

Special Reports

On-Purpose Propylene in an Era of Uncertainty

Table of Contents

A Report by NexantThinking™
Updated June 2016

www.nexantthinking.com

Section	Page
1 Executive Summary	1-1
1.1 INTRODUCTION.....	1-1
1.2 TRENDS AFFECTING PROPYLENE SUPPLY AND COMMERCIAL TECHNOLOGIES.....	1-2
1.2.1 Feedstock Shifts in Ethylene Production.....	1-2
1.2.2 Propylene from Fluid Catalytic Crackers.....	1-3
1.2.3 On-Purpose Propylene.....	1-4
1.2.4 Global Market Impact	1-4
1.3 FEEDSTOCK AND CO-PRODUCT PRICE FORECASTS UNDER THREE OIL PRICE SCENARIOS	1-5
1.3.1 Alberta, Canada	1-5
1.3.2 United States	1-5
1.3.3 Saudi Arabia.....	1-7
1.3.4 China	1-8
1.4 COMPARATIVE ECONOMICS OF PROPYLENE AND POLYPROPYLENE	1-8
1.4.1 Alberta, Canada	1-8
1.4.2 United States Gulf Coast.....	1-9
1.4.3 United States Northeast	1-9
1.4.4 United States West Coast	1-9
1.4.5 Kingdom of Saudi Arabia	1-9
1.4.6 West China.....	1-9
1.4.7 Shanghai, China.....	1-10

1.4.8	As Delivered to Shanghai, China	1-10
1.5	MARKET OVERVIEW	1-13
1.5.1	Global Trends in Propylene Pricing.....	1-14
1.6	CONCLUSIONS	1-15
2	Introduction.....	2-1
2.1	STUDY OBJECTIVES.....	2-1
2.2	APPROACH AND METHODOLOGY	2-2
2.2.1	Price Forecasts	2-2
2.2.2	Cost of Production Estimation.....	2-3
2.3	OIL PRICE SCENARIOS AND IMPACT ON PETROCHEMICALS	2-10
2.3.1	Crude Oil Price Basis	2-11
2.3.2	Crude Oil Scenarios	2-11
2.4	ON-PURPOSE PROPYLENE SCENARIOS.....	2-14
2.4.1	Product Slate and Implications on Configuration Economics	2-21
2.4.2	Capital Investment.....	2-23
3	Trends affecting the Propylene Supply and Commercial Technologies	3-1
3.1	FEEDSTOCK SHIFTS IN ETHYLENE PRODUCTION	3-1
3.1.1	The Rise and Fall and Rise Again of Coal	3-1
3.1.2	Rise of NGLs and the Fall of Naphtha	3-1
3.1.3	Trends in Olefins Feedstocks and Investments	3-4
3.2	PROPYLENE FROM FLUID CATALYTIC CRACKING UNITS	3-6
3.2.1	Factors Influencing Propylene Production and Extraction	3-6
3.2.2	Alkylation Value.....	3-7
3.2.3	Propylene from Refinery Splitter	3-8
3.3	ON-PURPOSE PROPYLENE	3-9
3.3.1	Methanol to Olefins/Propylene	3-9
3.3.2	Propane Dehydrogenation	3-24
3.3.3	Metathesis	3-30
3.4	GLOBAL MARKET IMPACT	3-36
3.4.1	Propylene Supply	3-37
3.4.2	Summary of Propylene Supply.....	3-39
4	Feedstock and Co-Product Price Forecasts	4-1
4.1	GLOBAL SUMMARY.....	4-1
4.1.1	Alberta, Canada	4-1
4.1.2	United States	4-1

