Trade Balance – Naphtha	6-8
6.8	Gasoline Net Trade – China.....	6-9
6.9	Regional Trade Balances and Flows – Gasoline	6-10
6.10	Regional Net Trade Balance – Gasoline.....	6-11
6.11	Kerosene Net Trade – China.....	6-12
6.12	Regional Trade Balances and Flows – Kerosene	6-13
6.13	Regional Net Trade Balance – Kerosene.....	6-14
6.14	Diesel/Gasoil Net Trade – China.....	6-15
6.15	Regional Trade Balances and Flows – Diesel/Gasoil	6-16
6.16	Regional Net Trade Balance – Diesel/Gasoil.....	6-17
6.17	Fuel Oil Net Trade – China.....	6-18
6.18	Regional Trade Balances and Flows – Fuel Oil.....	6-19
6.19	Regional Net Trade Balance – Fuel Oil.....	6-20
6.20	Petroleum Coke Net Trade – China	6-21
7.1	Refinery Competitiveness Criteria.....	7-2
7.2	Total Crude Distillation Capacity – Selected Asian Markets	7-3
7.3	Average Asian Crude Distillation Capacity.....	7-4
7.4	Factors Affecting Refinery Configuration	7-5
7.5	Nexant's Size – Complexity Matrix.....	7-6
7.6	Size and Complexity of Chinese Refineries	7-7
7.7	Geographical Location of Tier 1 Capacity	7-9
7.8	Geographical Location of Tier 2 Capacity	7-10
7.9	Geographical Location of Tier 3 Capacity	7-12
7.10	Competitiveness of Independent Refiners	7-13
7.11	Independent Refinery Capacity Analysis	7-14
8.1	Key Challenges for Refiners and Petrochemical Producers	8-1
8.2	Degrees of Refinery-Petrochemicals Integration	8-2
8.3	Global RPI Index	8-3
8.4	Propylene Production in China.....	8-4
8.5	Global Propylene Production.....	8-4
8.6	Propylene Production – China and Regional	8-5
8.7	Chinese Provincial Propylene Production	8-6

8.8	Global Ethylene Production	8-8
8.9	Ethylene Production in China by Technology	8-9
8.10	Ethylene Production by Province	8-10
8.11	Chinese Provincial Ethylene Production by Technology and Integration	8-10
8.12	Para-Xylene Production China and Regional.....	8-12
8.13	Chinese Provincial <i>para</i> -Xylene Production by Integration	8-13
8.14	Location of the Dushanzi Petrochemical Complex.....	8-14
8.15	Kazakhstan – China Crude Oil Pipeline	8-14
8.16	Dushanzi Petrochemical Complex	8-16
8.17	Sinopec Shanghai Petrochemical (Jinshanwei)	8-17
8.18	Shanghai Petrochemical Products	8-18
8.19	Refined Product and Petrochemical Production	8-18
8.20	Shanghai Petrochemical (Jinshanwei)	8-19
8.21	Sinopec Zhenhai Refining Company (ZRCC)	8-20
8.22	Zhenhai Refining Company(ZRCC)	8-22
8.23	Qilu Petrochemical	8-23
8.24	Sinopec Qilu Petrochemical.....	8-25
8.25	Fujian Refining and Petrochemical Complex	8-26
8.26	Fujian Refinery and Petrochemical	8-27

Table	Page
2.1 Freight Transport by Mode – China	2-12
3.1 Main Responsibility of Different National Oil Companies when Established	3-1
3.2 Daqing Crude Assay	3-9
3.3 Shengli Crude Assay	3-10
4.1 Worst and Best Air Quality Cities in China	4-4
4.2 Air Pollutions in Different Regions – China	4-5
4.3 New Energy Vehicle Policy Framework – China	4-8
4.4 Policy Incentives – Electric Vehicles	4-9
4.5 Direct Subsidy Development – New Energy Vehicles	4-10
4.6 Vehicle Fleet* by Fuel Source	4-27
4.7 Gasoline Specifications – China	4-28
4.8 Diesel Specifications – China	4-29
4.9 Maximum Sulfur Content of Bunker Fuel Oil	4-30
4.10 MARPOL Options – Shipping Industry	4-31
4.11 MARPOL Options – Refining Industry	4-31
4.12 Specification Impact on Oxygenating Gasoline Blendstock Requirements	4-32
4.13 Refined Product Demand – China	4-68
4.14 Demand by Region – LPG	4-73
4.15 Demand – Naphtha	4-74
4.16 Demand by Region – Gasoline	4-79
4.17 Demand by Region – Kerosene	4-83
4.18 Demand by Region – Diesel/Gasoil	4-90
4.19 Demand as Refinery Feedstock – Fuel Oil	4-93
4.20 Demand by Region – Fuel Oil	4-94
4.21 Demand – Petroleum Coke	4-97
5.1 Independent Refineries' Crude Import Quotas	5-38
5.2 China Refined Product Supply, 2010-2030	5-46
5.3 China Refined Product Supply by Region, 2010-2030	5-49
5.4 China LPG Supply, 2010-2030	5-52
5.5 China Naphtha Supply, 2010-2030	5-54
5.6 China Gasoline Supply, 2010-2030	5-57
5.7 China Jet Fuel/Kerosene Supply, 2010-2030	5-60
5.8 China Diesel/Gasoil Supply, 2010-2030	5-62
5.9 China Residual Fuel Oil Supply, 2010-2030	5-65
6.1 Refined Products Net Trade – China	6-2
6.2 Regional Net Trade Balance – LPG	6-5
6.3 Regional Net Trade Balance – Naphtha	6-8
6.4 Regional Net Trade Balance – Gasoline	6-11
6.5 Regional Net Trade Balance – Kerosene	6-14
6.6 Regional Net Trade Balance – Diesel/Gasoil	6-17
6.7 Regional Net Trade Balance – Fuel Oil	6-20

NexantThinking™ Special Reports



Contact Details:

Americas:

Marcos Nogueira Cesar, Vice President, Global Products, E&CA: Nexant Thinking™
Phone: + 1-914-609-0324, e-mail: mcesar@nexant.com

Erica Hill, Client Services Coordinator, E&CA-Products
Phone: + 1-914-609-0386, e-mail: ehill@nexant.com

EMEA:

Anna Ibbotson, Director, NexantThinking
Phone: +44-207-950-1528, aibbotson@nexant.com

Asia:

Chommanad Thammanayakatip, Managing Consultant, E&CA
Phone: +66-2793-4606, email: cthammanayakatip@nexant.com

Nexant, Inc. (www.nexant.com) is a leading management consultancy to the global energy, chemical, and related industries. For over 38 years, Nexant has helped clients increase business value through assistance in all aspects of business strategy, including business intelligence, project feasibility and implementation, operational improvement, portfolio planning, and growth through M&A activities. Nexant has its main offices in San Francisco (California), White Plains (New York), and London (UK), and satellite offices worldwide.

Copyright © by Nexant Inc. 2017. All Rights Reserved.