

NexantThinking™

Special Reports

**Opportunities in C₅ Chemicals: A
Business Analysis**

Prospectus
March 2014



 **Nexant**

NexantThinking™

Special Reports

Opportunities in C₅ Chemicals: A Business Analysis

Prospectus
March 2014



This Report was prepared by Nexant, Inc. ("Nexant") and is part of the NexantThinking™ suite. Except where specifically stated otherwise in this Report, the information contained herein is prepared on the basis of information that is publicly available, and contains no confidential third party technical information to the best knowledge of Nexant. Aforesaid information has not been independently verified or otherwise examined to determine its accuracy, completeness, or financial feasibility. Neither Nexant, Subscriber nor any person acting on behalf of either assumes any liabilities with respect to the use of or for damages resulting from the use of any information contained in this Report. Nexant does not represent or warrant that any assumed conditions will come to pass.

The Report is submitted on the understanding that the Subscriber will maintain the contents confidential except for the Subscriber's internal use. The Report should not be reproduced, distributed, or used without first obtaining prior written consent by Nexant. Each Subscriber agrees to use reasonable effort to protect the confidential nature of the Report.

Copyright © by Nexant Inc. 2014. All rights reserved.

Contents

Section	Page
1 Introduction	1
1.1 STUDY OVERVIEW	1
1.2 C ₅ INDUSTRY REVIEW	1
1.3 C ₅ MARKET DRIVERS	3
2 Report Scope	7
2.1 OBJECTIVE	7
2.2 SCOPE	7
3 Report Table of Contents	11
4 Methodology	14
4.1 GENERAL APPROACH	14
4.2 MARKET ANALYSIS	14
4.3 ECONOMICS EVALUATION	16
5 Contact Details	17
5.1 CONTACT DETAILS	17

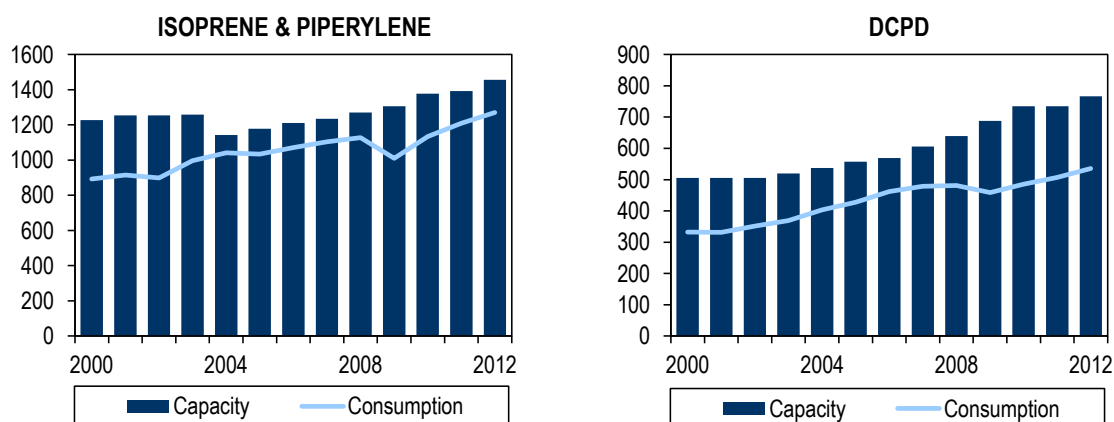
Figure	Page
1.1 Global Capacity and Demand Developments in C ₅ Chemicals	1
1.2 Uses of the C ₅ Stream	2
1.3 Representative Isoprene Yield by Steam Cracker Feedstock	3
1.4 Feedstock Trends for Global Ethylene Capacity	4
1.5 Global Isoprene and DCPD Demand by Application	5
1.6 Uses for Different DCPD Grades	5
4.1 Overview of the Global Industry Simulator	15
4.2 Dataflow within the Global Industry Simulator	15
4.3 Historical Correlation of Return on Capital and Operating Rate	16

Table	Page
2.1 Illustrative DCPD Cost of Production	9

1.1 STUDY OVERVIEW

A first impression of the C₅ chemicals industry could be one of relatively healthy profit margins, set against a background of reliable supply sources from established steam crackers, coupled with firm demand fundamentals for C₅ components in end-use markets. Such a view could also lead to the conclusion that C₅ chemicals offer a guaranteed investment opportunity. However, based on the relatively small number of producers and consumers worldwide, as well as the relatively limited recent investment activity outside of China, the C₅ chemicals sector evidently presents not only various potential business opportunities, but also a host of investment hurdles and strategic considerations.