4.1.3	Saudi Arabia	4-3
4.1.4	China	4-4
4.2	COAL PRICE ANALYSIS AND FORECASTS	4-4
4.2.1	Regional Coal Pricing Structures	4-4
4.2.2	Coal Price Histories and Forecasts	4-8
4.3	NATURAL GAS PRICE ANALYSIS AND TRENDS	4-10
4.3.1	Regional Natural Gas Pricing Structures	4-10
4.3.2	Natural Gas Price Histories and Forecasts	4-13
4.4	ETHANE PRICE ANALYSIS AND FORECASTS	4-16
4.4.1	Regional Ethane Pricing Structures	4-16
4.4.2	Ethane Price Histories and Forecasts	4-19
4.5	PROPANE PRICE ANALYSIS AND FORECASTS	4-22
4.5.1	Regional Propane Pricing Structures	4-22
4.5.2	Propane Price Histories and Forecasts	4-25
4.6	ETHYLENE PRICE ANALYSIS AND FORECASTS	4-27
4.6.1	Regional Ethylene Pricing Structures	4-27
4.6.2	Ethylene Price Histories and Forecasts	4-29
5	Comparative Economics for Propylene and Polypropylene	5-1
5.1	COMPARISON BY TECHNOLOGY	5-1
5.1.1	Steam Cracking with Metathesis	5-1
5.1.2	Propane Dehydrogenation	5-13
5.1.3	MTP	5-23
5.1.4	MTO with OCP	5-35
5.2	COMPARISON BY REGION	5-47
5.2.1	Alberta, Canada	5-47
5.2.2	United States Gulf Coast	5-57
5.2.3	United States Northeast	5-67
5.2.4	United States West Coast	5-77
5.2.5	Kingdom of Saudi Arabia	5-83
5.2.6	West China	5-93
5.2.7	Shanghai, China	5-99
5.3	ON-PURPOSE PROPYLENE TECHNOLOGIES AS DELIVERED TO SHANGHAI	5-109
5.3.1	Propylene	5-109
5.3.2	Polypropylene	5-125

5.4	COMPETIVENESS AS COMPARED TO PROPANE CRACKING, DELIVERED TO SHANGHAI.....	5-142
6	Regional Market Analysis.....	6-1
6.1	GLOBAL SUMMARY.....	6-1
6.1.1	Global Market Outlook and Trade Summary.....	6-1
6.1.2	Global Trends in Propylene Pricing.....	6-3
6.2	NORTH AMERICA	6-4
6.2.1	Consumption	6-4
6.2.2	Supply	6-7
6.2.3	Supply, Demand, and Trade	6-13
6.2.4	Pricing	6-14
6.3	WESTERN EUROPE	6-16
6.3.1	Consumption	6-16
6.3.2	Supply	6-18
6.3.3	Supply, Demand, and Trade	6-22
6.3.4	Pricing	6-23
6.4	MIDDLE EAST	6-25
6.4.1	Consumption	6-25
6.4.2	Supply	6-27
6.4.3	Supply, Demand, and Trade	6-31
6.4.4	Pricing	6-32
6.5.1	Consumption	6-34
6.5.2	Supply	6-36
6.5.3	Supply, Demand, and Trade	6-45
6.5.4	Pricing	6-47
7	Key Issues and Conclusions	7-1
7.1	THE WINNING ON PURPOSE PROPYLENE TECHNOLOGY FOR EACH REGION	7-1
7.1.1	Alberta, Canada	7-1
7.1.2	United States Gulf Coast.....	7-1
7.1.3	United States Northeast	7-1
7.1.4	United States West Coast.....	7-1
7.1.5	Kingdom of Saudi Arabia	7-2
7.1.6	West China.....	7-2
7.1.7	Shanghai, China.....	7-2
7.1.8	As Delivered to Shanghai, China	7-2

7.2	SENSITIVITY ANALYSIS WITH VARIOUS OIL PRICE ASSUMPTIONS	7-3
7.2.1	Low Oil Scenario	7-3
7.2.2	Medium Oil Scenario	7-5
7.2.3	High Oil Scenario	7-7
7.3	KEY ISSUES AND UNCERTAINTIES	7-9
7.3.1	Political Implications Associated with Saudi Arabian Partnerships	7-9
7.3.2	Co-Product Economics	7-9
7.3.3	Other End-Uses and Regions	7-9
7.4	CONCLUSIONS	7-9

