CHAPTER V
REGIONAL MARKET ANALYSIS
REGIONAL METHANOL MARKET ANALYSIS

WORLD

Overview

Over the past few years, global methanol demand growth has been less dependent upon its traditional driver, growth of macroeconomic activity. Rather, methanol demand has risen on the back of its competitiveness in innovative applications which replace increasingly high cost refined crude products, especially gasoline, naphtha, LPG, and diesel. Therefore, over the past two years, despite continued deceleration of the Chinese economy, methanol demand growth has been healthy, driven by demand growth in Asia. On the supply side, continued 2015 addition to Asian production capacity was matched with new US Gulf Coast methanol production facilities, and restarts of key Southeast Asian operations. At the same time, the industry was shown the impact of price sensitivity on demand into MTO operations, with methanol prices capped by MTO purchaser’s ability to afford methanol, keeping the rest of the world prices in check. The ability of refined product substitute (RPS) demand to purchase remains compromised by lowered oil prices, which brought energy complex values down as well. By early 2016, methanol prices are near their floors, collared by low affordability into energy based applications.

Robust growth in China kept up through 2011, despite a massive earthquake and resulting tsunami in Japan, with methanol demand joining. However it was clear by the end of 2011 that serious problems related to Eurodollar denominated debt in certain countries was crimping economic expansion on the continent. Those debt concerns lingered on through 2012, yet did not lead to collapse of the Eurozone or the Euro itself. By 2015, the Eurozone had stabilized and begun to post strong growth, which has continued as of this writing. In North America, unemployment has moved down somewhat. The manufacturing sector continues to prosper based upon healthy company finances and the continued availability and development of low cost natural gas (which as will be discussed, has provided a mini-renaissance for the United States methanol industry). Accordingly, methanol demand growth continues at healthy levels. It is now China’s economy which receives the bulk of the world’s worries, as growth rates decelerate, and cracks within that country’s macroeconomic structure become exposed.

MMSA has developed its own GDP scenario where, as has been the case, positive forces eventually overcome negatives ones. Positive forces include continued improvements in productivity via technology leverage, modernization of production methods, and a greater global economic “interconnectedness” (esp. services such as trade and financing) that makes the global economy more efficient, with the most competitive suppliers continuing to expand their operations. Forces that work to weaken per capita economic output include sovereign debt problems, swiftly
expanding populations (5 billion people in 1988, 6 billion in 2000, and an estimated 7.3 billion plus in 2016), financial illiquidity, massive trade imbalances (especially between the US and China), continued geopolitical strife, and the turmoil inherent in the increasing interconnected global economies, where flows of people, goods, funds, jobs, and technology threaten the ability of some central governments to control their own resources, and in some cases lead to political upheaval.

Please note that previous studies by MMSA show that GDP, while alone not the best predictor of methanol demand growth, gives reliable correlations with historical methanol demand over a 20 year period. As a result, MMSA forecasts GDP growth for all of the regions and countries in this analysis. However, in a nod to the increasing role of energy related applications of methanol, MMSA has spent a large effort vetting MTO and gasoline blending applications in China, which have, for the time being, helped sever the traditional relationship of methanol demand growth and GDP. A summary of the individual country GDP figures and forecasts over the study period is tabulated below:

The global economy will continue its upward direction, as the positive aspects of global economic development outnumber the disappointments. By the end of the forecast, Asia “powerhouses” (especially China and India) are expected to maintain healthy economic growth, while the outlook is more moderate for other countries. Note that, while the overall expectation for global economic growth is positive, stark differences between emerging and mature economies remain. These figures are
applied consistently in forecasting all of the major methanol derivatives, as well as “derivatives of derivatives” for formaldehyde and acetic acid. In summary, the global economic forecast will be positive, reflecting growth in need for for construction, automotive, and other consumer goods. Ultimately, this will be positive for methanol demand growth. The burgeoning use of methanol for energy use appears to be less tied to economies and more to economics.

**Market Outlook**

**Demand**

Over the past five years, methanol demand growth rates have been uniquely higher than most “base” petrochemicals, which include ethylene, propylene, benzene, and paraxylene. Methanol demand growth continues to be driven by cost-effective substitution of refined products in energy applications, particularly in China. Given expectations for the value spread between hydrocarbon (especially coal and natural gas) and refined crude oil product pricing, the continued expansion in use of technologies which convert affordable hydrocarbons to replace refined products via methanol is expected in the forecast. In this period, the distribution of methanol demand will be markedly changed by use of methanol to replace naphtha (via methanol to olefins (MTO), gasoline (via blends as well as direct methanol to gasoline conversion), LPG (via DME), mostly in China, but also in parts of the world which have affordable hydrocarbons. This dynamic has made Asia the dominant producing and consuming region globally, and the preponderance of demand growth remains the domain of this part of the world. Global methanol demand is forecast to grow by just under 39.9 million metric tons in the forecast. Gains in methanol demand into methyl methacrylate, formaldehyde, acetic acid, and other “traditional” applications will continue, although energy demand will dominate the growth, especially in China.

The strongest growth of methanol demand in the forecast will come from the MTO application, driven by a number of commercial projects now underway. It is expected that this application will consume just over 37.0 million metric tons of methanol in 2021. Major change in the methanol demand landscape will also come from the balance of the “alternative” fuel uses (gasoline blending, direct combustion (cooking and heating), biodiesel, dimethyl ether, and power generation). By 2021, these uses will have grown to consume about 21.7 million tons of methanol per year. The basic underpinning of this outlook is the continued expectation of a relatively low cost energy unit contained within methanol, which is a primary desire of users in China. This expectation factors the severe correction to crude oil prices.

MMSA includes the use of methanol as a transportation fuel and direct combustion into a combined category called “Gasoline Blending and Combustion” – please refer to Appendix B for detailed supply and demand tables including this category. It includes a popular uses of direct combustion in China for commercial cooking in restaurant and hotels. Although the absolute amount for each eating establishment is
small, the number of users is large, and aggregate demand is sizeable, if not perfectly quantified.

The chart below depicts the distribution of global methanol demand at the beginning and end of the forecast. It shows that energy use of methanol will shrink the percent of demand for in the three largest traditional uses (formaldehyde, acetic acid, and MTBE) by 2021. Alternative uses will claim almost 55 percent of overall methanol demand by the end of the study forecast, while MTO demand will comprise about 32 percent of the global methanol market.

From this chart, it can be surmised that the relatively slow growth in use of methanol for traditional applications (particularly formaldehyde and acetic acid) contrasts with the swift MTO growth. The growing demand from Asia, in particular China, is largely energy related. Generally, all traditional methanol sectors are expected to grow with global economies in the next five year period.

Regionally, growth in methanol demand is expected to remain focused in Asia, with increased support from the US, Europe, and Africa. Consider the table on the next page, which breaks down regional demand growth of methanol over the study period. The large methanol demand growth anticipated in Asia will be driven predominantly by China and, to a lesser extent, India and the Southeast Asian block. Demand in North America is based upon investments in derivative production, including formaldehyde, which is recovering with the US economy. Methanol and gasoline blends, along with DME production in China, will also significantly affect methanol demand in Asia. Russia, Europe, and the Middle East will require more methanol as investments in derivative production continue.
Within Asia, China remains the largest engine of methanol demand growth. China is a larger methanol consumer on its own than any other region globally. The chart below shows demand for methanol by region, separating out China. The other regions’ methanol demand growth pales by comparison, meaning the world will continue to rely on Asia for incremental methanol demand growth.

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Supply

In the forecast years of this study, over 32 million tons of net incremental methanol capacity is expected to issue. The chart on the next page displays the regional change in capacity over the course of the forecast. Investment in methanol production capacity, mostly in China and the Americas, will be required in the forecast. A large
portion of the new capacity is dedicated to olefins production, which produces crude methanol that would not immediately be able to affect global supply.

The next largest region for methanol production capacity growth is anticipated to be North America, advantaged by low cost natural gas. US Greenfield investments are anticipated by the end of the forecast. Despite rich natural gas reserves, only a modest amount of methanol capacity is anticipated in the Middle East in the forecast years. Methanol projects in many other locales, including Africa, Algeria, and Russia are being considered, although MMSA has only included projects it deems realistic. Longer term, additions to methanol production capacity will issue from those locales which can most competitively support growing demand for methanol in Asia.

Combining the supply and demand outlook, the graphical summary of the global supply and demand is provided on the following page. Generally, since 2011, the rate of addition of methanol production capacity has kept pace with that of demand. In the past few years, because of relatively poor operations (especially China, Iran, Chile, Malaysia, Trinidad, and Libya), the “paper” gap shown can somewhat illusory as significant disruptions to supply (in the form of cancelled feedstock supply, technical difficulties in running larger and larger plants, and/or unplanned turnarounds – particularly the bane of coal based facilities) occur.
Methanol Derivatives

Formaldehyde

Formaldehyde remains the largest consumer of methanol, with 20.5 million metric tons of methanol needed globally in 2014 to support its use. Formaldehyde based applications have largely recovered from the global financial crisis’ impact on construction and automotive production. The forecast includes pre-crisis growth rates, yielding continued Asian and improving EU and US formaldehyde demand.

Growth for formaldehyde has been driven volumetrically by resins (urea formaldehyde, phenol formaldehyde, and melamine formaldehyde). It is clear that a healthy pace of global economic growth through 2015 has helped the growth of this sector, delivering a positive aggregate global market rate of consumption growth. Despite this track record, dark clouds loom on the horizon, mostly in China, where deceleration and worries about a housing bubble persist. Nevertheless, growth momentum for formaldehyde is expected to be sustained in the forecast.

The total contributions of all major formaldehyde derivatives towards global formaldehyde demand are shown in the chart on the next page. Most formaldehyde derivatives are back on a pre-crisis trend, and are expected to grow along with the economy at different rates. This chart was made from data included in Appendix B, which lists supply and demand for formaldehyde globally by these uses.
Regionally, growth in formaldehyde demand over the study period is shown in tabular format below:

### Growth in Formaldehyde Demand (-000- metric tons)

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<td>1,947</td>
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Not surprisingly, Asia (China) continues to be the center of global formaldehyde demand growth. North American demand growth slowed again in 2015, after strong construction activity in 2013. Demand in Europe and Russia continues to recover strongly in the forecast years. In Asia, which is dominated by Chinese demand growth, formaldehyde use for not only construction, but for advanced chemicals like polyacetal, polyurethanes (polyols and MDI), and polyesters, is expected to continue growth at a slightly lower pace than the previous five years. Formaldehyde demand...
growth in every region is expected to be positive in the forecast, and while China growth rates are lower, Indian rates should remain strong.

Capacity for formaldehyde is also growing (for a complete list of global formaldehyde capacities, please see Appendix A, “Global Capacities”). Unlike methanol, formaldehyde producers have not enjoyed large, reinvestment level margins, and in fact there is a trend toward formaldehyde users investing in manufacturing of their own, becoming captive consumers of methanol (as is the case for many board manufacturers and larger chemical producers). Though the end of the study period, new capacities will generally be in line with growth.

A comparison of global formaldehyde supply and demand is shown in the chart above, which captures the slow narrowing of supply and demand towards the end of the study period, suggesting that more formaldehyde facilities will be needed.

**Acetic Acid**

Methanol has become the feedstock of choice to make acetic acid globally. In 2015, the manufacture of acetic acid consumed 5.97 million metric tons of methanol. Acetic acid had been among the fastest growing of methanol derivatives, driven by its use as a reaction medium in the production of terephthalic acid (TPA), which in turn is used in the production of polyesters. Similar to other derivatives, the industry suffered from demand destruction due to the global economic crisis - including rapid declines in textile, construction and automotive uses. Nevertheless, demand rebounded strongly on the back of various stimulus programs and overall macroeconomic improvement, and will continue to grow in the forecast.
Of the expected global acetic acid demand growth in the forecast years, the biggest contributions volume-wise will come from TPA and VAM. A surge in demand for acetic acid in the Middle East (from a complex producing derivatives) has conspired with recovery in western markets, and added growth expectations in China, to produce a steadily growing acetic acid demand. TPA demand continues to benefit from significant new production capacity in China which has either started up commercially or will do so in the near future, with growth slowing somewhat in the forecast as that sector looks to redistribute production. Acetic acid demand will grow from increased vinyl acetate monomer production in China, particularly for paint and EVA applications. Other acetic acid uses in China, including monochloroacetic acid will continue to grow as well.

The source of acetic acid demand growth varies by region, and essentially tracks investment in derivatives. Looking at the table on the next page, Asian needs, particularly for TPA production, clearly take the lead role in acetic acid demand development. The impact of an integrated acetyls investment in the Middle East is waning with no new facilities expected during the forecast. VAM use in the Middle East region will continue to increase. An increase in acetic acid demand into a new application, ethanol production, has been underwhelming, and any demand for acid into this sector is expected to be limited in the forecast.
Chapter V - Regional Methanol Market Analysis - World

Capacity to supply acetic acid had been increasing at a slightly faster pace than demand growth, with the trend expected to reverse over the next few years. Demand (and production) growth over the next five years is expected to increase. However, average annual capacity growth over the next five years will be lower, resulting in stable to gradually increasing operating rates in the forecast. During this period, it is likely that non-carbonylation capacity will continue to be either campaign run or mothballed.

For a change, new acetic acid production facilities forecast for China have slowed, based on years of poor industry profit margins of recent years. Please see the capacity listings in the appendices for a detailed listing of current and future acetic acid producing locations globally.

Growth in Acetic Acid Demand (-000- metric tons)  
2011-2021E

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Growth in Acetic Acid Demand (-000- metric tons)  
2011-2021E

Acetic Acid Supply and Demand - World

- Total Demand
- Production
- Production Capacity
- Net Trade

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The chart on the previous page, “Acetic Acid Supply and Demand – World,” puts together the high level view of acetic acid markets globally through the forecast. As acid demand returns to trend growth, and capacity increases slow down, markets are expected to heal, with a corresponding increase in prices and margins.

**Methyl tert-Butyl Ether (MTBE)**

Demand for MTBE is no longer dominated by the United States. MTBE use in the US has been eradicated by legislative efforts to remove the methanol-consuming additive from the US gasoline pool. The causes for MTBE removal are related to its detection in water supplies across the country and the drive by environmental parties to ban its use as a solution to further threats to water quality. However, China and the Middle East have been much more supportive of MTBE use, as it optimizes scarce octane supply. MTBE demand will continue to shift through the end of the study period geographically to Asia. The table below summarizes the MTBE demand growth (and loss) expectations by region. Clearly, losses in North America have been more than made up by gains in Europe (which switched dramatically from ETBE in 2013), the Middle East and Asia.

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In the forecast, North American MTBE demand will come from opportunistic production into isobutylene and exports. European, MTBE growth in the forecast period is slightly positive, with many current operators increasingly shifting away from ETBE growth. By the end of the study period, the Middle East and Asian regions are expected to increase their global share of MTBE production to the vast majority of the global total. This material will largely supply Asian demand, especially to feed the burgeoning growth in gasoline consumption in China.

On the other side of the supply and demand equation, capacity to produce MTBE is expected to be mostly from expansions within refineries in Asia to increase conversion of stray crude C4 streams. The reticence to build capacity is based upon several factors, including the competing economics of selling feedstocks longer term and residual concerns about further global phase out based on the US experience.
The chart below, “Methyl Tertiary Butyl Ether Capacities by Region,” segments global MTBE capacity by study region for the study period.

As the chart demonstrates, supply growth is expected to be non-existent. With the exception of Malaysia, Asian MTBE capacity is mainly from refinery butylenes in China. This underscores the effect of the recent acceleration MTBE production in China, which has proceeded at a pace ahead of demand. Nevertheless, MTBE will remain a major global methanol consumer through the end of the study period, with consumption in China and other Asian countries driving global demand.

**Methyl Methacrylate (MMA)**

MMA consumption is driven by its polymerized forms, polymethyl methacrylate (PMMA) or co-polymers with other monomers. These polymers are the foundation of “organic glass,” which is more shatter resistant and clear than conventional glass, and can also be found in a variety of other applications. Notably, PMMA and co-polymer variants are being used to make flat panel electronic displays, and this has brought about a rejuvenation of product demand. Asian demand has been the strongest and will continue to be so in the forecast. Between those uses and uses for MMA as impact modifiers, the outlook for global MMA demand is positive. In 2014, 4.19 million metric tons of MMA were produced, consuming 1.63 million metric tons of methanol. Demand growth has recovered somewhat together with economies and improved discretionary spending, positively impacting optical applications (ie. LCD and LED devices). Demand growth from cast sheet and other “general purpose” grades of MMA has been notable. MMA production capacity (see chart below) is currently split evenly between the Americas (mostly US) and Asia (used to be dominated by Japan, but with increased involvement of Korean, Singaporean,
Thailand and especially Chinese manufacturers). In addition, a new MMA facility in Saudi Arabia utilizing ethylene based routes (Mitsubishi Rayon’s Alpha technology) has been envisaged in the forecast. The chart quantifies the additions to MMA capacity expected in the forecast, by region during the study period. The chart shows the predominant role that Asia will play in MMA production (and methanol demand) by the end of the study period.

Chloromethanes

Methyl chloride is the basis for hundreds of commercially significant processes, with the largest of these for the production of silicones (elastomers, fluids, and resins, representing over 75 percent of methyl chloride use). Methylene chloride is used primarily as a paint stripper. In total, these and other derivatives (including chloroform and carbon tetrachloride) required 2.09 million metric tons of methanol globally in 2015. Production capacity is generally distributed evenly around the globe, as trade is limited, with the focus of new capacity additions on Asia. Please refer to the regional and country sections of this chapter for further details.

Methylamines

Total methanol demand for mixed methylamine (mono-, di-, and trimethylamine) production globally in 2015 was approximately 1.52 million metric tons, with close to 45 percent of this total for dimethylamines. Dimethylamines are used in the production of dimethylformamide (used in synthetic leather processes). The balance of methylamine production is almost split between mono- and tri- methylamines. Growth in this market is expected to benefit from growth in developing countries, in applications like footwear, and grain storage pesticides (replacing methyl bromide).
Total production capacity globally for mixed methylamines is now about 1.76 million tons per year. In the North America, most capacity is located in the US, with smaller facilities in Canada (some of which have rationalized production) and Mexico. Most investment in new production capacities is expected in Asia, for the eventual production of DMF through dimethylamine, although the US has benefitted from a renaissance based on low cost natural gas. Total European, Russian, and Asian capacities are smaller than the Americas. Given methanol and ammonia as feedstocks, the Middle East, US, and South America are ideal locales for methylamines production given their access to both.

*Methanethiol*

Methanethiol (aka methyl mercaptan) is primarily used with acrolein in the manufacture of DL-methionine (one of a class of amino acids used to fortify plant proteins, e.g. soybean). DL-methionine is also an important chicken feed supplement.

Methanethiol is made commercially using methanol substitution with hydrogen sulfide. A significant amount of DL-methionine is manufactured in the world, with a large proportion used in Asia. This amount required roughly to 0.49 million tons of methanol annually in 2014. The global demand for DL-methionine in its primary use as a feed supplement varies considerably depending on such factors as soybean harvests.

*Biodiesel*

Europe pioneered the biodiesel business, creating a large market requiring significant quantities of methanol in production. However, until lately, continually increasing crude oil and energy prices along with growing environmental fervor compelled other regions to invest in biodiesel production. By 2014, global biodiesel production used an estimated 1.2 million metric tons of methanol. However, the ability of biodiesel to competitively substitute for petroleum diesel is being hurt by escalating costs for vegetable oils of all kinds globally – soy, rapeseed, and palm, as well as lower crude and refined product pricing. Many new biodiesel facilities around the world are running at very low operation rates, mostly due to negative economics. In addition, less supportive government support and mandates have hurt consumption as well as future use. By the end of the forecast, the need for methanol in this application will climb only modestly. And this growth is at risk unless the economic conditions for biodiesel relative to petroleum based diesel improve. Many proposed projects, including in the US, Europe, and Asia have been delayed or cancelled.
The chart above segments by region the growth in biodiesel capacity during the study period. The flatness in the forecast underscores the lack of investor enthusiasm in supporting new capacities globally. Additionally, many of these projects will not produce because of currently unfavorable process economics.

In summary, the interest and demand for biodiesel emerged quickly, and then waned as the realities of high production costs took over. Low operating rates in the industry will only be allowed to improve based on improved economics, which currently puts biodiesel producers at the mercy of vegetable oil suppliers. This segment of methanol demand is expected to grow only in select locations where economics are justifiable (e.g. South America or Southeast Asia) in the forecast years. Some groups are working on alternative (i.e. non-edible) feedstocks for biodiesel production; however this will likely need further time for development and refinement.

**Gasoline Blending and Combustion**

China has been the largest user of methanol for gasoline blending and combustion, due to a combination of economic incentive and provincial government support. Note that this category includes the use of methanol in direct combustion applications, such as heating or cooking. For this segment, the estimated global demand for methanol in 2015 was 11.3 million metric tons, driven by a still positive spread between the value of methanol and gasoline (magnified after the Chinese government introduced a new gasoline pricing mechanism which is more aligned with the movement in energy values). Chinese demand accounted for 97 percent of the global total, with the balance distributed among North America, South America, Europe, and South Korea. By the end of the forecast, the segment is estimated to
consume slightly more than 16.7 million metric tons of methanol globally. Despite the expected boom in Chinese automobile and fuel markets, bullishness in this area has been moderated by delay in official specifications for a “M15” blend (15 percent by weight meOH in gasoline) as well as skepticism from the existing refiners in the country. National standards for methanol fuel blendstock (M100) and M85 blends came into force in late 2009, but have yet to impact the market due mostly to a concurrent requirement for flexible-fuel vehicles and other supporting infrastructure. M100 vehicles are becoming more prevalent in China also, with at least one auto manufacturer setting up production facilities to make vehicles that will utilize this fuel.

On a unit energy basis (dollars per BTU), methanol can be competitive as a directly combustible fuel depending on the price of methanol, oil, and gas. That being the case, no plans have been put forth towards a methanol plant dedicated to produce methanol as a fuel for a large consuming application such as power generation, although methanol has been certified as a fuel by major turbine manufacturers, and test/demonstration facilities using methanol as fuel to generate electricity exist. The combination of low methanol prices and high energy prices is prerequisite for considering this application. Current methanol usage for direct combustion centers on commercial cooking in eating establishments, resulting in a surprisingly large drum business, which is difficult to precisely quantify. Usage as a “general purpose” fuel (e.g. for water heater boiler heating fuel in some provinces within China) has been noted, advantaged by improved availability versus other refined oil products. Overall, growth in the gasoline blending and combustion segment is largely limited to China and its unique set of circumstances globally, although the trend of increasing valuation of crude oil and traditional energy materials has been, and should continue to be beneficial for methanol demand into energy.

This segment of forecast uses figures which assume a continuation of positive actions on the part of Chinese government, industry (especially refining and automotive segments), and the current relatively large value spread between coal and crude oil, and minimal margins for methanol producers in China. As has been learned from the MTBE experience in the US, governments can both provide and remove support for transportation fuels with swift and sudden impact.

*Dimethyl Ether (DME)*

The market for DME as a fuel and LPG substitute has been flat in recent years, after becoming popular in China due to advantaged economics. Almost all global DME production is based in China. Total demand for methanol into DME amounted to an estimated 3.8 million metric tons in 2015. By the end of the forecast, MMSA estimates that the methanol demand for DME will rise to 4.3 million metric tons. Roughly 8.9 million tons of DME capacity are anticipated to be on stream in 2021 in China. The move to build large DME plants was originally encouraged by the government as it is hoped DME will effectively reduce China’s dependence on oil and gas-based fuels. However, the development of use beyond household/retail bottle heating has been
and will be more difficult, and an oversupply situation in China exists. For LPG blending, the spread between LPG and methanol prices have not always been favorable for DME producers, often hurting production rates. For the past several years, negative news surrounding illegal use of DME blending into LPG for domestic purposes has caused market uncertainty, although these discussions have lead to nationwide legislation governing the use of the product. In the interim, several provincial governments have drafted their own local standards, showing product stewardship, a positive future development. More discussion about DME can be found in the China section of this chapter.

The fate of merchant produced DME does not appear highly promising. It is a form of methanol demand with high potential and high uncertainty. Additionally, oil prices and China’s ability to develop the infrastructure to transport and use DME will have a large impact on the extent to which the market grows.

Direct Methanol Fuel Cells

Fuel cells that use liquid methanol cartridges of sizes ranging from milliliters to liters continue to make advancements towards larger scale commercial use, particularly in “luxury” applications. The market for direct methanol fuel cells (DMFCs) for small handheld electronics and laptops has grown somewhat in the US and Europe, although more progress has been made in remote generation needs (including military), standby power, and replacement of batteries in electric forklifts. Currently, it is estimated that DMFCs consume a small, but swiftly growing amount of methanol globally. The forecast calls for this demand to increase to around 11,000 metric tons by 2020.

Methanol to Olefins (MTO)

Viable use of methanol to produce olefins (ethylene and propylene) relies heavily on favorable and somewhat complex relationships between energy, methanol, and olefins pricing. Countries like China are particularly motivated due to their lack of self-sufficiency in olefins production (i.e. they are very large net importers of olefins owing to too little production capacity). In this country, eight integrated MTO plants in China and eight non-integrated MTO facilities are now in operation. In addition, several more facilities are envisioned in the forecast years. The current fervor for MTO is balanced by the complexity of MTO projects, feedstock requirements, water scarcity in many parts of China, and other operational challenges. By 2021, it is estimated that 37 million metric tons of methanol will be consumed for MTO production, mainly by operations in China.

Since most MTO project plans require large amounts of methanol, most are being designed with dedicated methanol production. In theory, one possible risk to conventional markets should be considered as a result: the methanol portion of the olefins production can become “decoupled,” perhaps by poor olefins economics, or by unplanned olefins outages, leaving open the chance that large quantities of
methanol could be put onto (and taken off) the market in a short period of time, leading to volatility. This scenario, however, is not forecasted long term, especially as most of the integrated facilities are designed to produce crude methanol, which would need to be refined before use.

Alternatively, in order to achieve scale in downstream olefins derivatives, the limits of scale of coal gasifiers is also being tested, and this makes the process less cost efficient. All of these factors run up the costs and risks of future MTO success, and are the basic reasons behind the outlook in this study. All considered, this area of petrochemical development is expected to create another great potential methanol consumer. Significantly more discussion of the MTO opportunity is found in the China section of this chapter, as well as in Chapter IV.
ASIA

Overview

The massive strides made in the Chinese economy, especially since the start of the global financial crisis, represents a significant portion of economic activity in this broad region, which includes East, South, and Southeast Asia. In 2010, China surpassed Japan as the world’s second-largest economy, culminating the three-decade economic transformation of China from an isolated, state planned economy to an emerging superpower. Despite many concerns, this trend has continued through 2015. Although fears of a China slowdown have emerged, these are expected to engineered in such a way that a “soft” landing of that previously high-flying economy results. Overall, in the forecast, the Asia growth trend is expected to continue.

Asian, methanol markets have been dominated by additions to methanol capacity in China, which has supported massive growth in regional demand, especially demand into Refined Product Substitutes (RPS) in China, particularly demand from non-integrated MTO operations. Asia is now the largest producing and consuming region for methanol globally. In addition, strong demand growth for methanol in Southeast Asian countries persists, and more supply in this region has been envisaged.

Market Outlook

Supply

Asia (defined here as Japan, China, Taiwan, Korea, Singapore, Malaysia, Indonesia, Australia, New Zealand, India, and other Southeast and South Asian countries) relies on imports of methanol from deep sea locations to satisfy demand. Asian countries have seen intermittent supply to its rapidly growing markets and the rapid demand growth for methanol has been met with several supply disruptions in the past few years (ongoing Iranian and Southeast Asian supply especially). These and other events conspired to promote high methanol prices and margins which spurred Chinese production. Production margins in the past few years have continued to encourage record Chinese methanol production, but operating rates there remain low due to a seemingly non-ending stream of capacity addition, and some issues with coal and natural gas feedstock access. Moving forward, most of the new capacity to produce methanol in Asia will issue from China, integrated into MTO production, with details provided in the relevant country sections and Appendix A of this study.

