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
4.4 Other Fuel Demand: Specification Developments

4.5 Other Fuel Demand: Power Generation

4.6 Other Fuel Demand: Cooking & Heating

4.7 Refined Product Demand Forecast

4.7.1 Introduction

4.7.2 Gasoline

4.7.3 Naphtha

4.7.4 LPG

4.7.5 Kerosene

4.8 Petrochemical Feedstock Demand

4.8.1 Ethylene Feedstock Demand

4.8.2 Propylene Feedstock Demand

4.8.3 Aromatics Feedstock Demand

4.8.4 Summary

4.9 Refined Product Demand Forecast

4.9.1 Introduction

4.9.2 LPG

4.9.3 Naphtha

4.9.4 Gasoline

4.9.5 Kerosene
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 RENEWED 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

Appendix

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

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