Figure	Page
1.1 Increasing Global Capacity for On-Purpose Propylene	1-1
1.2 U.S. Steam Cracker Feedstock Mix	1-3
1.3 Feedstock and Co-Product Pricing in Alberta, Canada	1-5
1.4 Feedstock and Co-Product Pricing in the U.S. Gulf Coast	1-6
1.5 Feedstock and Co-Product Pricing in the U.S. Northeast.....	1-6
1.6 Feedstock and Co-Product Pricing in the U.S. Northwest	1-7
1.7 Feedstock and Co-Product Pricing in Saudi Arabia	1-7
1.8 Feedstock and Co-Product Pricing in China, Shanghai and Inner Mongolia	1-8
1.9 Polypropylene Economics as Delivered to Shanghai, versus Total Plant Capital	1-11
1.10 Polypropylene Profitability versus Total Plant Capital.....	1-12
1.11 Polypropylene Profitability versus Total Plant Capital.....	1-12
1.12 Global GDP Growth vs Propylene Consumption Growth.....	1-13
1.13 Global Propylene Demand, 2015	1-13
1.14 Global Propylene Price Forecasts through 2030	1-15
2.1 Increasing Global Capacity for On-Purpose Propylene	2-1
2.2 Crude Oil Price Scenarios	2-12
2.3 Product Slate of Studied Propylene Production Technologies (<i>percent</i>).....	2-22
2.4 Product Slate of Studied Propylene Production Technologies (<i>ktons per year</i>).....	2-23
2.5 Total Plant Capital in 2025 for 500 thousand tons/year of Propylene (\$millions)	2-24
3.1 U.S. Steam Cracker Feedstock Mix	3-2
3.2 End-Uses for Refinery Propylene.....	3-7
3.3 Propylene Alkylation Value versus Refinery Grade Contract Prices	3-8
3.4 Propylene Splitter Cash Cost Margins	3-9
3.5 Three Main Gasification Processes	3-11
3.6 Selected Methanol Reformer Options	3-14
3.7 UOP/Hydro MTO Process Block Flow Diagram.....	3-20
3.8 Air Liquide Lurgi MTP® Block Flow Diagram.....	3-22
3.9 Paraffin Dehydrogenation: Thermodynamic Conversion at 1.0 Bara.....	3-25
3.10 Oleflex™ Propane Dehydrogenation Block Flow Diagram	3-28
3.11 Delta Price - Propylene and Ethylene	3-31
3.12 Lummus OCT Block Flow Diagram.....	3-35
3.13 Regional Propylene Capacity Addition, Overall	3-36
3.14 Regional Propylene Capacity Addition, On Purpose vs. Conventional.....	3-36

3.15	Current and Past Capacity Projections, Pre- and Post-Oil Price Decline	3-37
3.16	Regional Propylene Capacity	3-39
4.1	Feedstock and Co-Product Pricing in Alberta, Canada	4-1
4.2	Feedstock and Co-Product Pricing in the U.S. Gulf Coast	4-2
4.3	Feedstock and Co-Product Pricing in the U.S. Northeast.....	4-2
4.4	Feedstock and Co-Product Pricing in the U.S. Northwest	4-3
4.5	Feedstock and Co-Product Pricing in Saudi Arabia.....	4-3
4.6	Feedstock and Co-Product Pricing in China, Shanghai and Inner Mongolia.....	4-4
4.7	Types of Coal	4-5
4.8	Typical Coal Sales Cost Breakdown	4-6
4.9	Chinese Coal Prices	4-7
4.10	Historical Coal Prices and Forecast	4-9
4.11	Historical Coal Prices and Forecast	4-9
4.12	Global Natural Gas Prices (<i>Medium Oil Price Scenario, Current Dollars</i>)	4-14
4.13	Global Natural Gas Prices (<i>Low Oil Price Scenario, Current Dollars</i>)	4-14
4.14	U.S. Ethylene Feedstock Sources	4-16
4.15	Ethane Price Relative to Natural Gas Price	4-17
4.16	Estimated U.S. Ethane Rejection by PADD Region	4-18
4.17	Global Ethane Price Histories and Forecast (<i>Medium Oil Price Scenario, Current Dollar</i>) ...	4-20
4.18	Global Ethane Price Histories and Forecast (<i>Low Oil Price Scenario, Current Dollar</i>).....	4-20
4.19	Relative Value of U.S. Gulf Coast Propane – Medium Oil Scenario.....	4-23
4.20	China CIF versus Saudi CP	4-24
4.21	Historical Propane Price and Forecast (<i>Medium Oil Price Scenario, Current Dollars</i>)	4-25
4.22	Historical Propane Price and Forecast (<i>Low Oil Price Scenario, Current Dollars</i>)	4-25
4.23	Historical Ethylene Price and Forecast (<i>Medium Oil Price Scenario, Current Dollars</i>).....	4-30
4.24	Historical Ethylene Price and Forecast (<i>Low Oil Price Scenario, Current Dollars</i>).....	4-30
5.1	Propylene via Steam Cracking with Metathesis in 2015	5-2
5.2	Propylene via Steam Cracking with Metathesis in 2020	5-3
5.3	Propylene via Steam Cracking with Metathesis in 2020	5-4
5.4	Propylene via Steam Cracking with Metathesis in 2020	5-4
5.5	Propylene via Steam Cracking with Metathesis in 2025	5-5
5.6	Propylene via Steam Cracking with Metathesis in 2025	5-6
5.7	Propylene via Steam Cracking with Metathesis in 2025	5-6
5.8	Propylene via Steam Cracking with Metathesis in 2030	5-7
5.9	Propylene via Steam Cracking with Metathesis in 2030	5-8