Demand

The Asian region will continue to provide the vast majority of global methanol demand growth during the study period. Positive demand growth from all sectors is expected, with commercial quantities of methanol for olefins manufacture expected...
to grow most strongly. RPS (esp. DME and gasoline blending and combustion) demand will grow at a noticeably slower, but still strong pace. Formaldehyde, acetic acid, MMA and MTBE will also exhibit relatively robust growth based on rising demand of their downstream derivatives. The chart below reflects the growing share of the pie which MTO and alternative fuel uses in Asia will possess.

A graphical version of the Asian methanol balance is shown below. In the forecast, production growth comes from China. Towards the end of the study period, Asia is
expected to increase its methanol production, yet at the same time preferring to import molecules from lower cost locales such as the Middle East and the Americas in order to support swift demand growth. By the end of the study period, China will remain both the largest producer and importer of methanol in the region, with Japan, Korea, Taiwan, and Singapore also significant importers. Please refer to the individual country sections for more detail.

**Methanol Derivatives**

As with methanol, China is the lead factor in significant demand growth for formaldehyde in Asia. Growth in Asia after 2011 accelerated after a global economic slump, rebounding through 2015. A similar trend is expected in the forecast, albeit at lower CAGR. Please refer to individual country analyses for details.

![Formaldehyde Supply and Demand - Asia](image)

Capacity additions are expected by the end of the study forecast as demand currently outpaces capacity addition in Asia. Capacities are detailed in the Appendix A of the study.

Formaldehyde growth in Asia is primarily from UF and PF resins, as shown in the graph on the next page. A positive contribution from the BDO and MDI sector is also expected. Please refer to individual country sections for a description of market dynamics.
**Acetic Acid**

As the chart below suggests, the spurt of investment in Asian acetic acid capacity ahead of demand growth, especially in Northeast Asia, has changed regional...
dynamics through the forecast period. The Asian region has moved back to a more balanced trade position, with more new production reducing the need for extraregional imports. However, expectations of a slight need for external molecules in the forecast exist, driven mostly by India. The large gap in demand will be an increasing irritant for higher cost non-carbonylation production, to say the least. What has happened in India, where only carbonylation production makes economic sense, is a perfect illustration of this matter, and non-methanol based acid operations in China are also threatened by the oversupply. A budding but still uncommercialized technology to convert acetic acid to ethanol has yet to materialize substantially, but contributes to a small degree, improving balance in the region.

Acid demand recovered swiftly in the Asian region through 2015, and is expected to continue growing through the forecast. The largest driver of acetic acid demand growth in Asia will be from terephthalic acid (TPA) and vinyl acetate monomer (VAM), needed to satisfy increasing consumption in China. Details can be found in the individual country sections contained in the study.

MMA

As shown in the chart on the next page, swift growth in demand for MMA in Asia in the forecast will pace with increased capacity of recent years by the end of the forecast. Most of these recent and new projects are in China, Singapore, and Thailand, which should ensure that trade within the region remains balanced. External trade dynamics will change slightly by the end of the forecast, with the Asian region expected to ratchet up imports of MMA from the Middle East. Demand for MMA will continue to be driven by growth in Asian PMMA production, particularly into optical flat-panel displays.
Alternative Fuels

Asia has become a strong staging ground for the various alternative fuel uses of methanol, with many countries close to following China’s lead in this area. In the region, DME, gasoline-blending and combustion, and biodiesel will be the most prevalent uses, having the greatest potential to make a large impact on methanol demand. Nevertheless, the demand for methanol for these uses has seen early signs of maturation for the near term, with significant developmental effort required for full scale adoption.

Global DME markets will be almost exclusive to China through the forecast, with some anticipated usage in Indonesia. In this country, DME demand will be driven by the government’s desire to substitute LPG and diesel with DME so as to reduce the nation’s dependence on imported crude oil. A project envisioned for this country has been delayed because of both project financing issues, although interest in other projects remains high.

The chart on the next page shows Chinese DME capacity through the forecast and displays lack of new capacity additions, with several of the current facilities remaining idle. Please refer to the China section of this study for greater detail.

Biodiesel efforts in Asia have slowed appreciably. Unlike DME, biodiesel has piqued nearly every Asian country’s interest. Many Southeast Asian countries see the biodiesel market as an opportunity to leverage their large vegetable oil production
(especially palm oil in Indonesia and Malaysia). North Asian countries such as China, Japan, and Korea are considering biodiesel as an environmentally-friendly alternative to petroleum-based diesel. Countries with large land availability such as China and India are planning to devote acreage for new vegetable oil plantation.

Much of the planned biodiesel output is earmarked for export to Europe, which has a more established market for biodiesel blending and use. Separately, several countries in Asia have embarked on programs to increase usage within their own country. Nevertheless, significant demand for Asian biodiesel will largely be dependent on the access and feasibility to send exports to other regions in the world. Such strategies will face roadblocks as policies in some export destinations are often seen to be slanted towards protection of local biodiesel industries.

The too-quick rush to biodiesel in Asia is best reflected in the chart on the next page. A massive number of projects have been developed throughout the continent. The chart segments out biodiesel production capacity by country in the forecast period. Given the overbuilding of Asian biodiesel capacity, significant new investment in facilities in the forecast is unforeseen.

Over 10 million tons of capacity is on schedule to be available by the end of the forecast. In the hypothetical situation where all of this capacity was operating at 100%, this would close to than 1 million tons of methanol. However, operating rates are expected to be well below this, especially given the lack of economic competitiveness of biodiesel.

Gasoline blending and combustion in Asia is almost singularly a Chinese phenomenon. Blending methanol with gasoline allows the fuel supplier to enjoy advantageous economics since methanol is traditionally cheaper than gasoline – a
phenomenon that has persisted since the end of 2008. The price of gasoline is now adjusted via formula more in line with global energy values (with some government intervention), yielding higher prices and greater affordability for blenders. Methanol use in direct combustion also offers some practical solution in logistics and others for heating and cooking applications.

There are varying estimates of demand for methanol from gasoline blending and direct combustion as practices are not regulated on a nationwide basis yet. However, the sophistication of the parties involved in provincial trials has increased. The prior chart (previous page) shows forecast demand for methanol in gasoline blending and combustion in Asia. The pace of growth to should continue to allow for significant demand growth to ensue, given current expectations for crude and coal pricing.
CHINA

Overview

The People's Republic of China is the world's most populous country, as well as the world's largest methanol producing and consuming country. Thanks to a reformation of government and markets that continues today, China is close to becoming the world’s largest economy. Production and consumption of coal, which is abundant across the country, is the highest in the world. Economic progress in the country has had a major impact on methanol and energy demand, and imports have made China a significant factor in world oil markets. Accordingly, the global methanol balance in the forecast period will be largely determined in China. Substantial addition to methanol production capacity in the country continues, with many integrated with MTO production. Facilities from the Middle East and Southeast Asia also fulfill Chinese needs. Demand growth for methanol remains positive, based on continued large investments downstream, and developments in the use of methanol for gasoline blends as well as for the manufacture of MTO. After many years of reinvestment level margins for Chinese producers, followed by a record pace of capacity addition, reinvestment and rapid production growth continues. Some of the high cost producers in China are believed to be in danger of permanent rationalization, and this has been reflected in the forecast.

Market Outlook

The impact of China on global methanol demand is apparent in the chart below, which tracks demand by major global region during the study region.
China has been and will continue to be the engine driving global methanol demand. In fact, China as a country has over 5-fold methanol demand versus the next largest global region. The recipe for growth has included a mix of rampant local demand for commodities of all types, investment in manufacturing by local and foreign firms, and leveraging of the abundance of low cost and efficient labor to make items for both local demand and export. This model is expected to continue while the Chinese economy continues its “long march” from a state planned to market driven economy. Most importantly, and as described in greater detail below, the country’s use of methanol in the replacement of refined crude products – namely gasoline, naphtha, LPG, and diesel – has been remarkable, underpinned by economic efficiency, and is the ultimate driver of world methanol demand growth.

China has become mostly self-sufficient as its methanol appetite has increased. This has been the result of local investment in large scale coal and natural gas based methanol facilities which have prospered in an era of reinvestment margin methanol prices. While these facilities are generally considered high in cost, they are a necessary supply option for this country, as not enough material from abroad is available to satisfy demand. A large proportion of coal-based methanol manufacturers in China take temporary shutdowns whenever they reach negative cash economics. Coupled with emergence of larger methanol production facilities, some of the non-competitive facilities in China are in the process of mothballing, and further rationalization of highest cost producers is expected.

On top of high production, China has shown that it has export capabilities as well, with exports on a large scale as the result of sustained arbitrage opportunities globally. Nevertheless, the country is expected to continue its reliance on imported methanol, mostly due to the ability of methanol from overseas to price its way into market. The import is expected to accelerate in the coastal to meet the demand growth from MTO sectors. As the trade flow from local production in inland China to coastal will be much intercepted by the inland MTO facilities. In the future, Chinese producers will continue to seize export opportunities (mainly to the Asian region) when economics allow, although these are not widely projected in the forecast.

The map on the following page shows the distribution of methanol production capacity by province, with darker colors symbolizing higher production capacity. China methanol production, while centered in the coal rich provinces of Inner Mongolia, Shandong, Shaanxi, Shanxi, Hebei and Henan, is distributed broadly across the country, with almost every province registering demand. This feature is a remnant of the state planning era, when refinery and chemical production was distributed geographically to ensure provincial self-sufficiency (i.e. spurred by military strategy in case of invasion and/or loss of provincial control). However, supply is increasingly becoming centralized in provinces with coal based feedstock, or in provinces with gas feedstock which do not contain coal (a government mandate prohibits coal-rich provinces from utilizing precious natural gas for anything but necessities such as heating and power generation).
A detailed listing of annual methanol production capacity in China, showing company name, location, and size for the study period can be found in Appendix A.

Moving to the topic of trade, in late 2010, China's Ministry of Commerce (MOFCOM) announced anti-dumping duties on methanol imported from Indonesia, Malaysia and New Zealand. The announcement also stated that the final anti-dumping margin would issue for a period of 5 years. Nevertheless, the implementation date of this new rule has yet to be announced, and trade has returned from those countries.

The methanol that is imported into China is sourced mostly from the Middle East (see pie chart, next page). The usual trio of importers into China (Iran, Oman, and Saudi Arabia) lead methanol trade to the country in 2015. Imports in 2015 expanded versus 2014, reversing a four-year downtrend, thanks to the improved trade from Iran coupled with the import growth from New Zealand. Generally, import facilities in the country continue to improve size and storage options, as well as establishing larger jetty/berthing facilities that can house larger cargoes. Many end-users and traders in this country have also invested in their own storage facilities, further supporting increased imports forecast in the study years. The phenomenon of owned storage is expanding along with new MTO facilities, where new facilities are essential to maintain given the large volumes of methanol required in the MTO application.
Breaking down China methanol imports by provincial region (see chart below), the majority of methanol is imported at the Eastern coastal provinces (Jiangsu, Zhejiang, Shanghai). Ports in these provinces handled over 4.0 million metric tons of methanol through the course of the year. Not only do these provinces contain new logistics infrastructure to handle larger cargoes, but they are close to the high growth downstream demand zones near Shanghai.
The southeast provincial region (Fujian, Guangdong) imports the second greatest amount of methanol to feed the downstream demand near Guangzhou. A dearth of large methanol capacity nearby requires southeastern China to accept imports.

Methanol exports from China waned in 2015 as arbitrage opportunities disappeared. The central coast region predominates this trade, with producers near Shanghai able to take advantage of relatively easy access to shipping options. The south provincial region (Guangdong, Hainan) exports from world scale methanol facilities on Hainan Island are also occasional. These two natural gas-based plants will continue to be a force in methanol trade flows.

With respect to the demand side of Chinese methanol markets, paralleling the country’s seemingly unbridled economic performance; Chinese methanol demand growth will continue to lead the world on both an absolute and relative basis. The main features of methanol demand in China are:

1. The rapid increase in methanol requirement for the Methanol-to-Olefins process
2. A large and significant consumption of methanol as a fuel, partly in blends with gasoline as well as direct combustion, and in the form of DME, driven by the large gap between lower methanol prices and gasoline, LPG prices,
3. A still significant acceleration of investment in formaldehyde production, particularly to meet needs across the formaldehyde consumption spectrum,
4. Near term increase of both local production net methanol imports, as economic conditions warrant domestic production, and imports regain momentum to meet demand growth in coastal MTO sectors, followed by a progressive increase in imports from remote locales with more competitive delivered cost to major consuming centers in China, especially for new MTO facilities.

In terms of demand, the most prominent increase in methanol usage was for MTO, with eight commercial non-integrated MTO plants in operation as of this writing. China witnessed three MTO startups in 2015, with up to another three this year. In addition, usage of methanol into alternative energy applications for 2015 was again bigger than the rest of methanol demand combined. Among traditional applications, formaldehyde is still the most important methanol consumer in China. These manufacturers are becoming increasingly sophisticated and larger in scale, with resin manufacturers backward-integrating into larger scale formaldehyde production, and becoming consumers of methanol.

The use of formaldehyde to manufacture UF resins for MDF has been of particular note. In the 2000 - 2015 period, almost 3.8 million metric tons of methanol demand for MDF production was added across China, with the country now well exceeding all other regions in the world in terms of this use for methanol. Growth has slowed (including reduced export demand) but remains positive.

To meet demand for methanol, China relies on a mixture of domestic production and imports. Domestically, there are more than 180 manufacturers, with a significant
number of these generating as little as 1,500 metric tons per month of material from coal, feeding small adjacent derivative production facilities (note that the largest methanol facilities planned today can produce over 5,000 metric tons in one day). These small Chinese facilities are relatively inefficient, and some are expected to be permanently rationalized in the future, especially under environmental and energy efficiency pressure from the government as more efficient facilities come online. It is anticipated that eventually, this capacity, which represents about 2.4 million annual metric tons of production, will be rationalized. On the other hand, some of these high cost facilities are able to provide the “swing” supply for China. The cost of manufacturing methanol in China has large ramifications for the global industry, particularly since enormous global capacity additions are expected. Another way to look at this is that prices will not drop below the economics of making methanol in China until global supply catches up (i.e. “floor price”). Pricing of methanol is discussed in a separate section, but it is worth mentioning here as it is highly tied into the collective behavior of Chinese methanol producers.

Previously, a combination of high methanol producer profits, seemingly endless demand growth and investment in methanol derivatives, a “windfall” for coal miners due to the near doubling of coal prices, along with the promise of potential fuels markets, produced an intoxicating alcohol-based elixir for new methanol investment. However, as methanol prices slumped in the past two years, the willingness to invest in methanol in this country had rather ebbed. Most of the capacity addition in this country is integrated with olefin production, leaving limited methanol production addition in this country, forcing the coastal endusers,
especially the new MTO, to rely heavily on imports. In fact, given the anticipated need for MTO production, the amount of new methanol imports in China will accelerate in the forecast years.

The map on the previous page shows the distribution of these projects. The development of new methanol capacity in China is further analyzed in the chart below. These capacities represent existing plants as well as those projects which have been approved and have announced the beginning of construction. The dark blue line represents total capacity. The red line is total demand (includes imports). The other colored lines represent capacities segmented into single-site scale. The chart raises a number of questions, and also provides some insight into future competitiveness of China production. Demand for methanol in China will require that relatively small, high cost methanol provide the marginal source of supply versus the option of imports, reinforcing the view that imports will continue to be favored in the country. At times, when decent production of methanol in other parts of the world make smaller coal based manufacturers feel squeezed at the margin of supply, they must slow or stop operations. Eventually, most of the smaller facilities and natural gas based methanol operations will be shut in, or unable to access feedstock. Accordingly, higher production of methanol in the coal based provinces is noted.

Worth mentioning here that in the forecast, most new capacity is attributable to production in integrated MTO projects. Product from these plants will be used captively (ie. for polyolefins and other olefin derivative production) and does not bear much effect on the merchant methanol market, with minor exceptions. Nine integrated MTO projects have been envisaged to start by the end of forecast years,
whereas the six non-integrated MTO projects will not add to methanol capacity. The summary list of new MTO facilities is available from MMSA.

The topic of coal as a feedstock is addressed in greater detail in Chapter VI: “Methanol Supply – Feedstock Dynamics”. For China, while continued investment in large scale coal to methanol production processes can be expected, there are several factors assumed in this study which impact the expansion of coal to methanol projects in the longer term:

1. High capital costs associated with a more complex coal to methanol process relative to natural gas based options.
2. Varying and more labor intensive operation of coal to methanol facilities (especially with respect to by-product ash and sulphur handling).
3. Logistics – most China coal to methanol projects would either be near coal mines, requiring shipment of methanol to market via rail, or near consumption centers, requiring shipment of coal to coastal regions. In both cases, significant costs and limited options are apparent.
4. Availability of water on-site, a crucial element in this process but remains scarce in various areas within China.

The chart below quantifies the total China supply and demand over the study period, constructed from the data provided in the supply and demand balances in the Appendix. The rise in capacity is slowing, and production rates will need to be improved, opening a door for low cost global projects to import methanol to China.

![Methanol Supply and Demand - China](chart_image)

By the end of the forecast, both rationalization of smaller scale methanol production in China, along with an increase in methanol imports to China are anticipated.
The makeup of methanol demand by derivative for China now, and at the end of the forecast, is shown in the chart below. In addition to the rapid rise in the use of methanol in MTO and gasoline and direct combustion, the need for conventional methanol derivatives will increase thanks to textile, construction, and automotive industry growth. While the rate of growth of methanol demand in China is expected to slow in the study period, the absolute quantity of methanol demand growth will drive the world need for methanol.

-as shown in the chart on the next page, formaldehyde resins, polyoxymethylene (POM), MDI, and 1,4 butanediol are the specific beneficiaries of the multi-sector boom in China. Paraformaldehyde production is also increasingly popular.
New, world scale carbonylation facilities in China are driving the growth of methanol supply into acetic acid, with the acid itself used increasingly to make terephthalic acid, as shown in the chart below.

The “derivatives of derivatives” are still being imported into China. The chart on the next page shows the calculated amount of methanol imported annually via derivatives, called “methanol equivalent imports.” In 2015, slightly just over 200,000 metric tons of methanol entered China in the form of acetic acid, MTBE, MMA, paraformaldehyde, and terephthalic acid. The number sunk versus the year prior
(with a gain in MTBE imports particularly notable) and does not include further downstream methanol in the form of silicone, wood products and other commodity materials. The drop in “latent” need for methanol in China suggests that the country has become more adequately supplied through the methanol chain. Equivalent imports into China waned by MTBE import decreases, due to the oversupply in China domestic market. In the future, “equivalent imports” should moderate given strong growth in new methanol downstream investments in China.

Methanol Demand for DME Production in China

Methanol Equivalent Imports into China
Finally, alternative fuel and emerging uses for methanol have taken different strides in establishing roles as significant forms of methanol demand. DME appears to have matured. It is estimated that methanol demand into DME will be just around 3.7 million metric tons in 2015 and will reach 4.2 million tons by 2021. These figures are captured in the chart on the previous page, which tracks methanol demand for DME production in China during the study period.

In addition, DME demand has taken most of the “easy” markets for products and will face more resistance moving into fuels and large scale heating uses. [For those interested in further analysis of China and global DME markets, MMSA maintains separate balances which are beyond the scope of this study; please contact MMSA for more information.]

Biodiesel interest in China continues, but ambitions have been tempered by the reality of high cost production. Jatropha and waste oil feedstocks appear to be the most logical choices for Chinese production so as not to encroach on the demand for vegetable oils from traditional sources (corn, soy, etc.) that are used for food. China biodiesel production is estimated to remain relatively constant at in the forecast. Methanol demand for biodiesel use in 2015 was 80,000 metric tons and will reach 151,000 tons by the end of the forecast. Generally, until China develops large and productive vegoil yields, biodiesel will remain a contained form of demand as waste oil feed requires extensive logistic costs and imported vegetable oils remain costly.

The government of China rolled out specifications for methanol fuel (M100) and higher alcohol-gasoline blends (M85 – containing 85 percent of methanol) in late
2009. Pilot testing of methanol powered cars in Shaanxi province, Shanxi province and Shanghai municipality were announced in early 2011, and assessments of feasibility, reliability, economic efficiency, safety and environment friendliness of the high-methanol automobile are expected in the next few years. Although this announcement represented a rare national level effort regarding methanol-gasoline blending, the scope remains limited and involves those areas that have been promoting this type fuel for quite some time. As such, no “step jump” in demand can be expected as a result of this latest initiative. There has been no immediate mention of the specific timetable as well as publication for the low level methanol-gasoline blended standard.

Methanol-gasoline blending specifications are modeled after those developed in the United States. Currently, there is a significant amount of sanctioned and non-sanctioned activity (mostly M15). Several provinces have regulated blending standards in place, but this application is still seen as a temporary solution for oil refiners and gasoline blenders (especially the independent entities) until national specifications issue (please refer to the table below for details).

<table>
<thead>
<tr>
<th>Province</th>
<th>Provincial Standard for Methanol-Gasoline Blending</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fujian</td>
<td>M15*</td>
</tr>
<tr>
<td>Gansu</td>
<td>M15, M30</td>
</tr>
<tr>
<td>Guizhou</td>
<td>M15*, M85</td>
</tr>
<tr>
<td>Hebei</td>
<td>M15</td>
</tr>
<tr>
<td>Heilongjiang</td>
<td>M15*</td>
</tr>
<tr>
<td>Jiangsu</td>
<td>M45*</td>
</tr>
<tr>
<td>Liaoning</td>
<td>M15</td>
</tr>
<tr>
<td>Shaanxi</td>
<td>M15, M25</td>
</tr>
<tr>
<td>Shandong</td>
<td>M30</td>
</tr>
<tr>
<td>Shanghai</td>
<td>M100</td>
</tr>
<tr>
<td>Shanxi</td>
<td>M5, M15, M85, M100</td>
</tr>
<tr>
<td>Sichuan</td>
<td>M100</td>
</tr>
<tr>
<td>Xinjiang</td>
<td>M5, M15, M85, M100</td>
</tr>
<tr>
<td>Zhejiang</td>
<td>M15, M30, M60</td>
</tr>
</tbody>
</table>

*- Some specific details exist

In early 2012, Shaanxi Yanchang Zhongli New Energy opened its first MeOH gasoline station in Xi’an. Parent Shaanxi Yanchang Petroleum Group is directly attached to Shaanxi’s Provincial Government. One estimate pointed out that there are at least 30 methanol-gasoline stations in Shaanxi, with another 30 stations to be built this year. Shaanxi Province plans to build 260 methanol gasoline stations in the Twelfth Five Year Plan period.

Despite progress on M85, and although engine modification can performed cost effectively, various stakeholders are waiting for the government to pass national
standards and/or mandate low-level gasoline blending (M15), as this requirement will require very minimal adaptation to existing cars. In turn, methanol demand will benefit, although the immediate effects will be to allow those who currently use methanol “unofficially” to take more bold steps. For other stakeholders, a national specification will set useful guidelines for automobile engine manufacturers, as well as refiners to develop products around. In addition, methanol usage for direct combustion, especially for cooking fuel within commercial eating establishments (hotels, restaurants, etc), will also contribute significantly for future demand growth of methanol. Overall, the adaption of any M15 specification will help, but not drive, China’s use for methanol blends in gasoline.

To underscore the economic value driving increased consumption of methanol, consider the current economics of gasoline in China. The chart below shows Chinese wholesale (ex-tank) gasoline pricing since 2008 (green line), along with the “energy equivalent” prices (value adjusted for lower calorific value of methanol) as well as domestic China methanol market prices. Recall that the upper limit of gasoline price in China is set by the government at the retail level, with guidelines for ex-refinery and wholesale prices (to ensure some margin for the distributor). The graph shows the wholesale price for private companies in China. Since late 2008, methanol prices have been below their energy based value in China, and have thus fostered a large and growing use for methanol as a combustible product (not only in gasoline, but as a fuel in direct combustion). The advantageous economics for blending methanol into gasoline thus became slightly more so in terms of both energy and volume equivalence.
As it stands, MMSA’s estimate of methanol demand for gasoline blending and direct combustion in China will increase to almost 15.7 million metric tons by 2021. Caution is noted, as government action does carry risk. The chart on the next page tracks methanol demand through the study period for this category, highlighting the forecast of steady and large, but decelerating growth of this sector.

MTO development looks to continue its acceleration in the forecast. The construction of sixteen commercial scale MTO plants in China has been completed. As of early 2016, the performance of these facilities has been generally positive. A quick review:

- Shenhua Baotou’s MTO plant has been operating well since startup.
- Shenhua Ningxia’s MTP complex has been running at maximum rates. It is understood that the plant has been buying small amounts of merchant methanol on occasion. The same company has other 2 coal based MeOH plants at the same site (total about 850 ktpa), which appeared to be running well at this time.
- Shenhua Ningmei MTP (600 ktpa) Phase II has been running well, despite previous occasional outages.
- Datang Duolon’s MTP complex has also been running, but at 50 percent rates for most of the time due to a technical issue in its coal gasification facility, with the MeOH plant running at less than nameplate capacity.
- Shaanxi Yanchang Zhongmei (600 ktpa) started up in July 2014, and has been running well, despite some intermittent technical problems.
- Zhongmei Shaanxi (600 ktpa, E P) started up July 2014, and is running consistently.
- Ningxia Baofeng (600 ktpa) started up November 2014, and now runs well;
- Pucheng Clean Energy (600 ktpa) started December 2014, and then experienced unstable production for various reasons. It has also been shut by
injunction of the local environment protection bureau citing waste water and air emission violations, running at roughly 60 percent rates.

- A non-integrated MTO operation of Sinopec Zhongyuan Petrochemical has been running well, at full capacity.
- A non-integrated MTO facility of Ningbo Skyford is now in operation, consuming up to 5,000 metric tons of methanol daily at nameplate rates from a combination of domestic and international supply.
- A predominantly non-integrated MTO facility at Wison is also operational.
- A non-integrated facility of Shandong Shenda (Legend Holdings) started up early in 2015 and had improved to 90 percent rates from earlier 50 – 60 percent rates, after its integrated EVA capacity comes online.
- Zhejiang Xingxing (600 ktpa) started up in April 2015 in Zhejiang province, and continues to run at around 90 percent rates as of writing. It totally relies on merchant methanol.
- Shandong Yangmei Hengtong (900 ktpa) started up July 2015 and has been running at 70 percent rates.
- Shenhua Yulin (1800 ktpa) started up December 2015 and is now running at 90 percent rates.

Of more interest to the methanol community, the non-integrated MTO plants will need to purchase methanol from the open market. Most of these use a combination of domestically produced material (at a higher proportion, at least in the early period after start-up) as well as deep-sea imported materials. The economics of MTO has become negative in the past year as crude and naphtha slumped, but recovered by early 2016 as crude and olefin rebounded. The economics of MTO process also benefit from its integrated derivatives production including polyolefins and MEG. The recent increase in naphtha prices (accompanied by relatively moderate increase in the values of co products) has made the spreads across coal and gas to olefins more favorable. Another interest in MTO technology lies on its ability to tailor the propylene yield, especially as propylene prices fluctuate. Of course the choice of whether to produce ethylene and/or propylene will also depend on the downstream integration desired. For example, project sponsors wanting to produce MEG on site will have higher propensity to produce ethylene instead of propylene.

Please contact MMSA for further details on MTO.

Alternative fuels uses for methanol have started a prodigious increase in methanol demand in China, a trend expected to continue in the forecast period. Other established uses of methanol, particularly methylamines, methyl chloride, and methanethiol, are expected to grow in line with economic growth in the forecast. The annual progression of each end use is shown in the chart on the next page.
Methanol Derivatives

**Formaldehyde**

Before MTO, gasoline blending and DME uses were established in China, formaldehyde demand had been the single biggest driver of Chinese methanol demand growth. In the forecast, formaldehyde will continue growth and retain a significant consumer of methanol. Two reasons will underpin this growth.

The first is continued growth in basic construction material needs. As the China economy enables construction of new office buildings and homes, growth will be required in formaldehyde-resin containing plywood, MDF, and particleboard, most of which will be made, and increasingly consumed, in China. Secondly, as the economy continues its transformation towards more sophisticated products like automobiles and electronic goods, and begins to make these durable goods in China, more and more of the raw materials supplied to the OEMs will be made domestically. This will drive not only “non-wood” uses of formaldehyde resins, but will ramp up formaldehyde consumed into POM, 1,4 butanediol, and MDI.

