THE MIDDLE EAST CATALYST MARKET:
TECHNOLOGIES, APPLICATIONS AND OPPORTUNITIES

MULTI-CLIENT STUDY PRESENTATION

(study completed March 2016)

TCGR THE CATALYST GROUP RESOURCES™

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I. INTRODUCTION

The Middle East, broadly defined as countries bordering the Mediterranean Sea, North Africa, or Western Asia, continues to undergo transformation and modernization. The world witnessed the recent "Arab Spring", another step in the political transition after gradual market-based reforms over the past decades. For millennia, this region has been a vibrant and dynamic region with an abundance of natural resources.

Over the past several decades, there has been a consistent shift away from oil and gas export alone: there is a growing trend to convert these raw materials to increasing value-added chemical intermediates such as petrochemical intermediates, polyolefins, methanol, and other value-added products. There is also a strong emphasis on technology development and innovation, with a drive towards self-sufficiency in areas surrounding raw materials upgrading. This region continues to be an important contributor of feedstocks and intermediates for, as well as talent and leadership in, the global economy.

The Catalyst Group Resources (TCGR) has been active with clients in the Middle East over the last 30 years, on both client confidential consulting projects as well as membership consortia like the **Catalytic Advances Program (CAP)** and the **CO2 Capture and Conversion (CO2CC) Program**. This report is the first time the region is featured in a stand-alone multi-client study, exploring refining and petrochemicals (including polymers) and environmental catalyst technologies. This report describes applications and opportunities for players within the Middle East as well as multinationals pursuing growth and a better understanding of this complex and dynamic region.

This completed study entitled **"THE MIDDLE EAST CATALYST MARKET: Technologies, Applications and Opportunities,"** examines the following countries in or adjacent to the region:

- Algeria
- Bahrain
- Egypt
- Iraq
- Islamic Republic of Iran
- Israel
- Kingdom of Saudi Arabia
- Kuwait
- Qatar
- Turkey
- United Arab Emirates

The countries above have been identified as having significant refining capacity and natural gas and petrochemicals production. Other countries in the region (e.g. Oman, Yemen, etc) are excluded from the scope of this study, as these catalyst markets are currently not of sufficient size to warrant in-depth consideration in this report.

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This report is a third in a series of examinations of catalyst industries in developing and emerging regions of global growth. TCGR with its partner the CNCIC completed a four (4) part series in 2013 on the Chinese catalyst markets – **"The Catalytic Process Industries in China: Markets, Technologies & Strategic Implications".** In 2015, TCGR completed a study on the Asia-Pacific catalyst market entitled **"The Asia-Pacific Catalyst Industry: Markets, Technologies and Manufacturers"**. Further information on these reports is available at http://www.catalystgrp.com/.

II. BACKGROUND

The countries featured in this study are diverse, with varying degrees of industrialization, urbanization and GDP growth rates. Overall, the GDP growth rate for this region is estimated to be 3-4% in 2015, as lower price oil (lower revenues) affect spending and slow growth rate. Despite the global recession, there are regional strengths such as >7% CAGR in naphtha production from 2007-2013.[1] Global megatrends in economic development will result in expectations for increased refinery and petrochemical profitability, including renewed emphasis around the value of innovative technology, plant performance and supply agreements.

As the global economic recovery continues, this region is emerging as a more significant contributor of raw material and petrochemical intermediates. Many of the countries featured in this report are experiencing growing urbanization, developing middle classes and embracing advanced technologies. **These growth indicators are requiring governments to focus on improving infrastructure and modernization of local refining, petrochemical/chemical, polymer and environmental catalyst applications. In turn, new local catalyst companies are emerging to meet that demand, as well as multinationals who continue to invest in manufacturing and logistics facilities to better serve these markets.**

A country such as the Kingdom of Saudi Arabia (KSA), with a population of more than 27 million[2], means there are many potential consumers for refined petrol and plastics. In regard to exports, the region is well positioned to serve growing African and Central Asian economies. In addition, the appetite in the Far East remains strong for oil and gas feedstocks, as well as chemical intermediates, to meet the demands of growing economies.

