

**NexantThinking™**

**Special Reports**

**Competitiveness of Middle East  
Refining and its Global Impact**

Brochure

February 2016



# NexantThinking™

## Special Reports

### Competitiveness of Middle East Refining and its Global Impact

Brochure  
February 2016



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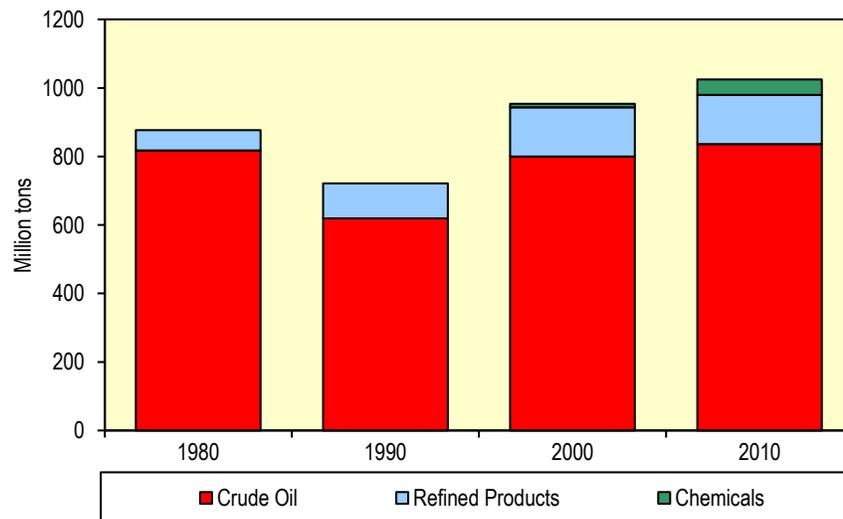
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## 1.1 OVERVIEW

The Middle East has historically been a major exporter of crude oil. Refining investments in this region have occurred to selectively meet domestic demand and serve some export markets. More recently, the Middle East has become a key growth market for refined products, second only to Asia. Investments have sought to add value to crude production and potentially increase exports whilst also meeting strong growth in regional demand. Middle East exports are shown in Figure 1.1.

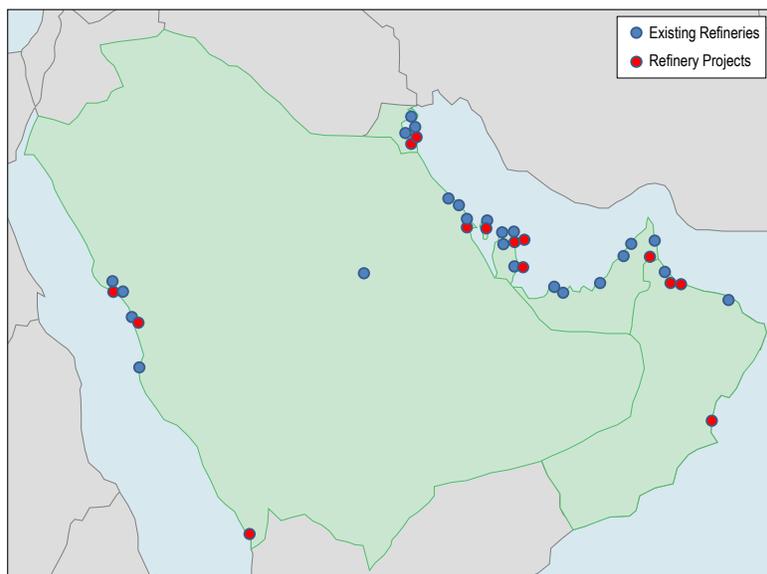
**Figure 1.1 Middle East Exports**



Due to the abundance of crude in this region, the number of existing refineries and potential projects is quite large. This is clearly exemplified in Figure 1.2. An estimated increase of approximately 45 percent is expected in the total tonnage of refined products between 2010 and 2020 from the Middle East, compared with approximately 25 percent in the previous decade. This will be achieved by adding new refining capacity which is both larger in size and more complex. If all projects were to proceed, this would amount to a significant refining center with raised internal competition for markets for refined products. Notable refinery capacity additions in the Middle East include the following:

- Karbala Refinery in Iraq
- Al Zour refinery, Kuwait
- The Messaied Refinery, Qatar
- Sohar Refinery Improvement Project, Oman
- Duqm Refinery, Oman
- Bapco Modernization Program, Bahrain
- SATORP refinery in Al-Jubail, Saudi Arabia
- YASREF refinery in Yanbu, Saudi Arabia
- Jizan refinery project, Saudi Arabia
- Fujairah Refinery, UAE
- Ruwais Refinery, UAE

**Figure 1.2 Existing Refineries and Potential Projects in the Middle East**



Even if some of these projects proceed, some important questions will be raised:

- Will there be enough market demand to sustain so many projects? How competitive will each of these refineries be?
- What will happen to older refineries?
- Will petrochemical integration be a differentiator?
- What will happen to future Middle East refining margins?
- What policies and investment models will best support further industry growth?
- How competitive will these refiners be in export markets?
- What is the impact of regional demand for power on liquid hydrocarbon fuels?
- How much of a role will petrochemical integration play?
- How do Middle East refinery margins compare with those for other refining centers, like USGC, Singapore, and Western Europe?
- How much additional Middle East capacity is viable? Is there a limit?
- To what extent do national initiatives like job creation play a role?
- What is the expected impact on margins if Middle East refiners are exposed to market prices for natural gas?
- How can refineries best be configured to help meet regional power requirements? What are the other options?

Although domestic demand is high in the Middle East, much of the refined product would likely be exported. As can be seen in Figure 1.3, Asia will be the major demand center for refined products over the forecast period. As would be expected, Asia has also experienced a large number of capacity additions, and these refineries have differing configurations from new capacity additions in the Middle East. How do Middle East investment models for increased capacity addition compare with those employed in Asia? How much of a competitive threat do Middle East refiners pose for other refining centers?

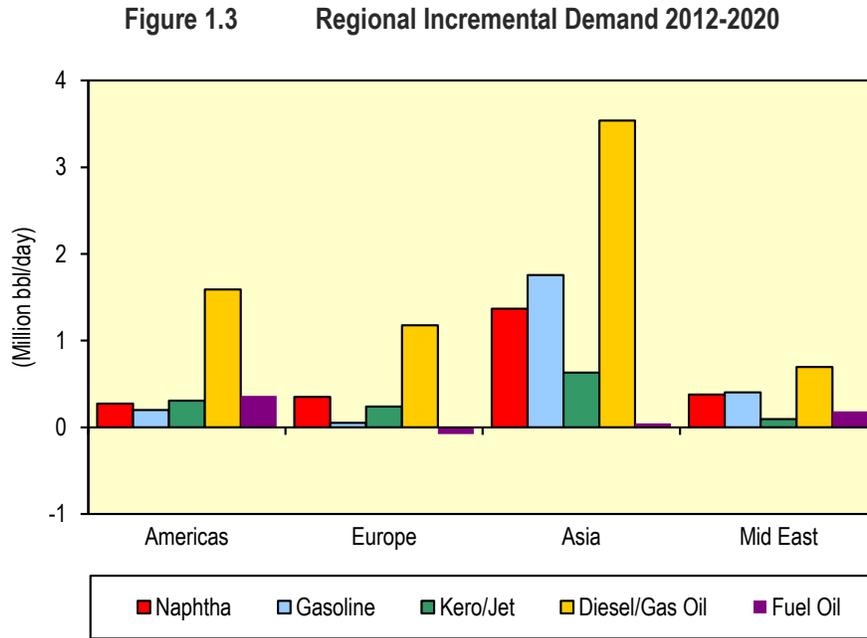
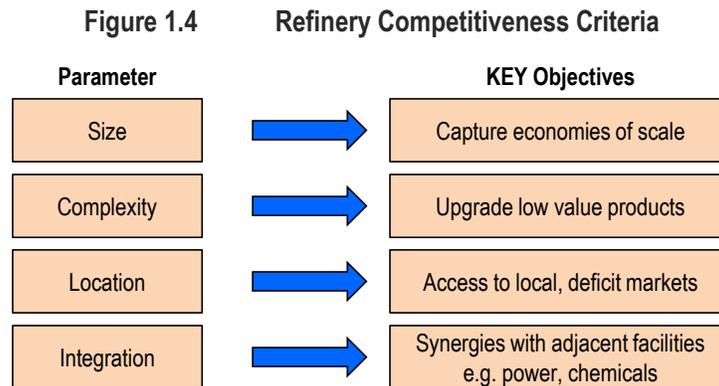
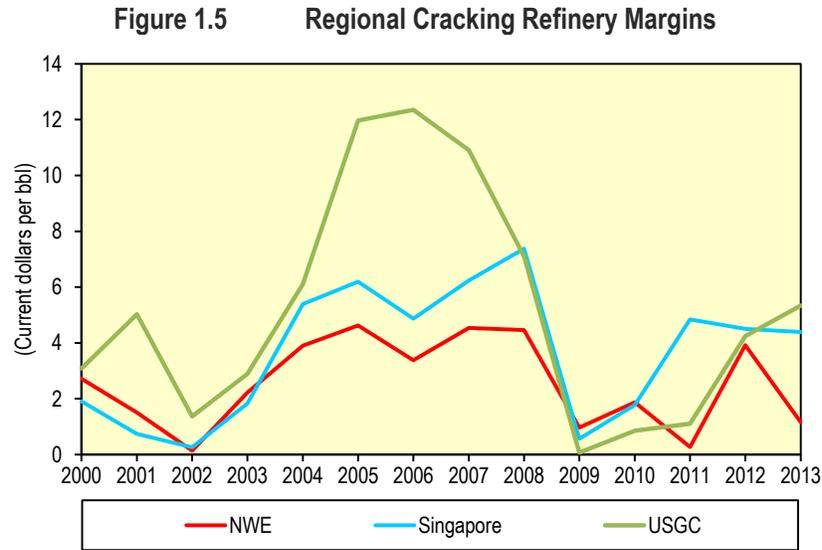