In China, although several world-scale plants from internationally well known technology providers have been noted, the scale of a great number of formaldehyde producers is minute relative to world scale, with a number of producers (who are not listed in the capacity tables) producing between a mere 1,000 and 2,000 metric tons per year or so. Of course, this trend has slowly changed with fierce competition requiring more operations with sufficient economic of scale. These mainly produce
UF and PF resin and associated adhesives, purchasing small quantities of methanol. Trends in the adhesive sector are toward larger scale, lower cost, improved product quality and performance. These producers of formaldehyde-based timber-processing adhesives have mostly sold products directly to the wood panel makers, although by necessity, these producers are either pooling production into regional markets, or the timber producers are backward integrating to resin production using larger scale formaldehyde production. One example of the market approach is in Fujian province, where forest resources are abundant and the timber-processing sector has developed well, an adhesive supply market centered in Sanming, Nanping and Zhangzhou has been formed and the annual output is around 100,000 metric tons (liquid adhesive).

However, backward integration holds more economic promise, and is assisting the cause of formaldehyde capacity increase in China. As the wood-based panels and adhesive market grows in size and sophistication, it is expected that these small methanol buying, resin making operations will give way to large-scale, more technically advanced processes. Key market data for formaldehyde is depicted in the chart below:

By the end of 2021, the five-year growth rate of formaldehyde consumption, on a compounded five-year basis, is estimated at 5.3 percent. This remarkable growth in demand was helped by UF and PF resins. Notably 1,4 butanediol, POM, MDI, and paraformaldehyde grew at even faster rates, albeit from a smaller base of demand. In the forecast period, strong growth from these same segments is anticipated, although at slower rates, in both percentage and absolute terms.
The largest absolute growth (i.e. physical tonnage) will continue to come from UF and PF resins, with significant investments in larger scale capacity anticipated, particularly in South and East China. After a slowing housing sector and global economic slowdown – affecting almost all regions in the world – stunted growth of some formaldehyde derivatives, growth resumed through 2015, and a positive trend is expected in the forecast.

The expected growth in formaldehyde consumption by derivative is shown in the following chart, demonstrating the importance of the various segments to China formaldehyde demand growth:

**Polyoxymethylene – POM (polyacetal)**

The demand for this engineering thermoplastic in China has risen dramatically since its introduction just two decades ago, in conjunction with fabrication operations for durable goods such as automotive, business machines, electronic goods, and household appliances. Current supply for China is overwhelmingly from imports, although a number of new producers have or will soon start new operations.

Current POM manufacturers are DuPont in Shenzhen (20,000 metric tons per year), Shijinggou United Chemical in Jilin (Jilin Chemical Company sub, 10,000 metric tons per year), and Shanghai Solvent (5,000 metric tons per year). DuPont and Asahi have a 50:50 joint venture (Asahi-DuPont POM (Zhangjiagang) Co. Ltd.) in Zhejiang province, a 60,000 metric ton per year facility. Not wanting to be left behind, Polylimetics Co. Ltd., MGC, Korea Engineering Plastics Co. Ltd. (KEP) and Ticona (a
business of Celanese), built a world-scale 60,000 metric ton polyacetal (POM) facility in Nantong, Jiangsu province. The JV company is called PTM Engineering Plastics (Nantong) Co., Ltd., with Polyplastics (itself a joint venture of Japan's Daicel Chemical Industries, Ltd. and Ticona) a 70.1 percent equity owner, and MGC holding the majority of the balance along with Ticona and KEP. The PTM facility commenced operations in early 2005. Shanghai Bluestar (a ChemChina subsidiary controlled by China National Bluestar (Group) Corporation), has started its 40,000 metric ton POM plant in Pudong, Shanghai. The largest POM facility operating in China belongs to Yuntianhua in Chongqing at 90,000 metric tons per year. Tianjin Soda has a facility of 40,000 metric tons per year, Kaifeng Lonygyu Chemical in Henan a 40,000 mtpa facility, Xinjiang Korla Pear with 40,000 mtpa, Shanxi Jincheng Lanhua has a 30,000 mtpa facility, and Daqing Oilfield at 20,000 mtpa. CNOOC Tianye commissioned its 60,000 mtpa facility in late 2010.

In addition, new facilities have come on stream, or will be doing so in the near future. Shenhua Group has a 60,000 metric ton per year POM project in the Ningxia region (Shenhua Ningmei). Shanhai Bluestar has a secondary phase of construction in the form of a 60,000 mtpa facility on the existing site, as well as Kaifeng Longyu, who have a similar sized facility on their current location under construction as well. As these projects issue, not only will the need for POM imports significantly be reduced, demand growth will have to keep on a very steep pace in order to accommodate China POM production.

Most POM imports are supplied by overseas manufacturers, such as DuPont, Ticona, Asahi, and Mitsubishi Gas Chemical (MGC), to local fully owned or fully qualified compounders for further conversion. Compounding of POM resins takes place primarily in the East China provinces of Shanghai, Jiangsu, and Zhejiang.

**Acetic Acid**

Yet another product growing in production, in support of the rapid increase of the Chinese economy, is acetic acid. In the past five years, production has increased at an annual rate averaging 3.3 percent mostly supported by an increase in demand for terephthalic acid, VAM, and acetic anhydride, reflecting a developing polyester segment, along with the surge in other parts of the economy.

There is a continued need for more terephthalic acid to support a rapidly expanding polyester production industry across China. This segment of acetic acid demand will produce by far the largest amount of physical demand growth for acetic acid in China.

Unfortunately, local additions to acetic acid capacity have overwhelmed the need from derivatives. Given the new acetic acid facilities planned, trade patterns for acetic acid in China have been and will continue to adjust accordingly. Chinese trade of acetic acid has switched to net exports, and China exported a record high amount of acetic acid in 2015. A significant quantity of non-methanol consuming (high cost)
production of acetic acid in China is expected to either run at low rates or shut in as the competition becoming very fierce. As a final point, Celanese continues to develop a process which would convert a portion of the capacity to utilize syngas normally used in acetic acid production in the production of ethanol. This has the net impact of lowering capacity for acetic acid production, and is envisioned to provide an option (i.e. ethanol versus acetic acid) for Celanese production facilities during the oversupply. This use is not expected to grow significantly in the forecast.

The following chart represents these views graphically:

As the next chart demonstrates, growth in demand for acetic acid has been strong across the board in China, with demand into VAM and acetic anhydride uses leading the way. Notably, in 2015, acetic acid demand slowed a bit, mostly due to demand reduction from “other” markets, which included ethanol and other price sensitive application. Nevertheless, the situation is expected to reverse in the forecast, with growth is seen for virtually all AA derivatives.

Terephthalic acid demand has been growing rapidly, but is slowing as the polyester industry in China slow investments in terephthalic acid production through the balance of the study period, with acetic acid demand correspondingly impacted.

Most terephthalic acid production (current and planned) in China is located in the coastal provinces where textile manufacture is the largest: Jiangsu, Fujian, Shanghai, and Zhejiang hold the larger facilities (capacities are listed in Appendix A). By the end of the forecast, there is an overwhelming number of projects which, if fully
executed, will likely cause dislocation in other world markets. With trade restrictions on textiles from China almost all gone, it is reasonable still to expect significant shifts in global demand for acetic acid for the production of terephthalic acid.

VAM demand growth is anticipated to be notable in the forecast. Although the rate
of demand growth was hampered in 2009 due to adjustments in VAM applications in various finished goods (including in automotive industries), the growth has returned through 2015. Growth is forecast to continue in the study period. Other acetic acid derivatives are anticipated to grow in line with general economic growth.

The chart on the previous page shows how acetic acid and derivatives net trade volumes have shifted to net exports in the past four years. Again in 2015, net equivalent acid trade direction regained its momentum, on exports of acetic acid and VAM, and lowered PTA imports. In general, the phenomenon depicted in the chart has been caused by a combination of major new acetic acid and derivative capacity build up, and increasing export for some materials (including ethyl acetate, as depicted above). The trend back to a more neutral trade position expected in the forecast. As a result investment in new acetic acid capacity should continue to slow.

*Methyl tert-butyl ether - MTBE*

MTBE has become an essential tool for Chinese refiners. China’s refining capacity has ramped up dramatically over the last few years, and most complexes are now equipped with MTBE facilities. As a result, significant growth in use of this ether continues in China, driving increased imports and investment in new capacity. Additionally, by utilizing spare C4 streams to increase octane in gasoline, refiners can free up aromatic molecules which can be converted to polyester feedstocks, sorely needed as China develops its textile industry. The capacity profile of MTBE in China is captured in the chart below:

![Methyl Tertiary Butyl Ether Capacity for China](chart.png)

China has shown a large capability to import MTBE as well. China can be expected to remain importing, especially due to fast growth in energy related demand in
China. However, this will be supplanted by growing MTBE operations in this country, especially as the countries’ refinery infrastructure grows in sophistication. The chart also shows the known additions to MTBE production capacity in China. The stop after 2016 does not necessarily mean that no new capacity will issue; in fact given the continued expansion of refineries in China, the actual capacities should increase. Unfortunately the refiners typically omit mention of MTBE, perhaps as a result of the relatively small part it plays in the capital cost of the refinery.

In the past, with wide variance in properties and composition depending upon refinery, Chinese gasoline had been typically high in vapor pressure, olefins and sulphur content, and inconsistent in octane rating. Recent regulatory efforts have focused on addressing these deficiencies, and a specification covering all of these elements for three levels of octane was implemented country wide beginning in 2005. These specifications have been in place in major cities of China (including Beijing, Shanghai, and Guangzhou) even longer – generally modeled after the Euro II, IV and V standards. These specifications have had their impact on gasoline regulations, supporting the rise of methanol demand for MTBE production in China forecast.

*Methyl Methacrylate - MMA*

Until recently, China had an aged and disadvantaged collection of MMA production capability, and relied on imports of MMA to fuel a rapidly growing appetite for polymethyl methacrylate (PMMA) and methacrylate-butadiene-styrene (MBS). Most applications for MMA are the traditional ones, but as the production revolution in China continues, more sophisticated, higher value added MMA/PMMA and derivative facilities, such as higher optics-grade organic glass, radiation shielding organic glass and optics fiber production facilities are being planned.

In 2015, total production capacity of MMA in this country was approximately 726,000 metric tons per year. Imports of MMA in 2015 remain around 211,000 metric tons as regional producers compete to place the product into this country. Currently, imports of MMA to China are widely available from a number of global sources. Large, new plants in China will increase the self sufficiency of MMA in this country, and can potentially displace imports from nearby Asian neighbors. However, China is still expected to play the role as an import destination for plants in SEA and Middle East in the forecast, and existing operations are expected to run at high rates to support growth.

Organic glass (PMMA), cast sheet, PVC and plastics processing additives (e.g. for MBS), and surface coatings dominate consumption of MMA. PVC production is anticipated to grow at double digit rates in China, taking MMA consumption into MBS with it, offering a large vehicle for growth. Surface coatings include solvent-based coatings, water- based coatings and latex paint, which are used extensively in sectors such as automobile, furniture, building, etc. With the establishment of sole-funded or joint ventures such multinationals as Nippon Paints and ICI, high-grade
and new type coatings have been introduced into China, boosting demand for MMA. Other sectors of MMA in China are acrylic fiber, textile sizing material, acrylic acid based adhesives, cross-linking agents for unsaturated polyester resin, lubricant agents, artificial marble mesa, and consumption is small and growing relatively slowly.

The MMA market in China is summarized in the following supply and demand chart. Despite a rapid increase in new production capacity in China, demand will keep pace longer term, and after a few years of ample availability, by the end of the forecast period, operating rates will recover to high levels on the heels of continued domestic demand growth, likely requiring more investment in MMA production facilities. Please refer to the supply and demand and capacity tables in the study appendices for exact details.

**Alternative Fuels (non-MTO)**

As mentioned in the “Market Outlook” portion of this section, alternative fuels uses have become the largest sector of methanol demand in China. Through 2015, a favorable spread between methanol and energy (including gasoline and LPG) prices continued to boost methanol demand from this sector. Due to the correction of crude oil and energy in the past year, the demand for energy uses of methanol continues but demand growth decelerated. These growth conditions are envisioned to prevail in the forecast years, demand for energy uses of methanol will continue to grow. The three largest forms of demand in this category are DME, biodiesel, and gasoline blending and combustion. Growth in gasoline blending and combustion will likely
continue to occur, even “illegally”, as refiners and wholesalers use increasing concentrations of methanol to save on costs. The chart on the next page segments out the contribution of DME, biodiesel, and gasoline blending to the total methanol demand for alternative fuels uses in China currently, and at the end of the forecast. The usage of DME, in particular, will slow considerably as the “easy demand” for LPG blending application has fast becoming saturated while the other developing usage (ie. diesel replacement and power generation) is still in the early developmental stage. As such, the percentage of DME usage in the entire alternative energy application can be expected to moderate in the forecast years.

**Methanol Demand for Alternative Fuels in China**

<table>
<thead>
<tr>
<th></th>
<th>2015</th>
<th>2021E</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gasoline Blending &amp; Combustion</td>
<td>14.76 million metric tons</td>
<td>20.00 million metric tons</td>
</tr>
<tr>
<td>Biodiesel</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DME</td>
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</tbody>
</table>

**Methanol Trade**

Methanol imports in China grew again in 2015. As usual, the bulk of the trade came from the Middle Eastern region, particularly Iran, Oman, and Saudi Arabia, as depicted in the chart on the next page.

High levels of imports of methanol were registered through 2011, reflecting an enormous thirst for methanol despite a notable increase in local production. Since 2010, Iran has taken the title of largest trader away from Saudi Arabia. Oman has since exceeded Saudi Arabia in trade to China. The forecast calls for the continuation of large scale imports of methanol in China, which will predominantly be from the slew of new projects slated for the Middle East, along with improved supply from Southeast Asia.

Lastly, an enormous storage capacity in this country has been available to support imports. Some facilities have flexibility to convert their storage tanks into methanol storage when needed. Major traders and importers in this country have invested in their own storage capability, further boosting the capacity. In any case, with monthly
methanol consumption (total production plus imports) over 3 million metric tons per month (and growing) it is clear that China is not yet ready to rely fully on imported methanol.

This certainly has implication on the role of coal-based methanol producers in this country as marginal cost producers – determining the price “floor” of methanol in this country and globally. Further discussion has been included in Chapter IX – “Price Forecasts”.

![China Methanol Imports](chart)

- **Saudi Arabia**
- **Iran**
- **Qatar**
- **Oman**
- **New Zealand**
- **South America**
- **Malaysia**
- **United States**
- **Indonesia**
- **Japan**
- **Other SEA**
- **Other ME**
- **India**
- **Others**
JAPAN

Overview

Japan has one of the largest and most extensively developed economies in Asia. Yet for almost two decades, Japan has experienced slow economic growth, despite having taken large steps towards economic deregulation and restructuring, particularly in the banking sector. Nevertheless, Japan has survived in this period and remains the region’s third largest methanol consumer and importer. In the forecast years, the current government is pursuing a fiscal and monetary policy which supports large government projects, which should help recovery efforts despite a somewhat controversial approach. While a modest and slowly increasing consumer of methanol, Japan plays an important role in methanol fortunes – both on the supply side as investor, offtaker, and trader at some of the methanol plants around the world as well as the on the demand and technology sides.

A location map of major methanol consuming producers (including secondary derivatives of methanol) has been included below. It is clear that most methanol consumers are spread around the country, located in its southern or western parts.
Market Outlook

Methanol

Due to the lack of competitively priced feedstock, there are no domestic methanol producers in Japan. In order to source methanol at reasonable cost and sustain derivative operations, Japanese chemical players and trading houses (Mitsubishi Gas Chemical, Mitsui, Sumitomo, Kuraray, and others) have joined to form the Japan Saudi Arabia Methanol Company (JSMC). JSMC has in turn formed a 50:50 joint venture with SABIC called the Saudi Methanol Company (Ar-Razi – see Middle East section). Ar-Razi now has one of the world’s largest methanol production complex in Al-Jubail, Saudi Arabia at over 5.1 million tons per year of nameplate capacity. Typically, around 50 percent of Japanese demand for methanol is supplied via JSMC. JSMC and other Japanese traders have a network of coastal tanks aligned with major derivative production centers around the country. The balance of supply is “open market,” but is also generally from deep sea destinations.

Mitsubishi Gas Chemical Co. (MGC), in conjunction with Mitsubishi Heavy Industries, has its own, highly efficient process technology for manufacturing methanol, and licenses it globally, typically in return for guaranteed quantities of material for offtake, which MGC supplies to its global derivative facilities. In addition to the Ar-Razi offtake, MGC has primary access to production from Metor in Jose, Venezuela and Brunei. MGC also has small dimethyl ether (DME) facility using its own process technology, which requires methanol. MGC technology has been used in the 1.7 million metric ton per year expansion of Ar-Razi’s production complex in Al-Jubail, as well as the 850 thousand metric ton per year facilities of the Brunei Methanol Company and Metor II (Venezuela).

The International Methanol Co. (IMC) produces methanol from its 1 million ton per year facility in Al-Jubail, Saudi Arabia. IMC is a joint venture between Saudi International Petrochemical Company (Sipchem – 65 percent ownership) and Japan-Arabia Methanol Company Ltd. (JAMC – 35 percent ownership. JAMC Ltd., like JSMC, is owned by a consortium of major Japanese companies led by the traders Mitsui & Co., Ltd. (55%), Mitsubishi Corporation, Daicel Chemical Industries, Ltd. and Iino Kaiun Kaisha Ltd. (with the latter three entities taking a stake of 15% each).

As shown in the next chart, methanol is used in traditional applications in Japan, although a large percentage of “other” uses exist. Formaldehyde and acetic acid uses are covered in subsequent text. Notably, there is no longer MTBE manufacturing for gasoline blending in Japan. MTBE production was stopped in 2001, soon after the state of California set a timeline for the ban of MTBE. Many of the “other” uses of methanol in Japan are small volume, high value applications, such as direct POM manufacture, modified polyphenylene ether, polycarbonate, choline chloride, methacrylic acid, and dimethyl formamide production.
From 2011, methanol use in Japan has declined, as high cost derivative consuming locations were shut down (particularly for commodity formaldehyde resin manufacture).
Until recently, Japanese demand for methanol has fared even worse than the domestic economy, where construction and exports of finished goods within Asia (esp. China) set the pace for consumption. The economic rebound in 2010 had a positive effect on methanol demand, although since then a slight dip has ensued, first due to the earthquake in 2011, followed by a strengthening yen and the aforementioned rationalization of uncompetitive derivative production.

In the forecast period, the rate of new methanol derivative capacity addition will be limited to non-existent, as growth in most methanol derivative capacity is expected outside of the Japanese region. In addition, the devastating impact of the recent earthquake has not been fully overcome.

It is worth mentioning that Japan is one of the most active countries in developing technology using methanol for fuel applications. One example is fuel cell research and development, which has found its first commercial application in “microcell” battery applications, essentially replacing heavy batteries for laptop computers, or in special military applications. This application is not expected to significantly impact methanol demand in the study period.

Another fuel application for methanol, which currently consumes about 50,000 metric tons of methanol annually, is in the manufacture of dimethyl ether (DME) from methanol. The 80,000 ton per year DME facility in Niigata started up in 2008. However, further progress on DME space in this country seems limited due to lack of support from the governmental departments as well as from the industry players.

**Methanol Derivatives**

Japanese methanol demand, heavily reliant on formaldehyde use, rebounded in 2011, only to settle back the next four years. In the forecast period, there will be only minor changes to the distribution of methanol derivatives in Japan.

Formaldehyde demand is expected to increase slowly, due to an improved domestic economy, along with development of smaller volume, higher value markets and possible expansion of facilities. Growth in MMA and acetic acid within Japan is expected to be limited to the ability of existing assets to expand rather than the buildup of new capacity. A similar situation applies with acetic acid.
Formaldehyde

After a period of rationalization which pared over 325,000 metric tons per year of idled formaldehyde production across Japan, formaldehyde operations have recovered to above-average operating rates. Sumitomo, Mitsui Chemical, and MGC are the largest producers of formaldehyde in Japan. Mitsui Chemical and MGC each mothballed sizeable operations in Chiba and Tokyo, respectively. Towards the end of the study period, as operating rates increase, it is possible that some portion of these operations will come back on line. Key market data for formaldehyde is depicted in the chart next page.

Japan has diversified away from commodity, highly competitive resin uses for formaldehyde, and investments in these areas – particularly POM, 1,4 butanediol, and MDI, should prop up formaldehyde demand in Japan over the forecast period. Formaldehyde demand should recover to respectable levels, although at a slow pace. The next chart on the subsequent page highlights these observations. Given the need for increased production, it is possible that some minor expansion of existing Japanese formaldehyde facilities could be considered.
Unique to Japan is the preponderance of use of formaldehyde into POM, MDI, and other non-wood related applications, as shown in the chart below. Again this underscores the advanced state of technology used to differentiate Japan.
Polyoxymethylene – POM (polyacetal)

Japan has lead Asian POM manufacturing, sales, and technology development since 1962, when Daicel Chemical Industries, Limited (Daicel) began imports of POM copolymers manufactured by Celanese Corporation of the United States. Shortly thereafter, Daicel and Celanese formed a joint venture called Polyplastics Company, Limited (Polyplastics), which eventually built production capacity in Fuji City, Japan that now totals 100,000 metric tons per year. Du Pont responded by transferring POM production technology to Asahi Kasei Chemicals, who have a 44,000 metric ton facility in Okayama. Finally, MGC have developed their own technology and currently are able to manufacture 20,000 metric tons per year of POM in Yokkaichi.

Future capacity expansions of Japanese companies have been and will continue to be outside of Japan, particularly in China, and involve joint venture operations. Polyplastics, Ticona, and MGC have joined together in a company called PTM Engineering Plastics. PTM has an operation in Nantong (Jiangsu province). Polyplastics also has POM manufacturing operations in Malaysia and Taiwan. MGC has a POM operation in Thailand. Asahi and Du Pont are building a smaller, but scalable, facility in Zhangjiagang (Jiangsu province). Toray is a Japanese company who is more involved in engineering thermoplastic compound operations, is one of the partners in KTP, a Japanese-Korean JV POM production facility (see South Korea section for more details).

The forecast anticipates that POM demand growth in Japan will be limited to debottlenecks and minor expansions from existing facilities, with increasing imports from JV operations in China.

Acetic Acid

As with their formaldehyde counterparts, competitive pressures arising from the Asian Financial Crisis caused Japanese acetic acid producers to rethink their strategies. The Showa Denko plant, for example, has been periodically idled a portion of capacity at its Oita manufacturing location since 2000, due to the relatively high cost of its operation. At roughly the same time, imports of acetic acid from lower cost locations increased. Kyodo Sakusan has the largest and most cost effective acetic acid production facility in Japan, with its 430,000 metric ton per year, methanol carbonylation facility in Himeji.

In 2015, a turnaround at Showa Denko required the import of a significant amount of acetic acid. Currently, acid operating rates are very high, and are expected to remain so for the study forecast. Much of the growth later in the forecast will be met by imports from new capacity in China, unless idled facilities and/or plant debottlenecks are justified.

The supply and demand situation for acetic acid in Japan is summarized in the chart on the next page.
Demand for acetic acid in Japan will continue to be dominated by vinyl acetate monomer production, with terephthalic acid production limited to existing capacity, which is not expected to grow significantly. Production has recovered recently and will remain relatively stable, with demand supplanted by imports.

**Acetic Acid Demand By Derivative - Japan**

- Others
- Acetate Esters
- Acetic Anhydride
- Terephthalic Acid
- Vinyl Acetate Monomer
Japan currently has over 650,000 metric tons of VAM capacity, led by Nippon Synthetic Chemical in Mizushima, Kuraray in Okayama, and Showa Denko in Oita. No major expansions of these facilities have been announced. Terephthalic acid production in Japan is also anticipated to be flat, with more competitive polyester chain economics and integration in China. Mitsui, Toray, Mitsubishi Chemical, and Mizushima Aromatics are the major TPA producers, and Mitsubishi Chemical has idled production lines which could be restarted depending upon market conditions. However, no great expansion of TPA operating conditions in Japan is warranted.

**Methyl Methacrylate - MMA**

MMA production in Japan is led by Mitsubishi Rayon (three trains in Otake), Asahi Chemical (Kawasaki), Sumitomo (Himeji and Niihama), and Kuraray (Nakajo). The expected supply and demand outlook is presented in the chart below. Demand is to pick up modestly in the forecast due to emergence of “electronic powerhouses” in China, Taiwan, and Korea. In overall, local production is expected to slow towards the end of forecast and incremental demand met by imports from lower cost production centers.

Most operations are based on refinery or olefins butylenes streams, although some ACH based processes, particularly one very large train of Mitsubishi Rayon, still operate. Total Japanese MMA production capacity is just over 550,000 metric tons per year, and details are shown in the appendices.
PMMA is the largest use for MMA in Japan, and growth opportunities for domestically produced PMMA will be limited. Automotive and other industries that are using finished products of MMA has been severely hit by global economic crisis, but demand for MMA has rebounded in the historic period, with a modest increase in the forecast period expected.

**Methanol Trade**

As mentioned in the opening text, the development of JSMC has led to a consistently growing amount of imports coming from Saudi Arabia. Similar to the past few years, most imports came from Saudi Arabia and New Zealand in 2015, while imports from Iran have been eliminated, a trend that can be expected to continue until political sanctions and the resulting commercial difficulties in dealing with Iran end.

In the forecast, imports from New Zealand are expected to grow further on the restart of all NZ production capacity. Total imports will be slightly over 1.8 million tons per year by the end of the forecast, with Saudi Arabian dominance of supply into Japan expected to continue. With Iranian imports disappearing, competition between all other exporters has increased.
SOUTH KOREA

Overview

South Korea, with a still-growing and IT centric, export oriented economy, is the fourth largest methanol consuming country in the Asian region, behind China, India, and Japan. Like Japan, South Korea has no domestic methanol production. Methanol is used across all major derivative uses, mostly by the major chaebols (large, multi-industry conglomerates), whose products are consumed locally and via exports. Methanol demand growth in this country remains generally positive, yet future growth will be less spectacular than in previous years. Korean methanol demand was surprisingly strong in a very difficult 2009, underscoring the relative strength of the Korean automotive and electronic industries, which have found their place in the global markets. Methanol demand moderated in 2014, then improved slowly in 2015. Future investment in methanol derivative capacity is expected to stretch this lead, although the pace of growth will be modest.

Market Outlook

Methanol

The South Korean methanol industry is set up to import methanol, with Samsung, LG, and SK Global being the largest importers, but other smaller traders also participating in the market. These organizations import methanol both to support downstream operations, and also trade methanol opportunistically and/or when market conditions within South Korea require. Material is brought into large terminal locations, including Ulsan, Pyongtaek, and Yeosu. Methanex built three storage tanks in Yeosu with a total capacity of 40,000 metric tons in 2000, and expanded these in by 70,000 metric tons in 2005 (Methanex also manages additional leased tank capacity of 24,000 metric tons).

On the demand side of equation, and as shown in the graph on the following page, derivative demand is strong across the spectrum, with formaldehyde, acetic acid, and MTBE consumption taking the majority of methanol demand in South Korea. As the donut chart suggests, no major changes in the distribution of methanol derivative demand are expected other than MMA.

Growth in South Korean methanol demand has been slow and steady over the years, with 2015 still a high mark for demand, driven by continued strong growth in Korean OEM domestic and export demand growth (especially flat panel and automotive growth). The major investment in downstream consumption capacity will be in the methacrylates area, where LG is maximizing production, largely to support their flat panel and other optical businesses. The expansion of Methanex’ storage operations at Yeosu have supported increased imports of methanol, some of which is then sent on to Japan and to China. Additionally, there was some methanol demand for (illegal) blending into gasoline, influenced by the difference in cost
between the two, although crackdowns on its use have occurred and will limit growth of that application. Some technologies utilizing methanol in gasoline were attempting to be approved in the country, but the scale remains generally small.