Figure 1.1 Global Capacity and Demand Developments in C₅ Chemicals
(thousand tons)



Source: Nexant

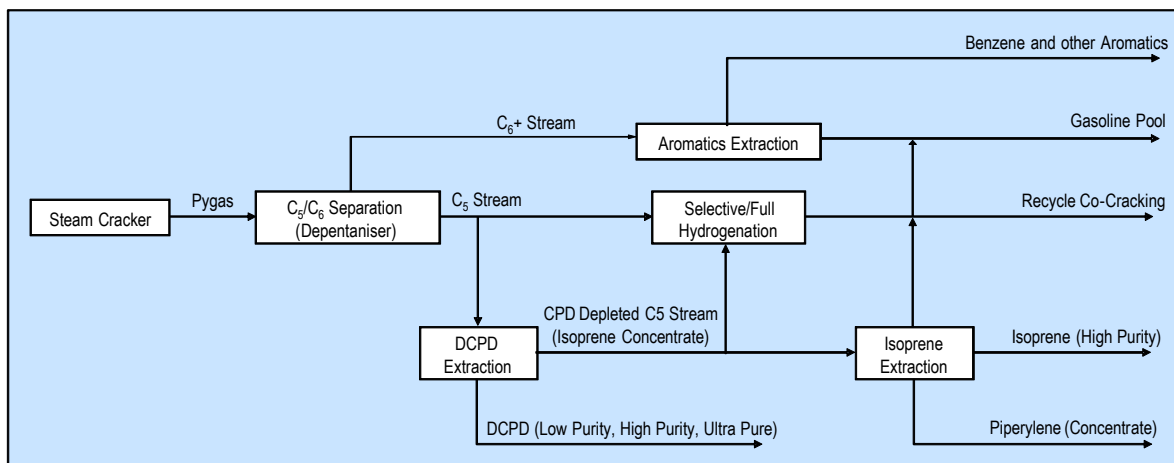
Nexant has completed a new report that provides detailed insights and analyses into the industry dynamics that are shaping the C₅ chemicals business. This prospectus outlines Nexant's approach and details the key areas of focus and analysis.

1.2 C₅ INDUSTRY REVIEW

The C₅ stream from the steam cracker is a rich source of diolefins, which are used as feedstocks for a wide variety of derivatives, including hydrocarbon resins, elastomers of various kinds, and even fine chemicals. This C₅ stream is contained within pyrolysis gasoline (pygas) and the normal fate for these C₅ hydrocarbons within most steam cracker complexes is in the gasoline pool or in recycle co-cracking.

However, some steam crackers depentanize the co-product pygas, opening up several options to add chemical value to the C₅ stream. The major C₅ components which are currently extracted or synthesized for chemical uses include isoprene, dicyclopentadiene (DCPD) and piperylene. The main options for chemical uses of the C₅ stream from a steam cracker are summarized in Figure 1.2.

Figure 1.2 Uses of the C₅ Stream
(extraction from pygas)



Source: Nexant

With their long histories, the C₅ chemicals industries in North America, Western Europe, and Japan have undergone restructuring and consolidation, and face relatively modest growth in generally maturing domestic end-use markets. Meanwhile, new C₅ extraction units have been added in China at a rapid pace in recent years to support surging demand, and the limited investment activity in mature markets is also opening up potential C₅ investment opportunities for steam cracker operators in other areas of the world. Key issues facing the C₅ chemicals industry today are tied to not only the availability and production of C₅ streams from steam crackers, but also the evolving requirements for sustaining a profitable C₅ business for both existing producers and new entrants.

As such, the C₅ chemicals industry involves a complex business that requires key investment considerations and questions to be addressed, such as:

- Market factors:
 - What are the key features and development trends in end-use markets, and how will these impact the outlook for C₅ chemicals and derivatives demand?
 - What are the implications for crude C₅ supply, based on projected feedstock preferences and investment patterns in the ethylene sector?
- Strategic considerations:
 - Are there opportunities in the merchant market, or will investments heavily rely on forward integration?
 - Can sufficient feedstock volumes be secured, and what are the appropriate options for site configuration?

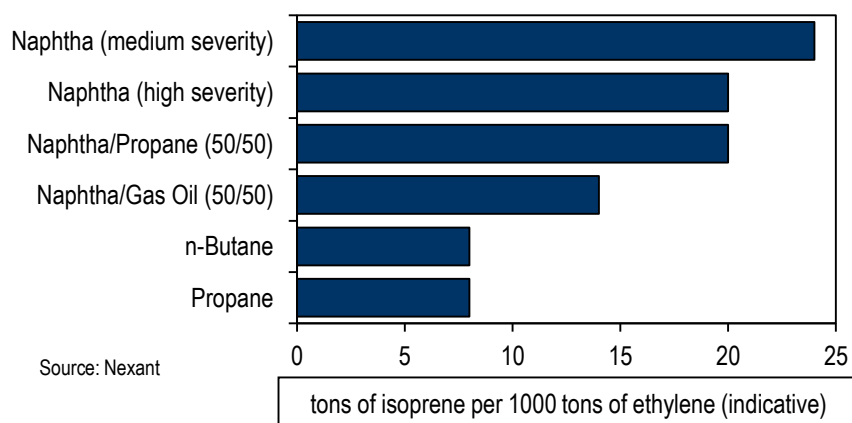
1.3 C₅ MARKET DRIVERS

1.3.1 Supply-Side Factors

Some players in the C₅ chemicals industry are also steam cracker operators, while other players procure C₅ streams or even isoprene concentrate to extract C₅ chemicals. Although isoprene is primarily produced via extraction from C₅ co-product streams of steam crackers, routes for on-purpose isoprene production are also in commercial use. Furthermore, DCPD can be produced in different purities, and multiple production configurations are available for optimizing around targeted DCPD purities, while piperylene can also be recovered in different concentrates, depending on the extraction process employed.