Several world-scale projects, in refining and integrated petrochemical complexes, are in various stages of completion. YASREF, Sinopec's first overseas refining and petrochemical project, started commercial operation earlier this year[3]. Major projects and expected commissioning dates include:

- Al Zour, Kuwait: 615k bbl/day refinery complex (2019)
- Jizan, KSA: 400k bbl/day refinery complex (2018)
- Fujairah, UAE: 200k bbl/day refinery complex (2018)
- Sadara, KSA: 1,500 kmt/yr ethylene cracker (2016)
- Al Sajeel, Qatar: 1,400 kmt/yr ethylene cracker (2018)
- Sohar, Oman: 1.1-million ton/yr PTA facility (2018)

[1] http://www.news.kenresearch.com/post/96680898738/naphtha-market-report-saudi-arabia
[2] https://www.cia.gov/library/publications/the-world-factbook/geos/sa.html
[3] http://www.sinopecgroup.com/group/en/Sinopecnews/20150202/news_20150202_555627649932.shtml

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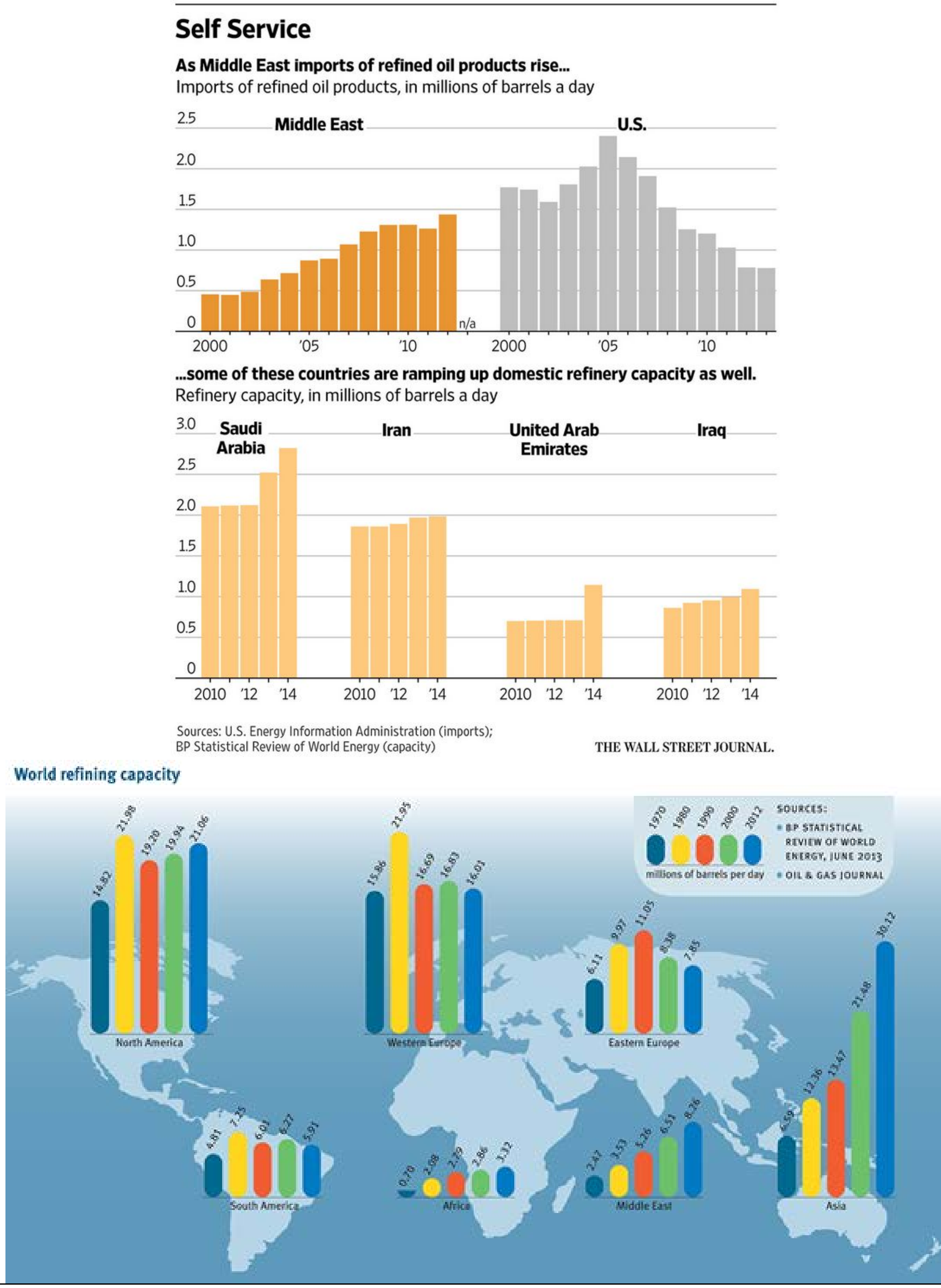
Figure 1: Increasing Trends of Middle Eastern Domestic Refining Capacities[4]