Figure 1.4 provides a summary of the factors that will form the basis of our competitive analysis and that will help answer some of the questions listed above.



Petrochemicals are not new to the Middle East. Tonnages are small yet growing fast, with major projects such as Sadara showing the region’s determination to diversify further from the cracker +1 configurations. Polyolefins, methanol and MEG account for a major share of petrochemical production. What is this figure expected to look like in 2020? Will the tonnages of petrochemicals production begin to compare with those of refined products?

Profitability is key to sustained growth and also for returning capital from investment. As shown in Figure 1.5, global refining margins have been taken through a roller coaster ride in the last 15 years. During this time, peak oil prices and demand forced refining margins to a high level between 2006 and 2008. Margins plummeted in 2009 with the financial crisis, recovering somewhat in 2012. Will Middle East refineries be better placed to weather such financial upsets?



In summary, the Middle East has proven to be a region of opportunities with beginnings as a crude exporter and now firmly placing itself as an exporter of refined products and petrochemicals to the world. Capitalizing on these opportunities in a managed way will help investments to be made which are sustainable in the context of other projects and changing demand landscapes. National initiatives will play a vital role but how much will they influence investment strategies?

## 2.1 OBJECTIVE

The study objective provides a strategic analysis of the key elements of change expected in the refining industry within the Middle East region, and how this is likely to be different from other regions of the world. It aims to assess the drivers which have influenced the refining investments as well as what the shape of the future may be. The analysis provides subscribers with the key insights necessary to make informed decisions regarding the future opportunities in and effects of the refining industry in the Middle East.

## 2.2 SCOPE

This report analyzes:

- What is driving demand, (i.e. < current and forecast growth by country)
- What is the current status of the sector, (i.e., current refining sector and planned firm projects)
- What policies exist to support future growth? Where will new projects emerge and what policies will support them?
- What investment models meet the opportunities:
  - Export or refined crude, domestic vs export products, integrate with petrochemicals or not?
- How to define the Middle East in terms of refining
  - Country specific considerations
  - Relevance of other countries
  - Countries with common trends
- What factors govern current demand patterns
  - National power requirements
  - Country demographics
    - Energy demand per capita
  - Fuel specifications
  - Vehicle fleet analysis
- What factors will influence Investment Models
  - The Middle East export refinery
    - Crude availability and type
    - Current and Future Trade Flows
    - Impact of domestic demand
  - Investment strategy per country
  - Capacity versus Complexity – Where is the optimum?
  - What is the current and future extent of petrochemical integration
    - Why?