5.10 Propylene via Steam Cracking with Metathesis in 2030	5-8
5.11 Cost of Production + ROCE for Ethane to Polypropylene via Steam Cracking with Metathesis	5-9
5.12 Cost of Production + ROCE for Ethane to Polypropylene via Steam Cracking with Metathesis	5-10
5.13 Cost of Production + ROCE for Ethane to Polypropylene via Steam Cracking with Metathesis	5-10
5.14 Cost of Production + ROCE for Propane to Polypropylene via Steam Cracking with Metathesis	5-11
5.15 Cost of Production + ROCE for Propane to Polypropylene via Steam Cracking with Metathesis	5-12
5.16 Cost of Production + ROCE for Propane to Polypropylene via Steam Cracking with Metathesis	5-12
5.17 Propane to Propylene via Propane Dehydrogenation in 2015.....	5-14
5.18 Propane to Propylene via Propane Dehydrogenation in 2020.....	5-15
5.19 Propane to Propylene via Propane Dehydrogenation in 2020.....	5-16
5.20 Propane to Propylene via Propane Dehydrogenation in 2020.....	5-16
5.21 Propane to Propylene via Propane Dehydrogenation in 2025.....	5-17
5.22 Propane to Propylene via Propane Dehydrogenation in 2025.....	5-18
5.23 Propane to Propylene via Propane Dehydrogenation in 2025.....	5-18
5.24 Propane to Propylene via Propane Dehydrogenation in 2030.....	5-19
5.25 Propane to Propylene via Propane Dehydrogenation in 2030.....	5-20
5.26 Propane to Propylene via Propane Dehydrogenation in 2030.....	5-20
5.27 Cost of Production + ROCE for Propane to Polypropylene via Propane Dehydrogenation ..	5-21
5.28 Cost of Production + ROCE for Propane to Polypropylene via Propane Dehydrogenation ..	5-22
5.29 Cost of Production + ROCE for Propane to Polypropylene via Propane Dehydrogenation ..	5-22
5.30 Propylene via MTP in 2015	5-24
5.31 Propylene via MTP in 2020	5-25
5.32 Propylene via MTP in 2020	5-26
5.33 Propylene via MTP in 2020	5-26
5.34 Propylene via MTP in 2025	5-27
5.35 Propylene via MTP in 2025	5-28
5.36 Propylene via MTP in 2025	5-28
5.37 Propylene via MTP in 2030	5-29
5.38 Propylene via MTP in 2030	5-30
5.39 Propylene via MTP in 2030	5-30
5.40 Top Ten Cost of Production for + ROCE Natural Gas to Polypropylene via MTP	5-31