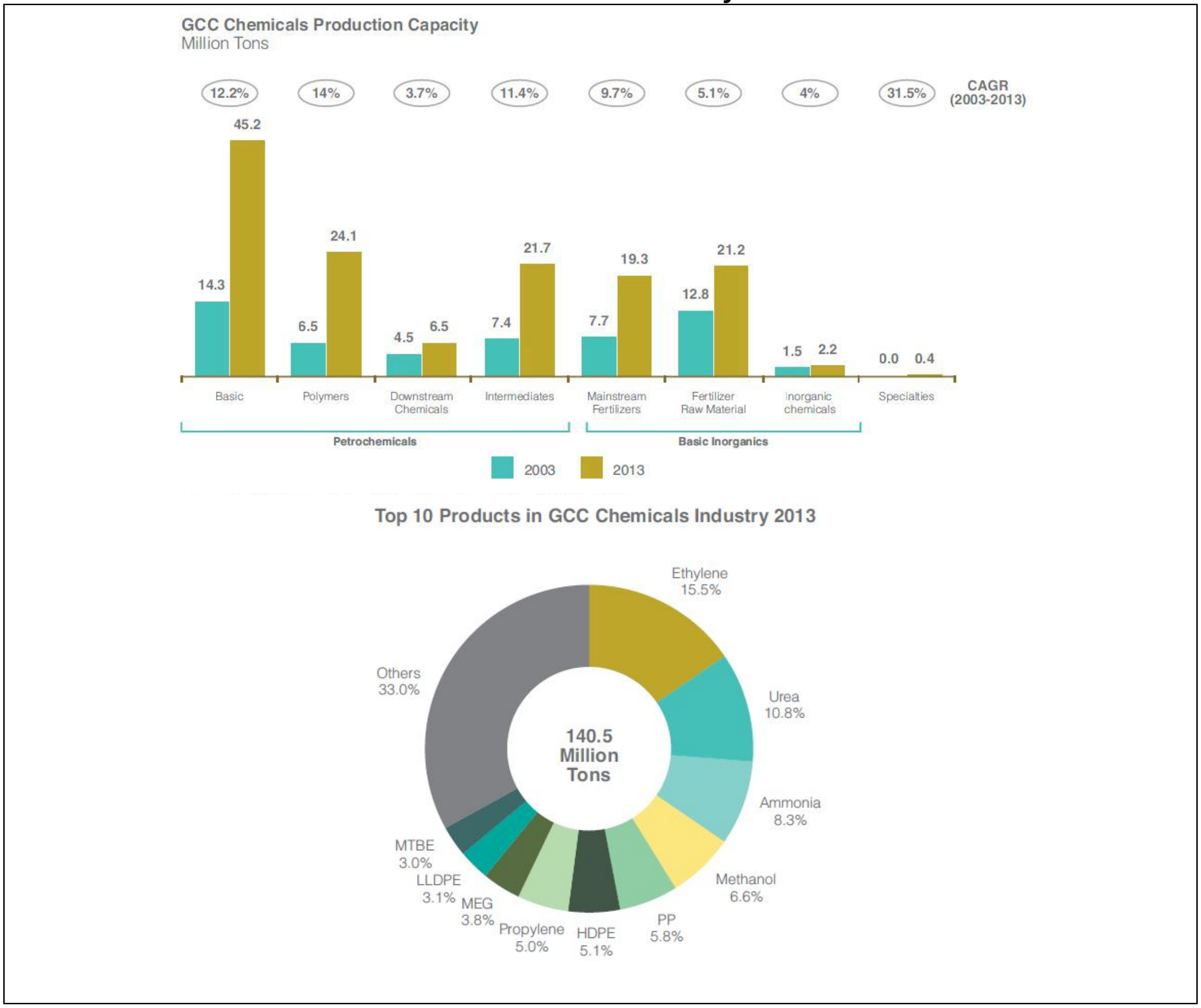


[4] Sources: The Wall Street Journal (8-3-15) and http://www.aip.com.au/industry/dp2013/dp2013_4.htm

The refining catalyst market remains a very attractive opportunity for global suppliers and technology licensors. As shown in Figure 2, the region's downstream industries have grown at 3-14% CAGR (2003-2013). The Middle East refining catalyst market was estimated at over $US 350 million in 2013 and is expected to grow to $US 560 million by 2020[5].