The chart below provides the forecast of the South Korean methanol market as constructed from the supply and demand data provided in this study’s appendices. As shown, demand growth will continue at a modest pace in the coming years.
Sanctions by the European Union against Iran have become a small issue, with other Middle East supply (mainly Saudi Arabia) taking its place.

**Methanol Derivatives**

As the chart below suggests, distribution of methanol demand across the various methanol derivatives in South Korea is expected to be generally positive across all sectors, with MMA representing a key driver. Investments in methyl methacrylate facilities are providing a boost to Korean methanol demand. MMA will join formaldehyde, MTBE, and acetic acid as the dominant consuming applications of methanol in South Korea in the forecast.

**Formaldehyde**

As the chart on the next page indicates, in 2015, formaldehyde operations in South Korea recovered after it took a pause in 2014 due to competition in the very competitive China export markets for finished formaldehyde goods. Typically, the distribution of formaldehyde demand across the various methanol derivatives is dominated by urea formaldehyde and POM production. This trend will continue in the forecast despite the closure of LG’s POM operations, which will moderate growth from that segment. The addition of 1,4 BDO capacity also adds to formaldehyde needs.
Polyoxymethylene – POM (polyacetal)

POM resin is made by two major companies, the two biggest of which are joint ventures. Korea Engineering Plastics (KEP), co-owned by Celanese Holdings BV (50 percent), Mitsubishi Gas Chemical, and Mitsubishi Corporation, is the largest POM manufacturer; with a 65,000 metric ton per year facility in Ulsan (has been expanded 3 times since it started a 10,000 metric ton per year facility). KTP Industries, Inc. (a 70/30 joint venture between Kolon Industries, Inc. of South Korea and Toray Industries, Inc. of Japan) has the ability to produce 25,000 metric tons annually at their facility in Kim Chong City. LG Chemical had 13,000 metric tons of POM production capacity in Yeosu, but has shut this down in favor of purchasing POM.

South Korean domestic consumption of POM is saturated, and manufacturers rely on exports of engineering thermoplastics to China, where they are converted to gears for electronic and limited automotive applications. While domestic demand growth for POM generally exceeds GDP growth, capacity to produce POM exceeds local needs.

Acetic Acid

Production of acetic acid is led by Samsung, who (further) expanded their Ulsan manufacturing location to 600,000 metric tons in year 2011. Acetic acid production is primarily via the methanol carbonylation route in South Korea. This facility has served both domestic and export markets, although exports of acetic acid continue, competing with production facilities in China and Taiwan. While exports have held
steady, imports have waned. The net impact is that South Korea should remain a slight net exporter of acetic acid over the forecast period. The chart below represents these views graphically:

**Acetic Acid Supply and Demand - South Korea**

As shown in the chart below, acid demand is expected to continue its upward progression through the study period, distributed evenly across derivatives, at a

**Acetic Acid Demand By Derivative - South Korea**
notable pace. Terephthalic acid process consumption is anticipated to remain the biggest contributor to acetic acid demand in South Korea.

*Methyl tert-butyl ether - MTBE*

All of the South Korean MTBE production comes from butylene streams which emanate from either refineries or olefin crackers. The chart below captures the capacity of manufacturers to produce MTBE. SK Corporation (SK) is the largest manufacturer of MTBE in South Korea, with two separate olefin trains in Ulsan providing C4 feedstock. SK has expanded production to incorporate FCC-based butylene streams in their Ulsan refinery. Most of the MTBE from SK operations is blended into gasoline. Yeochon Naphtha Cracking Center (YNCC) also uses raffinate-1 streams off their butadiene separation facility in Yeosu, and sells to domestic blenders and export traders. LG Caltex' MTBE facility in their Yeosu refinery location uses refinery FCC butylene streams with methanol to make MTBE. At this location, MTBE is consumed directly into gasoline and is not often traded.

LG MMA produces MTBE as a feedstock in the production of MMA in Yeosu, with almost all MTBE remaining captive (unless unplanned MMA shutdowns occur) at this facility. The LG and Honam also purchased the facilities of Hyundai in Daesan, which included their MTBE facility, which receives raffinate-1 butlyenes from a butadiene separation unit. This MTBE is consumed by domestic blenders and traders. Finally, S-Oil maintains a smaller MTBE facility which supplies its own gasoline blends.

### 2015 Korea MTBE Capacity

- **GS-Caltex Oil Corporation**: 100 metric tons
- **LG Chemical, Ltd**: 170 metric tons
- **Yeochon NCC**: 170 metric tons
- **LG MMA**: 145 metric tons
- **S-Oil Corporation**: 75 metric tons
- **SK Corporation**: 60 metric tons
- **SK Corporation**: 118 metric tons
South Korea has a gasoline specification which encourages the use of oxygenates, with maximum values for the summer months (related to vapor pressure) and minimum values for winter months. Traditionally, MTBE from South Korea had been exported to the United States West Coast, but now focuses on opportunities in the region, especially China. Over the past few years, domestic demand for MTBE has increased. In fact, South Korea has started imports of MTBE, and is actually balanced with respect to supply, with little spare capacity.

For that reason, consideration of expansion of production has begun at the LG owned operations of Hyundai Petrochemical Co. (HPC) in Daesan, South Korea, in conjunction with a naphtha cracker expansion. However this is not included in the supply and demand balance in this study.

*Methyl Methacrylate - MMA*

LG MMA, with its 176,000 metric ton per year facility, and Honam, with a 50,000 metric ton per year operation, both in Yeosu, are the two “incumbent” South Korean MMA producers. LG MMA is a joint venture which includes LG Chemical, Ltd., Sumitomo Chemical Co., Ltd, and Japan Catalyst Inc.

They use MMA exclusively for PMMA production, as LG MMA owns and operate their own PMMA facility. PMMA is used in the automotive industry, for components of electric and electronic products, and construction materials.
To support strong domestic demand for optical applications, both LG and Honam (via a JV with Mitsubishi Rayon called Daesan MMA) started up new facilities in mid 2009. These will ensure that there is ample room for operating growth in the forecast, but not for long. In fact, an announcement of a 98 thousand metric ton per year facility was made in 2011, with start-up in mid 2013. New MMA capacity in Saudi Arabia that is expected to start towards the end of forecast, and may increase methanol imports into this country (or decrease exports to China). Please refer to the supply and demand table and capacity listings for MMA in the appendices for numerical details behind these charts.

**Methanol Trade**

Korea has a very diverse set of methanol import sources, as shown in the chart below. The 2013 removal of Iran as an import option has therefore had a very minor impact on overall supply of methanol in this country. The chart below provides a representation of the development of trade from various locations to South Korea:

![South Korea Methanol Imports](chart.png)

In the forecast years, mostly due to availability and cost competitiveness, supply from New Zealand (supplied to the terminals in Yeosu) as well as the Middle East (increasingly Oman) and SEA, will continue to predominate South Korean imports. Once again, some players in this country have indicated increasing difficulties in dealing with Iranian cargoes as such the import from Iran has fallen to nil.
Overview

Located across the Taiwan Strait from mainland China (80 miles at the closest point), Taiwan is a leading economic and trading center, with its main port, Kaohsiung, one of the busiest ports in the world. Taiwan lacks sufficient domestic energy sources, and is almost totally dependent on energy imports. That lack of domestic energy translates into high values for natural gas, which also means that methanol is not manufactured in this country. Taiwan's economy is heavily oriented toward the manufacturing of consumer electronics products for export, and this facet will continue to influence methanol use in Taiwan, from the manufacture of printed circuit boards to the use of MMA and POM for the manufacture of computers. As such, it is not surprising that methanol demand in 2009 took a significant dip due to slowdown in downstream areas, and then generally has rebounded through 2015. In addition, trade with mainland China for industrial goods is also on the increase, as Taipei recently has lifted some restrictions on direct trade with and investment in mainland China. It is still reasonable to expect that methanol derivatives businesses are needed to support future growth, and correspondingly, methanol import requirements will rise in the forecast period.

Market Outlook

Methanol

Supply of methanol in Taiwan comes solely from imports, which are, most of the time, coordinated directly by the methanol derivative manufacturer. This approach differs significantly from Japan and South Korea, where third party intermediaries

![Methanol Use - Taiwan By Derivative](image)
typically get involved. The main ports handling methanol are, not surprisingly, Kaohsiung and Mai Liao, with the latter growing in significance with the start up of an acetic acid production facility there in 2005.

As demonstrated in the chart on the previous page, methanol consumption has remained dominated by formaldehyde, acetic acid, and MTBE uses. Successful start ups of derivative facilities, plus a notable increase in trade of finished goods with China and overseas partners have helped get the country back on track in 2010. Methanol demand growth was muted in the year 2011, and then recovered to trend through 2015 along with improved economic performance. In the forecast period, this same distribution is expected, with no known plans to invest in methanol derivative production capacity in this country announced.

Methanol Derivatives

All current derivatives are anticipated to grow at rates slightly below historical rates, as expansion of downstream operations are limited by similar operations in China. The exception on this would be for Acetic Acid, with new facilities of Chang Chun Petrochemical (450,000 metric tons per year in capacity) impacting demand in the last three years.

The chart on the next page offers a representation of the quantities of various methanol consumption sectors in Taiwan.
Formaldehyde

Two major producers of formaldehyde exist in Taiwan, each utilizing the output for a wide spectrum of downstream uses covering many of the numerous formaldehyde derivatives. One of these is Chang Chun, who via a number of subsidiaries, are involved with the manufacture of hexamine, PF, MF, UF, paraformaldehyde, and TMP. In 2002, Chang Chun expanded their formaldehyde operations at Mai Liao. In mid 2005, they started up a 100,000 metric ton per year 1,4 BDO facility in Mai Liao, and then added another 100,000 metric tons per year by early 2006. This production will be sent to China to support PTMEG production there (Lycra/Spandex materials).

Lee Chang Yung Chemical Industry Corporation (LCYCIC) is the other major formaldehyde producer in Taiwan, and they have integrated downstream to pentaerythritol, paraformaldehyde, and UF resin, among others. Additionally, LCYCIC is part owner of the QAFAC methanol production facilities in Qatar, assuring access to methanol for these operations (although the two agreements seemed to be handled separately). LCY has also invested in formaldehyde plants on mainland China. The well integrated and sophisticated operations in the formaldehyde chain keep most assets there running at high rates. Key market data for Taiwanese formaldehyde supply and demand is shown in the following chart:
Demand growth prospects for formaldehyde in Taiwan are solid, given the diversity of demand away from traditional, commodity oriented derivatives. The distribution of demand by derivative is shown in the chart below. Essentially all derivatives are expected to benefit from increased economic interaction with the mainland.
**Polyoxymethylene – POM (polyacetal)**

In the early 1990's, Taiwan Engineering Plastics Co., Ltd. (TEPCO), a joint venture of Chang Chun Group, and a group of Celanese based companies (including Polyplastics), began production at a 20,000 metric ton per year POM production facility. This facility is in Ta Fa (near Kaohsiung), and is believed to have expanded over time. In 2001, the assets of this facility were assigned to Polyplastics Taiwan Co., Ltd., and are now majority owned by Polyplastics. Formosa Plastics Corporation (FPC) also has 25,000 metric tons of POM production capacity, using in-house technology.

Markets for POM in Taiwan appear to be saturated, although demand is still growing. In the forecast, no major new investment in POM capacity in Taiwan is expected, and growth from POM is expected to be limited as a result.

**Acetic Acid**

This derivative continues to hold the key to methanol demand growth in Taiwan. The most recent capacity addition of Chang Chun Petrochemical, who started a methanol carbonylation based AA facility of 450,000 metric tons per year, is the latest investment. BP and Formosa started their 350,000 metric ton per year acetic acid facility in Mai Liao in 2005. China Petrochemical Development Company (CPDC) has a 130,000 metric ton per year methanol carbonylation facility in Kaohsiung. Yet oversupply in the Asian acid sector has hit CPDC, who was forced to idle its facility in 2012, then set up VAM production in Singapore to which acid exports have been targeted. However, the China Petrochemical Company (CPC) plan to build its own 300,000 metric ton per year acetic acid production facility is not expected to materialize by the end of the study period.

Historically, demand for acetic acid in Taiwan has far exceeded local production capacity. The new facility in Mai Liao has changed this situation, but trade of acetic acid in Taiwan remains at net imports due to less than nameplate operations in the country. Domestic production from local facilities has been pressured by the slew of new capacity additions in China, but owing to the start of new production facility in the country, the import amount can be expected to slowly decreasing.

The chart on the next page represents these views graphically, with the impact of exports of acid to Singapore highly notable:
Acetic acid demand in Taiwan is mostly generated by VAM production; Dairen is the island’s main manufacturer, having commenced operations in 1982, and with large facilities in Mai Liao and Kaohsiung. VAM goes into their downstream operations, including PVA and allyl alcohol. Darien is seen as the major consumer of
Formosa/BP production, but may source (or seek to export) acetic acid as market conditions warrant. New, large scale acetic acid domestic derivative projects are not anticipated make an impact commercially in the study forecast, with growth in demand limited to minor expansions and de-bottlenecks in existing producer’s locales. In fact, several petrochemicals and polyester producers have expanded the capacity in China instead.

**Methyl tert-butyl Ether - MTBE**

Taiwan Synthetic Petrochemical Corporation (TSCP), a division of the petrochemical business of Chinese Petroleum Corporation (CPC), a major refiner, were the first MTBE makers here. TSCP use the isobutylene fraction from butadiene raffinate with methanol to produce MTBE in a 250,000 metric ton per year facility outside of Kaohsiung. Most of this material goes into gasoline, with the rest used to make methyl-ethyl ketone (MEK). FPC has a 324,000 metric ton per year facility in Mai Liao. This production is primarily used for gasoline blends.

**Methyl Methacrylate - MMA**

Mitsubishi Rayon (previously Lucite International, which was itself a rebranded version of the DuPont acrylics business, and before that ICI), assumed a share of a joint venture with CPDC in Taiwan, called Kaohsiung Monomer Company (KMC), in 2002. KMC produces MMA in an 110,000 metric ton per year facility using the ACH process. FPC began operations at its 70,000 metric ton per year facility in Mai Liao in 2001. A summary of Taiwan’s MMA supply and demand situation is summarized in the chart below:  

**Methyl Methacrylate Supply and Demand - Taiwan**

![Methyl Methacrylate Supply and Demand Chart](image-url)
Taiwan’s well developed electronic sector continues to increase demand for MMA derivatives into flat-panel screen applications. Accordingly, Formosa has expanded its operations at Mailiao. However, as new MMA capacity is introduced in the rest of the region, Taiwan finds it difficult to exporter. For that reason, although new facilities are being contemplated, growth in methanol demand from MMA in Taiwan will be limited to the ability of existing facilities to either expand or de-bottleneck. Due to the disadvantaged export position of Taiwanese producers and new capacity build up in other parts of Asia as well as Middle East, Taiwan will remain dependent on MMA imports in the forecast, although domestic operations will be strong.

**Methanol Trade**

As the chart below demonstrates, imports of methanol into Taiwan continue to be predominantly from the Middle East, beginning with Saudi Arabia, followed by Oman. In addition, Qatari methanol imports, which began to make an impact in 2000 (a natural result of LCY and CPC’s involvement in the project), have been prominent. In recent years, competitive Malaysian, Indonesian, New Zealand, and Iran imports have made inroads to support demand growth. Imports into Taiwan have risen well from a variety of origins in the past few years to meet demand.

![Taiwan Methanol Imports Chart](chart)

Future demand is expected to be supplied from the same sources, with incremental volumes available from Middle East and SEA, and with materials originated from Iran continue to be pressured in the forecast years due to political factors.
SINGAPORE

Overview

Singapore’s strategic location at the entrance to the Strait of Malacca has helped it become one of the most important shipping and trading centers in Asia. The Port of Singapore, one of the world's busiest in terms of shipping tonnage, is a key component of Singapore’s economic health. Singapore is also a leader in new biotechnologies, petroleum refining, olefins, aromatics, and derivative production, and the manufacturing of computer components, successfully integrating the oil value chain from crude oil to finished products. This integration to high-value petrochemicals necessitates ever-increasing imports of methanol. It is also strategically located near the Strait of Malacca, a major route for oil tankers and methanol tankers which carries almost one-third of all global shipping. Imports of methanol to support this advanced methanol derivative containing island is recovering after a 2012 hiccup in acetic acid production. Singapore also will remain a significant a methanol “hub” for other smaller countries in the region. At the same time, methanol derivative production will continue to flourish, especially for export purposes.

Worth mentioning here, the recent completion of new steam crackers in this country by Shell and ExxonMobil has invigorated the future of petrochemical industry in this country as a number of petrochemical players have begun to consider Singapore as a solid location from which to expand their operations.

Market Outlook

Methanol

As with most other Asian countries, methanol is not manufactured in Singapore, owing to a lack of natural gas feedstock at competitive pricing. Methanol is imported and stored in several complexes around the island, particularly in Vopak’s facilities on the islets of Sakra, Penjuru, and Sebarok as well as other terminalling facilities. Additionally, Saudi Basic Industries Corporation (SABIC) currently maintains a petrochemical hub for Asia Pacific in Singapore (using third party storage), and can store large amounts of methanol and MTBE for transshipment to other parts of Asia.

A well established network of traders uses these tanks, particularly Mitsubishi Gas Chemicals (MGC) and Itochu, along with derivative producers on the island.

The use of methanol last year, and by the end of the forecast, by derivative, is depicted in the chart on the next page. The growth in the use of “others” reflects the use of growth of solvent and methionine uses in 2015 as the cost of methanol increased during the year.
The island nation became a significant importer of methanol when Celanese brought its 500,000 metric ton per year methanol carbonylation technology acetic acid facility on stream at the turn of the century, and then expanded it to 700,000 metric tons per year. There has been an expectation that this facility will be expanded in the future, based largely on the strong growth in VAM demand in Asia, with no official announcement thus far.

MTBE is the next-most significant consumer of methanol in Singapore, as three local refineries utilize available butylene streams to make the gasoline additive. Recent expansions at Shell and ExxonMobil steam cracker operations are eventually expected to enable expansion of local MTBE facilities.

Sumitomo Chemical has developed an MMA production hub in Singapore, and investments by Mitsubishi Rayon (ie. Lucite) in MMA will continue to drive the growth of methanol demand in Singapore over the forecast period.

The chart on the next page quantifies historic and anticipated growth in methanol demand in Singapore, constructed from the supply and demand data provided in this study’s appendices. Demand for methanol rose sharply through 2010, owing to the commercial operations of additional MMA plant on the island. Demand growth took a dip in 2011, with a bearish situation for the MMA sector. The dip worsened in 2012 with the aforementioned outage at the acetic acid production location on the island. Yet a return to trend growth is expected as this facility has been restarted, and the island remains a competitive location to manufacture high value-added derivatives.
Methanol Derivatives

As is evident in the figure below, the AA carbonylation and MMA facilities in Singapore are key drivers of methanol demand in the country, with the loss of acid
production in 2012 – 2013 having a major impact on the need for imports. Biodiesel based methanol demand has not materialized given the current economics of production, and there is no real demand in the forecast based on the lack of potential for improved supply of vegetable oils. Most other methanol derivatives are expected to grow at positive, but relatively low, rates.

Notably, imports of MTBE into Singapore for further blending and re-export of blends has been significant, making Singapore an even larger net consumer of methanol, and suggesting by some measures that the island is ready to support a methanol facility of its own. MMSA is not expecting any methanol operation in the forecast, but would understand if discussions around methanol production took place.

**Formaldehyde**

There is only one formaldehyde producer in Singapore, which produces mainly phenol formaldehyde and other electronic or specialty formaldehyde based resins. The following charts provide details.

![Formaldehyde Supply and Demand - Singapore](chart)

Formaldehyde in Singapore has much more use in the electronic industry rather than wood panels as in the rest of Southeast Asia. There is no new investment in formaldehyde producing capacity in Singapore anticipated in the study period.

**Polyoxymethylene – POM (polyacetal)**

DuPont Singapore Pte Ltd has manufacturing facilities which include the production of polyacetal resins on Jurong Island, among other engineering thermoplastics.
These products are consumed partially by the local electronics industry, with the balance exported to other countries in Asia.

**Acetic Acid**

The Celanese acetyl complex on the Sakra region of the Jurong Island industrial complex reached full integration when its acetic acid facility started. The acetic acid process is from Celanese, and the carbon monoxide feeding the facility comes from Linde Syngas Singapore, using the Texaco/Messer oxidation technology on widely available heavy oils coming from Singapore’s refinery complex. With a number of other CO producers in the Jurong Island complex, a “grid” of CO pipelines within the island has been developed. Some facilities have converted the feedstock to natural gas (with the natural gas sourced from neighboring countries).

The facility compliments downstream vinyl acetate monomer facilities and a 100,000 metric ton acetate esters plant, which currently makes ethyl acetate and butyl acetate. VAM is processed further in Singapore to make specialty chemicals like polyvinyl alcohol, a lesser amount of polyvinyl acetate, and vinyl, acrylic, and vinyl-acrylic paints, among other smaller uses. Most notably, Taiwan Chang Chun’s group has started its 350,000 metric ton per year VAM facility in Singapore, along with a number of other products. This has boosted demand for acid significantly. Notably, the acetic acid used for this facility has been imported from the sponsor company in Taiwan (Chang Chun), as it tries to run its acid facility there at higher rates. It is a seemingly inefficient way to operate, and it may be that a middle ground will be worked out eventually, which would limit acid availability from Singapore.

![Acetic Acid Supply and Demand - Singapore](image_url)
Otherwise, acetic acid produced is in excess of local demand, and despite the massive new local demand for acid created by the new VAM facility, a large amount of acetic acid is exported from Singapore, primarily to India and other Asian countries. Production from this part of the world face stiff, but less frequent competition from manufacturing capability in China.

It might be technically possible to expand the acetyls complex in Singapore at relatively low cost; however, as Celanese has a major new facility in China, it is unlikely that such an expansion would occur in the immediate future. Singapore has no terephthalic acid production facilities, and there are no major acetic acid consuming derivative facilities anticipated to be built to provide supply in significant quantities during the forecast period.

**Methyl tert-butyl Ether - MTBE**

Singapore is a major refining center, and not only is MTBE produced there, it is imported for transshipment and also blended into gasoline in a network of local blending service suppliers (including several major energy traders). ExxonMobil Chemical Company has the largest MTBE facility, which produces 80,000 metric tons per year. Singapore serves as a distribution center for SABIC, who imports up to 600,000 metric tons per year for intermediate storage in SABIC-owned tanks. Malaysia imports approximately 60,000 metric tons per year, mostly on a spot basis, mainly to Singapore blending operators. Significant quantities of MTBE are also exported from SABIC and other storage facilities to refining centers in Asia. China,
and to a lesser extent, Thailand are typically the locations of choice for exports. MTBE is also exported in blended gasoline to many locations in Asia.

There has been discussion of a new MTBE facility in Singapore owing to the increase availability of C4 streams after the expansion of two major olefins cracking operations in the country, although these has been excluded from the forecast at the moment lacking details as to technology. Certainly given the large amount of imports of MTBE a case could be made for such an operation, pending feedstock availability and cost.

*Methyl Methacrylate - MMA*

Sumitomo Chemical assumed ownership of a 53,000 metric ton per year facility on the Sakra portion of Jurong Island in 2002 and added another 80,000 tons in 2005. Sumitomo has built a third plant capable of producing 90,000 tons that has been commissioned, despite the initial delays. Of particular importance, the number-2 plant has been restarted in early 2010 after extended turnaround period due to a technical issue. Similarly, Mitsubishi Rayon (Lucite) has opened its first plant in Singapore in the same year using a proprietary technology that consumes ethylene. This plant is the largest in Singapore at 120,000 tons and has been able to run close to design rates when the circumstances allow.

As it currently stands, Singapore remains a heavy net exporter of MMA. The next chart summarizes Singapore’s MMA supply, demand, and trade situation in the years ahead.

**Methyl Methacrylate Supply and Demand - Singapore**
Biodiesel

Singapore’s participation in the biofuels market has been underwhelming. Due to its proximity to Malaysia and Indonesia (the two largest palm oil producing countries in the world), biodiesel producers in Singapore had hoped to leverage cheap palm oil feedstocks. Being in Singapore, they also hoped to reduce logistics costs in delivering their product to high demand markets such as Europe. However continued struggles in the effort to operate biodiesel plants here have beset operations, and Neste Oil’s new 800,000 tons per annum biodiesel production in Singapore employs direct hydrogenation process, and hence does not consume methanol, and offers competition to vegoil based operations.

Methanol Trade

Most of the methanol imported into Singapore is used in the manufacture of acetic acid, and smaller parcels are transshipped to Malaysia, Thailand, and Vietnam.

Saudi Arabia is and will be the dominant supplier of methanol to Singapore, and no major change from this arrangement is envisioned in the forecast period. Other Middle East players will jockey with one another to take larger portions of the export market share away from each other. In addition, material from Malaysia come and go as availability dictates. Saudi imports were the most affected by the downtime taken at the acetic acid plant in 2012 and 2013.
MALAYSIA

Economy and Methanol

Malaysia is important to world methanol markets because of its sizeable natural gas reserves, some of which has been used to extend its lead as the largest methanol producer in Southeast Asia. Malaysia has in the past alternated between net imports and net exports of methanol, but with the addition of a massive facility will become a large net exporter in the forecast – especially as some of the technical and operational glitches at the new manufacturing plant are solved.

Market Outlook

Methanol

Methanol is mainly produced on the island of Labuan in Borneo, where Petronas has a fully owned 720,000 metric ton per year (maximum available) production facility. Additionally, in 2009 Petronas completed a 1.7 million metric ton per year Lurgi facility, a greenfield project proximate to the current Labuan operations. Several operational and technical problems (including feedstock limitation) have plagued this facility, keeping it from being able to run at full capacities. The first Labuan facility has also had its fair share of struggle, and has been unable to run at designed rates. Nevertheless, it is fair to expect that the two facilities will be ramping up run rates in a gradual manner over time.

Methanol Use - Malaysia

<table>
<thead>
<tr>
<th>Derivative</th>
<th>2015 (0.88 million metric tons)</th>
<th>2021E (1.13 million metric tons)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Formaldehyde</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Methyl Methacrylate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Methylamines</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Biodiesel</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Methanol-to-Olefins</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acetic Acid</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dimethyl terephthalate (DMT)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Methyl Chloride (Chloromethane)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DME</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Methyl tert-Butyl Ether (MTBE)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Methanethiol (Methyl Mercaptan)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gasoline Blending &amp; Combustion</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fuel Cells</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Methanol is primarily shipped within the country from Labuan to several large facilities in the region (including a MTBE plant in Kuantan - on the east coast of the
Malay peninsula), to distributors, and to small, spot market buyers who produce formaldehyde primarily for wood resins all over Southeast Asia.

With the exception of biodiesel, there are few investment plans for downstream consumption facilities. Unfortunately, the growth in this sector has been muted by disadvantageous economics (versus traditional alternatives), delay in implementation of biodiesel-mixed fuel initiatives domestically and internationally.

BASF and Petronas stated they are considering a joint venture to expand the production of speciality chemicals in Malaysia. The companies have a current JV (BASF Petronas Chemicals) which currently owns and operates integrated complexes in Gebeng, Pahang, and Kuantan that produce speciality chemicals including 1,4 butanediol. Expansions along the formaldehyde chain are not expected to occur before the end of the study period, however.

Because of the need to service the rather scattered and small formaldehyde operations, a fair amount of trading and distribution capability exists in Malaysia. Notably, net exports expanded just slightly in 2015 on the slowed operations in Labuan. More expansion of exports is expected in the forecast, expected to slow down in the absence of new investment of methanol derivative plants in this region.

The chart below (Methanol Supply and Demand – Malaysia) quantifies these points, constructed from the supply and demand data provided in this study’s appendices.
Methanol Derivatives

Most derivatives of methanol will grow at rates akin to economic growth. There is no production of MMA, DMT, or methanethiol in Malaysia. Biodiesel market participants remain hopeful of improvement in demand in the forecast period - both in export and domestic application. Nevertheless, a huge increase in demand for biodiesel is not reflected in this study.