5.41	Top Ten Cost of Production + ROCE for Natural Gas to Polypropylene via MTP	5-32
5.42	Top Ten Cost of Production + ROCE for Natural Gas to Polypropylene via MTP	5-32
5.43	Cost of Production + ROCE for Coal to Polypropylene via MTP	5-33
5.44	Cost of Production + ROCE for Coal to Polypropylene via MTP	5-34
5.45	Cost of Production + ROCE for Coal to Polypropylene via MTP	5-34
5.46	Propylene via MTO with OCP in 2015	5-36
5.47	Propylene via MTO with OCP in 2020	5-37
5.48	Propylene via MTO with OCP in 2020	5-38
5.49	Propylene via MTO with OCP in 2020	5-38
5.50	Propylene via MTO with OCP in 2025	5-39
5.51	Propylene via MTO with OCP in 2025	5-40
5.52	Propylene via MTO with OCP in 2025	5-40
5.53	Propylene via MTO with OCP in 2030	5-41
5.54	Propylene via MTO with OCP in 2030	5-42
5.55	Propylene via MTO with OCP in 2030	5-42
5.56	Top Ten Cost of Production + ROCE for Natural Gas to Polypropylene via MTO with OCP	5-43
5.57	Top Ten Cost of Production + ROCE for Natural Gas to Polypropylene via MTO with OCP	5-44
5.58	Top Ten Cost of Production + ROCE for Natural Gas to Polypropylene via MTO with OCP	5-44
5.59	Cost of Production + ROCE for Coal to Polypropylene via MTO with OCP	5-45
5.60	Cost of Production + ROCE for Coal to Polypropylene via MTO with OCP	5-46
5.61	Cost of Production + ROCE for Coal to Polypropylene via MTO with OCP	5-46
5.62	Propylene Production Technologies in Alberta, Canada in 2015.....	5-48
5.63	Propylene Production Technologies in Alberta, Canada in 2020.....	5-49
5.64	Propylene Production Technologies in Alberta, Canada in 2020.....	5-50
5.65	Propylene Production Technologies in Alberta, Canada in 2020.....	5-50
5.66	Propylene Production Technologies in Alberta, Canada in 2025.....	5-51
5.67	Propylene Production Technologies in Alberta, Canada in 2025.....	5-52
5.68	Propylene Production Technologies in Alberta, Canada in 2025.....	5-52
5.69	Propylene Production Technologies in Alberta, Canada in 2030.....	5-53
5.70	Propylene Production Technologies in Alberta, Canada in 2030.....	5-53
5.71	Propylene Production Technologies in Alberta, Canada in 2030.....	5-54
5.72	Cost of Production + ROCE for Polypropylene Production in Alberta, Canada.....	5-55
5.73	Cost of Production + ROCE for Polypropylene Production in Alberta, Canada.....	5-56

5.74 Cost of Production + ROCE for Polypropylene Production in Alberta, Canada	5-56
5.75 Propylene Production Technologies in USGC in 2015	5-58
5.76 Propylene Production Technologies in USGC in 2020	5-59
5.77 Propylene Production Technologies in USGC in 2020	5-60
5.78 Propylene Production Technologies in USGC in 2020	5-60
5.79 Propylene Production Technologies in USGC in 2025	5-61
5.80 Propylene Production Technologies in USGC in 2025	5-62
5.81 Propylene Production Technologies in USGC in 2025	5-62
5.82 Propylene Production Technologies in USGC in 2030	5-63
5.83 Propylene Production Technologies in USGC in 2030	5-64
5.84 Propylene Production Technologies in USGC in 2030	5-64
5.85 Cost of Production + ROCE for Polypropylene Production in USGC	5-65
5.86 Cost of Production + ROCE for Polypropylene Production in USGC	5-66
5.87 Cost of Production + ROCE for Polypropylene Production in USGC	5-66
5.88 Propylene Production Technologies in the US Northeast in 2015	5-68
5.89 Propylene Production Technologies in the US Northeast in 2020	5-69
5.90 Propylene Production Technologies in the US Northeast in 2020	5-70
5.91 Propylene Production Technologies in the US Northeast in 2020	5-70
5.92 Propylene Production Technologies in the US Northeast in 2025	5-71
5.93 Propylene Production Technologies in the US Northeast in 2025	5-72
5.94 Propylene Production Technologies in the US Northeast in 2025	5-72
5.95 Propylene Production Technologies in the US Northeast in 2030	5-73
5.96 Propylene Production Technologies in the US Northeast in 2030	5-74
5.97 Propylene Production Technologies in the US Northeast in 2030	5-74
5.98 Cost of Production + ROCE for Polypropylene Production in the US Northeast	5-75
5.99 Cost of Production + ROCE for Polypropylene Production in the US Northeast	5-76
5.100 Cost of Production + ROCE for Polypropylene Production in the US Northeast	5-76
5.101 Propylene Production Technologies in the US West Coast in 2015	5-77
5.102 Propylene Production Technologies in the US West Coast in 2020	5-78
5.103 Propylene Production Technologies in the US West Coast in 2020	5-78
5.104 Propylene Production Technologies in the US West Coast in 2020	5-78
5.105 Propylene Production Technologies in the US West Coast in 2025	5-79
5.106 Propylene Production Technologies in the US West Coast in 2025	5-79
5.107 Propylene Production Technologies in the US West Coast in 2025	5-79
5.108 Propylene Production Technologies in the US West Coast in 2030	5-80

