IHS CHEMICAL

# Light Linear Alpha Olefin Market Study

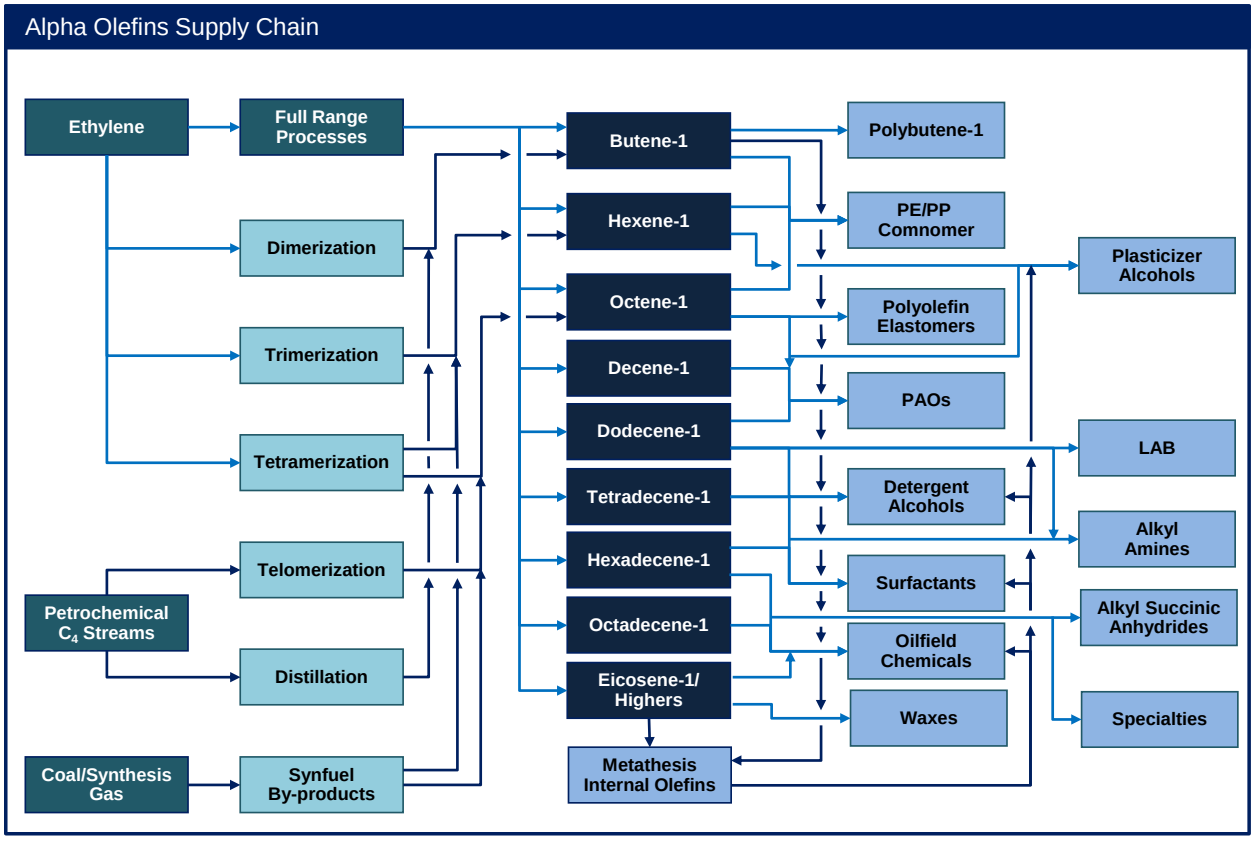
Special Report Prospectus

# Contents

# Introduction

The linear alpha olefin ("LAO") business is complex, serving a broad range of industries and applications therein from commodity plastics to small volume fine and performance chemicals.

A simplified map of the LAO value chain is given below:




The figure reinforces the complexity of the business. From the supply side, ethylene remains the dominant building block, although there alternative sources, e.g. from refinery/petrochemical C4 operations and also from synthetic fuel co-products streams derived from synthesis gas.

There are a range of technologies in commercial operation today. These are assumed to be grouped into two families, namely full range and on-purpose. The full range technologies are operated by only a few companies and each company tends to have different levels of integration downstream. Producers of full range alpha olefins include:

- ChevronPhillips
- Shell
- Ineos
- SABIC
- Idemitsu

The nature of technology, especially the catalysts used, dictates the distribution of LAOs produced in the full range plants from the oligomerization of ethylene. Technologies are also offered for license from Axens and UOP.