The chart shown here quantifies the various contributions of methanol derivatives to total methanol demand in Malaysia.

![Methanol Demand By Derivative - Malaysia](chart)

**Formaldehyde**

Formaldehyde operations in Malaysia are spread over a wide geography, from the Malay Peninsula to the island of Borneo (Kalimantan, or East Malaysia, including Sabah and Sarawak sultanates) and are small in size relative to global counterparts. What they lack in size is made up in numbers, and currently around 910,000 metric tons of formaldehyde can be manufactured in Malaysia (details in the capacity listings in the appendices).

Many of the operations are focused on wood adhesives, which are used in local forestry operations (predominantly plywood and MDF). Methanol is delivered in relatively small parcels to these locations, and most of the terms are spot in nature.
Supply and demand expectations for Malaysian formaldehyde are depicted in the chart below:

Most formaldehyde in Malaysia goes into basic UF adhesive grades. Most of these adhesives in turn are used on wood panels and/or furniture which are exported, mainly to Japan and a few other trading partners.

No major other formaldehyde derivative investments are envisioned for the forecast period, although they appear justified based on the expected growth in demand.

Operating rates for formaldehyde production facilities in Malaysia have improved over the past five years. Capacity to produce formaldehyde will be adequate to cover market needs in Malaysia until the end of forecast period, when current facilities likely to be expanded using more sophisticated processes, or de-bottlenecked. However no current announcements of such expansions are available.

A breakdown of formaldehyde demand by sector over the study period is shown in the next figure, reflecting the dominance of UF, POM, and 1,4 BDO on formaldehyde demand in the country.
1,4 Butanediol

BASF Petronas Chemicals Sdn Bhd (a 60:40 joint venture of BASF and Petronas), operates a 1,4-butandiol (BDO) plant in Kuantan, Malaysia. This facility utilizes a Davy Process Technology license, which utilizes maleic anhydride and methanol.

Polyoxymethylene – POM (polyacetal)

Polyplastics Asia Pacific Sdn Bhd (Polyplastics) operates the countries’ only POM facility in Kuantan, which has a nameplate capacity of 30,000 metric tons per year. No expansion of this facility is expected in the forecast.

Acetic Acid

Malaysia was put on the global acetic acid map upon the successful start up of BP Petronas Acetyls’ 500,000 metric ton per year facility in Kuantan in late 2000, albeit utilities-related issues (mostly CO supply) have plagued operations sporadically since then, and with operations in 2011-2013 challenged, and reflected in a reduction of acid export quantities. [Due to a relatively small domestic market for acetic acid, the majority of this plant’s production is exported across Asia]. Export from this facility been increasingly focused on India. Reliance on exports continues in the forecast, as there are currently no plans to introduce major acetic acid derivative facilities in the country.
The chart below represents the overall supply and demand picture in Malaysia graphically:

**Acetic Acid Supply and Demand - Malaysia**

<table>
<thead>
<tr>
<th>Year</th>
<th>Production Capacity</th>
<th>Production</th>
<th>Net Trade</th>
<th>Total Demand</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td></td>
<td>100</td>
<td></td>
<td>50</td>
</tr>
<tr>
<td>2012</td>
<td></td>
<td>150</td>
<td></td>
<td>100</td>
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<tr>
<td>2013</td>
<td></td>
<td>200</td>
<td></td>
<td>150</td>
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<tr>
<td>2014</td>
<td></td>
<td>250</td>
<td></td>
<td>200</td>
</tr>
<tr>
<td>2015</td>
<td></td>
<td>300</td>
<td></td>
<td>250</td>
</tr>
<tr>
<td>2016E</td>
<td></td>
<td>350</td>
<td></td>
<td>300</td>
</tr>
<tr>
<td>2017E</td>
<td></td>
<td>400</td>
<td></td>
<td>350</td>
</tr>
<tr>
<td>2018E</td>
<td></td>
<td>450</td>
<td></td>
<td>400</td>
</tr>
<tr>
<td>2019E</td>
<td></td>
<td>500</td>
<td></td>
<td>450</td>
</tr>
<tr>
<td>2020E</td>
<td></td>
<td>550</td>
<td></td>
<td>500</td>
</tr>
<tr>
<td>2021E</td>
<td></td>
<td>600</td>
<td></td>
<td>550</td>
</tr>
</tbody>
</table>

In the forecast, it is expected that this facility will be able to operate more successfully, with more methanol available for operations.

**Acetic Acid Demand By Derivative - Malaysia**

- Others
- Acetate Esters
- Acetic Anhydride
- Terephthalic Acid
- Vinyl Acetate Monomer
As suggested by the chart on the previous page, there is no VAM production in Malaysia. BP uses acetic acid for its terephthalic acid production in Kuantan, and acetate esters are used in the fledgling automotive industry in Malaysia. No major additions to acetic acid derivatives are anticipated in the forecast period.

Methyl tert-butyl ether - MTBE

MTBE Malaysia, which is a Petronas company, operates the only MTBE production facility in Malaysia, and the only isobutane based MTBE facility in Asia. The majority of MTBE manufactured had been sent to the United States West Coast until the elimination of the ester in gasoline supplies there. The facility has been able to sustain operations by various ways, including in the recent past tolling MTBE for Iran. Increasing exports of MTBE to China and other countries have been noted at the same time.

Methyl Methacrylate - MMA

There is no production of MMA in Malaysia, and most MMA imported is for use in the electronics industry. No plans for MMA production in Malaysia are in the public domain at this time.

Biodiesel

Biodiesel had been expected to be the largest form of methanol demand growth in Malaysia during the study period, despite some setbacks in the recent years. Although the expectation has been toned down recently, Malaysia’s extensive palm oil production places it at the front of the pack in development of biodiesel production. With the appetite for biodiesel and other renewable fuels growing internationally like never before, Malaysia sees an opportunity to become the Asian leader in this emerging market.

Economics, for the most part, continue to yield negative margins, and the several large facilities in Malaysia that have started up have been mostly campaign run. The situation has not improved in the subsequent years, with the most lucrative option to export this material mainly into European countries. Without any subsidy and/or support from government and other stakeholders, biodiesel exports remain relatively insignificant.

Finally, one must wonder if plantation owners of biodiesel production can use the demand, which affects roughly 1 of 16 million tons of production of palm oil, as a means of keeping industry operating rates high and generating greater overall profit (than were biodiesel demand not there). This argument applies generally; i.e. to the large palm oil plantation owners who operate biodiesel capacity in Indonesia as well. Nevertheless, high CPO pricing (and demand), as well as competition from Indonesia (explained more on the next page) are also another important factors for the plantation owners to “bypass” biodiesel route recently.
Nevertheless, a glimmer of hope has been spotted recently, related to domestic demand for biodiesel. The Malaysia government announced that several areas within the central peninsular Malaysia region started using B5 fuel (ie. 5% biodiesel, with remaining of conventional gasoline) in 2011 (please see map below), and had raised the mandate to B7 end 2014. Nonetheless, despite further calls to expand Malay mandates from B7 to B10, the blending did not meet expectations as economics of producing palm based biodiesel remain threatened by low diesel prices, as explained previously, and as such some incentive to utilize high cost biodiesel must exist before large scale use issues.

**Methanol Trade**

The charts on the next page detail sources of methanol trade in Malaysia, showing the major drop in net exports as the Labuan facilities struggled in 2013 and 2014, and then recovered in 2015 on the improved operations. Saudi Arabia, Oman, and Indonesia were able to help supplant supply in the country. “Other SEA” material (mainly from Brunei Darussalam), which had become a regular source of supply to Malaysia, dropped on the year as that country had its own methanol production issues (see next section).

![Malaysia Methanol Imports Chart](image)

Methanol exports from Malaysia to traditional locales were tremendously impacted in 2014 and 2015, especially in China, Indonesia and to smaller Southeast Asian countries, especially Thailand and Vietnam. There are storage facilities for methanol in Port Klang, which traders move product in and out of for further export.
Chapter V - Regional Market Analysis – Malaysia

Malaysia Methanol Exports

![Graph showing Malaysia Methanol Exports from 2011 to 2015 with exports to China, Japan, Indonesia, Other SEA, Korea South, Singapore, Taiwan, India, and Others.]
INDONESIA

Overview

Indonesia has substantial, but declining, oil and gas production. Despite abundant gas reserves, and its role as the world’s largest liquefied natural gas (LNG) exporter, LNG production has begun to wane. There is only one sub-world scale capacity methanol facility operating in this country, and an even smaller methanol derivative industry. Given declines in LNG production capability, and higher LNG netback values in recent years, Indonesian natural gas has become a more precious commodity, and this has a cost-increasing effect on methanol operations current and planned in this country. Although methanol demand in this country took a significant hit in 2009, demand for methanol improved in 2010 and 2011 thanks to a better than average economic performance (which included a partial recovery in the wood panel industry) as well as increased biodiesel use, supported by government policy which taxes feedstock CPO exports significantly. Through 2015, demand has been relatively flat to strong. In the forecast, energy policy will augur well for methanol demand, particularly in the creation of demand for LPG (based on switching from previously subsidized kerosene fuels), which opens up opportunities for DME use, although a project for such production remains delayed. Also several parties interested in coal based methanol production have yet to assemble viable projects.

Market Outlook

Methanol

Methanol is produced on the island of Kalimantan (Borneo). At one point, two facilities existed. The smaller and oldest of the two facilities, owned by PT Medco, was shutdown in early 2009 due to lack of natural gas availability. PT Kaltim Methanol Industri (KMI), a joint venture between Sojitz, Daicel, and PT Humpuss, a local trading firm, began exporting methanol from a 660,000 metric ton per year facility in Bontang (also on Borneo) in 1998. No new production of methanol is anticipated in the forecast period, with coal and biomass based syngas facilities to replace syngas produced via natural gas being considered. However, discussions about the restart of the aged facilities of PT Medco in Bunyu persist. In 2008, the KMI natural gas feedstock agreement was renegotiated, enabling the operation of the facility through 2018, with some restrictions on supply in certain portions of the year (which basically mimics the reality on the ground in the past several years).

Consumption of methanol is limited primarily to formaldehyde and MTBE although to a modest extent, biodiesel will become an important derivative in the forecast. Other derivatives, such as acetic acid, are imported. The chart on the following page provides the distribution of derivative demand in Indonesia in the current year as compared to the last year of the forecast.
A planned DME project is an exciting development, although the path to this facility has not been very smooth. In fact, there are other ambitions projects in Indonesia which also have a good chance of development at the moment, although these are not included in the forecast. The government of Indonesia has appeared to be focusing its main efforts towards tackling the burgeoning subsidy in the gasoline sector – where the government has tried to increase the retail price of RON-88 gasoline, naturally causing strong reaction among the citizens. Nevertheless, the macro trend of LPG replacement belies the need for methanol for DME in Indonesia in the forecast.

Other than the DME facility, there are very few methanol derivative facilities currently being planned. Biodiesel development was touted as one of the most promising methanol derivatives in this country, but poor manufacturing economics and negative dynamics impacting palm-based biodiesel production has clouded the outlook. Until DME demand is developed, derivative consumption of methanol in Indonesia will be smaller than the production capacity, meaning that a significant amount of exports of methanol, mainly to the rest of Asia, exist. Traditional derivatives’ expansion will be limited to growth in formaldehyde production, which mirrors economic growth. The chart on the next page quantifies these points, constructed from the supply and demand data provided in this study’s appendices:
Methanol Derivatives

Little diversity exists in methanol derivatives in Indonesia. Formaldehyde use has improved with the improvement of the Indonesian economy since the end of the
Asian Financial Crisis. The demand from this sector, however took a dip in 2012 due to reduced wood-panel exports especially to the mature economies. The good news is that the situation has reversed, and gentle growth in the forecast can be expected. A small amount of MTBE is made, and even smaller amounts are used to manufacture solvents and other commodities. Growth for methanol will be driven by the DME project (which is a “game changer” for Indonesia), as well as development of biodiesel production facilities (which improved in 2015) and their ability to operate at significant rates. This is borne out in the previous chart.

Formaldehyde

Formaldehyde use has mirrored the Indonesian economy since the end of the Asian Financial Crisis. Decreasing wood panel exports in 2012 negatively affected demand, but the situation has improved in 2013, with supply to local consumption more likely in the near future.

A number of producers, mainly in Kalimantan and Sumatra, make formaldehyde, mostly for the production of UF resins, which is in turn directly consumed for wood manufacture. Wood exports to mature economies as well as China and other have led a recovery in these operations in the past few years.

Demand for Indonesian wood panels is expected to increase over the forecast period. The chart below shows that demand is well below existing recorded capacity to produce formaldehyde in Indonesia, suggesting that formaldehyde producers are running at low rates or some producers have been forced to rationalize.
Like methanol derivatives, formaldehyde derivatives are not particularly diverse, focused on commodity UF resins. There are no known plans for investment into other derivatives in the forecast, although discussion about forward integration into acetic acid production continues. UF concentrates are used as additives to urea fertilizer to resist clumping/blocking in storage, and this practice is used in Indonesia.

**Acetic Acid**

One small acetic acid facility that does not consume methanol exists in Indonesia. The balance of the country’s requirement comes from imports. Acetic acid imports mainly service the terephthalic acid industry in Indonesia. At one time, the textile industry was expected to grow at a very swift rate. However, there are several Japanese owned terephthalic acid facilities on West Java. Gradual but unspectacular recovery in demand from terephthalic acid facilities is anticipated. In the forecast, an improvement in operations is anticipated, driving small, but swift growth in acetic acid demand.

![Acetic Acid Demand By Derivative - Indonesia](image)

**Methyl tert-butyl ether - MTBE**

State-owned Pertamina has a small MTBE unit in its refinery, representing the total production capacity in the country. In 2005, a long awaited mandated phase out of lead in gasoline began, and MTBE demand has benefited as a result. There are no plans to expand MTBE production.

**Biodiesel**
Chapter V - Regional Market Analysis – Indonesia

Indonesia is the second largest producer of palm oil in the world behind Malaysia. As such, they can similarly leverage those palm oil feedstocks to produce biodiesel from methanol. Indonesia has begun overcoming the same hurdles as Malaysia to properly maximize the potential of an emerging biodiesel market. Feasibility and process economics are currently not in favor of biodiesel production, yet mandates from the government to use biodiesel into the energy mix have intensified lately. Indonesia’s government raised biodiesel mandates from B10 in 2014 to B20 in 2016. However actual blending has been far below expectations as low crude continued to issue low diesel pricing, affecting sentiment for biodiesel. Thus, while improving, appetite for biodiesel remains a major unrealized potential, with diesel prices at record spreads below feedstock palm oil. As a result, subsidy and other support from the government will be needed in a consistent manner – something that has not been seen in the recent past. In short, as long as diesel prices remain at current low levels, biodiesel will face challenges in becoming a strong and consistent source of methanol demand.

Nevertheless, it is not all “doom and gloom” in this area. A significant export tax by the government of Indonesia on crude CPO exports has forced some producers to consider ramping up the palm oil derivative products, including biodiesel and various oleochemicals. Accordingly, biodiesel exports in this country have been fairing well against neighbor Malaysia. Official data and recent estimates pointed out that Indonesia exported slightly around 300 thousand metric tons of palm based biodiesel in 2015.

However, several inhibiting factors exist for palm-based biodiesel producers. After recent negative comments about palm based biodiesel in Europe, as well as doubts over the cold temperature properties of this material, pressure on palm-based biodiesel exports have intensified recently, especially after the US Environmental Protection Agency declared palm oil based biodiesel unfit to join the United States’ renewable fuel program. Additionally, thanks to anti-dumping duties assessed by the European Union on Indonesian biodiesel, some Indonesian firms have purchased biodiesel production capability in Europe and are supplying palm oil rather than biodiesel made in Indonesia, shifting the source of methanol demand.

Domestically, although there have been some mandates for the use of biodiesel as a transportation fuel, the realization has been generally slow.

Most biodiesel production capacity in Indonesia has been attributable to several sizeable plants developed by Wilmar Holdings, including the newest one in Gresik, East Java. Nevertheless, those plants are not run at full rates, mostly due to poor economics. Large scale plants run by well-integrated plantation companies such as these will have the best chance of operating through the current period of unfavorable process economics. Should production conditions become favorable later in the forecast, these plants will be well-positioned to secure large market
shares. Most other plants in the country scheduled to come on stream will be relatively small (<50,000 tons).

**Biodiesel Capacity & Methanol Demand - Indonesia**

<table>
<thead>
<tr>
<th>(-000- metric tons)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capacity</td>
</tr>
</tbody>
</table>

**DME**

Several private investors, together with state-owned PT Pertamina, are currently investigating the use of DME to support the conversion of domestic cooking fuel (i.e. kerosene to LPG). Trial runs and other preliminary preparation steps have been conducted, together with preliminary engineering designs, and other preparations for the commercial realizations of at least one new industrial-sized DME plant. Due to the delicate nature of realizing this pioneering plant, including financing, government approval, and other related issues, delays have occurred.

**Methanol Trade**

Because of the scattered nature of formaldehyde facilities around Indonesia, the country imports methanol. These cargoes are typically small and spot in nature, but have increased substantially in past years as local demand increased. The loss in supply from hindered Malaysian operations in 2015 were replaced by supply from New Zealand.
Trade to Malaysia has been replaced by more lucrative exports to the North East Asian countries. KMI owns a vessel which makes rounds between Northeast Asian countries, explaining the large amounts of exports to these countries. In addition, since 2012, trade into Thailand (denoted “other SEA” in the trade matrix and graph below) has been considerable, with occasional opportunistic trade into the United States.
AUSTRALIA

Overview

From a methanol perspective, Australia is important mainly as a potential source of feedstock from the vast proven natural gas reserves in the country. Its fast growing economy will not have a significant impact on methanol demand, due to the relative advantages of importing methanol derivatives versus manufacturing the same goods in the country. And, as will be discussed, the conditions in Australia have developed such that investment in the country in export-oriented methanol production has proven to be difficult, although there are at least two active entities which have located gas with an idea for monetization via methanol. Australia has exhibited robust economic growth over the last decade, and is one of the world’s fastest growing industrialized countries. In the forecast period, the small amount of methanol demand that exists in Australia will be met by a mix of local production and imports.

Market Outlook

Methanol

Australia is a small consumer of methanol, and despite a significant amount of proven natural gas reserves, has only one small production facility in Victoria. Methanol use is mainly for formaldehyde. In the forecast, biodiesel can also be expected to contribute into the methanol demand growth. The chart below highlights this growth as well as formaldehyde’s large methanol draw.
Since the early 2000’s, several large scale methanol projects were planned using natural gas from the Northwest Shelf (NWS)/Darwin areas (along the northern coast of Australia). These included three different variants of Methanex (one in Darwin, two different sized facilities in the Burrup region of the NWS), and large scale projects from two groups promoting large scale projects, predicated on low cost gas and proximity to the rapidly growing Asian markets. A world-scale, sea-based floating methanol platform is also on the drawing board, using advanced and economically sized reformer technology, and has gained momentum with a recent natural gas find off the coast. One group that is still active exploring their options is MEO Australia. On the other hand, Magellan Petroleum seems to have stopped pursuing the methanol project due to “factors outside of the Company’s control” according to its official statement.

For a variety of reasons, these projects have not come to fruition, and in this forecast they are not included. Additionally, with LNG contracts being renegotiated with customers in Japan and Korea at USD 13 - 18 per million Btu (for crude prices around USD 100 per barrel), the netback value for natural gas has become much more attractive in that application.

As a result, Australia will increase imports of methanol to accommodate local growth in methanol demand, until production from the new facility occurs, as the next chart displays:
There is almost no diversity in methanol demand in Australia, with formaldehyde consumption driving methanol needs. Formaldehyde is expected to drive methanol growth through the forecast period as shown in the chart below.

Methanol Derivatives

Formaldehyde

Formaldehyde production is spread throughout the country amongst mostly multinational corporations: Arclin, Lucite, and Perstorp. Momentive has operations in a resin production facility. The forecast contains no new additions to capacity.
As shown on the next chart, major uses for formaldehyde in Australia will continue to be resins, along with polyols.
**Biodiesel**

Australia entered the biodiesel arena in 2006 with the start up of 4 plants having a total capacity of 255,000 tons and belonging to the Australian Biodiesel Group and Australian Renewable Fuels. In 2007, two more players, Natural Fuels and Axiom Energy, started production with 120,000 metric ton per year plants. By 2008, Australia had more than 500,000 tons of biodiesel capacity available, but their path remains rocky (in fact Natural Fuel has ceased operation, affecting both of its facilities in Singapore and Australia). The majority of these operations seek to utilize either palm oil or animal fats as the source of triglycerides. However they remain idled on poor economics as of late 2015.

**Gasoline Blending**

Pilot scale trials of methanol and ethanol with gasoline are underway in Australia, with hopes for a M5 specification remaining despite current low levels of crude and gasoline pricing in the country.

**Methanol Trade**

With continued methanol production in New Zealand and a number of Asian locations, imports are still available from there in the near-term. As an additional supply, traders will likely fill the void for methanol supply from outside Australia.
NEW ZEALAND

Overview

Given its relatively small methanol consumption, the New Zealand economy is a minor factor in the global methanol and methanol derivatives markets. This country was once one of the largest methanol producing countries globally, utilizing an allotment of gas available from the substantial reserves (Maui field). This field was in its waning production years, and the value of natural gas (due to high demand for power generation and industrial use) has limited the efficient manufacture of methanol (along with the appreciation of the New Zealand dollar) until 2012. Nevertheless, methanol production has regained its momentum in this country. Methanex has formally announced its intention to keep the methanol production in New Zealand for a foreseeable period of time, and in fact restarted a third methanol synthesis line in Waitara Valley, catalyzed by improved gas availabilities.

Market Outlook

Methanol

By the end of 2013, Methanex had entirely restarted it’s nearly 2.4 million metric ton per year methanol production complex in New Zealand after almost 10 years of sub-maximum operations. One site in Motunui, near the North Island city of New Plymouth (aka the Taranaki location), has three trains of methanol distillation, an original 500,000 metric ton per year line converted from a gas to gasoline project (Mobil Synfuels) plus twin distillation lines of 700,000 – 750,000 metric tons per year of methanol capacity. [Note that the plant has also been classified as having two lines of 900,000 metric tons per year capacity each, referring to the capacity of their methanol synthesis operations.] Another facility in Waitara Valley (520,000 metric ton per year) completed the restart.

With respect to derivative consumption, formaldehyde production dominates and is expected to continue to do so in the forecast. However, total methanol consumption in New Zealand is miniscule.
The volumes from the second Motunui train had increased the net export position of New Zealand and will continue to help the export in the following forecast period, as depicted in the chart below.
The local methanol industry experienced a dip in 2009 due to the general global economic malaise. Methanol demand in New Zealand is expected to be flat in the next few years, with some improvement seen through 2015.

**Methanol Derivatives**

**Formaldehyde**

No grassroots investment in formaldehyde derivative capacity is anticipated; formaldehyde is used almost exclusively in the production of resins used in the wood panel industry, which is significant in New Zealand. GDP-like growth in demand is forecast.
Biodiesel

It is not expected that New Zealand will have any significant biodiesel production in the forecast, but there have been stated plans for large scale plants to be built using animal fats or even algae as the feed source.

Methanol Trade

As mentioned above, New Zealand will maintain its net exporter status throughout the study years. The 2015 export destinations for material originating from this country are detailed in the chart below. Clearly, methanol export to Korea has been dominant due to Methanex’s involvement in South Korea (including the terminal facility in Yeosu), but Japan, China, and Taiwan are also among the major export destinations.
Chapter V - Regional Market Analysis – New Zealand

2015 New Zealand Methanol Exports

Total Exports 1,996 thousand metric tonnes
OTHER SOUTHEAST ASIA

Overview

As it relates to methanol, Thailand, the Philippines, Vietnam, and Brunei are the “other Southeast Asia” countries of most significance, with Thailand having the largest role in methanol consumption among these. These countries, in aggregate, have large potential for growth, and in the case of Vietnam and Brunei, available gas reserves. This area represents an interesting future market for methanol and methanol derivatives, and a large methanol investment in Brunei started in 2010, diversifying that country’s downstream natural gas industry away from LNG. Strong growth in methanol demand in these countries will be therefore able to access even more methanol in the forecast, and the “other Southeast Asia” region will become a net exporter of methanol.

Market Outlook

Methanol

The importance of this region as methanol producer took a big leap when a 50/25/25 joint venture between Brunei Petroleum, Mitsubishi Gas Chemical, and Itochu (Brunei Methanol Company or BMC) started-up a 1.0 million metric ton per year facility the plant in early 2010. The plant is located in Sungai Liang, not too distant from methanol production in Malaysia. Strengths of this project include ample and reasonably priced gas supply, experienced methanol partners (technology and market capable), and a location near growing markets. A company consisting of MGC, Itochu, and Petroleum Brunei, called the Brunei Methanol Company (BMC), has been established. Additionally, the project is part of a larger complex envisioned in the Sungai Liang Park (“SPARK”), which is intended to foster downstream investment in methanol derivatives. Since its startup, unfortunately, there have been intermittent problems from this facility, mostly related to feedstock delivery.

A small facility in Myanmar (formerly Burma), is not being utilized as gas is being diverted to more profitable uses. Methanol consumption growth in the region will be positive, although small in volume. Methanol is imported in relatively small parcels to these countries, the exception being Thailand, which has ongoing purchases for methanol derivative facilities in the petrochemical complex of Map Ta Phut, on the Gulf of Thailand south of Bangkok.

On the next page, the distribution of methanol demand in this region is shown.
Methanol demand in the region is dominated by Thailand, and comes mostly from formaldehyde production for the wood and electronics industries. There are also MTBE and (expanding) MMA facilities in Thailand which consume methanol. Other uses are for solvents and other commodity applications. Growth in demand will be led by alternative fuels, namely biodiesel. Thailand and the Philippines have ample vegetable oil stocks that they can divert for use in making fuels. Other derivatives lack investment for expansion and new projects. As a result most of the production from the Brunei facility will be exported.

The chart on the following page graphically summarizes the very interesting switch in the overall market view for this “Other” region in the forecast, highlighting the essential self sufficiency of this region after the start up of the operations at BMC.

Formaldehyde demand is expected to dominate methanol demand growth in the region. MTBE demand for methanol in Thailand will stagnate as domestic demand has essentially diminished following the government mandate to implement gasoline-ethanol blending (called “gasohol”). Biodiesel will be the highest growth outlet for methanol consumption in the forecast.
Methanol Derivatives

**Formaldehyde**

Aica (formerly Dynea), Arclin, Dovechem, Better Resins, and Green Chemical are among the multinational companies with formaldehyde and formaldehyde derivative operations in Thailand and Vietnam. Formaldehyde in this region is employed mainly in the manufacture of UF and PF resins for the wood panel industry.
Arclin has started a world-scale formaldehyde and resins plant in Hatyai, in Southern Thailand. This facility will compliment their facility in Krabi, and serve production of particleboard and medium density fiberboard (MDF).

Dynea also produces adhesive resins in Dong Nai near Ho Chi Minh City in southern Vietnam.

Formaldehyde resin production is distributed around UF, PF, and MF resins, with UF resins being the largest in use. Due to increasing demand, new capacity(es) of formaldehyde could be added in the forecast years.

**Polyoxymethylene – POM (polyacetal)**

Thai Polyacetal Co. (TPAC), a joint venture between Mitsubishi Gas Chemical, with a 60% share, and Toa Chemical, has the manufacturing capacity to produce 20,000 metric tons of POM, most of this for export markets. The facility takes methanol directly. The trend of Japanese auto part suppliers transferring production of POM-containing parts is expected to continue, limiting POM exports.

**Acetic Acid**

There are no acetic acid producers in this region, and only one country, Thailand, has significant use of acetic acid, which is met by imports. Acetic acid consumption has risen at a fast pace along with the polyester industry in Thailand.
Significant investments in terephthalic acid production are anticipated in the forecast period, increasing the need for acetic acid in Thailand. However, no investment in acetic acid capacity is anticipated, given the ample supply from nearby regional sources in Singapore, Malaysia, and, in the future, China and Taiwan.