There is a similar growth story for petrochemicals and polymers. Chemical output among Gulf Cooperation Council (GCC) members tripled over the past 10 years, as indicated in Figure 2. Basic petrochemicals and polymers have increased to 45 million tons and 24 million tons, respectively, in 2013.

Figure 2: GCC Chemical Production Capacity and Top 10 Products in GCC Chemicals Industry 2013[6]



[5] TCGR's "The Intelligence Report: Business Shifts in the Global Catalytic Process Industries, 2013-2019" (2014)
[6] Gulf Petrochemicals and Chemicals Association (GPCA), 2014

For global catalyst manufacturers, several questions must be asked:

- How much of the region's growth will be satisfied by local suppliers?
- Will catalyst sales be displaced by other Western catalyst manufacturers?
- What new demands and opportunities should be anticipated?

To answer these questions, one must also consider the unique and interesting mix of state-owned enterprises, foreign joint-ventures, and private companies in the region. How are these companies related? What are the current catalyst technologies in use? And how will growth demands affect catalyst manufacturers' and licensors' sales, new partnerships, and acquisitions?

These are important questions and **TCGR has delineated the numerous and complex relationships among the industry participants with an indication of how these affect process technology and catalyst selection in important areas, including refining, petrochemical/chemical, polymers and environmental.** Example companies/relationships included are:

- Borouge (ADNOC / Borealis JV)
- OMPET (Oman Oil Company / LG International JV)
- QAPCO / QATOFIN (Qatar / Total JV)
- PDO (Oman / Shell JV)
- SOCC (Albemarle / SABIC JV)
- ADNOC / Takreer

In order to add subscriber-specific value to the report, TCGR has sought and received inputs from its "charter" subscribers (i.e., those who subscribed prior to the study's launch) on the scope/T of C as well as nominations for 4-6 company profiles for inclusion of the report. As a result, the study reflects the current interest of the industrial participants in the catalysis and process licensing marketplace.

III. THE NEED FOR THE STUDY

The Middle Eastern refining, petrochemicals, polymers and environmental catalyst markets are forecasted as high growth over the coming decade. More and more global companies are investigating how best to participate in these markets. Some of the market demand for all products will be met by local manufacturers and distributors, as well as Western companies who understand and can navigate the complexities of the region. This applies to the catalyst industries as much as any other industry associated with the refining, chemical/petrochemical, polymer and environmental segments.

The difference, of course, is that information from other sources is "sparse" at best because of the inherent challenges of data accuracy in, and analysis of, these markets. Having industry expertise as part of the analysis is vital to provide clarity and insight into markets and applications in order to better understand the risks and opportunities. The Catalyst Group Resources (TCGR) is uniquely positioned with the skill, knowledge, and resources to assemble this report.

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For those that understand and appreciate this study undertaking, you will know how important it is to have a better understanding of the respective catalyst market segments both for new potential sales as well as understanding the capabilities of emerging suppliers – either to understand local competition better or as potential partner or M&A targets.

This recently completed report, **"THE MIDDLE EAST CATALYST MARKET: Technologies, Applications and Opportunities"** complements an ongoing portfolio of similarly well-received TCGR reports delivered to clients over recent years. This growing experience demonstrates TCGR's unique capability, resources, and expertise to deliver exceptional insight.

Recent multi-client studies and limited-client reports include:

- ***The Asia-Pacific Catalyst Industry: Markets, Technologies and Manufacturers*** (September 2015)
- ***The Intelligence Report: Business Shifts in the Global Catalytic Process Industries, 2013-2019*** (May 2014)
- ***Specialty Zeolites in Catalysis, 2002-2020: International, Commercial and Technical Progress – A New Era!*** (March 2014)
- ***The Catalytic Process Industries in China: Markets, Technologies & Strategic Implications*** (4 part Series – 2013)
- ***The Industrial Adsorbents Business: Commercial Strategy, Technical and R&D Assessment in Refining, Chemicals/Syngas, Natural Gas and Industrial Gases*** (July 2013)
- ***FCC Additives: Meeting Refiners' Environmental, Performance & Product Slate Flexibility Requirements 2013-2018*** (June 2013)
- ***Unconventional Catalytic Olefins Production: Commercial Vision and Breakout?*** (January 2013)