Most current commercial LAO plants produce a broad range of even-numbered alpha-olefins based on ethylene oligomerization. There is also a growing family of so-called “on-purpose” technologies targeting specific molecules. These include:

- Butene-1
  - Distillation of butylene-containing C4 streams
  - Ethylene dimerization (developed by Axens)
- Hexene-1
  - Ethylene trimerization (developed by Phillips and others)1
  - Butene-1 self-metathesis (developed by CBI Lummus)
- Octene-1
  - Ethylene tetramerization (developed by Sasol)
  - Butadiene telomerization (developed by Dow Chemical)

The disparity between demand growth for comonomer grades compared to demand growth for higher fractions produced in the broad range plants has driven the above on-purpose developments.

[1] Hexene-1 is also a co-product form the ethylene tetramerization process.

## Study Scope

This report will provide an examination of the lower Linear Alpha Olefins market for Butene-1, Hexene-1 and Octene-1 globally and by major region, offering a unique level of detail.

IHS will provide:

- Supply/demand balances for the LAO products and applications for the 2015 through 2025 period.
- LAO supply/demand balances will provide geographic breakdown for the following regions:

  Global

  North America

  Europe

  Northeast Asia

  Southeast Asia

  India Sub-Continent

  South America

  Africa

  Middle East

LAO demand segmentation by application and by carbon group included in the report is shown in the next table:

| Linear Alpha Olefin Demand Segmentation | | | |
|---|---|---|---|
| | Linear Alpha Olefin Fractions | | |
| **Application Segments** | **Butene-1** | **Hexene-1** | **Octene-1** |
| HDPE Comonomer | X | X | X |
| LLPDPE Comonomer | X | X | X |
| Polypropylene Comonomer | X | | |
| Plastomer Comonomer | X | | X |
| Elastomer Comonomer | X | X | X |
| Poly Alpha Olefins | | | X |
| Polybutene-1 | X | | |
| Other Specialties | X | X | X |

LAO supply/demand balances will separate demand by application as detailed above and delineate production to include both full range and on-purpose technologies as appropriate, as well as Fischer-Tropsch-derived hexene-1 and octene-1.

A grouping by technology type is then provided in the report in each carbon group section as follows:

| Butene-1 | Hexene-1 | Octene-1 |
|---|---|---|
| Oligomerization | Oligomerization | Oligomerization |
| Raffinate | Fisher Tropsch | Fisher Tropsch |
| Ethylene Dimerization | Trimerization | Tetramerization |
| Other On-purpose | Tetramerization | Telomerization |
| | Other On-purpose | Other On-purpose |

Each of the above technology types is then further classified by technology licensor, namely, CP Chem, Sasol, Ineos, Sabic etc.

In the Megatrends section, we review key trends influencing the LAO market outlook. The considerations are reported by major LAO applications and by LAO chain as envisaged by IHS Chemical. This review focuses on the key applications which have a significant impact on the lower LAO outlook:

- Comonomer use in LLDPE
- Comonomer use in plastomers/elastomers

With all fractions balanced, IHS Chemical will provide its views of historical and future inter-regional trade in Butene-1, Hexene-1 and Octene-1.

Price forecasts covering the specified LAO products and applications will be provided on an annual basis through 2025 for primary market regions such as North America, Northwest Europe, and Southeast Asia.

## Key Questions Addressed in the Study

- What are the underlying drivers in end-use applications along relevant value chains?
- What are the upstream and downstream integration of various competitors in the global alpha olefin business including CP Chem, Ineos, SABIC, Sasol and Shell, etc.?
- What is the potential impact of polymer inter-competition in Butene-1, Hexene-1 and Octene-1 grades and the impact of emerging technology?
- What is the likely growth in solution LLDPE versus gas phase technology as these impact both comonomer selection and the quantity consumed?
- What is the potential impact of growth for plastomers and like materials on octene-1 demand ?
- How much on-purpose capacity will be needed for the lower Linear Alpha Olefins to supplement the volumes provided by full range plants?
- What are typical pricing bases and types of formulas used for Butene-1, Hexene-1 and Octene-1?

## Deliverables

In addition to the final report in narrative form (PDF), this report includes online access to data tables in Excel format. Clients also receive access to IHS Chemical alpha olefin experts, who can provide additional explanation about market fundamentals and trends discussed in the report.