As shown in the appendices, Indorama Petrochemical and Siam Mitsui PTA started new TPA lines in Map Ta Phut in early 2006, setting the pace for acetic acid growth in the forecast period for this region. Demand from this material recovered strongly in 2011, but has been sporadic since. The slow growth trend is expected to continue in the near future due to competition from other regions.

**Methyl tert-butyl ether - MTBE**

Bangkok Synthetics has a small MTBE facility which uses raffinate available from the petrochemical complex in Map Ta Phut. Oxygenated gasoline is somewhat of a “political football” in Thailand, with a very strong agricultural lobby which supports the replacement of MTBE with ethanol. In fact, the Petroleum Authority of Thailand Plc (PTT), which owns portions of almost a third of the country’s refining capacity, has fostered a “gradual curbing” of MTBE imports, with refiners replacing MTBE with ethanol. The situation remains as such as of early 2012, with almost no MTBE demand for local use existed in Thailand. Vietnam is considering expansions to their refining capacity that might involve MTBE production. Otherwise, no major growth in MTBE demand is anticipated for the combined region.
Methyl Methacrylate - MMA

MMA production in Thailand has progressed well since the start up of the Thai MMA (a joint venture of Mitsubishi Rayon Co., Ltd. [45%], Cementhai Chemicals Co., Ltd. [45%], Bangkok Synthetics [5%], Mitsubishi Corporation [4%], and Thai MC [1%]) facility in Map Ta Phut in 1999. The facility was also expanded in 2004 to accommodate local demand. A second Thai MMA plant as well as the the PTT-Asahi plant have restarted.

Biodiesel

The Philippines, Thailand, and Vietnam are all pursuing biodiesel development to varying degrees. In the Philippines, coconut oil is a locally sourced product that can be used for making biodiesel. Recently, high prices of coconut oil due to weather-related supply restrictions have hindered serious progress in establishing production. As it stands, though the Philippines has come up with mandated blending levels for coconut methyl ester (CME) based diesel, there are few other incentives for producers to run. There is no large scale production on the board and coconut oil is expensive. It is not anticipated that the Philippines will develop any significant levels of biodiesel production for the duration of the forecast.

Thailand will likely develop to the greatest extent of the three countries mentioned above. A few companies started plants in 2007, and are now running. In fact, the government has kept its ambitious target to increase the mandated 3% mixture of biodiesel (i.e. B3) into 5% (i.e. B5). Nevertheless, the implementation has had some setbacks in late-2010 due to insufficient supply of palm oil as the feedstock of biodiesel.

Producer wise, Thai Oleochemical has a large 200,000 metric ton per year plant and uses by products through integration to produce fatty acids, reducing net costs. Southern Palm and Bio Energy Plus will have the benefit of collaborating with PTT which should ensure greater sales of product. Additionally, ethanol support and measures in Thailand are concurrently setting an example and facilitating future acceptance of biodiesel in fuel streams. By the end of the forecast, it is estimated that Thailand will demand greater than 20,000 tons of methanol per year for this application alone. Vietnam does not have large oil plantations like other Southeast Asian countries. However, one producer, Agifish, has developed technology that produces biodiesel from catfish fat. A 10,000 ton plant is currently running in southern Vietnam. Nevertheless, no other projects have been announced in the country and it appears that biodiesel will not be a primary focus for the fuels market in the forecast.

Methanol Trade

Methanol is imported in relatively small parcels to these countries, the exception being Thailand, which has ongoing purchases for methanol derivative facilities in
the petrochemical complex of Map Ta Phut, on the Gulf of Thailand south of Bangkok.

Methanol exports out of this region have started after the commencement of the plant in Brunei. The export destination out of this country has been quite diverse, but countries in North East Asia (China, Japan, Taiwan, and South Korea) made up the majority of 2015 exports, as depicted in the picture below.

### 2015 Other Southeast Asia Methanol Exports

- **China**: 150
- **South Korea**: 47.566
- **Taiwan**: 54.14
- **Japan**: 22.24
- **Singapore**: 15
- **US**: 29

*Total Exports: 318 thousand metric tonnes*
INDIA

Overview

India's diverse economy encompasses traditional village farming, modern agriculture, handicrafts, a wide range of modern industries, and a multitude of services. The methanol industry in this country is small, but growing well, increasingly reliant on imports of methanol, which are becoming more and more available in the country from the Middle East. In the forecast period, only incremental expansions of production capacity are expected, and bullish demand growth is expected to be met with increased imports, primarily from the Middle East.

The map above highlights the great distribution of methanol production, import terminals, and derivative consumption, and gives an idea of the concentration of activity on the West Coast of India. This map is becoming more and more populated in this very dynamic country.

Market Outlook

Methanol

There are five rather small methanol production facilities which mostly utilize natural gas, which is a precious commodity in India, as feedstock. Natural gas is
available in India, but the most readily accessible gas is near sensitive regions in the northern parts of the country, and consuming markets are mainly on the west coast, in Gujarat.

In 2008, GNFC expanded their operations in Gujarat by an additional 66,000 metric tons per year. Nevertheless, due to the high cost of natural gas, earlier plan(s) of production expansions have been halted. A plan for a new 165 ktpa methanol plant by Gujarat State Fertilizer Company (GSFC) in Vadodara has been completed in 2012, due to expectation of higher pricing especially with reduced availabilities from Iran and other traditional exporters. There is also a plan for small methanol – AA integrated plants by Assam Petrochemical, with methanol capacity at 165 ktpa.

For some time, there is also preliminary discussion of two new facilities for methanol production, both with Reliance as the sponsor, although these are not anticipated to provide commercially available material in the study forecast period. One of these projects would utilize pet coke from the RIL refinery operations in Jamnagar as feedstock, with a 100,000 metric ton per year scale, which fits nicely into their refinery system, as the material could be utilized for TAME production. The other project would be a much larger, natural gas based facility integrated to acetic acid and possibly TAME using gas from the East Coast of India; this ambitious project would certainly change the dynamic of the Indian methanol industry. Recently, coal-based methanol production have been talked by potential project sponsors, but not expected to come online during the study period.

Methanol demand growth in India is proceeding, and will continue to proceed, at an appreciable rate as the economy grows. This demand growth will be broad, meaning from all derivatives and based on incremental expansions to existing derivative

Methanol Use - India

<table>
<thead>
<tr>
<th>By Derivative</th>
<th>2015</th>
<th>2021E</th>
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<tbody>
<tr>
<td>Formaldehyde</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Methyl Methacrylate</td>
<td></td>
<td></td>
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<tr>
<td>Methylamines</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Biodiesel</td>
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<td></td>
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<tr>
<td>Methanol-to-Olefins</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acetic Acid</td>
<td>2.01</td>
<td>3.44</td>
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<tr>
<td>Dimethyl terephthalate (DMT)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Methyl Chloride (Chloromethane)</td>
<td></td>
<td></td>
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<tr>
<td>DME</td>
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<tr>
<td>Gasoline Blending &amp; Combustion</td>
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<tr>
<td>Fuel Cells</td>
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<tr>
<td>Methyl tert-Butyl Ether (MTBE)</td>
<td></td>
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<tr>
<td>Methanethiol (Methyl Mercaptan)</td>
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</tbody>
</table>
locations. However, formaldehyde demand is increasing at a fast pace, and is likely to expand its share of methanol consumption in India by the end of the forecast. Methanol imports are needed to accommodate the increase in demand, with local methanol producers extremely limited in their ability to operate, let alone expand production capacity.

All told, as shown in the figure below, by the end of the study period, India will become a more than 3.0 million metric ton per year methanol consumer, the second largest in the region, and require almost million metric tons per year of methanol imports to support derivative operations. Domestic production has not improved recently due to availability of competitive methanol from Middle East, but can be expected to strengthen in in the forecast years as competitiveness improves.

Since the economic slowdown in 2009, methanol derivative fortunes have recovered, and a continuation of this upward progression is anticipated across the current derivative slate. Formaldehyde is the largest single use for methanol, with acetic acid demand a potential source of growth, depending upon investments in this sector. The chart on the next page, “Methanol Demand by Derivative – India,” shows the growth in methanol demand since 2009 (particularly for acetic acid production), followed by steady growth, driven by formaldehyde consumption, which is expected to continue in forecast. The increasing methanol consumption is expected to be robust in the next few years.
Methanol Derivatives

**Formaldehyde**

A collection of moderately sized production facilities throughout the country uses methanol for the production of formaldehyde. The number of producers is poorly chronicled, and not all of the production capacity listed in the appendices is assigned to known entities.

The remainder is likely even smaller, family run operations dotted throughout the vast and populous Indian countryside. Small increments to formaldehyde consumption capacity are expected, although these have not been (nor are widely expected to be) announced.

The rate of formaldehyde demand growth is expected to remain constant throughout the study period, as demonstrated in the chart on the next page, “Formaldehyde Supply and Demand – India.” Formaldehyde use is concentrated on the basic resins used in wood panel manufacturing, but increasingly for laminate construction and electronic uses. Some polyol manufacturing exists, as well as hexamine production, although these are relatively small.
Plywood and laminate construction and pharmaceutical chemical activity has emerged as a large force in the increase in Indian formaldehyde consumption, with the growth in the latter significantly impacting demand. Laminates are made using low cost labor and imported wood. Finished laminates are exported to Europe, with some consumed domestically to support rapid construction growth in India. Of recent, some parties have explored the introduction of “engineered” wood panels (including MDF and particleboard). The consumption of this material can be expected to grow in the future, although it is currently starting from a small basis. Also, high value pharmaceutical uses have helped drive growth.
Acetic Acid

Somewhat strangely, India is a net importer of acetic acid, despite ample capacity to produce. Operating rates for acetic acid production facilities, particularly the small and scattered locations dotting the country, are low, with imported material much more economical. GNFC in Gujarat has the countries’ only methanol carbonylation facility, which uses BP technology. This facility has been operating at high rates, and was expanded in 2003 and 2005. As shown in the chart on the next page, production capacity for acetic acid is expected to remain constant for most of the forecast, and local production is expected to continue to be well below nameplate capacity.

Several parties are investing new AA plants in the country. Most notably, Assam Petrochemicals are preparing a plan for its 66,000 tons per year facility at Namrup, Assam. On a bigger scale, BP and Indian Oil Corporation have inked a Memorandum of Understanding to set-up a 50:50 joint venture acetic acid plant in Gujarat. The 1 million metric tons per year AA plant would come up with associated petcoke gasification facilities in the same complex. This project will likely require more rounds of discussion. However, it appears needed.

Imports have increased through 2015 due to availability of competitive molecules in the region (mostly from China, Malaysia and Singapore), and these are expected to increase in the forecast until improved production from the one carbonylation facility in country, then a new production facility, as well as a recovery in other parts of Asia.
The chart below represents these views graphically:

Acetic acid demand in India is concentrated on vinyl acetate monomer and terephthalic acid production.

The emergence of a refining industry in India has provided the aromatic molecules which can support the production of polyester, much desired in this country, which has a massive textile industry.

These aromatic molecules are increasingly being used to make the building blocks along the polyester chain, specifically terephthalic acid. India relied mainly on imports of acetic acid in 2010 as low prices limited the economic viability of local production (ie. Non-carbonylation facilities have been affected by high molasses price).

As shown in the appendices, major investments in new terephthalic acid capacity are underway. This will create an increase in demand for acetic acid.
**Methyl tert-butyl ether - MTBE**

MTBE use in India grew at a swift pace in the previous five year period, as lead replacement initiatives are taking place, and new production capacities came online. However, due to a strong agrarian industry, the use of MTBE is being contested as unsafe by the farm lobby, with the desire to use ethanol and ETBE in its stead.

Nevertheless, in 2011, Reliance Industries completed its 144,000 metric tons per year MTBE plant in Hazira (Gujarat), with products from this facility targeted mainly for export movement. It is expected that new investments in MTBE production capacity in India will be few, if any, in the forecast period.

**Methyl Methacrylate (MMA)**

A very small MMA production facility exists, and little change in MMA capacity is planned over the forecast period.

**Biodiesel**

With its large land area, India has the means to develop vegetable oil crops for large scale biodiesel production. India’s first industrial scale biodiesel plants has been started back to 2006, and the industry now has a 691,000 tons of capacity.

A major issue in biodiesel development in India is oil feedstock procurement. The government has set high import tariffs for soy and palm oil to protect local edible oil
producers supplying the food market. In this case, potential biodiesel producers will have to rely more heavily on domestic feedstocks. Many current plans to develop plantations for vegetable oil production use the jatropha plant as the main source of oil. Jatropha is an attractive option because it can grow in less arable soils and is not used in the edible oil industry. The successful development of large jatropha plantations will dictate biodiesel growth potential beyond the forecast years.

**Methanol Trade**

Methanol will be imported to accommodate the increase in demand, with local methanol producers limited in their ability to expand production capacity. All told, as shown in the previous figure, by the end of the study period, India will need well over 3 million metric tons per year of methanol to support derivative operations.

With the bulk of methanol import demand coming from the west coast of India, Middle Eastern sourced methanol should be the predominate trade into this country, with some movement on an opportunistic basis from Southeast Asia.

In fact, there is a potential that low enough cost methanol could reduce the operating rates in the country; the extent of this possibility will be highly dependent on the differential between natural gas prices and methanol prices in India.

Of particular interest, India is one of the countries still importing materials from Iran (at least in the near future), but with increasing difficulties (including payment arrangement, transportation and logistics, etc). In fact, a wave of imports from Iran caused market havoc in 2012 and 2013. Iranian material was sold at very low values through the year until most storage was full around the country. Cargoes were then diverted as India stopped its spot purchase from Iran. Iran typically find better netback pricing through direct trade to China, stopping opportunistic exports from India to China.
OTHER SOUTH ASIA

Overview

Pakistan is the largest economy in this region, although very small on a global basis, and is really the only large consumer of methanol. Pakistan is a small methanol consumer, with very little sophistication in derivative demand. All of the demand in this region comes from imported material, and this is expected to hold constant. The growth rate in demand is expected to be healthy over the forecast period, but given the small scale and little investment in derivative consumption, is not expected to significantly influence methanol markets.

Market Outlook

Methanol

This region is and will remain a small methanol consumer, with formaldehyde the largest consumer of methanol, and several small, drum scale uses of methanol in the “others” category following.

There is no methanol production, so imports are required to fulfill demand.

The chart on the next page highlights anticipated supply and demand in the Other South Asia region.
Methanol Derivatives

*Formaldehyde*

As shown in the following chart, UF resin demand will dominate and drive formaldehyde use.
Other use of methanol includes methyl chloride manufacturing, gasoline blending and solvent use. The demand took a hit in 2009 due to global economic crisis, but rebounded in 2010 and 2011, and with the same trend expected to continue in the coming years. Methanol is imported into the region mostly from the Middle East.
NORTH AMERICA

Overview

North America consists of the United States of America (US), Canada, and Mexico, with the US the overwhelming center of the region’s economic activity. Accordingly, the US dominates methanol demand in the region, with events there having the largest impact. The economy of the US continues post-financial crisis growth in an uneven, but overall positive fashion. While the US has a very sophisticated investment in derivative consumption of methanol, demand in the country remains largely reliant upon the construction and automotive industries, with US demand for MTBE in gasoline blends limited to exports. With a recent wave of significant new investments in production capacity in the US, spurred by availability of low cost natural gas, North America has become more self-sufficient, although supply of methanol from Trinidad and Venezuela continues, despite ongoing feedstock curtailments in both those South American countries. Additional methanol production in the US has increased Atlantic Basin (includes Europe) buyer options, and along with future investments in the study period, will keep markets in North America well supplied. The ability to secure investment in larger energy-based applications for methanol, such as methanol to gasoline (MTG), along with the ability to export and swap molecules will be important future factors in North American methanol markets.

Tables showing US, Canadian, and Mexican supply and demand for all study products during the forecast period can be found in the study appendices.

Market Outlook

Methanol

As the map on the left indicates, demand for methanol in North America is dominated by traditional use in the US, mainly in the United States Gulf Coast (USGC) region. The US imports the majority of methanol needs in the Houston Ship Channel, followed by the Port of New Orleans, the Port of Wilmington, NC, the Ports of New York
and New Jersey, West Coast Ports, among others. From these locations, product is stored and distributed through a multi-modal labyrinth comprised of barges, rail cars, and trucks to end users.

The chart below, showing the distribution of demand in North America, underscores US importance in the region. On the supply side, methanol producers in the USGC have benefitted from low cost natural gas feedstock (in turn due to ample supply – pls refer to feedstock section), which has made US methanol production increasingly competitive and profitable. As such, North America methanol production capacity will continue to issue, based on the expectation that natural gas supply will continue to be abundant. The US will remain a significant consumer of methanol in the forecast period, and the US decreases its net import position. A list of the new projects expected in the United States during the study period is shown in the appendices.

Methanol supply in North America has been volatile over the years. North American methanol capacity peaked in the mid 1990’s, declining by almost 90 percent by 2008 as natural gas prices rose to prohibitive levels. This led to a reconfiguration of global methanol trade flows, with regional supply replaced by new production facilities using flexibly priced and low cost natural gas feedstock in remote South American regions. However, from 2012, those with access to reasonably priced natural gas in North America restarted facilities in Canada and the US Gulf Coast, with that trend through 2015, with at least one more project to issue in the next five years.

Another notable major market event in North America is the near elimination of methyl tert-butyl ether (MTBE) use for gasoline blending in the US, driven by legislative efforts to remove the methanol-consuming additive from the US gasoline pool. The causes for MTBE removal are related to its detection in water supplies across the country and the drive by environmental parties to ban its use. Some
MTBE is produced for isobutylene value and for exports to South America, especially as natural gas pricing becomes lower.

The chart below, “Methanol Use – North America,” segments the 2015 and 2021E distribution of demand for methanol. Traditional methanol derivatives are expected to dominate growth through the study period, with formaldehyde remaining the major use. The use of methanol to manufacture gasoline via Ziegler-Natta catalysis (methanol to gasoline or MTG) is absent in the forecast, mostly as the spread between natural gas and gasoline prices in the United States has shrunk along with a major correction in crude prices.

Methanol demand will grow moderately in North America in the study forecast period, increasing along with the US economy. The formaldehyde sector has returned to pre-crisis level demand, driven by US construction, and to a lesser extent, automobile markets, as the US economy gets back to a steadier growth mode. A small amount of investment in new MTBE capacity (for export) was also made.

Imports from South America will continue to arrive, augmented by other regions (especially Africa). By the end of the period, the region will reduce its import dependency, with the US being both a major importer and exporter of methanol (net exporter overall). Some of the exports will need to be placed in Asian markets, which not only carries some risk, but also will come at a detriment to profitability. The chart on the next page summarizes the data provided in the supply and demand balances for methanol in North America.
The chart below shows the growth profile of methanol derivatives in the forecast. Demand growth will generally follow the moderate economic growth of the region. Notable also is a relatively flat demand growth profile for methanol consumption into acetic acid, with no major acid production facilities envisioned for the forecast period.
Methanol Derivatives

Formaldehyde

The tremendous scale and resulting competitiveness of operations relative to other global producers had allowed the big North American formaldehyde producers - Hexion, Celanese, Georgia Pacific, and Arclin - to grow with the expansion of the US economy. After the global financial crisis damaged the formaldehyde resin business in North America, a recovery in new home construction, a major driver for demand brought the industry back to life, with formaldehyde markets recovering swiftly, marked by slow but positive demand growth through 2015. Demand from the US construction industry is expected to continue is positive growth in the forecast, along with the US economy. One negative factor impacting longer term potential growth is related to the possible link of formaldehyde and cancer. In 2004, the International Agency for Research on Cancer (IARC) reclassified formaldehyde as “carcinogenic to humans” and determined that there is “sufficient evidence that formaldehyde causes nasopharyngeal cancer in humans. In early 2010, a major study by global academic and cancer research organizations concluded that exposure to formaldehyde increases the ability of the human body to develop leukemia. However, industry organizations continue to dispute results of these studies, and have taken several precautions intended to address public concerns. Based on these efforts and the limited availability of readily available low cost alternatives, the status of formaldehyde is not anticipated to be materially affected in the study period, although this development merits further monitoring.

The largest single production center for formaldehyde is Celanese’ Bishop, Texas facility in the USA, near USGC lumber producing areas. Smaller, but still significant scale formaldehyde locations are also located near timber producing regions in the Northwest US and Canada. Canadian operations are split between the western province of Alberta and eastern provinces. A complete list of formaldehyde producers is given in the study appendices.

The supply and demand outlook for formaldehyde utilizing data from this analysis is depicted in the chart on the next page. As shown, formaldehyde is principally used in urea formaldehyde (UF) and phenol formaldehyde (PF) resins, with POM, 1,4 butanediol, and MDI as the largest other consumers. Wood panel and other industries using formaldehyde derivatives are relatively mature in the US, and as a result the use of formaldehyde in North America has more moderate growth than in Asia. The chart clearly shows the recovery in demand for formaldehyde after 2012, after resin demand had been compromised by the global financial crisis. The rebound is expected to continue, although at a moderate pace, through the forecast, mostly using existing formaldehyde derivative assets.
Polyoxymethylene – POM (polyacetal)

Commercial POM production began in 1960, by DuPont in the United States. The industry in North America has been focused in the US since, with most production in the region. While the industry is growing at a relatively fast rate as compared to other methanol derivatives, it is considered largely developed, especially in comparison to Asia. Supply of POM is limited to three large producers in the Americas: DuPont, with roughly 55,000 metric tons per year of production capacity; Ticona (a business owned by Celanese), with approximately 86,000 metric tons of operations spread across the US; and Ultraform (a JV between BASF and Evonik), with 44,000 metric tons per year of production in Theodore, Alabama.

The United States has been a leader in the development of new grades of POM and POM co-polymers, and has also supported new market growth via POM resin exports, particularly to Asia. However, with the consumption and production of POM resins growing rapidly in Asia (see Asia section of this chapter), no new investment in POM capacity in North America is forecast to commence in the study period. Correspondingly, regional growth of POM resins in North America will be supported by existing capacity, at the expense of exports to Asia.

Acetic Acid

Acetic acid production in the North America is almost entirely located in the United States, and US production is based on the process utilizing methanol carbonylation. Celanese is the largest manufacturer in the region, followed by Millennium
Chemicals (a wholly owned LyondellBasell subsidiary), Sterling Chemical Co. (with marketing rights for output owned by BP), and Eastman.

With production levels comfortably ahead of domestic demand growth for acetic acid derivatives, little investment in new production capacity, beyond perhaps debottlenecking at existing operations, is forecast in the study period. In fact, acetic acid investment has suffered after a period of significantly low profitability. However, availability of advantageously priced methanol may eventually help plans for investment.

Demand for acetic acid in derivative use in the US is dominated by vinyl acetate monomer. Interest in investing in the polyester chain in North America has picked up, but is not yet well enough defined to include in this forecast; as such acid demand is grows modestly in the forecast. As a result, the outlook for acetic acid markets in the Americas in the forecast is for a relatively constant operation of existing facilities, with demand being met by reduced exports from the region. The following chart represents these views graphically:

**Acetic Acid Supply and Demand - North America**

![Acetic Acid Supply and Demand Chart]

By the end of the forecast, existing assets in North America will be taxed to support local demand while maintaining exports, and there is some potential that current exports are served by production in other parts of the world.

As mentioned previously, vinyl acetate monomer (VAM) is and will remain the prime consumer of acetic acid in North America, as shown in the chart below. Celanese is the largest VAM producer, followed by Millennium Chemicals, Dow Chemical, and Dupont. All are based in the US.
Due to substitution by non-acetate textile fibers, Celanese closed several cellulose acetate flake and tow plants and exited the acetate filament business globally, mostly affecting operations in the US (Virginia) and Mexico. This action supports the slow demand for VAM forecast for the region, although any restart of such operations (not yet anticipated) could change this assumption.

Terephthalic acid (TPA) consumption of acid in the Americas is also centered in the US, with BP maintaining a decidedly major portion of the region’s TPA production capacity. Other manufacturers of note are Temex and Petrocel in Mexico, along with DAK Americas and Eastman in the US.

Acetic acid derivatives, including PTA and VAM, have been relatively flat in North America, and will only expand marginally through the forecast. Relative historical and forecast consumption of acetic acid into the key derivatives is shown graphically on the next chart, and further detail is provided in the appendices.

**Methyl tert-butyl ether - MTBE**

In the 1990’s, MTBE was developed as a gasoline additive in the United States, and within just over a decade its use rose, then fell on the back of US legislation. Amendments requiring the use of oxygenated and “reformulated” gasoline were ratified by the US Congress. Oxygenated additives like MTBE promote carbon dioxide formation during combustion as opposed to hazardous carbon monoxide, reformulated gasoline utilizes MTBE in place of higher combusting, but more volatile components, and is designed to reduce emissions of volatile organic compounds and nitrogen oxides in order to abate ground level ozone/smog.
formation – more details in the MTBE section in Chapter III, “Methanol and Derivatives Uses’]. This legislation spurred a rapid increase in production and use of MTBE in the United States. MTBE use was successful in delivering significant increases in air quality, despite continuously increasing automobile traffic. Smog-causing pollutants, including VOC’s, decreased 17% in a four-year period from 1995 to 1999. More stringent regulations went into effect on January 1, 2000, and subsequently VOC emissions and NOx emissions were reduced significantly.

Regardless, MTBE was undone, beginning with its ability to be detected in surface and groundwater sources. MTBE showed up in several ecologically sensitive locales after 1995, inciting a literal riot among environmental concerns in the US. MTBE can enter the groundwater through leaking gasoline tanks and lines, incomplete combustion, and through improper disposal or dumping of gasoline. MTBE is much more soluble in water than most other components of gasoline, so its transport by groundwater is much faster than that of the other components. Even at extremely low levels, MTBE has a pungent turpentine-like odor and taste. A 1999 report commissioned by the EPA found a link between MTBE use and groundwater contamination, giving the State of California the justification it needed to ban the use of MTBE in reformulated gasoline after 2002. In 2000, the EPA began regulatory action to phase out use of MTBE in gasoline nationwide. Congress then enacted bills that ban MTBE use in all U.S. gasoline and provide for renewable fuels such as ethanol. In 2005, US Congress passed an Energy Bill, which began the removal of the oxygenate requirement in RFG in 2006. All major users of MTBE removed the ether from their gasoline formulations. As a result, the figures in this study show MTBE use in the US to be restricted to isobutylene production and exports (including to a number of countries in South America).

Methyl Methacrylate - MMA

As with many other methanol derivatives in North America, the center of gravity of MMA resides in the United States, with two small facilities in Mexico the only exceptions. Evonik in Deer Park, Texas is the leading manufacturer, having started up production in 2003. A significant portion of this material is dedicated to PMMA sheet and resin manufacture. Lucite International also has production in Texas and Tennessee, among other notable US manufacture.

On the demand side, manufacturers in the US have pioneered the development of more sophisticated, higher value-added MMA/PMMA and derivative applications and facilities, such as higher optics-grade organic glass, radiation shielding organic glass and optics fiber. MMA is also impacted greatly by PVC, as it is used to make plastics processing additives (e.g. for MBS), and surface coatings. After the decline in construction activity through 2009, the industry rebounded and has maintained demand growth through 2015. Growth is expected to continue upwards at a moderate pace through the end of the study.
Most trans-Pacific trade of MMA to Asia from North America comes in the form of derivatives such as PMMA and MBS (especially for higher value added applications). New capacity for these derivatives will be added in Asia at a rate much faster than that in the US, and as a result, the rate of increase in MMA and corresponding methanol consumption into MMA for is anticipated to be moderate in the forecast.

The MMA market in North America is summarized in the chart above. Demand’s upward path forward after through the forecast has kept production rates high and it is anticipated that investment in new MMA capacity will ensue sometime before the end of the study period.

**Methylamines**

Markets for methylamines in North America are spread out in the US, Canada, and Mexico. Taminco is the largest manufacturer of these products in North America. Manufacturing of methylamines, considering the increasing competitiveness of feedstock methanol and ammonia production, is becoming increasingly competitive in this region.