The content and composition of C₅ hydrocarbons in the steam cracker pygas stream also depends on the type of feedstock and operating severity (temperature and residence time) of the cracker. For example, the isoprene content in the C₅ stream is higher when lighter feedstocks are cracked. However, cracking lighter feedstocks also reduces the overall pygas yield, thereby decreasing the effective yield of isoprene from the cracker. As such, this causes some operational challenges for producers of C₅ components that are linked to steam crackers with considerable feedstock flexibility. Figure 1.3 conveys the way in which the isoprene yield may vary depending on cracking severity as well as the type of feedstock cracked. The yields of DCPD and piperylene are similarly impacted by both feedstock type and cracker operating severity.

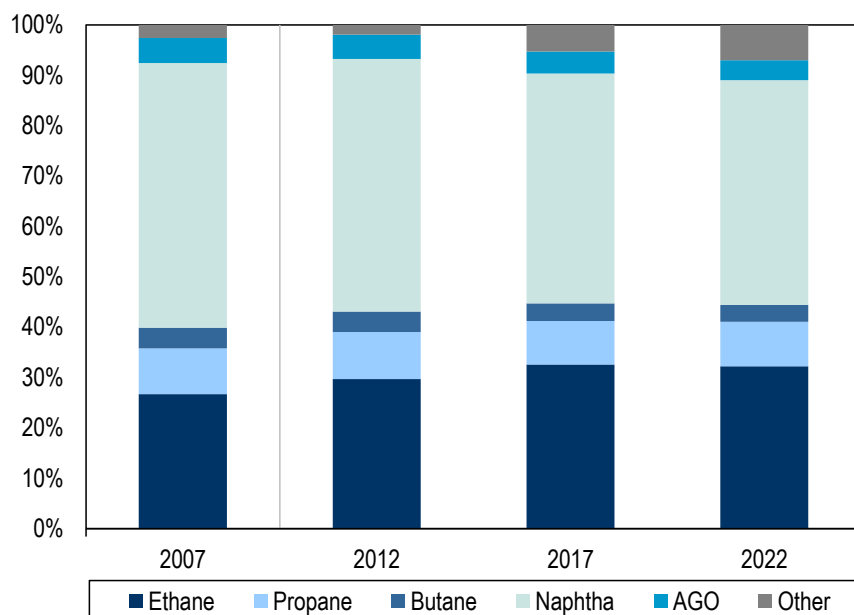
Figure 1.3 Representative Isoprene Yield by Steam Cracker Feedstock



In the global ethylene sector, a large portion of future investments will be based on lighter feedstocks, impacting the potential availability of C₅ hydrocarbons for extraction. In North America, shale gas has reversed the fortunes of the chemicals sector, as lower natural gas and ethane prices have reinvigorated investment interest, leading to a strong migration towards using a lighter feedstock slate, thereby somewhat reducing the availability of C₅ streams. In the Middle East, ethylene production is still predominantly based on lighter feedstocks, although the region has also been gradually trending towards using a heavier feedstock slate, with a higher proportion of crackers now using a combination of ethane and other natural gas liquids (NGLs).

Meanwhile, in Asia, certain new ethylene capacity additions are still expected to be based on naphtha feedstock, driven by continued investments in integrated refinery and petrochemical projects. In China, various coal-to-olefins (CTO) projects, which unlike steam crackers do not impact the potential availability of extractable C₅ hydrocarbons, are also projected to start up in the coming years. The economics and feasibility of such CTO projects are impacted by the availability of competitive mine-mouth coal and sufficient water, as well as issues related to project scale, configuration, and the development of nearby end-use markets. Projected feedstock trends within the global ethylene industry are portrayed in Figure 1.4.

Figure 1.4 Feedstock Trends for Global Ethylene Capacity
(percentage of global ethylene capacity by feedstock)



Source: Nexant

The investment landscape for the C₅ chemicals industry on the supply side is being shaped by several factors, including feedstock availability, operational factors, as well as issues related to scale and configuration. Producer concentration in the C₅ chemicals industry is generally high, and new supply options for C₅ streams in mature markets like North America and Japan are increasingly limited. Hence, the C₅ chemicals sector is also attracting potential new entrants, such as certain steam cracker operators in other parts of the world, and some of the key questions to be addressed may include:

- Will a world-scale naphtha cracker provide sufficient feedstock to support a new C₅ chemicals complex?
- Can the viability of a potential C₅ extraction unit be justified based on purchased or imported pygas or even mixed C₅ streams?
- Will steam crackers providing the unsaturated C₅ streams have the flexibility to crack different types of feedstocks and operate at different cracking severities?
- How will the C₅ complex be configured and optimised to extract multiple C₅ components?

1.3.2 Demand-Side Issues

The current global isoprene and DCPD markets and applications are summarized in Figure 1.5, while the production and uses for different DCPD grades are demonstrated in Figure 1.6. For piperylene, the main uses include hydrocarbon resins and specialty intermediate and fine chemicals. The key end-use sectors impacting overall C₅ chemicals demand include the tyre and automotive industries, as well as the adhesives and construction sector, amongst others. Some of the markets for the major derivatives of C₅ chemicals, such as polyisoprene, styrene block copolymers, or even certain hydrocarbon resins, may generally be associated with high entry barriers. Forward integration in such derivatives is significant in some cases, while businesses heavily based on merchant sales are also prevalent in other cases.