# Proposed Table of Contents

b. Hexene-1
    i. North.America
    ii. West Europe
    iii. Northeast Asia
    iv. Southeast Asia
    v. Indian Sub continent
    vi. South. America
    vii. Africa
    viii. Middle East
c. Octene-1
    i. North.America
    ii. West Europe
    iii. Northeast Asia
    iv. Southeast Asia
    v. Indian Sub continent
    vi. South America
    vii. Africa
    viii. Middle East

**7) Price Analysis**

a. Overview
b. Price Dynamics for Butene-1
c. Price Dynamics for Hexene -1
d. Price Dynamics for Octene -1

**8) Appendix (Excel format)**

a. Demand and supply tables through 2025
b. Capacity listings through 2025
c. Price Forecasts through 2025

# Methodology

IHS has earned a reputation within the petrochemical industry for its ability to build upon its extensive models and databases and to provide meaningful forecasting and strategic planning services to its clients. Looking past the "numbers" has allowed IHS to not only provide clients with short-term solutions, but to also become a valuable partner in longer-term strategic planning with an eye to the global petrochemical picture.

Over three decades in the business of petrochemical consulting, IHS has developed the most comprehensive databases of supply/demand that are available to the industry, providing a solid base of information from which to build.

**Supply/Demand Forecasting Methodology**

In order to prepare historical and forecast demand for the basic petrochemicals, such as ethylene, propylene and benzene, we first prepare demand and production forecasts for all of the derivatives. For example, by first completing a comprehensive worldwide balance for acrylonitrile, country by country, we can determine the amount of acrylonitrile that will be manufactured in each country and, therefore, the amount of propylene that will be required for production of acrylonitrile. This model has been developed for a wide variety of petrochemicals.

With the model constructed, the key to the longer term forecast is how to establish demand growth. Most of the derivatives that follow from the base petrochemicals are used to produce items that are best classified as consumer goods, whether they are the goods themselves or the packaging for the goods. Demand for consumer goods is driven by consumer spending which is a function of many factors; among them interest rates, prices, consumer confidence and economic strength.

Breaking down all sectors of each derivative and developing demand models for each, by country, would result in a model that would be far too cumbersome to use, and far too expensive to maintain. As a first approximation, IHS has developed a demand model driven by expected GDP growth, and for each country and product a GDP elasticity forecast has been developed. Petrochemical elasticities are the ratio of growth of demand for a particular petrochemical versus growth for GDP. An elasticity of 2.0 means that demand is growing at twice the rate of GDP. In general, the elasticity of industrialized regions and countries vary between 1.0-2.0, while those for developing countries vary between 2.0-6.0. The forecast of elasticity is based on several factors:

- Past Relationships
- Per Capita Consumption
- New Capacity Additions
- Prices

Countries with a low per capita consumption of a product will tend to have higher GDP elasticity, provided there are no government restrictions on currency for imports. Where there are new capacity additions for polymers, especially in developing countries, there is a tendency for a one to two year step change in GDP elasticity. The new polymers unit tends to attract new conversion investment and demand for the polymers rises quickly. In a developed country such as the U.S., GDP elasticity is generally not high unless a derivative finds a new end-use through technology advances or through relative price changes.

The issue of price driven demand growth is much more complicated. High prices will reduce demand growth, but relative prices tend to be more important. For example, if polystyrene prices do not change but

polypropylene prices fall significantly, polystyrene will lose market share to polypropylene. If all polymer prices increase together, market share may be lost to other materials such as paper, wood or steel.

Having developed a demand forecast, IHS will then estimate how the demand will be met. Where there is spare capacity to produce, or where new units are under construction or planned, production can be increased and trade patterns are changed in order to supply growth in importing countries. Where new capacity is needed, IHS makes assumptions based on the rate of demand growth in a country, its requirement to import without the new capacity and its competitiveness. For example, in a long term forecast, IHS will assume more new polyethylene capacity in countries or regions with access to cheap ethane than in those needing to import naphtha.

The balances for the "derivatives" are completed so that there is no trade imbalance nor inventory swing in the forecast years. The production numbers generated for each country are fed back into the "intermediate" or "petrochemical" balance in order to derive demand for these products. Production and trade are estimated for these products using the guidelines indicated above.

This hierarchy of product balances ensures consistency throughout the IHS database and creates a system that is flexible enough to reflect changing economic assumptions.

**Price Forecasting Methodology**

IHS's price forecast methodology provides a cycle forecast for one future cycle, generally 5-7 years, and then reverts to a trend forecast for the long term.

Petrochemical business cycles are influenced by periods of over and under-capacity. Since companies seldom make announcements for capacity additions greater than 5 years forward, IHS includes a cycle forecast, based on the correlation between margin and operating rate, only during the near term forecast. The cycle forecast is followed by a trend forecast based on a margin high enough to provide sufficient return to encourage investment in additional capacity as required to meet demand growth.