While some markets remain strong, i.e. choline chloride (via trimethylamine), dimethylamines for dimethyl formamide (DMF), and pharmaceuticals, cost factors have working to the favor of US production. As a result, growth in the forecast is expected to remain positive.
**Chloromethane**

In North America, methanol consumption into methyl chloride is also dominated by the US, mostly due to the well established chlorine production facilities in the United States Gulf Coast area. Dow and Vulcan Materials are the largest producers of methyl chloride. The overwhelming majority use for methyl chloride is in the production of silicones (elastomers, fluids, and resins). Silicones have diverse utility and are growing at a pace near or above that of the economy. However, some of these markets are mature, and in the US methyl chloride has been the subject of some government regulatory scrutiny (since methyl chloride is utilized largely as a chemical intermediate, environmental concerns are minimal compared to some of the other chloromethanes and chlorinated C2 solvents). The benefits of silicone are expected to outweigh environmental concerns in the forecast, which calls for moderate methanol demand growth from this sector in the North American region.

**Biodiesel**

As crude and refined product prices surged, interest in biofuels in the US was high, as energy and environmental issues were thrust to the forefront of the public’s conscience. However, the correction in energy prices through early 2016 and government meddling in markets has put the enormous amount of investment in poor standing, with many operations idled or running at low rates.

Biodiesel can be seen as beneficial as it substitutes for diesel from crude, is environmentally friendly, and gives greater support to domestic farmers. Nevertheless, process economics for biodiesel production in the US are no better than in Asia. If anything, costs are higher since soybean oil (the predominant biodiesel feedstock in the US) is more expensive than palm oil and logistic considerations are more complex as much production is based in the land-locked Midwest. These rising production costs will be the highest hurdle that the market will have to deal with in growing actual production, not just capacity.

In 2010, biodiesel plants in the US experienced a very tough situation after the expiration of the USD 1 per gallon blenders’ federal tax credit (NOTE: the “Biodiesel Mixture Excise Tax Credit” pays USD 1 per gallon for blending biodiesel into diesel fuel). Combined with European Union’s sanction on US biodiesel imports, the biodiesel industry in this region was indeed at the brink of collapse. By the end of 2010, US President Barak Obama approved an extension of the tax credit through 2011. Since then, with the country unable to balance its budget, enthusiasm for the continuation of the tax credit requires an approval for extension each year, which have been granted for 2016, but create uncertainty which dulls interest in the sector.

In addition, the cost model for a 17,000 ton biodiesel plant using soy oil feed compared with low sulfur diesel spot FOB prices in the US Gulf Coast remains negative. The differential has been typically been more than the amount of subsidy
that had been provided by the US Government – again due to expensive feedstock price. As a result those who are operating are doing so under duress.

In terms of supply, the US has approximately 200 biodiesel facilities which have a capacity to produce roughly 9.5 million metric tons of biodiesel annually. The great majority of these plants use soy oil as the feed, but many are utilizing technology that can handle multiple types of vegetable oil feedstocks (please see the appendices for a list). Canada also has a number of plants that are currently operational. These facilities run at a very low operation rate in aggregate, and no new investment in this area is anticipated in the forecast.

The large build up of biodiesel capacity has yet to reflect in increased methanol demand in North America. Unless biodiesel process economics improve to make production viable or more favorable policies are handed down from the government, operating rates are sure to remain low in the near-term.

**Methanol Trade**

In 2015, and as depicted in the following chart, North America net imports continued to plummet, despite demand growth in the United States, as US methanol production increased. In the next few years as more new facilities arise, an increased self-reliance will emerge, and exports will be required to support new production facilities. Most of the imports now come from mainly from Trinidad and Venezuela, with support from Equatorial Guinea (see global trade matrix and map in “Methanol and Derivative Trade” section of the study for details on sources and quantities).
SOUTH AMERICA

Overview

The South American economies of Brazil, Argentina, Chile, Trinidad, and Venezuela are the largest and most crucial in the region from the methanol purview, as they represent those countries with the most supply of, and demand for, methanol. With the exception of Venezuela, these countries have seen economic improvements over the past several years, and despite concerns about structural solidity, their outlook remains positive, increasing the small base of methanol demand in the region.

Yet on the supply side, methanol production in the region has contracted over the past five years, the result of a variety of factors which resulted in a limitation of natural gas supply in Chile, Trinidad, and Venezuela. These regions have been supplanted in large part by the United States in the Atlantic Basin, and increasingly must look to Asia as a target market for production. In fact, Methanex moved two of the idled facilities it owns in Chile to the US Gulf Coast, where they now both operate. That leaves the massive methanol complex in Trinidad as the leading South American producer.

Market Outlook

Trinidad has become one of the largest methanol producing countries in the world, in part by offering natural gas at competitive and flexible pricing such that operators are able to remain cash flow positive over a wide range of market conditions. Methanol Holdings (Trinidad) Ltd. (MHTL) followed Atlas with a commissioning of the world’s largest methanol facility in 2005, M-5000, also known as Titan. Trinidad has capacity to produce over 6.5 million metric tons of methanol per year, making it the second largest methanol producing country in the world (behind China, with the US close behind). Unfortunately, in recent years, the facilities have been plagued by restricted supply of natural gas feedstock to their operations. This had been a troubling development for both European and North American consumers who have relied on this production. Nevertheless, in the forecast there is a good chance that another 1 million metric ton per annum methanol facility will be constructed by a Japanese consortium, lead by Mitsubishi Corporation, which will be partially downstream integrated with DME production (100,000 metric tons per year). The project is expected to be justified as it is intended to support a government push to develop diesel-free transport on the island, among other factors. However, until financial close issues, the project has been omitted from the MMSA capacity list.

Chilean production of methanol is the sole domain of Methanex, which manufactures from a shrinking hub in Punta Arenas (at the southern tip of the continent), using a local natural gas as feedstock. The natural gas had been until 2007 purchased under long term arrangements from Argentina at significantly advantaged pricing, to the point where supply of methanol from this location was highly competitive, even after shipment to the USGC, and even to Europe.
(Rotterdam) and Asia (Yeosu). However, those days are long past, and the one operation still manufacturing methanol supplies local markets.

Chile has limited indigenous energy resources, with the exception of hydropower. As a result, the country must import the bulk of its energy needs. Chile's growing reliance on energy imports, particularly on natural gas, has not been without consequences. In 2004, Argentina began restricting natural gas exports to Chile, with cuts reaching nearly 50 percent of contracted volumes. Chile, in turn, began to reconsider its energy policy, which, prior to the import restrictions, had assumed an increased use of natural gas and power imports from Argentina. With Argentine gas still not flowing to Chile, the running rates of the Chilean facility remain restricted. As mentioned, two of the production lines in Chile have been relocated to the US. Methanex continues to search for natural gas in the region; there are some indications of success, although commercial terms have not been agreed.

Venezuelan methanol production is split between two large producers in Jose, a city which is the focus of the country’s gas processing industry. A third 850,000 metric ton per year Venezuelan methanol production facility was completed in 2010. Like Trinidad, Venezuela operations have suffered from limitations in natural gas supply – up to as much as 30 percent lower than required, especially when hydropower demand wanes (dry weather), and nat gas is diverted. The facilities here mostly serve markets in the US and Europe, with some demand in Brazil also met from Jose.

The chart above shows that South American methanol demand, which grows only modestly in the forecast, will come from traditional sources in the region. Biodiesel, particularly in Brazil, where diesel production from refineries is limited, and demand is supplied by expensive imports, is realizing growth in use, as is biodiesel demand in Argentina to a lesser extent.
Chapter V - Regional Market Analysis – South America

The chart below summarizes the South American supply and demand balance. The region will continue to suffer from poor operability due to limited feedstock, while continuing to be a major net exporter of methanol to the world, primarily to the Atlantic Basin, and these exports are not expected to grow appreciably in the forecast. Notably, the emergence of several large facilities in the US and Canada will generate more competition for methanol exports across the Atlantic Basin, and force some methanol exports form the region to Asia (which has already begun in 2016).

![Methanol Supply and Demand - South America](chart)

**Methanol Derivatives**

**Formaldehyde**

South American formaldehyde production capacity is sizable, protected by the impracticalities of shipping formaldehyde from remote locations. Major facilities are based in Brazil, Chile, and Venezuela, as listed in the study capacity tables. Smaller formaldehyde locations are also located near timber and wood panel producing regions of the continent. Brazil has the highest capacity in the region, including Hexion’s formaldehyde and resins factory at Montenegro, Rio Grande do Sul, Brazil. The facility manufactures 450,000 metric tons per year of phenol and urea formaldehyde resins. Venezuela has approximately 250,000 metric tons per year of capacity. Chile and Argentina both have less than 200,000 metric tons per year.

Formaldehyde operation rates in South America are positioned to decrease based on the expectation of investment in new capacity growing ahead of small, but accelerating demand growth. Formaldehyde demand will track economic activity in
the region as supply capacity remains constant. Investments in new formaldehyde capacity may be necessary later in the forecast to meet demand.

As shown in the chart on the following page, “Formaldehyde Demand by Derivative - South America”, formaldehyde is principally used in urea formaldehyde (UF), melamine formaldehyde (MF), and phenol formaldehyde (PF) resins, along with POM. After the global financial crisis, recovery has been observed through 2015. In addition, improved economies and strong domestic regional demand will account for the increase in demand later in the forecast. Investments in MDI and BDO would be possible if the infrastructure for urethanes and polyesters expands.

**Polyoxymethylene – POM (polyacetal)**

POM demand will grow more in the next five years than the previous five. By the end of the forecast, POM is estimated to require close to 100,000 tons of formaldehyde in South America. Ticona (a business owned by Celanese) is one of the major POM producers with one location in Brazil. Similar to North America, there are no new investments in POM capacity forecasted in the study period. Existing capacity will likely fill the growth in demand regionally.
Acetic Acid

There is currently no methanol carbonylation acetic acid plants located in South America. This is due to the fact that the US has large, established production bases for acetic acid. The five small-scale non-carbonylation plants are located in...
Colombia, Venezuela, Brazil, and Argentina. The previous chart summarizes the acetic acid supply and demand situation in South America for the forecast.

Demand for acetic acid mostly comes from VAM production. This demand is mostly met by imports from North America. Besides the relatively strong demand from VAM, TPA will also exert strong acetic acid demand in the forecast thanks to two new planned facilities in Brazil – causing the step jump from 2013.

![Acetic Acid Demand By Derivative - South America](image)

**Methyl tert-butyl ether - MTBE**

The ban of MTBE use in the US has had major implications on the need for methanol in South America. MTBE production is currently the secondly largest form of methanol demand in the region, but it has lost most of its market in the US. The use of MTBE has continued in South America, and methanol demand for MTBE remains at relatively small levels. The majority of plants located in Brazil, Argentina, and Venezuela have been forced to shut down or slow operations.

**Methyl Methacrylate - MMA**

Only one small MMA plant exists in Brazil. With production estimated at 51,000 tons in 2014, it required approximately 20,000 tons of methanol. The forecast does not call for any developments of MMA or downstream production. As a result, modest growth is reflected in methanol demand from MMA production in South America.
Biodiesel

Brazil has taken the initiative and interest to create and grow biodiesel production. In the forecast, Brazil will be the focal point of biodiesel development in the region due to its large arable land size, growing demand for diesel (without supporting investments in refining capacity) and its experience as a consumer and exporter of biofuels. Plants have been producing material there for blending since 2005.

In the forecast, Brazil will slow investment, although recent mandates for use, beginning with B8 (8 percent biodiesel blends with conventional diesel), increasing one percent per year up to a possible B15 level, are being proposed by the government.

Methanol Trade

As Trinidadian, Venezuelan, and Chilean production waned, the region was unable to grow its net export position. In the future, exports from South America will continue to meet new challenges as capacity is added significantly in the US.

Exports from South America continue to be redistributed mostly between Europe and the United States. However, plants in Venezuela, Chile, and Trinidad do not all have access to low cost transportation and terminalling capacity. As new US capacity comes on stream in the forecast, South American producers will be challenged in the Atlantic Basin. However, growth in exports is anticipated as natural gas availability in Trinidad is restored in the forecast and even greater should another Trinidad facility emerge.

**Methanol Net Trade - South America**

![Bar chart showing Methanol Net Trade from 2011 to 2021E.](#)
EUROPE

Overview

In this study, the Europe region is defined as the combination of West and East European countries. The lion’s share of this continent’s economic and methanol consuming activity is contained within the 28 European Union (EU) member countries, namely Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, The Netherlands, Portugal, Spain, Sweden, and the United Kingdom, plus the newly added (2004) countries of Poland, the Czech Republic, Slovakia, Hungary, Estonia, Latvia, Lithuania, Slovenia, Malta, Cyprus, Romania, Bulgaria, and Croatia (2013). Attempts to integrate business across this zone is slowly in coming, yet as a group these countries would seem to represent a major methanol consuming force. Yet the EU population significantly exceeds that of the US, with a lower GDP per capita. This suggests room for improvement in the economy. However, many of the debt-laden EU member countries are in stagnation economically, with recent high energy prices adding to the dynamics. Thus in the near term, economic growth in the European area will be remain modest at best.

Methanol consumption is relatively mature, although growth in Eastern European countries has been evident. Supply in Europe predominates in Germany, and there is the large facility in Norway which has the advantage of processing associated gas from crude oil production. In the forecast, European production capacity is not expected to grow, and as Middle Eastern and African imports become more and more available in the forecast, production of methanol in Europe will be threatened. Given the integration of methanol production with refinery streams, a new battleground in Europe for methanol supply could well be established in the study forecast period.

Market Outlook

Methanol

Today’s methanol industry formed its roots in Europe, with several applications and processes making and using methanol developed there as far back as the 1930’s. To this day, a large amount of methanol production and catalyst technology resides in European countries.

However, given the age of methanol and methanol derivative facilities, and relative high cost of feedstock for any potential expansion of production, and the proximity to the Middle East and North Africa, where methanol is produced at low cost, it is expected that this region of the world will slow down its relatively high cost production, and meet demand growth from increased levels of imports of methanol during the study period.
There are 4.35 million metric tons per year of methanol production capacity in Germany (with 480,000 metric tons per year captive), The Netherlands, Norway, the Former Yugoslavia, and Romania. The latter two facilities are run opportunistically, with the Romanian asset having captive needs. Operations, though high cost, are somewhat insulated as methanol demand is centered in the middle of the continent, and requires additional costs for competitive deep sea methanol suppliers to surmount.

Demand for methanol in Europe is summarized in the chart below, showing the large role that formaldehyde has and will continue to play in methanol fortunes in the region.

In the forecast, high cost or non-advantaged methanol production in Europe will continue to rationalize, particularly gas based operations which must purchase feedstock at market prices. Methanol production facilities linked to refineries or with access to “associated” natural gas (e.g. Statoil in Norway) should be able to continue operations in the study period, although European facilities are now exposed to much lower cost methanol production, and refineries will have to consider whether or not their operations continue to make economic sense (particularly with the high values of liquid feed in the refinery based facilities). Alternatively, the marginal income from methanol operations at these facilities does cover a lot of cost. Egyptian methanol production is targeted at coastal European markets, accommodating growth in demand but also challenging continental operations. Providing a near term respite for local production has been the EU sanctions on Iran, which removed a significant supplier of methanol to the continent. However, this has required the use of high cost capacity, and has helped generate price increases in Europe.
By the end of the study period, the added demand for methanol in Europe will be met from import sources, and production from European sources will continue to decrease.

Total demand is well in excess of supply capability, and as a result Europe is a large net importer of methanol. The following chart quantifies these points, constructed from the supply and demand data provided in this study’s appendices:

Methanol demand in Europe is weighted to the more traditional segment of formaldehyde. In 2013, surprising growth in methanol demand for MTBE arose as it was a more economic choice than high cost ETBE (which also suffered from waning support for first generation biofuel initiatives). Acetic acid based methanol demand has been slightly reduced in the near term forecast, as production facilities have closed. The distribution of methanol demand by derivative is shown in the chart on the following page.

Investment in methanol derivative capacity in Europe will continue, but will be limited to expansions at existing facilities, with few exceptions. One exception is the investment of EVONIK in 150,000 metric tons additional MTBE capacity shared between their units in Antwerp and Marl. Also, methanol demand growth for alternative energy purposes will be stimulated by the shipping industry, working under IMO (International Maritime Organisation) regulations reducing sulphur emissions. In particular, one ferry line – Stena in Sweden, is leading the effort. Over the report period an increasing methanol demand is assumed across the North Sea and the Baltic Sea SECA (Special Emmission Controlled Area). As the subsequent text in this section will elaborate derivative by derivative, the combined
total of methanol growth in Europe is expected to be positive, although with some limitation.

Within Europe, there are three major regions of market activity; Rotterdam in the Netherlands, Germany (along the Rhine and direct shipments along the Atlantic coast), and the broad Mediterranean region. These are discussed in bullet point format, below:

**Rotterdam**
- Rotterdam is one of the world’s major centers for oil and chemicals, a sprawling logistics center for the massive in and out flows of liquid, solid, and gaseous chemicals, among other goods. Its strength lies on its strategic location and easy access to markets all over Europe via road, rail, and barge.
- Widely recognized as the methanol hub for Europe, Rotterdam also serves as an important gateway for imported methanol, before being distributed into other areas within Europe. Because of this importance, spot methanol prices in Europe typically agreed on FOB Rotterdam basis.
- Several traders have used Rotterdam port as bulk breaking (or even bulk building) facility before re-distribution to other destinations.
- Rotterdam will continue to be a crucial market center for marketers of methanol to interact with, and understand how to utilize.

**Germany**

Methanol supply to German consumers comes in via the Rhine River from Rotterdam. However apart from shipping Germany needs additional supply via rail
and road to refineries, chemical parks and specialized chemical units for various applications. For biodiesel (rapeseed base) alone Germany needs more than 250,000 metric tons organized by distribution, not including the same for chloromethane (for silicones), animal feed, water treatment, coatings and other consumers.

- In terms of methanol demand into formaldehyde, BASF, at their Ludwigshafen chemical complex, dominates formaldehyde production. Notably, when combining BASF with the operations of Bayer, EVONIK, Perstorp, Lanxess, Ineos, and Celanese, Germany makes almost two out of every five metric tons of formaldehyde in Europe.
  - Correspondingly, this country also has strong formaldehyde derivatives capacities, including significant wood-based product production – a practiced fostered due to difficulties in shipping formaldehyde in large quantities (which is highly toxic and has been targeted as a potential carcinogen). Taking one example, the output of particleboard, fiberboard, and MDF are among the highest compared to other European countries in the last few years.

- Germany also has notable production capacity for other methanol derivatives, including MMA, MTBE, and silicon. Wacker Chemie operates two silicon manufacturing complexes in Burghausen and Nünchritz with no Rhine access. Elsewhere, imported methanol comes down the extensive river complexes in the center of the country, and on the Elbe in Hamburg in the north of the country.

- Germany has 1.68 million tons per annum of methanol production capacity. In the forecast, however, production at some of these facilities is threatened by Middle Eastern and African imports as these become more available. Nevertheless, given the integration of methanol production with refinery streams, a new battleground in some facilities in Europe for methanol supply could well be established in the next few years.

- In the summer of 2015, a drought in Southwest Germany served as a reminder of the importance of the Rhine to methanol markets, when certain segments of the river became unnavigable, requiring quick and massive changes to delivery channels in a short period of time. Round-trip timing for a vessel fully loaded to Ludwigshafen and back to Rotterdam (empty) takes roughly four days. Changes to water levels can occur on a much longer timeframe, and this consideration is a feature of German methanol markets, even though levels have returned to normal.

**Mediterranean (Med)**

- This broad region, stretching from Iberia to Turkey, has no methanol production, with all methanol demand supplied by imports into ports of widely ranging size.
  - Major importers to the Med are Libya and Algeria, with the Middle Eastern countries Russia, and Egypt making further and further inroads in the forecast period.
The Mediterranean methanol market for the countries and period studied pits different forces against each other

- On one hand, the combination of idled methanol derivative consuming assets and poor economy has hurt methanol consumption in the region in 2009. Some recovery has been seen since then, but the pace is still lagging other emerging economies, particularly due to ongoing economic concern in the region.
- On the other hand, biodiesel holds promise as a consumer, with large upside potential, however many political and economic hurdles stand in the way of realizing potential, which could be as large as an additional 500,000 metric tons per year.

- As economies recover, formaldehyde, which underpins most of the methanol consumption in the region, will eventually return.
- There is little foreseen investment in downstream methanol consuming capacity through 2016, and therefore, even with modest growth in biodiesel demand, methanol demand growth will be flat.

Finally, it is worth mentioning a fourth market within Europe – that of the Atlantic Coast. Ports in Sines, Aveiro, Vigo, La Conruna, and Bilbao organize direct supply of methanol, mostly used for formaldehyde and distribution. Supply to Bilboa serves consumers located in South France by truck.

**Methanol Derivatives**

*Formaldehyde*

Formaldehyde production also saw its origins in Europe in the early part of the 20th century, and a thriving industry still exists. Capacity to produce formaldehyde is concentrated in wood panel producing countries, with over 70 percent of this capacity found in the eight largest producing countries, depicted in the pie chart on the next page. Detailed listing of formaldehyde capacity for the study period is shown in the study appendices.
BASF, at their Ludwigshafen chemical complex, dominates formaldehyde production. Notably, when combining BASF with the operations of Bayer, EVONIK, Perstorp, Lanxess, Ineos, and Celanese, Germany makes almost one out of every three metric tons of formaldehyde in Europe.

As shown in the following chart, during the forecast period, new grassroots, world scale formaldehyde facilities for new derivative investment are not anticipated. However, expansions of capacity, particularly in the less developed countries of Europe, are possible, and a recent trend toward formaldehyde buyers installing their own facilities on location is likely to continue. Some examples are Arauco and Sonae, which formalized a previously announced JV (Sonae – Arauco, S. A.) in Spain. Arauco purchased 50 percent of Spain’s Tafisa, with production units in Spain, Portugal, Germany and South Africa. Sonae-Arauco’s production capacity will near 460,000 m3 OSB, 1.45 million m3 MDF, 2.27 million m3 particleboard and 100,000 m3 of sawn timber. In addition, ARAUCO has plans to build a new panel mill in Michigan, USA, with an overall annual production capacity of 750,000 m3. Also, Italy’s Fantoni SpA is expanding investment at its Osoppo site, with a new MDF production line of 460,000 m3 per annum (Start-up scheduled 2017) The group has 4 MDF lines at Osoppo with a total capacity of 800,000 m3 per annum, and 430,000 per annum of particleboard. Their Novolegno factory produces roughly 210,000 m3 per annum of MDF. In Russia and Eastern Europe, confidence in continued laminate flooring growth is high. Austria’s Egger Group is expanding its existing MDF facility in Gagarin, Russia, shifting a plant from Germany.
As the chart on the next page depicts, a majority of formaldehyde consumption goes into the production of resins, which are primarily used in the production of wood based products.
Not surprisingly, therefore, with the exception of a few locations, formaldehyde production is located in countries with very significant wood and wood-based panel production.

There is, of course, a strong correlation between formaldehyde capacity and wood-based product production. This mostly due to the difficulties in shipping formaldehyde in large quantities; formaldehyde is highly toxic and has been targeted as a potential carcinogen. There is also trade of resin product between these countries, although this is also avoided where possible.

Other significant formaldehyde derivatives in Europe (other than POM, which is detailed in commentary below) are MDI and 1, 4 butanediol (BDO). BASF, Dow, and Huntsman are all leading MDI producers, with Hungarian producer Borodschem adding new capacity in 2005. BASF is the leader in BDO production in Europe.

As in North America, regulatory issues relating to concerns about formaldehyde’s carcinogenicity are substantial on the continent. The European Wood Based Panel Federation (EPF) has taken several steps to help ensure common legislation throughout Europe, including classification of formaldehyde, and definition of which products can be used (including imported materials). For details, please contact the EPF.

With the anticipated growth in economy, along with continued health of the wood industry in Europe, formaldehyde derivatives demand will continue to grow. Therefore, the outlook for growth in methanol demand for the production of formaldehyde during the study period is positive, and is reflected in the forecast numbers available in the appendices.

**Polyoxymethylene – POM (polyacetal)**

This engineering plastic is made and consumed in significant quantities in Europe. The largest producers are Ticona (83,000 metric tons per year of POM production capacity in its Kelsterbach, Germany processing and compounding complex), Ultraform GmbH (a JV involving BASF, with 32,000 metric tons of POM production operated by BASF at its Ludwigshafen integrated complex), and DuPont, with a 30,000 metric ton per year polyacetal operation in Dordrecht, the Netherlands. Minor quantities of polyacetal resins are also produced in Eastern Europe.

Demand is concentrated primarily on the automotive industry, which is the prime consumer of POM in Europe. There is significant use in mechanical parts, including seat belts, in automotive applications.

There is also significant use in electrical, consumer and industrial applications such as keyboards, ski bindings and audio and videocassettes. The more developed applications for POM in Europe are becoming is increasingly impacted by imports of resin, notably from Asia. The region also exports products, and in the forecast
period, growth in methanol/formaldehyde demand from this sector will be limited to expansions in existing facilities.

Acetic Acid

After a 2009 rationalization of French operations, the majority of European acetic acid capacity remains contained within the UK and Germany, based on the methanol carbonylation process. The European market had been extremely oversupplied, with production well below nameplate capacity (just below 50 percent – see supply and demand balance tables in the study appendices). In addition, supply of acetic acid as a co-product of polyvinyl alcohol production lengthened acid supply on the continent. The chart here demonstrates the distribution of supply geographically within Europe, with BP in the UK having the lion’s share of production:

![2015 European Acetic Acid Capacity Distribution](chart)

In response to the market length, Celanese and BP Chemicals closed non-carbonylation process acetic acid facilities in the UK and Germany in 2005. Additionally, BP increased production of acetic acid in Hull in 2007 using a lower cost process. In 2009, Celanese mothballed an older and higher cost acetic acid facility in Pardies, France.

With acetic acid derivatives growing at a relative slow pace relative to other regions of the world, particularly Asia, and production availability from Asia and the Middle East increasing, the Europe region has become a net importer of acetic acid, and is expected to remain so in the study period. By the end of the study period, thanks to the rationalization of Pardies, and modest demand growth, operating rates should improve. The chart below represents these views graphically:
With respect to demand, vinyl acetate monomer dominates acetic acid consumption in Europe. Celanese is the clear leader in VAM production on the continent. No new addition of VAM capacity is anticipated in the forecast, holding back demand growth for acetic acid. There is little investment in acetic acid consuming derivatives.
in Europe identified in the forecast, and as such demand growth is seen to be relatively flat in the forecast. The previous chart shows a graphic representation of sector demand growth for acetic acid in Europe:

In short, only a slightly positive demand for methanol from acetic acid operations in Europe is forecast through the study period.

*Methyl tert-butyl ether - MTBE*

The experience of the MTBE industry in Europe, while less politically controversial than in the United States, has several of its own challenges. The industry grew along with the market in the United States, with several international refiners utilizing MTBE as a replacement for lead and, in general, an extension of the octane pool from available C4 streams from existing refineries. However, several MTBE facilities in Europe have been converted to utilize ethanol in place of methanol, creating ETBE. These facilities have been campaign run, as the cost of ethanol permits. Until 2013, methanol demand into MTBE production had been negatively affected. However the campaign turned solidly to MTBE after ETBE costs soared. In the forecast, it is assumed that both MTBE and ETBE will be produced in Europe, and given the current political climate as it relates to EU biofuels, the majority of oxygenate producers should continue to switch back to MTBE.

Additionally, the future of the local European ethanol business is threatened by low priced imports of ethanol from the US. So much so, that in 2015, the European Commission proposed anti-dumping duties on US fuel ethanol imports for five

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**2015 European MTBE Capacity Distribution**

-000- metric tons

- Netherlands 2,085
- Austria 610
- France 305
- Sweden 134
- Bulgaria 76
- Czech Republic & Slovakia 61
- Germany 512
- Italy 135
- Portugal 50
- Italy 360
- Germany 610
- Austria 134
- Bulgaria 76
- Czech Republic & Slovakia 145
- Former Yugoslavia 61

Total Capacity: 4,748 thousand metric tons
years. While this helps protect the local industry, it does little to make ethanol more competitive as ether based oxygenate feedstock.

The chart above shows that, of the over 3.3 million metric tons of MTBE production capacity in Europe, the top five countries (each with major refinery and petrochemical centers) contain about 70 percent of the MTBE manufacturing capability. (Note that in 2013, almost 1.5 million metric tons of ETBE capacity switched back to MTBE, including a Ravenna facility late in the year. The pie chart above will be modified to reflect these changes – please contact MMSA).