Figure 1.5 Global Isoprene and DCPD Demand by Application (2012)

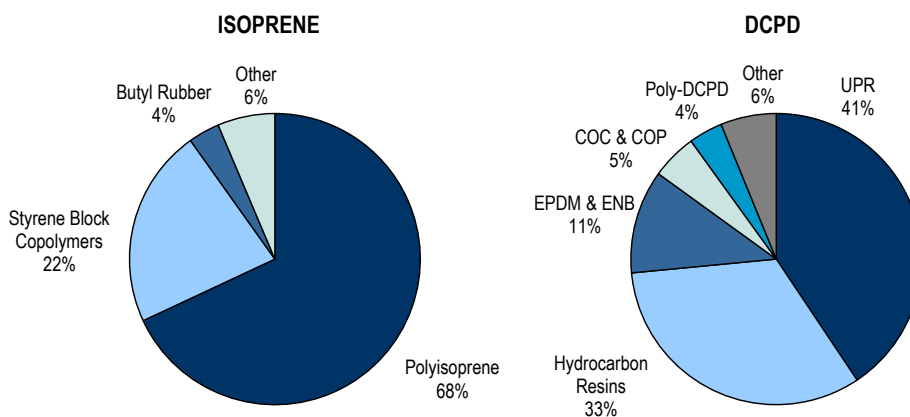
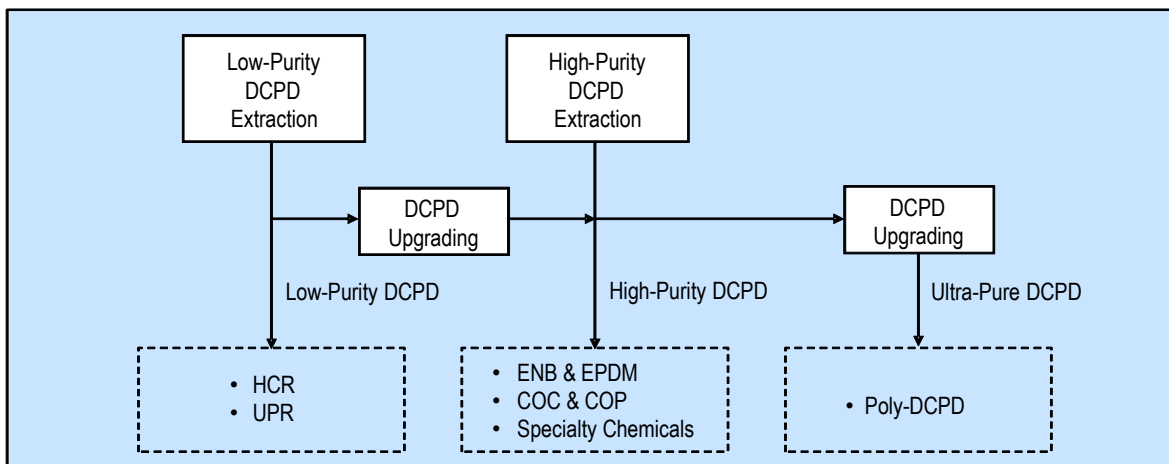


Figure 1.6 Uses for Different DCPD Grades (extraction and upgrading)



Source: Nexant

Some of the important questions to be addressed regarding the demand-side factors of the C₅ chemicals sector may include:

- Are the technologies for producing C₅ component derivatives available for licensing, and are there any other major entry barriers for forward integration?
- What are the opportunities available in the merchant market for C₅ chemicals and derivatives?
- Which regions are expected to be the major importers, and will any developing surpluses in nearby markets present risks to a new C₅ complex?
- Which market and applications are projected to have the highest growth potential, and are there any major threats for product substitution?

2.1 OBJECTIVE

The objective of this study was to examine the current and developing situation in the global C₅ chemicals industry. The report provides a comprehensive business analysis, including commercial, economic, and strategic considerations, and offers insights on the following key areas of the C₅ chemicals sector:

- Demand-side market fundamentals, comprising:
 - Prospects of emerging markets.
 - Trends in mature markets.
- Supply-side market factors, such as:
 - Underlying C₅ availability and supply potential amidst evolving developments in the ethylene industry.
 - Likelihood of isolating unsaturated C₅ streams from by-product streams of steam crackers and developing a viable C₅ chemicals complex.
 - Relative competitiveness of alternative production routes, such as on-purpose isoprene production.
- Trade considerations and their implications on trade flows and patterns, with attention to projected supply/demand imbalances.
- Production economics and drivers of production costs, product pricing, and profitability.
- Industry attractiveness and business strategies, including:
 - Industry structure, competitive intensity, and market attractiveness, with consideration to different participants along the value chain
 - Sustainable business models based on integration, optimization, or co-operation along the value chain
- C₅ investment considerations and the associated opportunities and challenges for different types of players in the chemicals sector.

2.2 SCOPE

2.2.1 Basis and Coverage

This study provides geographic coverage on global and regional bases, including:

- North America
- South America
- Europe
- Asia Pacific
- Middle East and Africa

The report's data is based on a 10-year history and 10-year forecasts. Detailed coverage is provided for the three primary C₅ chemicals of commercial importance, specifically:

- Isoprene (high purity)
- DCPD (low purity, high purity and ultra-pure)
- Piperylene

2.2.2 Demand Analysis

Nexant provides an overview of global C₅ diolefin and olefin consumption, discussing derivatives and end-use demand drivers, to review the overall C₅ chemicals market and its major products. Moreover, a detailed analysis of global and regional demand for isoprene, DCPD, and piperylene is presented, supported by supply/demand balances of key derivatives, offering insights on the trends, potential, and rationale for growth in end uses.