A discussion of the price forecast methodology, factors driving the price forecast, trends in pricing, and price-setting mechanisms will be provided as supporting documentation to each forecast. IHS consultants employ several different price forecasting methodologies depending on the timeframe in question.

- Short Term - Defined as the period inside two years, the consultant is looking carefully at current pricing in the regions, inventory levels, momentum, maintenance outage schedules and other market-oriented indicators. IHS consultants will review the month-by-month energy prices and adjust their short-term petrochemical forecasts accordingly.
- Mid Term - IHS considers the mid-term to be the next petrochemical pricing cycle. This of course differs from product to product, thus the length of this term differs. Price forecasting within this mid-term is done by examining the factors used in the short term, but more emphasis is placed on the supply and demand fundamentals and the underlying cost structure of production. Within the mid-term consultants will also use historical data to apply the appropriate margin levels to the cost of production. These margins are a function of the supply and demand balances as well as an understanding of how these markets behave in different parts of the cycle. Changes in energy costs will flow through and affect these prices.

- Long Term - The long term is the segment of the price forecast most obviously impacted by the underlying energy price change. After a complete price cycle, the product prices are forecasted on a trend basis. The cost of production for the price setting technology is examined regionally. To this cost a margin is added to derive a market price.

The margin is determined by examining the returns on investment necessary to entice new construction without making them so attractive as to encourage overbuilding. It is within this long-term segment where the true effect of a base energy change is seen on petrochemical pricing.

Over the long term, international commodity petrochemical prices are ultimately a function of production costs plus some level of profitability for the high cost producer. Three elements are therefore necessary to generate a price forecast. The first is to calculate a production cost forecast, the second a margin/profitability forecast and the third, to insure price linkages between regions, a forecast of trade patterns and freight cost.

To generate a forecast of production costs one must generate a forecast of feedstock cost and, in most cases, these feedstock are either other petrochemicals or petrochemical feedstock, such as naphtha, propane and ethane.

It is therefore necessary to generate a price forecast for the feedstock first that is related to basic energy values. Yet petrochemical demand, ethylene consumption of natural gas liquids in particular, can impact the feedstock price forecast. As a result, some iteration is required.

Supply/demand balances are used to generate the forecast of margins and profitability. High operating rates lead to good margins and low operating rates lead to poor margins. Historic trends are used to derive these forecasts. For the short-term, competitive cash cost curves set the floor prices on both a world and regional basis. In the long-term price forecast, an understanding of supply and investment economics is essential.

**Capacity Data**

IHS has an extensive proprietary program to manage capacity data information called CAPS (Commercial Analysis & Planning System). Capacity information is used to establish how much of a material can be produced or consumed in a country or region, who are the major producers of each product, and how the industry has changed in terms of ownership. IHS has capacity data for base petrochemicals and primary derivatives for every producing country in the world to include:

- Historical and forecast capacities for every country and company
- Summary lists of capacity expansions, closures and name changes
- Capacity integration tables by site for every country and company
- Top production/consumption and surplus/deficit lists by company or shareholder
- Company ownership and shareholder subsidiary research

The database is updated routinely with new project announcements, expansions, start-ups and shutdowns. IHS also maintains an extensive company ownership database that allows the system to extract capacity data by producing company name or by shareholder(s). IHS' basic capacity data has evolved over a period of years and is continually refined. Generally, this information is verified through discussions with representatives of the companies that are listed in the capacity tables during personal visits to their offices or during meetings at other venues.

This database contains existing and planned capacity, where planned capacity is either under construction or announced for completion over the next four to five years. Capacity announcements farther forward than five years in the future are seldom made and are often not very specific.

For supply/demand forecasts that go beyond the next five years it is necessary to make assumptions about further capacity additions. This is done in the supply/demand balances in order to ensure that production is increased to meet demand, but no new units have been included in the company by company capacity tables. Production is increased in specific countries in increments that reflect likely capacity additions, but these capacity additions are not associated with any specific company or location within the country. Capacity is increased in those locations which make the most economic sense, either because of local demand growth or because of advantaged feedstocks and proximity to growing markets.

# Study Team

## Mark Wegenka – Managing Director, Chemical Consulting

Mark currently serves as a Managing Director of IHS Chemical's Consulting Group. Mark has 40 years of experience in the chemical arena with the majority of his experience centered on strategic financial planning with a solid background in corporate finance, strategic decision analysis, business cash flow modeling, price/volume forecasting, statistical risk analysis, Mergers and Acquisition (M&A) analysis, new product development and capital planning & authorizations.