- What are the specifics of the refining Industry in the Middle East
  - National initiatives
  - Benefitting from favorable cost structures
    - Is Hydrogen addition more economical?
  - Crude export vs. Refined Product export?
    - Impact on crude slate
  - Impacts of policy
  - Key metrics to be considered by investors
- What makes Middle East refineries competitive?
  - What is the optimum size and complexity?
  - What basis should be used for ME Refining margins
  - Who are the main competitors?
  - How do they impact other regions?
  - Does shale oil in the US pose a threat?
  - How much petrochemical integration makes sense?
    - Does cost advantaged ethane make integration less favorable?
- What does the future hold for Middle East refineries?
  - What are the future target markets?
  - Future specification changes
  - Impact of other ME regional acceleration
  - Will further petrochemical integration play a role?

### 2.3 REPORT PRICE

This prospectus describes Nexant's multi-client study "Competitiveness of Middle East Refining", the scope of the proposed report, the methodology to be used, and Nexant's qualifications to perform such a study.

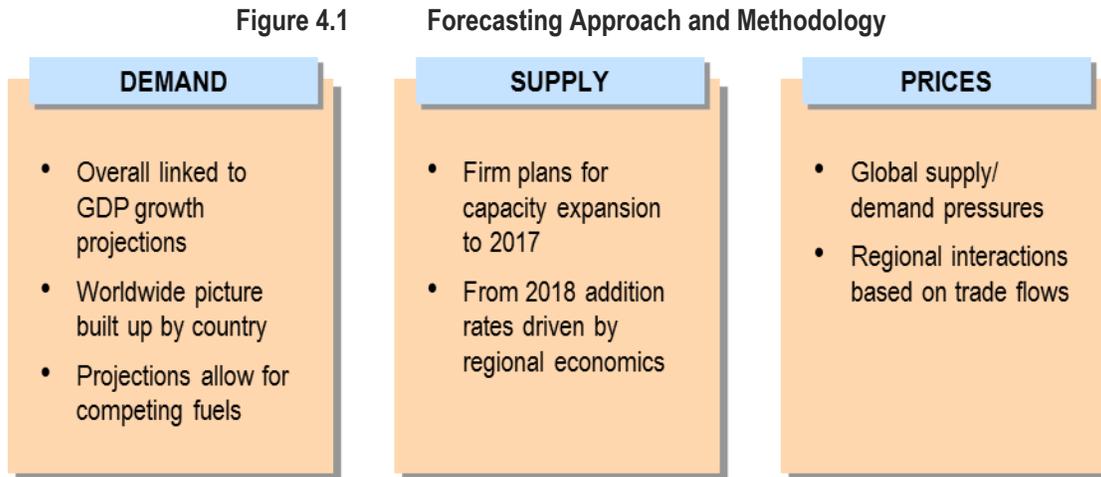
The study has been published in quarter four of 2015. The post-publication cost of the study is US\$22,000.00 (twenty-two thousand U.S. dollars).

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4.1 PRODUCT SUPPLY AND DEMAND

Nexant employs an integrated methodology for supply and demand forecasting which gives a world-wide view of projections for refined product demand based on oil’s share of the overall market. The overall methodology is summarized in Figure 4.1.