2.2.3 Supply Assessment

This reviews the commercial routes and feedstocks for producing C₅ chemicals, and evaluates market supply factors, such as the different C₅ yields for different feedstocks used in extraction processes. A detailed analysis of the ethylene industry, including supply/demand outlooks as well as current and future feedstock trends is provided, allowing for an investigation of the supply of mixed C₅ streams. Furthermore, availability of pygas and isolated unsaturated C₅ streams is estimated, conveying the supply-side prospects and limitations of C₅ chemicals. Nexant has assessed the supply of isoprene, DCPD, and piperylene with consideration for new plant additions and capacity rationalization.

2.2.4 Supply/Demand and Trade Review

The demand analysis coupled with the supply assessment allows for compiling net trade patterns, and Nexant has included an overview of C₅ market characteristics, as well as trade considerations and trends related to transporting the C₅ chemical products (i.e., isoprene, DCPD and piperylene) and their derivatives (e.g. polyisoprene and hydrocarbon resins). Supply/demand and net trade data is also summarized for isoprene, DCPD and piperylene, supplemented by further analyses of current and expected trade flows that balance the global market.

2.2.5 Production Economics Evaluation

This section presents representative cost of production estimates for isoprene, DCPD, piperylene, and their major derivatives, including both capital costs and operating costs for commercial production processes, which comprise co-product extraction processes, as well as on-purpose production routes, such as isobutylene carbonylation and isopentane dehydrogenation for on-purpose isoprene production. In addition, cost-based drivers and supply/demand-related factors are discussed regarding market pricing. Nexant analyzes the implied range of profitability for C₅ chemicals, based on relevant and defined assumptions and forecasts for the valuation of feedstocks and pricing of products.

Table 2.1 Illustrative DCPD Cost of Production

Product	DCPD					
Producer	Illustrative					
Process	Dimerization/Fractionation					
Feedstock	CPD Depleted C5 Stream					
Analysis Date	Illustrative					
Location	Illustrative					
Capacity	40.0 Thousand MT per Year					
Operating Rate	90 Percent					
Throughput	36.0 Thousand MT per Year					
				CAPITAL COST		MILLION USD
				ISBL		37.6
				OSBL		30.1
				Total Plant Capital		67.7
				Other Project Costs		16.9
				Total Project Investment		84.7
				Working Capital		43.0
				Total Capital Investment		127.7
				UNITS	PRICE	ANNUAL
				PER MT	USD	COST
				PRODUCT	PER UNIT	MM USD
PRODUCTION COST SUMMARY		UNITS				
RAW MATERIALS	Steam Cracker C5 Stream	MT	4.706	931.18	4,382.14	157.76
	Catalyst & Chemicals	-	1.000	1.07	1.07	0.04
	TOTAL RAW MATERIAL COST				4,383.20	157.80
BY-PRODUCTS	CPD Depleted C5 Stream	MT	(3.706)	911.98	(3,379.80)	(121.67)
	TOTAL BY-PRODUCT CREDIT				(3,379.80)	(121.67)
	NET RAW MATERIAL COST				1,003.40	36.12
UTILITIES	Power	MWh	0.024	109.70	2.66	0.10
	Cooling Water	kMT	0.250	49.13	12.30	0.44
	Steam (200 psig)	MT	1.000	64.11	64.11	2.31
	TOTAL UTILITY COST				79.07	2.85
	VARIABLE COST				1,082.47	38.97
DIRECT FIXED COSTS	Labourer	5 Workers	63.3	Thousand USD per Worker	8.80	0.32
	Foreman	1 Workers	91.6	Thousand USD per Worker	2.54	0.09
	Supervisor	0 Workers	108.4	Thousand USD per Worker	0.00	0.00
	Maintenance, Material & Labor		3.00	% ISBL	31.35	1.13
	Direct Overhead		45	% Total Labor Cost	5.10	0.18
	TOTAL DIRECT FIXED COST				47.80	1.72
ALLOCATED FIXED COSTS	General Plant Overhead		60	% Total Direct Fixed Cost	28.68	1.03
	Insurance & Property Tax		1.00	% Total Plant Capital	18.81	0.68
	TOTAL ALLOCATED FIXED COST				47.49	1.71
	FIXED COST				95.29	3.43
TOTAL CASH COST					1,177.76	42.40
DEPRECIATION		10.0 % ISBL & OPC	5.0	% OSBL	193.34	6.96
COST OF PRODUCTION					1,371.10	49.36
ROI (Simple Pre-Tax Return on Instantaneous Replacement Project Investment)				10.0 % Total Project Investment	235.14	8.47
COST OF PRODUCTION + ROI					1,606.24	57.82

Source: Nexant

2.2.6 Industry and Business Analysis

Drawing upon the analyses in the preceding sections, this section focuses on the strategic issues of the C₅ industry and business. The C₅ value chain is reviewed to examine the structure of the market, in terms of captive and merchant activities as well as relationships between different participants along the value chain.

The competitive intensity, market attractiveness and other factors that characterize the structure of the isoprene, DCPD and piperylene industries is discussed, while the different business models employed by industry players, in terms of integration levels and strategies, is also presented. Moreover, Nexant includes a summary of site optimization within developed C₅ clusters in certain mature markets, and explores the prospects for potential C₅ sites in selected emerging markets. This section concludes with a discussion on the key opportunities and challenges associated with investment considerations from the perspective of new prospective entrants as well as current established players.