Mark earned a Mechanical Engineering degree from the Indiana Institute of Technology. He earned a Masters of Industrial Management from Central Michigan University and completed a certificate of The Evaluation of Capital Projects – Business Decisions in Uncertain Environments from the University of Virginia's Darden School of Management.

## Andrea Borruso–Director, Chemical Consulting

Andrea currently serves as Director in IHS Chemical Consulting based in the Zurich office. He is dedicated in EMEA region and specializes in thermoplastics analysis with a global coverage. He brings over 35 years of postgraduate experience in the petrochemical industry, mainly in Olefins and Polymers and contributes to IHS Chemical consultancy business. He has an extensive knowledge of the petrochemical industry and key players worldwide although primarily in Asia and EMEA.

Andrea earned his Chemical Engineering degree from the University of Palermo, Italy.

## Pam Giordano – Managing Director, Chemical Consulting

Pam serves as the Managing Director at IHS Chemical Consulting. In 2006, Pam joined IHS as a senior consultant in the business advisory services group in New York. Pam's major area of industry experience and expertise is polyolefins markets, technologies, and business strategies. In July 2004, Pam started Polymer Resources, an independent market research service for the polymers and related industries. Prior to starting her own business, Pam had a long career in the industry starting with USI (now LyondellBasell) in sales and strategic planning, and Nexant/Chem Systems as a Senior Consultant in the petrochemical & polymer practices.

Pam has an undergraduate BA/BS degree in Chemistry, and Masters of Business Administration in Marketing.

## Bill Hyde – Director, C4 Olefins and Elastomers

Bill serves as Director of C4 Olefins & Elastomers with responsibility for IHS's global practice covering the global synthetic rubber markets including feedstock and derivatives. His focus has been primarily in the area of C4 olefins and derivatives including the analysis of the butadiene, butylenes, and synthetic rubber markets for hundreds of global clients. Bill regularly travels throughout the world to discuss these markets with producers, consumers, traders, bankers, engineers, and transportation companies. He regularly provides commentary to the monthly Global Outlook for Feedstocks (C4s) and Elastomers. trade patterns of the three major petrochemical regions (Americas, Europe, and Asia). Bill also contributes analyses to the World Butadiene Analysis. Bill has also published papers and presented at conferences around the world on subjects concerning the Olefins and Synthetic Rubber Industries.

Bill graduated from Brigham Young University with both a Bachelors and a Masters in Chemical Engineering. He received his MBA in General Management from Tulane University.

## Robin Waters – Director, Polyolefins – North America

Robin joined IHS in September 2012 as Director, Polyolefins North America. Robin brings to his role over 30 years of industry experience. Robin began his career at DuPont as a Business Analyst for Elastomers, moving from there to a series of positions in Technical Service and Sales for a variety of films and resins sold primarily into packaging markets. Robin also held a series of Product Management and Marketing positions covering EVA Resins, Low Density Polyethylene and Polyester Films. He later joined Basell Polyolefins , currently LyondellBasell, as Product Manager for Polyethylene and, later, Polypropylene. Additional roles at LyondellBasell include Sales Management, Strategic Planning, Market Analysis and Commercial Management for Polypropylene.

Robin earned a B.S. in Chemistry from the University of Georgia and his MBA at the University of Miami School of Business.

## Mark Morgan – Managing Director, Chemical Consulting

Mark joined IHS Chemical and is currently the Global Managing Director for business interests of IHS in the Renewable and life sciences sector. Mark is based in the UK and is responsible for all single client engagements globally in the sector as well as multiclient programs under development. Mark has over 17 years of experience in Consulting across many sectors covering chemicals, energy and renewables. Prior to joining IHS, Mark was Executive Consultant and Technology Director of Nexant's Energy and Chemicals Consulting Division. (Nexant acquired Chem Systems in 2001 from IBM), based in London.

Mark holds Bachelors and Doctoral degrees in Chemical Physics from the University of Bristol (UK).

## Amreen Ali – Analyst, Chemical Consulting

Amreen is currently an Analyst in IHS' Business Advisory Services group primarily responsible for commercial studies. Prior to joining IHS Chemical, Amreen worked as a Data Analyst researching start up ventures in the North American industrial manufacturing industry at Industrial Info Resources. There she was responsible for organizing and translating big data to a more communicable form by creating marketable charts, graphs and articles, identifying and analyzing trends in the industrial manufacturing industry over time.

Amreen earned a B.A. in Finance and an MBA in Business Modeling and Analytics from the University of Houston.