*Demand*

Projections of future demand for refined products are developed in relation to a number of general and specific factors. The key demand drivers for each product are summarized below.

| Key Drivers for Refined Product Growth |  |
|--|--|
| LPG                                    | Rate of penetration of electricity and natural gas into domestic market<br>Population growth<br>Substitution for gasoline and diesel automotive fuels<br>Industrial use linked to GDP growth |
| Naphtha                                | Petrochemical expansions and new projects<br>Growth in existing applications<br>New power generation schemes   |
| Gasoline                               | Vehicle population and consumption per vehicle   |
| Jet                                    | Growth in air transport and turbine efficiency improvements  |
| Diesel                                 | Vehicle population and use<br>Rail transport growth<br>Agricultural growth   |
| Fuel Oil                               | Power generation projects<br>Industrial growth linked to GDP   |

## Supply

Existing refining capacity (and utilization), together with announced addition, provides the basis for Nexant's forecast of refined product supply. Capacity additions, through 2017, are to be based on announced firm projects. For the period from 2018 onwards, supply projections assume a combination of investment plans currently being discussed and developed, together with speculative additions in regions where capacity is likely to become tight, and where refinery development is likely to be both politically acceptable and commercially attractive. Nexant maintains a comprehensive listing of announced projects, and applies judgment with regards to each project, and develops a "risk-adjusted" outlook for new capacity additions.

## 4.2 PRICING

### 4.2.1 Introduction

The supply/demand balances derived from forecasts of future product supply and demand give an indication of the pressures that the refining industry will face in the future. From an analysis of these pressures, Nexant develops forecasts of trend refinery margins and product pricing for standard configurations in the main refining centers. The crude oil and petroleum product price projections developed by Nexant are used by our clients to evaluate their investment opportunities and other business decisions.

### 4.2.2 Refined Products

Regional pricing differentials, for the same product in different markets, are developed from projected trade patterns derived from the supply/demand analysis. This will determine, for example, the pricing of products in Europe and Africa relative to those in Asia via trade interactions in the Middle East.

The differentials between different products are forecast based on the historic differentials combined with the impact of projected supply demand pressures. For example, the naphtha - gasoline spread will depend on the relative tightness of supply and demand projected for both products.

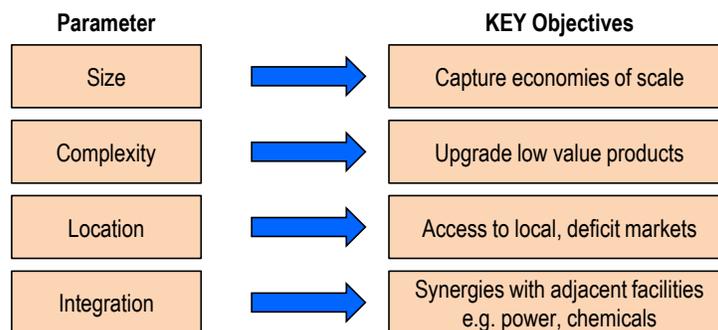
The overall level of refined product prices is determined from Nexant's forecasts for refining margins. Nexant will make use of its extensive databases on supply, demand, pricing and margins and its annual global multi-client studies.

## 4.3 COMPETITIVENESS

### 4.3.1 Introduction

Nexant utilizes a robust approach to evaluating the relative competitive position of global refinery assets, utilizing four key criteria that it establishes to facilitate a comparison of very different assets, on a common basis. These are summarized in Figure 4.2.

**Figure 4.2 Refinery Competitiveness**  
*Key Evaluation Criteria*



### 4.3.2 Complexity

There are various measures utilized to assess the complexity of a refinery, the simplest of which is to group refineries based on their degree of upgrading, for example:

- **Simple** or Hydroskimming (no upgrading)
- **Thermal** (including a thermal cracker or a visbreaker)
- **Complex** (including a process to upgrade vacuum gas oil – *FCC or Hydrocracking*)
- **Residue Upgrading** (including residue destruction via *residue processing or coking*)

An often cited measure of complexity is the Nelson Complexity Index. However, under this index the primary driver of complexity is a reference capital cost of the individual processing units utilized. In some ways this is overly simplistic because the relative upgrading capability of individual processing units is not directly linked to its investment cost. Directionally this index provides an indicator of complexity.

Nexant uses a Complexity Index based on an FCC-equivalence. Nexant also keeps an extensive database of Nelson Complexity for all refineries on a global basis.