Section	Page
1 Executive Summary	1-1
1.1 INTRODUCTION	1-1
1.2 DEMAND ANALYSIS	1-2
1.2.1 Isoprene	1-2
1.2.2 DCPD	1-3
1.2.3 Piperylene	1-5
1.3 SUPPLY ASSESSMENT	1-6
1.3.1 Feedstocks and Supply Drivers	1-6
1.3.2 Ethylene Industry and Supply of C ₅ Streams	1-7
1.3.3 Capacity of C ₅ Chemicals.....	1-12
1.4 SUPPLY/DEMAND AND TRADE REVIEW	1-16
1.4.1 Isoprene	1-16
1.4.2 DCPD	1-17
1.4.3 Piperylene	1-18
1.5 PRODUCTION ECONOMICS EVALUATION	1-19
1.5.1 Isoprene Production Costs	1-19
1.5.2 DCPD Production Costs.....	1-21
1.5.3 Pricing and Profitability.....	1-22
1.6 INDUSTRY AND BUSINESS ANALYSIS	1-29
1.6.1 Industry Structure	1-29
1.6.2 Business Models	1-30
1.6.3 Investment Considerations.....	1-36
2 Introduction.....	2-1
2.1 STUDY OVERVIEW	2-1
2.1.1 Background	2-1
2.1.2 Objectives.....	2-8
2.1.3 Report Coverage	2-8
2.1.4 Product Coverage	2-10
2.2 STUDY ASSUMPTIONS	2-12
2.2.1 Crude Oil Pricing	2-12
2.2.2 Economic Growth	2-14
2.2.3 Inflation	2-17
2.3 STUDY METHODOLOGY	2-19
2.3.1 General.....	2-19
2.3.2 Markets.....	2-20

	2.3.3 Economics	2-21
3	Demand Analysis	3-1
	3.1 OVERVIEW	3-1
	3.1.1 C ₅ Chemicals Consumption	3-1
	3.1.2 Derivatives and Demand Drivers	3-5
	3.2 ISOPRENE	3-32
	3.2.1 Isoprene Demand.....	3-32
	3.2.2 Isoprene Derivatives Supply/Demand.....	3-45
	3.3 DCPD	3-69
	3.3.1 DCPD Demand.....	3-69
	3.3.2 DCPD Derivatives Supply/Demand.....	3-85
	3.4 PIPERYLENE	3-126
	3.4.1 Piperylene Demand.....	3-126
	3.4.2 Piperylene Derivatives Supply/Demand.....	3-135
4	Supply Assessment.....	4-1
	4.1 OVERVIEW	4-1
	4.1.1 C ₅ Chemicals Production	4-1
	4.1.2 Feedstocks and Supply Drivers	4-6
	4.2 ETHYLENE INDUSTRY	4-14
	4.2.1 Ethylene Supply/Demand.....	4-14
	4.2.2 Ethylene Feedstock Trends	4-15
	4.3 SUPPLY OF C ₅ STREAMS.....	4-22
	4.3.1 Pygas Availability	4-22
	4.3.2 Crude C ₅ Availability.....	4-23
	4.4 CAPACITY OF C ₅ CHEMICALS	4-31
	4.4.1 Isoprene	4-31
	4.4.2 DCPD	4-39
	4.4.3 Piperylene	4-47
5	Supply/Demand and Trade Review	5-1
	5.1 ISOPRENE	5-1
	5.1.1 Supply/Demand and Net Trade.....	5-1
	5.1.2 Trade Flows.....	5-6
	5.2 DCPD	5-8
	5.2.1 Supply/Demand and Net Trade.....	5-8
	5.2.2 Trade Flows.....	5-14
	5.3 PIPERYLENE	5-16
	5.3.1 Supply/Demand and Net Trade.....	5-16
	5.3.2 Trade Flows.....	5-20
6	Production Economics Evaluation.....	6-1

6.1	OVERVIEW	6-1
6.1.1	Production Processes	6-1
6.1.2	Valuation of Feedstocks and C ₅ Streams	6-9
6.2	ISOPRENE PRODUCTION COSTS	6-12
6.2.1	Extractive Distillation	6-12
6.2.2	Isobutylene Carbonylation.....	6-15
6.2.3	Isopentane Dehydrogenation	6-20
6.2.4	Summary	6-22
6.3	DCPD PRODUCTION COSTS.....	6-25
6.3.1	DCPD Extraction	6-25
6.3.2	DCPD Upgrading.....	6-29
6.3.3	Summary	6-32
6.4	PRICING AND PROFITABILITY	6-33
6.4.1	Sources and Bases of Historical Prices	6-33
6.4.2	Feedstocks	6-34
6.4.3	Isoprene	6-37
6.4.3	DCPD	6-44
6.4.4	Piperylene	6-49
7	Industry and Business Analysis	7-1
7.1	INDUSTRY STRUCTURE.....	7-6
7.1.1	Isoprene	7-6
7.1.2	DCPD	7-7
7.1.3	Piperylene	7-10
7.2	BUSINESS MODELS	7-11
7.2.1	Isoprene	7-11
7.2.2	DCPD	7-14
7.2.3	Piperylene	7-16
7.3	C ₅ INTEGRATION AND SITES.....	7-18
7.3.1	DCPD Purification Options	7-18
7.3.2	Current C ₅ Operations.....	7-19
7.3.3	Potential C ₅ Sites	7-23
7.4	INVESTMENT CONSIDERATIONS AND CONCLUSIONS	7-35
7.4.1	Market Fundamentals.....	7-35
7.4.2	Production Economics.....	7-41
7.4.3	Other Factors	7-43