5.109 Propylene Production Technologies in the US West Coast in 2030	5-80
5.110 Propylene Production Technologies in the US West Coast in 2030	5-80
5.111 Cost of Production + ROCE for Polypropylene Production in the US West Coast	5-81
5.112 Cost of Production + ROCE for Polypropylene Production in the US West Coast	5-82
5.113 Cost of Production + ROCE for Polypropylene Production in the US West Coast	5-82
5.114 Propylene Production Technologies in Saudi Arabia in 2015	5-84
5.115 Propylene Production Technologies in Saudi Arabia in 2020	5-85
5.116 Propylene Production Technologies in Saudi Arabia in 2020	5-86
5.117 Propylene Production Technologies in Saudi Arabia in 2020	5-86
5.118 Propylene Production Technologies in Saudi Arabia in 2025	5-87
5.119 Propylene Production Technologies in Saudi Arabia in 2025	5-88
5.120 Propylene Production Technologies in Saudi Arabia in 2025	5-88
5.121 Propylene Production Technologies in Saudi Arabia in 2030	5-89
5.122 Propylene Production Technologies in Saudi Arabia in 2030	5-90
5.123 Propylene Production Technologies in Saudi Arabia in 2030	5-90
5.124 Cost of Production + ROCE for Polypropylene Production in Saudi Arabia	5-91
5.125 Cost of Production + ROCE for Polypropylene Production in Saudi Arabia	5-92
5.126 Cost of Production + ROCE for Polypropylene Production in Saudi Arabia	5-92
5.127 Propylene Production Technologies in West China in 2015	5-93
5.128 Propylene Production Technologies in West China in 2020	5-94
5.129 Propylene Production Technologies in West China in 2020	5-94
5.130 Propylene Production Technologies in West China in 2020	5-94
5.131 Propylene Production Technologies in West China in 2025	5-95
5.132 Propylene Production Technologies in West China in 2025	5-95
5.133 Propylene Production Technologies in West China in 2025	5-95
5.134 Propylene Production Technologies in West China in 2030	5-96
5.135 Propylene Production Technologies in West China in 2030	5-96
5.136 Propylene Production Technologies in West China in 2030	5-96
5.137 Cost of Production + ROCE for Polypropylene Production in West China	5-97
5.138 Cost of Production + ROCE for Polypropylene Production in West China	5-98
5.139 Cost of Production + ROCE for Polypropylene Production in West China	5-98
5.140 Propylene Production Technologies in Shanghai, China in 2015	5-100
5.141 Propylene Production Technologies in Shanghai, China in 2020	5-101
5.142 Propylene Production Technologies in Shanghai, China in 2020	5-102
5.143 Propylene Production Technologies in Shanghai, China in 2020	5-102