## John Davis – Analyst, Chemical Consulting

John is currently an Analyst in IHS' Business Advisory Services group primarily responsible for commercial studies. Prior to joining IHS Chemical, John worked as a contracted Data Analyst on a consulting project for TAM International Inc., a specialized oil well servicing and completion company. There he was responsible for organizing and translating financial statements to a more communicable form by creating marketable charts and graphs, identifying and analyzing trends in finances over time, and communicating findings to the consultants. He was also responsible for researching market share, demand, and pricing, and indexing growth of the firm versus its competitors.

John earned a B.S. in Economics from Texas A&M University.

# Qualifications

## IHS Chemical Consulting – Sample Projects

The IHS Chemical Consulting team has extensive expertise in the Linear Alpha Olefins market, and has completed a number of consulting engagements for major petrochemical companies related to supply/demand, opportunities, and strategies for new and existing producers and suppliers. A brief selection of sample projects relating to Linear Alpha Olefins can be found below:

### Alpha-Olefins Market and Supplier Study

IHS performed a market and supplier study for a Middle Eastern petrochemical producer to provide the market dynamics for various alpha-olefins and to suggest potential suppliers. In addition, pricing mechanisms in the major regions were investigated, product specifications were compared and price forecasts were provided.

### Alpha Olefins Market Overview

IHS was retained to provide a market overview focused on alpha olefins to include butene-1, hexene-1 and octene-1. The review focused on recent market trends and drivers for these products to include typical pricing structures for each product in Northeast Asia and North America with estimated annual prices for these regions for 2003 to 2010. Estimated supply, demand and trade data for each product to include the World, Northeast Asia, North America, West Europe and Middle East for 2003 to 2010 was included.

### North American Butene-1 and Hexene-1 Market Study

IHS was asked assist the Client with understanding the North America linear alpha olefins market. IHS developed detailed butene-1, hexene-1 and octene-1 supply/demand balances for 2009 to 2030. The balances provided capacity, operating rate, and trade data. The balances were provided for the World, as well as for North America, South America, West Europe, Central Europe, CIS and Baltic States, Africa, Middle East, Northeast Asia, Southeast Asia, and the Indian Subcontinent. Global capacity tables were provided for full range alpha olefins and butene-1 for the time period 2010 to 2020. The generic technology type used by each producer was also included. IHS also provided a global capacity expansion and closure table for major projects for the years 2014 - 2019. IHS Chemical provided net trade flow summaries for linear alpha olefins detailing imports and exports, including identification of major importing and exporting countries and regions.Trade patterns and expected shifts in trade flows were discussed.IHS Chemical provided prices for Butene-1, Hexene-1 and Octene-1 for 2009 to 2030.

### Review of Market and Pricing Dynamics in Linear Alpha and Internal Olefins

The objective of this consulting engagement was to provide the client with an assessment of the market and pricing dynamics for decene-1 and selected linear internal olefin fractions, together with a review of potential customers. IHS Chemical was engaged to define the market size, specification requirements, key applications, and pricing/values for Decene-1, C12-C14 Internal olefins, C15-C13 Internal olefins. IHS describee regional markets for the target products covering primarily Western Europe, Central Europe, U.S./North America and Asia Pacific. IHS provided a narrative description of the business covering the market dynamics for the target products as a result of various technologies practiced in the industry, an identification of leading players, how existing suppliers participate in the business, the balance between

merchant and captive demand, and an understanding of inter-material competition. Current as well as new potential applications of the anticipated product slate, and the related market value in relation to alternative suppliers and established feedstocks were considered.

**Linear Alpha Olefins Co-Monomer Market Study**

IHS was asked to assist the client in forecasting the supply and demand for linear alpha olefins used as a comonomer. Detailed global and regional supply/demand balances for the linear alpha olefins (1-butene, 1-hexene and 1-octene) were provided for 2008 to 2023. These balances provided capacity, operating rate, demand and trade data. IHS provided balances for the regions of North America, South America, West Europe, Central Europe, CIS & Baltic States, Africa, Middle East, Northeast Asia, Southeast Asia, and the Indian Subcontinent. Detailed global and regional supply/demand balances for Polyethylene (HDPE and LLDPE) were provided, which included the annual demand for each of the three linear alpha olefin co-monomers (1-butene, 1- hexene and 1-octene) for 2008 to 2023. These balances provided capacity, operating rate, demand and trade data for each polyolefin, and showed the expected annual volume of each comonomer used by that polyolefin, as well as the comonomer shares and growth rates used for each polyolefin. Demand breakdown estimates for 1-butene, 1- hexene and 1-octene were provided based on polyethylene and plastomers capacity assumptions, by plant, for the years 2013, 2018 and 2023. Demand estimates on a plant level basis were estimated for LLDPE and for HDPE plants. IHS also included plant-wise demand of linear alpha olefins into plastomers and elastomers. Polyolefin plants were identified by region, country, owner and location, as well as by process used.