4.1 GENERAL APPROACH

Nexant has considerable experience in undertaking assignments of this type. The basic approach includes:

- Utilizing experience from performing a similar role on a number of recent assignments
- Utilizing its global in-house databases on supply, demand and trade, as well as pricing and profitability
- Conducting direct market research and fieldwork with consumers, producers and other relevant bodies.
- Reviewing selected public domain sources to provide the latest view of market developments

Nexant has a strong track record in evaluating petrochemical markets. This experience, along with non-confidential information from previous studies, has been used for this study.

4.2 MARKET ANALYSIS

Market analysis developed by Nexant is compiled from external data, based on public domain information and industry interviews, ultimately using a comprehensive database engine that simulates global industry market dynamics, techno-economics, and profitability for all key petrochemicals. This state-of-the-art Global Industry Simulator (GIS) builds on reliable data and proven models.

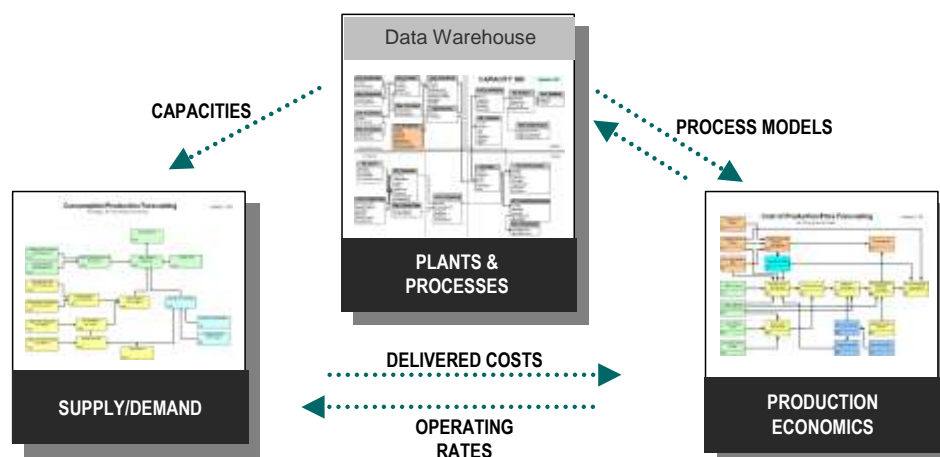
Already the industry leader in terms of its quality business planning consultancy, including profitability forecasting, the GIS has enabled Nexant to take a further leap forward. It has replaced over 10 000 spread-sheets and 25 databases, and ensures a rigorous convergence on consistent sets of projections that satisfy all the influencing business rules. This is unique in chemical industry consulting, providing greater confidence in consistency. An overview of the GIS is displayed in Figure 4.1 and the general layout of data flow is shown in Figure 4.2.

The principal factors considered for Nexant simulations are as follows:

- Primary energy pricing (crude oil and natural gas prices, petrochemical feedstocks, power, and utility costs)
- Economic growth (GDP growth projections; industrial, agriculture, automotive, construction, consumer spending and other sector projections; population growth)
- Currency exchange rate projections
- Inflation projections (capital, wage and general inflation)
- Petrochemical asset development profiles (both planned and expected in the next four years and speculative additions/shutdowns thereafter)

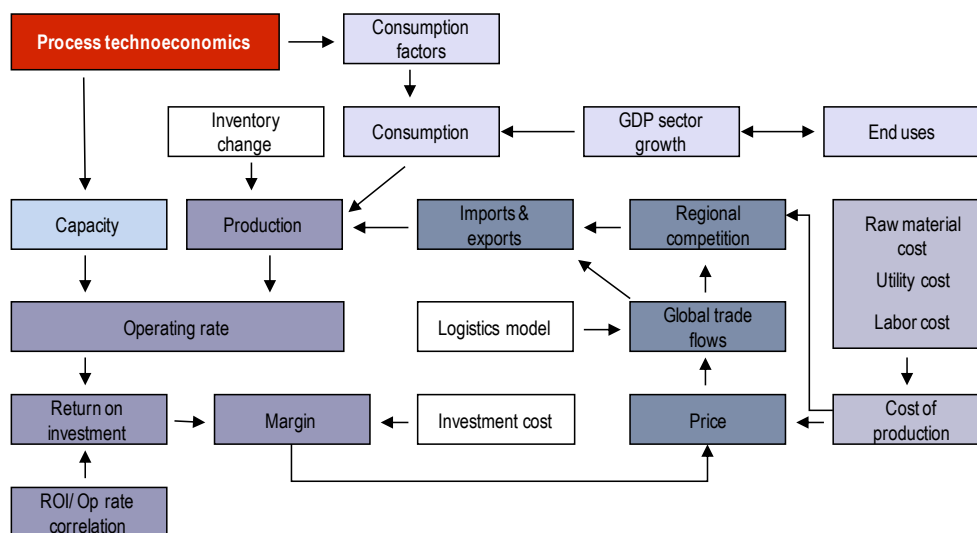
Figure 4.1 Overview of the Global Industry Simulator

Powered by a State of the art industry simulator
that builds on reliable data and proven models



Source: Nexant

Figure 4.2 Dataflow within the Global Industry Simulator



Source: Nexant

Due to the specific regional focus of this assignment for selected products, Nexant has also conducted direct fieldwork in selected markets where required. Nexant has a long history of working in all regional markets, and has access to an extensive network of contacts throughout various regions. Additionally, Nexant conducts annual field research on a global basis as part of its multi-client Petroleum and Petrochemical Economics (PPE) Program, and has an impressive contact base of suppliers and consumers within the sector.