5.144 Propylene Production Technologies in Shanghai, China in 2025	5-103
5.145 Propylene Production Technologies in Shanghai, China in 2025	5-104
5.146 Propylene Production Technologies in Shanghai, China in 2025	5-104
5.147 Propylene Production Technologies in Shanghai, China in 2030	5-105
5.148 Propylene Production Technologies in Shanghai, China in 2030	5-106
5.149 Propylene Production Technologies in Shanghai, China in 2030	5-106
5.150 Top Ten Cost of Production + ROCE for Polypropylene Production in Shanghai, China.....	5-107
5.151 Top Ten Cost of Production + ROCE for Polypropylene Production in Shanghai, China.....	5-108
5.152 Top Ten Cost of Production + ROCE for Polypropylene Production in Shanghai, China.....	5-108
5.153 Competitiveness as Delivered to Shanghai in 2015, Propylene	5-112
5.154 Competitiveness as Delivered to Shanghai in 2020, Propylene	5-114
5.155 Competitiveness as Delivered to Shanghai in 2020, Propylene	5-115
5.156 Competitiveness as Delivered to Shanghai in 2020, Propylene	5-116
5.157 Competitiveness as Delivered to Shanghai in 2025, Propylene	5-118
5.158 Competitiveness as Delivered to Shanghai in 2025, Propylene	5-119
5.159 Competitiveness as Delivered to Shanghai in 2025, Propylene	5-120
5.160 Competitiveness as Delivered to Shanghai in 2030, Propylene	5-122
5.161 Competitiveness as Delivered to Shanghai in 2030, Propylene	5-123
5.162 Competitiveness as Delivered to Shanghai in 2030, Propylene	5-124
5.163 Competitiveness as Delivered to Shanghai in 2015, Polypropylene	5-129
5.164 Competitiveness as Delivered to Shanghai in 2020, Polypropylene	5-131
5.165 Competitiveness as Delivered to Shanghai in 2020, Polypropylene	5-132
5.166 Competitiveness as Delivered to Shanghai in 2020, Polypropylene	5-133
5.167 Competitiveness as Delivered to Shanghai in 2025, Polypropylene	5-135
5.168 Competitiveness as Delivered to Shanghai in 2025, Polypropylene	5-136
5.169 Competitiveness as Delivered to Shanghai in 2025, Polypropylene	5-137
5.170 Competitiveness as Delivered to Shanghai in 2030, Polypropylene	5-139
5.171 Competitiveness as Delivered to Shanghai in 2030, Polypropylene	5-140
5.172 Competitiveness as Delivered to Shanghai in 2030, Polypropylene	5-141
5.173 Top Ten Configurations as Delivered to Shanghai, with and without Propane Cracking	5-143
5.174 Top Ten Configurations as Delivered to Shanghai, with and without Propane Cracking	5-144
5.175 Top Ten Configurations as Delivered to Shanghai, with and without Propane Cracking	5-145
6.1 Global GDP Growth vs Propylene Consumption Growth.....	6-1
6.2 Global Propylene Demand, 2014	6-2
6.3 Propylene Trade Routes	6-3

6.4	Global Propylene Price Forecasts through 2030	6-4
6.5	North American Combined Propylene Consumption, 2014	6-5
6.6	Firm Propylene Production by Process in North America	6-7
6.7	North America Combined Propylene Supply, Demand and Trade	6-14
6.8	U.S. Propylene: Ethylene Price Ratios.....	6-15
6.9	U.S. Propylene Price Scenarios	6-16
6.10	West European Propylene Consumption, 2014	6-16
6.11	Firm Propylene Production by Process in Western Europe.....	6-18
6.12	Western Europe Combined Propylene Supply/Demand and Trade	6-23
6.13	Western Europe Propylene: Ethylene Price Ratio	6-24
6.14	Western Europe Propylene Price Scenarios.....	6-25
6.15	Middle Eastern Propylene Consumption, 2014.....	6-26
6.16	Firm Combined Polymer/Chemical and Refinery Grade Propylene – Middle East and Africa	6-28
6.17	Middle Eastern Propylene Supply/Demand and Trade	6-31
6.18	Middle East Propylene: Ethylene Netback Price Ratio	6-32
6.19	Middle East Propylene Netback Price Scenarios.....	6-33
6.20	Asia Pacific Combined Propylene Consumption, 2014.....	6-34
6.21	Firm Propylene/Chemical Grade Propylene Capacity in Asia Pacific	6-36
6.22	Asia Pacific Propylene Supply/Demand and Trade	6-46
6.23	South East Asia Propylene: Ethylene Price Ratio.....	6-48
6.24	South East Asia Propylene Price Scenarios	6-49
7.1	Polypropylene Economics as Delivered to Shanghai, versus Total Plant Capital	7-3
7.2	Polypropylene Profitability versus Total Plant Capital.....	7-4
7.3	Polypropylene Profitability versus Total Plant Capital.....	7-4
7.4	Polypropylene Economics as Delivered to Shanghai, versus Total Plant Capital	7-5
7.5	Polypropylene Profitability versus Total Plant Capital.....	7-6
7.6	Polypropylene Profitability versus Total Plant Capital.....	7-6
7.7	Polypropylene Economics as Delivered to Shanghai, versus Total Plant Capital	7-7
7.8	Polypropylene Profitability versus Total Plant Capital.....	7-8
7.9	Polypropylene Profitability versus Total Plant Capital.....	7-8