**Alpha Olefins Market Analysis**

IHS was asked to assist the client in their evaluation of the global alpha olefins market. This included a summary market analysis with an overview of major trends and strategic issues for the alpha olefins market, including data on supply/demand, capacity, trade patterns and pricing. This study focused mainly on the markets for the lower olefins (butene-1, hexene-1 and octene-1) given the importance of these products. A brief high-level non-detailed overview of the market for higher olefins (C10+) and their applications was also provided. The balances provided capacity, operating rate, and trade data. The balances were provided for the World, as well as for North America, West Europe, Middle East/Africa, Northeast Asia, Southeast Asia, and China. Global capacity tables were provided for full range alpha olefins and butene-1 for the time period 2010 to 2020. The generic technology type used by each producer was also included. IHS Chemical provided net trade flow summaries for linear alpha olefins detailing imports and exports, including identification of major importing and exporting countries and regions.Trade patterns and expected shifts in trade flows were discussed.IHS Chemical provided prices for Butene-1, Hexene-1 and Octene-1 for 2010 to 2022.

**Assessment of Alpha Olefins and Butene-1 Market**

IHS was engaged to provide an annual supply/demand outlook for the world and by region for alpha olefins and butene-1.

A global capacity listing detailed by region, country and plant was provided for both products. Commentary on the global and regional market structure was included as well as trends and potential changes in industry structure that would impact global and regional markets. IHS provided annual North America contract pricing for butene-1. Assumptions that drive the forecast including inflation, crude oil, gasoline, ethylene and butadiene were included along with a brief discussion of the price forecast methodology.

### Alpha Olefins Price Forecast

IHS was retained to provide an Asian client with long-term price forecasting for butene-1 and hexene-1 in support of project development. Prices were provided for the Northeast Asia and Southeast Asia regions.

### C16-C18 Alpha Olefins

IHS was asked to provide assistance to a client looking to buy a C16- C18 olefins fraction from another producer. IHS provided valuable insight into possible acquisition prices for such streams allowing the client to negotiate further the supplier.

### Linear Alpha Olefins

Provided a detailed market analysis of alpha olefin consumption. The analysis focused on selected cuts – C12-C14; C14-C16; C16-C18 for non-polyolefin end-use markets such as detergent range applications, oilfield chemicals and others. The analysis evaluated current and future demand for these cuts based on the end-use segment demand drivers, current and future availability of such cuts.

### On-purpose Technologies for Polyethylene Comonomers

A PEP report presenting technical and economic appraisals of ethylene-based commercial technologies for production of polyethylene comonomers, namely, 1-butene, 1-hexene, and 1-octene. Although linear alpha-olefin and Fischer-Tropsch processes are currently the major sources for production of these comonomers, their demand is expanding at a faster rate with respect to higher alpha-olefins. This has created opportunites for alternative methods for their production through on-purpose technologies which offer producers a better way to balance productivity according to market demand. The following three technologies are evaluated:

- Ethylene tetramerization (for 1-octene production)
- Ethylene dimerization (for 1-butene production)
- Ethylene trimerization (for 1-hexene production)

### Linear Alpha Olefins

A series of PEP reports concerned with processes for the production of the homologous series of compounds having one double bond at the terminal position of a linear paraffin chain of more than four carbon atoms, compounds known as linear alpha olefins. More commonly in the industry these linear olefins are called simply alpha olefins with the linearity assumed as part of the shorter name