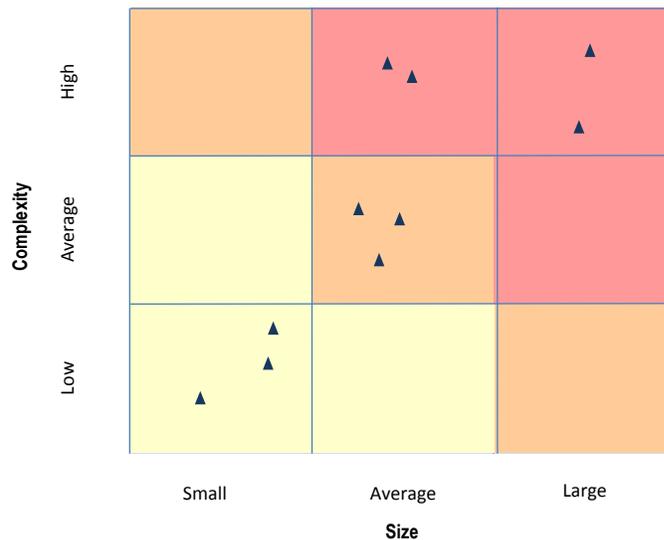
The FCC Equivalence Complexity Index assigns an upgrading index to each process unit that takes a residue (fuel oil) feed and assesses its capability to convert the residue to more valuable lighter products. The scoring reflects two primary factors:

- The heaviness of the residue feed.
- The degree of conversion to lighter products.

### 4.3.3 Size and Complexity

Nexant utilizes a standard 3x3 matrix to compare size and complexity of different refineries.

**Figure 4.3 Refinery Complexity Matrix**



#### 4.3.4 Location and Integration

The influence of location is of high importance, and can have a greater influence on pricing and margin performance than either of size or complexity. The important consideration is the impact of location on pricing; this normally falls between two extreme cases:

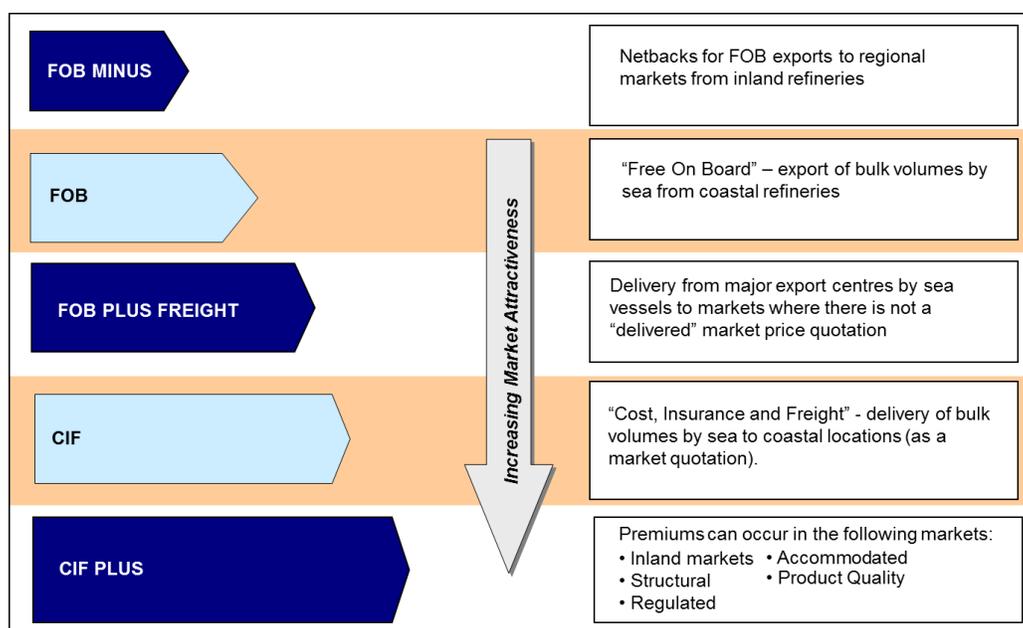
- Export parity pricing, where product is moving out of a region, which is less economically attractive.
- Import parity pricing, reflective a deficit region; this is desirable, especially where it is supported by an additional inland premium.

Another important implication of location is cost. This will govern two very important factors:

- The capital costs (which will be heavily location dependent).
- The operating costs (largely the price of fuel and labor).