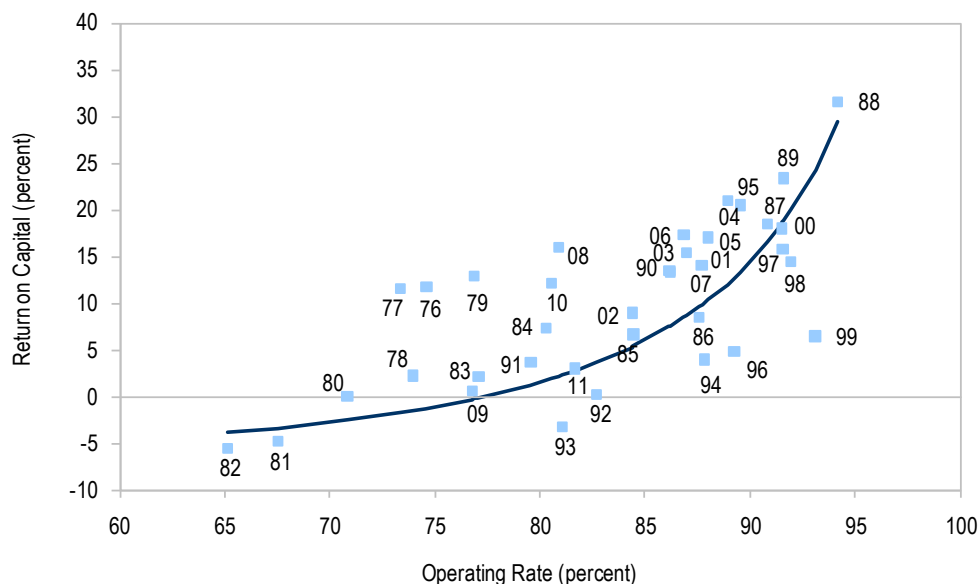
4.3 ECONOMICS EVALUATION

Nexant has well-established methodologies for developing investment and production cost estimates. Nexant monitors industry technology developments on a regular basis, with inputs derived from a number of sources, including licensor data, project reviews, patent research, and plant performance monitoring activities, where non-confidential data are available. Investment costs are estimated using a top-down approach, based on in-house data and previous project experience, rather than a bottom-up calculation, based on equipment specifications and contractor unit rates. Production costs are developed at different levels, including raw material costs, by-product credits, utility costs, direct fixed costs, and allocated fixed costs.

Nexant's petrochemical price forecasting methodology is largely based on an assumption for the underlying price of crude oil, which drives production costs, and on an understanding of the long-term relationship between supply and demand conditions and profit margins. This methodology primarily considers long-term fundamental industry developments in global supply, demand, and regional cost competitiveness, and also assumes that market conditions have come to equilibrium with no short-term disturbances.

Nexant's petroleum and petrochemical price forecasts are generally prepared using the GIS, which uses the latest simulation software and algorithms to simulate business dynamics in petrochemicals, intermediates, and polymers. Basic commodity theory dictates that market tightness, measured by average operating rates, is the primary driver of profitability, with inter-regional competition and inter-material competition adding to the complexity of price and cost drivers. Resulting prices must also be cross-checked in view of inter-regional trade, inter-material and inter-polymer competition, as well as implied upstream and downstream market competitiveness.

Figure 4.3 Historical Correlation of Return on Capital and Operating Rate
(example: representative petrochemical industry average)



Source: Nexant

5.1 CONTACT DETAILS

AMERICAS

Nexant, Inc.
44 South Broadway, 4th Floor
White Plains, NY 10601-4425, U.S.A.
Attn: Mr. James D. Virosco
Principal
Tel: + 1-914-609-0318
Fax: + 1-914-609-0399
Email: jvirosco@nexant.com

Or

Attn: Heidi Junker Coleman
Global Programs Support Manager
Tel: + 1-914-609-0381
Fax: + 1-914-609-0399
Email: hcoleman@nexant.com

ASIA & EUROPE

Nexant Singapore Pte. Ltd.
16 Collyer Quay
Level 10
Singapore 049318
Attn: Mr. Wonsoo Byun
Senior Consultant
Tel: + 65-6818-9723
Email: wbyun@nexant.com

MIDDLE EAST

Nexant Limited
P.O. Box 20705
Level 22, West Tower
Bahrain Financial Harbour
King Faisal Highway
Manama, Bahrain
Attn: Mr. Graham Hoar
Director, Middle East
Tel: + 97-3-1750-2962
Fax: + 97-3-1750-3030
Email: ghoar@nexant.com

Nexant, Inc.

San Francisco
New York
Houston
Washington
London
Frankfurt
Bahrain
Singapore
Bangkok
Shanghai
Kuala Lumpur

www.nexant.com

www.nexantthinking.com