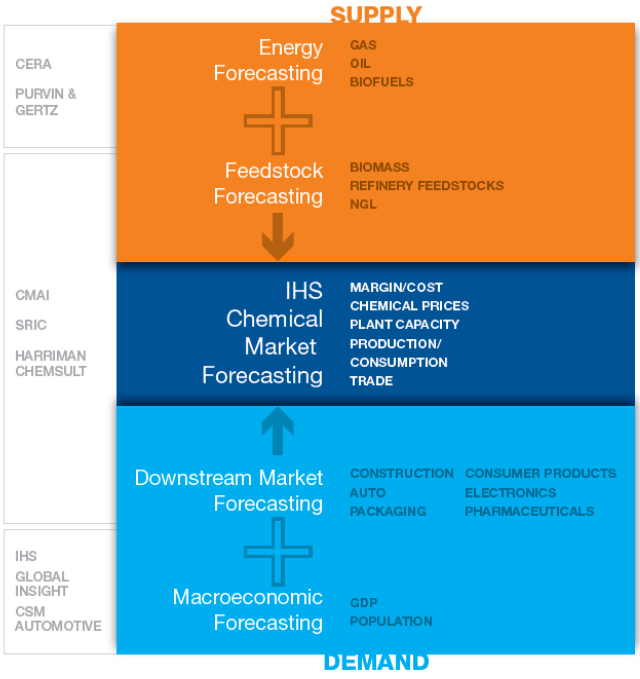
### Linear C12-C15 Primary Alcohols

A PEP report focuses on two coconut-oil-based processes and two synthetic processes- one based on ethylene oligomerization and one based on linear olefin hydroformylation. Processes for making fatty alcohols from coconut oil and processes for making alcohols by hydroformylation are included.

# About IHS Chemical

## Best-in-Class Brands

IHS Chemical now combines the former CMAI and SRI Consulting groups together with Chemical Week Magazine, Harriman Chemsult, IntelliChem and PCI Acrylonitrile into one integrated business unit comprising its multiclient and single client services. IHS Chemical's experts, analysts and researchers who are well respected throughout the industry for their deep-rooted analysis and forecasts, extends the value that IHS can now offer by connecting clients with the vast resource of insight and expertise that exists across IHS including energy, supply chain and economics.


## Comprehensive Coverage

IHS Chemical provides the most comprehensive chemical market content and industry expertise in the world. The company has more than 200 dedicated chemical experts working together to create a consistent and integrated view across more than 300 industrial chemical markets and 2,000 chemical processes for 95 industries. Ensure that your decisions are based on broad, comprehensive information, forecasts, intelligence, and analysis.

IHS has assembled a team of chemical experts that offers an unprecedented coverage level for core chemical markets and technologies. Backing them is a larger IHS community of experts covering related markets, from energy and the macro economy to the world's largest chemical-using industries, such as automotive, construction and others. IHS Chemical's intellectual capital is built on an operating model that utilizes over 1,800 consultants, researchers and economists to advance cross-disciplinary collaboration and analysis.

# About IHS

IHS is the leading source of information, insight and analytics in critical areas that shape today's business landscape. Businesses and governments in more than 165 countries around the globe rely on the comprehensive content, expert independent analysis and flexible delivery methods of IHS to make high-impact decisions and develop strategies with speed and confidence.

IHS has been in business since 1959 and became a publicly traded company on the New York Stock Exchange in 2005. Headquartered in Englewood, Colorado, USA, IHS is committed to sustainable, profitable growth and employs more than 8,000 people in 31 countries speaking 50 languages around the world.

IHS serves businesses and all levels of governments worldwide ranging from 85% of Global Fortune 500 to small businesses. IHS provides comprehensive content, software and expert analysis and forecasts to more customers in more than 180 countries worldwide.


## Information, analytics, and expertise

IHS offers must-have business information, advanced research and analytics, and deep expertise in core industry sectors, such as energy and natural resources, chemicals, electronics, and transportation. We focus on business-critical workflows that support our customers' needs, including:

- Strategy Planning & Analysis: Strategic Planning, Corporate Development, M&A, Investment Analysis, Risk Assessment
- Energy Technical: Exploration-Production, Geoscience, Engineering, Commercial Development
- Product Design: Engineering Design, Research and Development
- Supply Chain: Procurement, Logistics, Operations, Manufacturing
- Environmental Health, Safety & Sustainability: Sustainability, Regulatory, Environment Health and Safety

This interconnected information, expertise, and analytics across industries and workflows allows IHS to provide best-in-class solutions that power growth and value for our customers.

# Contact Information

To make an inquiry about this study, please reach out to the IHS Chemical Special Reports team at ChemicalSpecialReports@ihs.com.

## IHS Chemical Special Reports

IHS Chemical Special Reports address topical issues in the chemicals industry. Please find a list of available Special Reports below. If you would like to learn more about any of these products, please contact the Special Reports team at ChemicalSpecialReports@ihs.com.

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Chemical Industry Capital Costs: A Global Spending Outlook
China Coal Chemical Industry Analysis (2015 Update)
Global Ethylene Logistics Review: Ready to be Waterborne?
Methanol into Fuels Applications: New sources of growth?

### Upcoming Special Reports

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Higher Alpha Olefins Market Study
High Pressure EVA Copolymers: Adding Value to LDPE Assets
Opportunities for Plastics in the Asian Automotive Industry
Transformation of Middle East Petrochemical Industry by Asset Stretch, Integration and Supply Chain Optimization
India Olefins & Polyolefins Converter Study