The location driven price drivers are summarized in Figure 4.4, as they relate to product sales.

**Figure 4.4 Location Impact on Pricing**



A similar comparison is made for feedstocks, showing the positioning between export parity (favorable for a local consumer) and import parity (less favorable).

The evaluation criteria for Integration include the impact of co-location of refining with power generation or petrochemicals.

### 5.1 NEXANT ENERGY AND CHEMICALS ADVISORY

For over 40 years, Nexant's consulting professionals have helped clients by providing strategic advisory, technical and operations consulting services, and most importantly, privileged insights. The company has completed thousands of client assignments in more than 100 countries. Our clientele ranges from major oil and chemical companies, governments, and financial institutions to regulator and development agencies and law firms.

We are unique in our comprehensive focus on the entire energy, oil, gas and chemical sector. Staffed by over 150 seasoned industry experts, we understand the challenges facing senior management in the industries we serve. Our global consulting team brings together our collective technical, commercial and financial skills, who work closely and confidentially with our clients to address real world issues and identify opportunities that add value to their businesses. Our staff includes engineers, chemists, bio chemists, MBA's and seasoned business leaders from the sectors we serve.

Nexant provides a range of targeted consulting services from the initial assessment of corporate and business unit strategies to the development of actionable strategies, to advisory support in project finance and due diligence for mergers and acquisitions – all backed by deep knowledge of downstream oil & gas, petrochemicals, plastics, specialty chemicals and Clean Tech markets and products.

Significantly, Nexant has proprietary technology and commercial analysis, NexantThinking™ market data, which includes market dynamics and pricing forecasts, capacity developments and production cost economics.

Our purpose is to deliver subject matter expertise that gives a clearer perspective and to provide visionary thinking which allows our customers to be insightful and ahead of the competition

This can only be achieved through an unrivalled combination of:

- **Industry Knowledge** - our consultants all have extensive industry experience, and are engaged fulltime on identifying and addressing the challenges facing the Alternative Fuels, Petroleum/Gas and Chemical industry.
- **In-house Data** - we have an unrivalled database on the industry its technology and market dynamics, and employ teams of researchers to continually update this resource. Our NexantThinking™ products which can be accessed by subscribers, contains the core of this knowledge base covering the commodity chemicals and polymers plus a range of intermediates and specialties.
- **Proven and Tested Methodologies** - we have developed a range of methodologies to cover different types of assignments, such as feasibility studies, project finance support, privatizations, due diligence studies for acquisitions and financings, market and technology reviews. All of these have been tailored and continuously improved to suit the needs of the industry.
- **Technical Competence** - we continuously track the technical improvements in the industry and frequently review new process improvements for clients. Our NexantThinking™ Process Evaluation/Research Planning (PERP) product encapsulates some of this work and is available to subscribers. A core strength is our capability to provide independent support to the key issue of process technology selection.
- **Global Presence** - our permanent offices in London, Frankfurt, Bahrain, New York, Houston, Singapore, Bangkok, Kuala Lumpur and Shanghai will provide comprehensive coverage. In addition, we have long-term relationships with representatives or registered branch offices in most

major locations, including Beijing, Seoul and Tokyo. Nexant professionals have extensive experience in emerging markets such as the former Soviet Union and China, and our team of industry experts can work fluently in over ten languages.

- **Strategic Consulting** - we have been on the leading edge of many of the strategic initiatives in the industry, including major investments, acquisitions, consolidations, restructuring, and privatizations.
- **Thought Leadership** – We pride ourselves on identifying key issues at their formative stages and exploring options for the industry to capture any associated potential benefits.
- **Coverage** - across all relevant sectors. Our team can provide clients with a complete and holistic view of the sector and its place in the overall economy covering the entire hydrocarbon value chain.

**We are recognized for our quality and industry thought leadership:**

- Nexant is often quoted in the alternative fuels, petroleum/gas and chemical press on its views on markets and developments and team members are regularly called on to give expert papers at major conferences.
- Our team of experienced vice presidents is responsible for the quality of our work in their individual areas of expertise. They are expected to provide inputs to and supervise every assignment we undertake.