Table	Page
2.1 Feedstock and Processes for Comparison	2-14
2.2 Ethane to Polypropylene via Steam Cracking with Metathesis (<i>8 Cases Including Hybrids</i>)	2-15
2.3 Propane to Polypropylene via Steam Cracking with Metathesis (<i>8 Cases Including Hybrids</i>)	2-15
2.4 Propane to Polypropylene via Propane Dehydrogenation (<i>8 Cases, Including Hybrids</i>).....	2-16
2.5 Coal to Polypropylene via MTP (<i>4 Cases, Including Hybrids</i>)	2-16
2.6 Coal to Polypropylene via MTO with OCP	2-16
2.7 Natural Gas to Polypropylene via MTP (<i>13 Cases Including Hybrids</i>).....	2-17
2.8 Natural Gas to Polypropylene via MTO with OCP (<i>13 Cases Including Hybrids</i>).....	2-19
2.9 Propane to Polypropylene via Steam Cracking (<i>8 cases Including Hybrids</i>).....	2-21
3.1 Impact of Feedstock and Flexibility on Investment Cost	3-3
3.2 Gasifier Typical Characteristics.....	3-12
3.3 Catalyst Performance – MTP® Process	3-18
3.4 UOP/Hydro MTO Flexibility	3-19
3.5 Overall Material Balance - MTP® Process.....	3-24
3.6 Propane Dehydrogenation Process Characteristics	3-26
3.7 Generic Propane Dehydrogenation Material Balance.....	3-27
3.8 Lummus Metathesis Process Characteristics	3-33
3.9 Material Balance Comparison for Ethane and Propane Steam Crackers as Compared with a Propane Steam Cracker with Lummus OCU.....	3-34
4.1 Characteristics of Each Coal Type	4-5
4.2 Historical and Projected Global Coal Prices	4-10
4.3 Natural Gas Price Histories and Forecast.....	4-15
4.4 Historical and Projected Global Ethane Prices (<i>Medium/Low/High Oil Price Scenarios, Current Dollars</i>).....	4-21
4.5 Historical and Projected Global Propane Prices (<i>Medium/Low/High Oil Price Scenarios, Current Dollars</i>).....	4-26
4.6 Historical and Projected Global Ethylene Prices (<i>Medium/Low/High Oil Price Scenarios, Current Dollars</i>).....	4-31
5.1 On-Purpose Propylene in Shanghai - Studied Scenarios	5-110
5.2 Polypropylene in Shanghai Studied Scenarios	5-125
5.3 Propane Cracking to Polypropylene delivered to Shanghai Configurations	5-142
6.1 North American Combined Propylene Consumption by Country	6-5
6.2 North American Combined Propylene Consumption	6-6

6.3	North American Propylene Capacity	6-10
6.4	North American Refinery Grade Propylene, 75 percent Propylene	6-12
6.5	North America Combined Propylene Supply/Demand and Trade	6-13
6.6	U.S. Propylene Price Scenarios	6-15
6.7	Western European Propylene Consumption.....	6-17
6.8	Western Europe Propylene Capacity Database.....	6-20
6.9	Western Europe Refinery Propylene Capacity, 75 percent Propylene	6-22
6.10	West European Combined Propylene Supply/Demand and Trade	6-23
6.11	Western Europe Propylene Price Scenarios.....	6-25
6.12	Middle Eastern Propylene Consumption	6-26
6.13	Middle Eastern Propylene Consumption by Region.....	6-27
6.14	Middle East Propylene Capacity	6-30
6.15	Middle Eastern Propylene Supply/Demand and Trade	6-31
6.16	Middle East Propylene Netback Price Scenarios.....	6-33
6.17	Asia Pacific Combined Propylene Consumption by Country	6-34
6.18	Asia Pacific Combined Propylene Consumption by Region	6-35
6.19	Asia Pacific Propylene Capacity Database	6-40
6.20	Asia Pacific Refinery Propylene Capacity, 75 percent Propylene.....	6-45
6.21	Asia Pacific Propylene Supply/Demand and Trade	6-47
6.22	South East Asia Propylene Price Scenarios	6-48

NexantThinking™ Special Reports



Nexant, Inc. (www.nexanthinking.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.

Contact Details:

New York: Marcos Nogueira Cesar

Phone: + 1-914-609-0324, e-mail: mcesar@nexant.com

New York: Heidi Junker Coleman, Global Programs Support Manager

Phone: + 1-914-609-0381, e-mail: hcoleman@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. 2015. All Rights Reserved.