IV. SCOPE AND METHODOLOGY

This completed study looks at the following key Middle Eastern catalyst markets:

- Kingdom of Saudi Arabia (KSA)
- Islamic Republic of Iran
- Kuwait
- United Arab Emirates (UAE)
- Egypt
- Turkey
- Iraq
- Algeria
- Qatar
- Bahrain
- Israel

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As depicted in the actual Table of Contents (see pages 8-13), TCGR's study begins by completing an overview of the commercial and technical landscape in each country, by industry (**Section III**). The catalyst market size and growth of each country are evaluated and shown by segment (i.e. refining, petrochemicals/chemicals, polymers, and environmental). Historical information has been updated and condensed, and technical trends and business developments that are important growth areas in the future has been highlighted in detail.

Section IV, Select "Cameos", consists of cameos of local catalyst suppliers and multinationals' local joint ventures, local research organizations (such as KAUST) and key catalyst production facilities (such as SOCC Jubail). "Charter" subscribers have nominated company profiles of particular interest. TCGR has finalized the selection of profiles based on its expertise.

Section V, Special Feature – "Islamic Republic of Iran" includes an overview of current industries and players, as well as discusses the opportunities for, and risks facing, the incumbent catalyst suppliers as Iran emerges from Western sanctions. Of most importance is providing an expert opinion on the potential future directions of the Iranian refining, petrochemical, polymer and environmental catalyst industries – considering in particular motivations of the main players and the potential future strategies employed (i.e. adopting Western, Russian or Chinese technologies).

Section VI, Conclusions and Recommendations, provides a more insightful analysis of critical points in commercial and technical developments and opportunities. Issues of manufacturing capacity, process licensing and global positioning are evaluated. This section provides executive guidance due to its forward-looking timeframe to 2020.

TCGR's unique background and established global Dialog Group® ensures expert capability and skill level in this study area. TCGR has utilized numerous local, deeply experienced catalyst experts from the region to assist us to provide insights beyond what other sources that do not have the reach and industrial experience can provide.

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FIGURES

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IV. QUALIFICATIONS

The Catalyst Group Resources, a member of The Catalyst Group, works with clients to develop sustainable competitive advantage in technology-driven industries such as chemicals, refining, petrochemicals, polymers, specialty/fine chemicals, biotechnology, pharmaceuticals, and environmental protection. We provide concrete proven solutions based on our understanding of how technology impacts business.

Using our in-depth knowledge of molecular structures, process systems, and commercial applications, we offer a unique combination of business solutions and technology skills through a range of client-focused services. Often working as a member of our clients' planning teams, we combine our knowledge of cutting-edge technology with commercial expertise to:

- Define the business and commercial impacts of leading-edge technologies
- Develop technology strategies that support business objectives.
- Assess technology options through strategy development, including:
    - Independent appraisals and valuations of technology/potential
    - Acquisition consulting, planning and due diligence
- Provide leading-edge financial methodology for shareholder value creation
- Lead and/or manage client-sponsored R&D programs targeted through our opportunity identification process.
- Provide leading information and knowledge through:
    - World-class seminars, conferences and courses
    - Timely technical publications

The client-confidential assignments conducted by The Catalyst Group include projects in:

- Reinventing R&D pipelines
- Technology alliances
- Technology acquisition
- Market strategy

We have built our consulting practice on long-term client relationships, dedication, and integrity. Our philosophy is clear and focused:

We Provide the "Catalysts" for Business Growth by Linking Technology and Leading-Edge Business Practices to Market Opportunities

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V. DELIVERABLES AND PRICING

This report is timely and strategically important to those industry participants and observers both monitoring and investing in the Middle East markets for manufacturing and supply, as well as to process technology companies evaluating the respective catalyst markets. TCGR's report, based on technology evaluations, market assessments and interviews with key players goes beyond public domain information. As a result, subscribers are requested to complete and sign the "Order Form and Secrecy Agreement" on the following page.

The study, ***"THE MIDDLE EAST CATALYST MARKET: Technologies, Applications and Opportunities"*** was completed in March 2016 and is available immediately.

Participation

THE MIDDLE EAST CATALYST MARKET: Technologies, Applications and Opportunities	$18,500
Report in PDF format, in addition to subscription price	$1,000

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