## 5.2 REFINING STUDIES

Nexant has undertaken an extensive range of projects for refinery and integrated refinery petrochemical complexes. The form of single client engagements undertaken includes technology evaluations, feasibility studies, technical and commercial due diligence, market studies, etc. Some relevant examples are detailed below:

| Project                           | Scope   | Nexant's Role |                  |                    |                          |                     |
|-----------------------------------|---|---------------|------------------|--------------------|--------------------------|---------------------|
|                                   |   | Market Study  | Technical Review | Design Development | Environmental Assessment | Economic Evaluation |
| Grassroots Refinery, Nigeria      | Pre-Feasibility study for major grassroots refinery                     | ✓             | ✓                |                    |                          | ✓                   |
| Dalian Shide Group, China         | Feasibility study for major grassroots refinery & petrochemical complex | ✓             | ✓                | ✓                  |                          | ✓                   |
| Confidential, Syria               | Feasibility Study for a Grass Roots Refinery                            | ✓             | ✓                | ✓                  | ✓                        | ✓                   |
| Confidential, Sri Lanka           | Feasibility Study for a Grass Roots Refinery                            | ✓             | ✓                |                    |                          | ✓                   |
| ENAP, Chile                       | Refinery Master Plan Feasibility Study                                  | ✓             | ✓                |                    | ✓                        | ✓                   |
| BAPCO Refinery, Bahrain           | Feasibility study for major upgrade project                             | ✓             | ✓                |                    | ✓                        | ✓                   |
| Sohar Refinery, Oman              | Feasibility study for major grassroots refinery                         | ✓             | ✓                | ✓                  | ✓                        | ✓                   |
| Omsk Refinery, Russia             | Feasibility study for major upgrade project                             | ✓             | ✓                | ✓                  | ✓                        | ✓                   |
| Reliance Refinery, India          | Feasibility study for major grassroots refinery                         | ✓             | ✓                |                    | ✓                        | ✓                   |
| Hyundai Oilbank, S Korea          | Feasibility study for major upgrade project                             | ✓             | ✓                |                    |                          | ✓                   |
| Caribbean Refinery (Confidential) | Refinery upgrading feasibility study                                    | ✓             | ✓                |                    | ✓                        | ✓                   |
| Norsi Refinery, Russia            | Feasibility study for major upgrade project                             | ✓             | ✓                | ✓                  | ✓                        | ✓                   |
| TUPRAS Refinery, Turkey           | Feasibility study for major upgrade project                             | ✓             | ✓                | ✓                  | ✓                        | ✓                   |
| IRPC, Thailand                    | Feasibility study for major upgrading project                           | ✓             | ✓                |                    |                          | ✓                   |
| Bluestar, China                   | Feasibility study for major upgrade project                             | ✓             | ✓                |                    |                          | ✓                   |
| Tamoil Refinery, Switzerland      | Feasibility study for major upgrade project                             | ✓             | ✓                | ✓                  |                          | ✓                   |
| Confidential                      | Alkylate Market Study   | ✓             |                  |                    |                          |                     |
| Confidential                      | MTBE Market Study   | ✓             |                  |                    |                          |                     |
| Confidential                      | Residue Upgrading Project, FSU  | ✓             | ✓                |                    | ✓                        |                     |

## Section 6

## Contact Details and Subscription Information

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For more information or to place an order, contact as follows:

Nexant, Inc.

44 South Broadway, 4th Floor

White Plains, NY 10601-4425, U.S.A.

Attn: Heidi Junker Coleman

Global Programs Support Manager, E&CA: Nexant Thinking

Tel: + 1-914-609-0381

Fax: + 1-914-609-0399

Email: hcoleman@nexant.com

Nexant Limited

P.O. Box 20705

Level 22, West Tower

Bahrain Financial Harbour, King Faisal Highway

Manama, Bahrain

Attn: Raheel Shafi

Senior Consultant

Tel: +973 1750 2962

Fax: +973 1750 3030

Email: rshafi@nexant.com

**Nexant, Inc.**

San Francisco  
New York  
Houston  
Washington  
London  
Frankfurt  
Bahrain  
Singapore  
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