By far, the largest producer in Europe is LyondellBasell, with 1.2 million tons of capacity split almost evenly among two production centers in France and the Netherlands. Lyondell utilizes a process which involves the chemical removal of water from tert-butyl alcohol, which is readily available as byproduct of another petrochemical process in the Lyondell complexes. However, Lyondell and other manufacturers are increasingly switching capability to produce ETBE instead of MTBE, essentially using ethanol in place of methanol to make oxygenated gasoline additives.

Spain’s Energy Company Abengoa started insolvency proceedings in 2015. The Seville-based engineering and renewable energy firm, which has biofuel and solar-heated power plants in the United States, has been struggling for a year with high debts. Abengoa has been a supplier of ethanol for Spanish ETBE production. In Spain alone this company employs almost 30,000 people, and a switch back to MTBE would help save jobs. Currently Abengoa owns units in Cartagena, able to produce 100 million litres of Bio-Ethanol and La Coruña, which can produce 126 million litres of ethanol. In fact, Repsol YPF adapted its MTBE plants to produce ETBE from ethanol supplied by Abengoa. This process, which started in 2000 with a project for adapting the La Coruña and Puertollano facilities, was completed in 2002 with two plants in the Tarragona refinery and one in the Bilbao refinery. After revamping the five Repsol YPF ETBE production plants in Spain, production capacity for this product is about 450 million litres per year in all five ETBE production plants. All this capacity is subject to change assumed Abengoa will fall out as an ethanol supplier. The possible return to MTBE would create roughly 100 ktpa of demand for methanol in Spain.

Ongoing difficulties and returned outfalls of an olefins cracker in Moerdijk – NL resulted in interrupted C4 supplies impacting the local MTBE production. After explosion and steam leakage last year leading to close the operation for months, a fire in one of the compressors caused another closure. However, customers continue to feel the aftereffects under lack of supply. Certainly MTBE production is suffering under lack of C4 supply.

The near-term historical growth in MTBE demand has come from EU directives for gasoline specifications aimed at improving urban air quality. These directives phase out leaded gasoline (petrol), as well as reduce aromatics (benzene), olefins, and
sulphur levels in gasoline. The specifications were fully implemented in 2005, and compliance appears to be well implemented in the region. MTBE is anticipated to continue to make up for the loss in aromatics in gasoline which will issue from these directives.

Other major factors affecting MTBE demand in Europe:
1) MTBE can no longer be exported in the form of reformulated gasoline (RFG) to the United States.
2) Exports of neat and blended MTBE to South America, Nigeria, and other destinations have grown and will continue.
3) Anti-dumping measures have been taken against fuel ethanol from the US, limiting supply to the EU and keeping costs higher.
4) A change in politics has removed subsidies for bio-ethanol in Europe substantially. Major European merchant producers (representing about 1.9 million metric tons of MTBE production capacity) are therefore likely to maximize their purchases of methanol versus ethanol.
5) Finally, diesel fuel consumption in Europe continues to grow at the expense of gasoline demand, primarily the result of lower taxes on diesel fuel in several EU countries.
6) The once ballyhooed production of “bio-MTBE” from “bio-methanol” (made using the gasification of by-product glycerine from biodiesel production) looks to be highly improbable, mostly due to high glycerine costs on limited availability, among other factors.

On the whole, therefore, unlike the situation in the United States, MTBE will remain an important gasoline component in Europe through the study period. However, highly akin to the US problem, MTBE growth in Europe will remain checked by ethanol based alternatives and eco-political forces. The forecast accordingly has methanol demand from MTBE production in Europe growing to a small extent.

*Methyl Methacrylate - MMA*

MMA production in Europe has been consolidated by the major international manufacturers, EVONIK (Germany) and Lucite International (UK – recently purchased by Mitsubishi Rayon). Atofina has been aggressively expanding its access to production capacity, with two MMA production locations in France and Italy. In 2009, Arkema permanently closed down the 90 ktpa MMA plant in Carling, France whereas the new 100 ktpa MMA plant belonging to Quinn group (Leuna, Germany) has been delayed.

PMMA used dominates MMA consumption in Europe, and is consumed by the typical applications (sheet and resin products, used in automotive, construction, appliances, among others). In Europe, MMA is also used in applications such as acrylic emulsions, plastics additives, and specialty products that find their way into paints and coatings; packaging applications; vinyl siding and other construction materials. However, most of the large volume applications for MMA are mature, and
growth in these materials is anticipated to be moderate as a result. In the forecast, demand is expected to recover with the economies.

The Eurozone area had been net exporter of MMA, until recent decisions by local manufacturers to invest in China rather than Germany, and the incremental demand is partially made up by imports. Later in the forecast period, operating rates will improve.

**Biodiesel**

Europe is the only region to have significant biodiesel production operating since the 1990s. True to its relatively environmentally-friendly perspective, biodiesel production incentives such as subsidies and tax breaks have been in place for many years in certain countries to encourage production.

The EU passed legislation that set ambitious biofuel targets for 2010 and beyond. Interestingly, this legislation is non-binding and comes at a time when countries are becoming less willing to provide incentives for producers (due to rising costs of fuel subsidies) and when process costs are at all time highs (rapeseed oil is the predominant feedstock used in Europe, but is also one of the highest priced vegetable oils). As a result, production and use are well beneath target levels.

Biodiesel projects once in the pipeline have largely disappeared. Asian and South American production have been targeting the European market, although duties and protectionist actions are limiting these imports. Specifically, the council implementing regulation (EU) No 1194/2013 of November 2013 imposed a definitive
anti-dumping duty imposed and collected on imports of biodiesel originating in Argentina and Indonesia, with specific levels depending upon injury. The anti-dumping duty will also apply to blends that include biodiesel (in proportion to their biodiesel content by weight), as well as to pure biodiesel. For details, please contact MMSA.

The growth in European capacity during the forecast period is shown in the chart below. Like North America, new projects have been put on hold until the existing capacity can start to show profits.

As can be seen from the chart, Germany has been the largest biodiesel producer in Europe. France, Austria, and Italy are the other historically significant producers. In the forecast, Spain will continue to expand capacities. However, a large percentage of the projects that have been completed run at low operating rates. Projects in Belgium, the UK, and the Netherlands have also underwhelmed expectations for production due to costs. Demand in the market will be largely swayed by how well these “new” countries foster and grow their biodiesel policies. Methanol demand from this sector has been, and will continue to be, less than originally envisioned.

*Others*

The newly-converted Stena Germanica, the world’s first methanol-powered ferry, was delivered at the end of March 2015, and put into service soon after. By using methanol as its main fuel the vessel, which is owned and operated by the Swedish ferry operator Stena Line, is able to reduce her emissions of sulphur by 99%, NOx by 60%, particulates by 95% and CO₂ by 25% thus complying with the latest ECA
regulations on its Baltic Sea route. The Stena Germanica is one of the world’s largest ferries, 240 metres long, with a capacity for 300 cars and 1,300 passengers. The ship’s modified diesel engine runs on methanol and MGO – Maritime Gas oil containing 0.1% sulphur.

While regulations in the North Sea have created a large opportunity for methanol use, there are many reasons why markets will likely see relatively small demand from this application until later in the study period, first of which is the significant drop in costs of fuels competitive to methanol which can perform the same task. However, any return of oil prices to 2013 levels would certainly change this assumption.

Methanol Trade

The high cost of production of methanol in Europe begets imports. Historic imports of methanol to the major Eurozone countries are shown below.

Until 2015, Trinidad, Russia, Saudi Arabia, Venezuela, and Russia provided most European methanol supply. Then, The US and Oman stepped up trade to Europe, replacing Egyptian and African material. EU sanctions on Iran essentially stopped imports from there, yet are expected to return to a modest amount in the forecast. Otherwise, patterns are not expected to change after 2015, when significant new production in the United States will force a realignment of trade flows in the Atlantic Basin. In short, it is expected that the US will compete with higher cost elements of European trade (esp. Middle East Gulf) for supply of methanol to Europe.
RUSSIA (PLUS INDEPENDENT STATES)

Overview

Russia and the states which became independent from the USSR are included in this geographical grouping. Russia is and will remain the dominant economy in this category. Russia holds the world’s largest natural gas reserves, and is in the top ten in coal and oil reserves, making it a key player in the global methanol market outlook. [Russia is also the world’s largest exporter of natural gas.] Another precipitous economic collapse caused by a large drop in oil prices has the Russian economy once again slowed. With oil revenues making up almost a third of the GDP of the country, the economy of Russia has been negatively affected since the latter part of 2014. However, as the drop has helped devalue the ruble, which is the currency for natural gas sold in the country, Russia’s position as an exporter of methanol has been enhanced. Additionally, the region’s large forestry reserves offer the prospect of low cost feedstocks for wood panel production, supporting reinvestment in methanol consumption capacity.

Given its expansive shared borders, the country will have important ramifications on methanol use, particularly in Europe and Asia. Tensions with Ukraine remain in the background, although these are not expected to disrupt supply in the forecast. In the forecast, supplies of methanol from Russia (via Ukraine) to Europe are expected to come face to face with Middle Eastern and other lower cost supply. To the extent that this region can increase its own consumption of methanol and derivatives, it will improve the already good health of its current operations. However, any increase natural gas prices in the pipeline to Europe will continue to pose a threat to current and future local producers.

Market Outlook

Methanol

5.25 million tons of methanol production capacity exists in the region, and the operating rate of these facilities has risen and fallen over the past several years. Leading producers are Togliatti, Metafrax and Tomsk, each with world scale facilities that utilize remote (Metafrax is in Siberia) and reasonably priced natural gas feedstock. These facilities are reliant on the country’s rail infrastructure for exports, although each location has relatively large formaldehyde producers nearby who are reliant on their output. There are also a dozen or so smaller methanol producers who serve mostly local markets, almost all gas based.

Taking a cue from the oil industry in Russia, methanol producers have been able to survive over the past several years primarily from increasing exports (mostly to Europe). New methanol facilities have generally been non-integrated, increasing the needs for exports. However, integrated complexes which also manufacture methanol...
derivatives for in-country use are becoming more prevalent. A list of projects identified in the forecast is shown in the appendices.

New projects in this time period include a late 2011 startup of ShchekinoAzot’s 450,000 metric ton plant at Shcheyokino, which coincided with the mothballing of their nearby, old facility (384,000 metric tons). After almost 5 years of negotiations, the ZAO Uralmethanol Group 600,000 metric ton operation at Nizhny Tagil continues its quest to come onstream. The sponsors have selected the Haldor Topsoe A/S process for methanol production, with design developed by the Chimtechologiya LLP design institute of Ukraine. The EPC contract was awarded to Czechoslovakia’s ALTA. The start of construction occurred in mid 2012. Like most Russian facilities, a portion of the product will be marketed locally, with the rest slated for exports (via railway and truck tanks).

The 560,000 metric ton per year Azerbaijani facility of Azmeco, located at Garadagh near Baku has finally started after numerous delays. Its production has been limited due to limited market access, and some legal complications. In addition, there is an ammonia / methanol co-production facility in Tatarstan planned, although the target schedule is less clear. The facility is designed to produce of around 200 ktpa of methanol at full swing, but the actual production might be far less, especially if the ammonia production is maximized. Later in the forecast, a new facility near St. Petersburg is on the drawing board, seeking financing.

The enthusiasm for methanol projects which the Russian methanol industry displayed ahead of the financial crisis met with economic reality. Additional projects proposed in Russian are numerous. Several projects under consideration have been delayed or otherwise shelved. Please contact MMSA for details.

Methanol Use - Russia
By Derivative

- **Formaldehyde**
- **Acetic Acid**
- **Methyl Methacrylate**
- **Dimethyl terephthalate (DMT)**
- **Methyamines**
- **Methyl Chloride (Chloromethane)**
- **Biodiesel**
- **Methyl Methacrylate (Chloromethane)**
- **Methanol-to-Olefins**
- **DME**
- **Others**
- **Methyl tert-Butyl Ether (MTBE)**
- **Gasoline Blending & Combustion**
- **Fuel Cells**

<table>
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<th>Metric Tons</th>
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<td>2015</td>
<td>1.74</td>
</tr>
<tr>
<td>2021E</td>
<td>1.92</td>
</tr>
</tbody>
</table>
In terms of demand, as shown in the chart prior, Russian methanol is and will continue to be primarily used for formaldehyde and MTBE operations. Domestic demand remains well below total capacity to produce, and despite growth in the forecast period, this condition will hold. However, as will be discussed in the sections on methanol derivatives, significant investment in methanol consuming operations for formaldehyde and MTBE is being planned, mostly for domestic purposes (including wood panel operations which can be exported).

Geographically, methanol demand in Russia and independent former Soviet states is broadly distributed, as depicted in the map below, which shows the locations of major methanol producing and consuming locations around the region. With few exceptions, most of which are for MTBE production, methanol derivative demand is located close to methanol production hubs around the country. Methanol which is not consumed near the production location is dedicated for export. Methanol facilities in the center of the country rely on rail transportation of product, whereas some facilities in the northwest are able to access markets using ocean based freight. However, in these far northern ports, ice formation can be a hindrance to exports in the winter months, and rail and truck transportation of methanol to export markets is also practiced.
Russian production continues to grow, as shown in the table to the right. As domestic demand increased by almost 300 kmt in 2015 (to 2.38 million mt), exports dropped correspondingly. In 2017, Shekinoazot in Tula plans to commence operations at a 450 ktpa facility.

The chart above summarizes the forecast for methanol supply and demand (data provided in detail in the appendices). Notably, production is expected to rise in the forecast. Russian exporters of methanol will increasingly find competition with low cost Middle East, Trinidad, and Egyptian methanol in Europe, and with high distribution costs (especially rail), will find it difficult to compete on a cost basis. And local demand, while recovering, is not sufficient to keep all facilities running at full rates. As a result, high cost producers in Russia will find it more difficult to create high levels of margin during the forecast period, and will be dependent upon prices set by other regions (largely Asia). The forecast thus anticipates that methanol exports from this region will grow slowly as added capacity is brought on later in the forecast period. However, a recent depreciation of the ruble has helped some Russian production to be more competitive, as these buy natural gas in rubles (and sell internationally in € or USD).

The chart on the following page shows the region’s methanol demand by derivative, and underscores the dominant role of formaldehyde on methanol demand, which is
discussed in the next section. In 2010, the world’s economic slowdown was detrimental in terms of formaldehyde and MTBE consumption in Russia, but a rebound has been noted through 2013. Notably, and as discussed below, acetic acid demand is expected to moderate as lower cost production from Asia pressures high cost production in Russia. Note that MTBE demand is expected to remain relatively constant, with the assumption that the new facilities planned will not commence commercial operations before the end of the study period.

**Methanol Derivatives**

**Formaldehyde**

Russia is one of the world’s powerhouses in wood products, and, taking advantage of this resource via exports to Europe and China, the formaldehyde industry had blossomed until the global financial crisis impacted demand for wood panels in all markets. There are eight relatively large producers of formaldehyde in the region (see appendices for details), and two of the largest are located near the methanol producing centers in Tomsk and Gubakha. Metafrax started two urea-formaldehyde concentrate (UFC) plants in 2005, lifting their existing capacity there by 120,000 metric tons per year (37% basis). Additionally, a new formaldehyde plant of 270,000 metric tons per year is now operational also for Metafrax in partnership with Dynea (MetaDyne) in Gubakha. A 200,000 metric ton facility in Orekhovo-Zuevo has also started, owned by a Karbonit/Dynea JV.

The integration of methanol and formaldehyde with wood product in one complex supports domestic demand growth of formaldehyde, with a rebound in demand
seen through the study period (after the precipitous fall in 2009). Recovery is set to extend in the forecast period. Please refer to the chart on the following page:

Formaldehyde derivative investment is significant also. MetaDynia, a joint venture between Metafrax and resins and adhesives producer Dynea, completed its 400,000 metric ton per year formaldehyde resin facilities. The period growth in derivatives is

Formaldehyde Demand By Derivative - Russia
shown in the previous chart. Note that the “others” category is dominated by an isoprene manufacture process which consumes formaldehyde.

Istanbul based Turkish panel producer KASTAMONU opened a second MDF-line at its Russian woodworking site in Alabuga. On completing the pre-commissioning activities, the site’s production capacity will surpass 1 million m3 of panel boards per year. In 2016, the company expects to start chipboard production of 725,000 m3 per year, and in 2017-2018 OSB production of 575,000 m3 per year. Total capacity of the KASTAMONU plant in the SEZ Alabuga is slated to reach 1.8 million m3 per year, the largest wood processing facility in Europe.

**Acetic Acid**

Acetic acid producers in the region are relatively small on a world scale, with one methanol carbonylation facility in the Ukraine, and another in Russia. Production from these facilities is well below nameplate capacity, with the region currently a small net exporter, mainly due to the tight situation for acetic acid globally. There is only slight growth in acetic acid derivative demand, nevertheless it is expected that domestic demand for these materials will improve with the improving economy and related construction industries. The chart below represents these views graphically.

Currently, the traditional derivatives of VAM, acetate esters, and acetic anhydride dominate acetic acid consumption in the region. Beginning in 2006, new terephthalic acid capacity came on stream, which has slightly increased demand for acetic acid. VAM sector demand is expected to be flat, with industry capacity holding level.
Please refer to the chart on the following page, and the supply and demand balances (see the appendices) for details.

**Acetic Acid Demand By Derivative - Russia**

![Acetic Acid Demand By Derivative - Russia](image)

**Methyl tert-butyl ether – MTBE**

There are over 700,000 metric tons per year of MTBE production capacity in Russia, and these have been running at relatively high operating rates over the past several years. Growth in demand for these materials is forecast at GDP growth rates, mainly in support of the strong demand growth in gasoline and refinery operations in the region. However, the demand growth will largely need to be met by imported material.

There are plans for MTBE facilities integrated with methanol production, but these are not anticipated to make a significant commercial impact by the end of the forecast. Environmental issues around MTBE in Russia are not entirely clear, although there is less of a political lobby promoting ethanol, due mainly to the relatively weaker farm industry in the country.

**Methyl Methacrylate - MMA**

There are a mere 50,000 metric tons per year of MMA production capacity in Russia. Growth in demand for these materials is forecast at GDP growth rates, although the smaller operations are subject to competition from imports later in the forecast.
Methanol Trade

Net trade of methanol from this region has been overwhelmingly export oriented for the past few years, because of high international pricing (related to relative global shortness of methanol). A profile of regional exports and imports is shown below:

Methanol exports from Russia are expected to gradually improve as demand from Europe calls and/or other European suppliers either focus product on Asia.
MIDDLE EAST

Overview

With respect to methanol, the most important Middle Eastern countries are Saudi Arabia, Iran, Qatar, Oman, and Bahrain. These countries are major producer-exporters of methanol, having invested in natural gas conversion technology in an effort to keep value and grow jobs in their own countries. As compared to other regions in the world, these countries have a relatively minor methanol derivative consumption profile, although investments in derivative production will increasingly occur in the study forecast period. With access to enormous quantities of natural gas (three of the world’s top four countries in proven natural gas reserves are in this group: Iran, Qatar, and Saudi Arabia), Middle East countries are expected to contribute significantly to regional investment in methanol production capacity.

Supply of methanol is expected to be limited to Iran in the forecast. Economics for low cost natural gas projects remain plausible, and particularly attractive if they include integration downstream to methanol derivatives. In fact, more emphasis has been placed on downstream investment in this region rather than greenfield, export based methanol facilities. Regardless, Middle Eastern producers will continue to export methanol in the forecast, targeting Asia and Europe to keep facilities running at high rates. Following a summary of the regional methanol outlook, each country will be reviewed.

Concerns the global methanol community had about the impact of EU and US sanctions on the ability of Iranian methanol to continue flowing were largely unfounded. While a slow down in production and exports from Iran has occurred, the market has been able to accommodate these relatively minor changes, with the net result that Europe now has a slightly higher cost base of supply. With Iran now off the list of EU sanctions, the impact will likely be limited as well.

Market Outlook

The Middle East is the second largest methanol producing region globally after Asia. With the lopsided balance between the region’s natural gas resources and ability to consume methanol and methanol derivatives, this region will also remain the largest methanol net exporting region during the study period. The chart on the next page underscores the relative lack of diversity in methanol derivative use now, and by the end of the study forecast. Methyl tert-butyl ether (MTBE) production will be by a large margin the largest consumer of methanol in the region, in support of existing operations in Saudi Arabia and a relatively new MTBE facility in Iran, as well as the acetic acid demand resulted from an acetyl’s complex being planned for Saudi Arabia. In addition, the planned MMA and POM facilities in Saudi Arabia are expected towards the end of forecast.
The only addition to nameplate capacity in the forecast period will be a 2.3 million metric ton per year facility in Iran, which will be the largest single site facility in the world. As the demand of LNG globally has skyrocketed, expectations for natural gas as a feedstock for methanol production have also ratcheted upwards, often times doubling the previous regional benchmarks. Saudi Arabia set the regional model; with 60 percent of natural gas reserves associated with crude oil, there had been
Chapter V - Regional Market Analysis – Middle East

pressure to find markets for gas (as flaring natural gas carries a high environmental cost) and by setting a fixed, low price of USD 0.75 per mmBTU for natural gas (this value was raised to USD 1.25 per mmBTU in 2015), project economics had favored additional capacity. The result of low price natural gas (combined with strong margins for methanol producers over the past two years) had been a tremendous surge in new capacity. However, this low price has come at a cost, with few upstream companies willing to consider sales of natural gas at such levels. A detailed summary of these projects can be found in the appendix listings. More commentary is available under individual country sections in this chapter as well.

With positive, but small growth in derivative demand, and the massive development of methanol projects, the Middle East region has, and will have to continue boosting its export of methanol. The chart on the following page quantifies the amount of needed exports by the end of the study period, constructed from the supply and demand data provided in detail in the appendices.

MTBE has been, and will remain, the primary methanol derivative in the region. Scant growth in the formaldehyde and acetic acid sectors is forecast based on recent investments.
The chart below highlights the amount of growth in methanol demand expected in the region over the study period. MTBE is the main contributor to methanol demand growth in the forecast, although POM (reflected in formaldehyde demand in the chart on the next page) and MMA should be part of the growth equation as well.
Note that in the next few years, operating rates are expected to be improve, caused mostly by improvements in operations at facilities in Iran.

**Methanol Derivatives**

*Formaldehyde*

Formaldehyde production is relatively small compared to methanol in the Middle East, mostly because of the absence of a significant forest industry. Yet, with the ammonia industry in the region growing swiftly (for the same reasons as methanol), increased UF concentrate production, hexamine, and slow release fertilizer has helped demand grow in the region.

The largest methanol consumers are Chemanol (formerly Saudi Formaldehyde Chemical Company, Ltd.), and Al-Babtain Arabian Company, both in Al-Jubail. Qatar Fertilizer Company (Qafco - split between the private-sector Qatar General Petroleum Corp, which has a 75 percent stake, and Norsk Hydro, with 25 percent) produces formaldehyde, which it uses as feedstock for its joint venture urea formaldehyde operations, also in Messaieed. There is also consumption in Turkey, Iran, and the UAE. Expansion of formaldehyde production in Saudi Arabia and Oman is also included in the forecast. Please refer to the formaldehyde capacity listing in the appendices for details.

Formaldehyde demand in the Middle East region was largely unaffected by the global financial crisis, and with low cost feedstocks available, are expected to continue to grow in demand. An MMA facility that would use formaldehyde (Lucite/Mimubishi Rayon) is being planned for Saudi Arabia, but the impact should only be felt towards the end of the forecast and the demand would be listed under methanol S&D. Lastly, a new POM facility by Ibn Sina is expected towards the end of the forecast.

Key market data for formaldehyde in the Middle East is depicted in the next chart:
The chart on the next page highlights the uses for formaldehyde in the Middle East region by derivative type. Traditional uses for formaldehyde are relatively uncommon in the region, as there is little wood panel and furniture production in the region, with few exceptions. However, investments in higher value added formaldehyde derivatives are being planned.

Urea formaldehyde, pentaerythritol, paraformaldehyde, and slow release fertilizers (others) dominate the use of formaldehyde, with paraformaldehyde and fertilizer uses to dominate demand growth in the forecast. There is also a 75,000 metric ton per year 1,4 butanediol facility in Al Jubail, and a new MDI facility in the region.

Most formaldehyde production is installed in conjunction with a derivative facility, and with few announcements made for formaldehyde derivatives in the forecast period, demand remains at a respectable annual average pace.
Chapter V - Regional Market Analysis – Middle East

Acetic Acid

Production of acetic acid in the Middle East is limited, although given access to ample and low cost methanol, considerable progress has been made on large scale acetic acid production processes. Currently there are only two small acetic acid facilities in Saudi Arabia and Iran, plus two pilot scale facilities in Turkey.

Fanavaran Petrochemical Company, a NPC wholly owned subsidiary, brought an acetic acid facility online at the Bandar Imam complex in 2007, with stop and start operations characterizing its production.

Saudi International Petrochemical Company (Sipchem) has begun operations at its 200,000 metric ton per year facility. Sipchem has signed licensing agreements with Eastman to produce acetic acid and acetic anhydride and with DuPont to make vinyl acetate monomer (VAM). This facility will also consume methanol.

SABIC has announced that it has developed a proprietary process for converting ethane to acetic acid. SABIC’s subsidiary, Ibn Rushd, is planning to build a 30,000 metric ton per year acetic acid semi-works plant, although this project has been beset by delays.

The Middle East acetyls industry is not expected to change much by the end of the forecast period. The following chart shows quantitatively how the supply and demand balances are expected to develop through the study period. Note the rapid build up of methanol consuming acetic acid production capability by the end of the...
forecast period. Additionally, net exports will continue to grow through the study period.

The chart below depicts demand for methanol in the Middle East by derivative type for each year of the study. The derivative investments in Saudi Arabia (acetic

![Acetic Acid Demand By Derivative - Middle East](image-url)
anhydride and VAM) drive the demand growth in the region. VAM is expected to be consumed locally, with ample ethylene supplies in Al-Jubail, in the manufacture of EVA and other polymers.

**Methyl tert-butyl ether - MTBE**

The Middle East region is a rapidly growing crude oil refining center, as countries attempt to capture value of oil by refining it into distillates, which are then mostly exported. Around the region, and in Iran in particular (due to a large population of over 65 million), gasoline demand has rapidly increased, due to increased development of that countries’ infrastructure (and the resulting increased fuel demand), and government subsidies which promote the use of gasoline. MTBE demand has also increased sharply in the region, partially to satisfy growing regional demand, and also for export to Asia and to Europe. Environmental concerns related to groundwater contamination are much lower than in the United States, particularly given the relative lack of reservoirs and the drivers to increase MTBE use. Thus several MTBE production facilities have sprung up in the region (see individual country sections for details).

In the forecast, there are limited additions to MTBE production capacity in the Middle East region. While there are several conceptual projects conceived, the impact of the loss of US MTBE demand on export markets has stalled many of these projects, with the added burden that exports of butane have been profitable and this feedstock could be difficult for and MTBE project sponsor to source. As such, MTBE projects are not anticipated to materially impact the balances during this study period. Investments in acetic acid, and to a lesser extent, methylamines, are expected to impact local demand in the forecast period. Details are provided in the individual country sections immediately following, along with the study appendices (supply and demand, capacities).

**Methyl Methacrylate – MMA**

There is one ethylene-based MMA plant with capacity of 250,000 metric tons per year that is being planned by Mitsubishi Rayon (using the “alpha” technology after acquisition of Lucite) in Saudi Arabia. Impact on methanol demand is expected correspondingly, and this region is set to become MMA exporter.

**Methanol Trade**

Regional distribution of 2015 exports from the Middle East to key study regions are shown in the next chart. Over three quarters of this trade went to the Asian region, which includes India. In the forecast period, it is anticipated that Middle East to Asia and Middle East to Europe trade will capture most of the growth, with the distribution remaining roughly the same. Within Asia, the majority of growth will go to China and Japan. In fact, with start-up of US, Egypt and Azerbaijaini plants, Middle East producers will be forced to place more products into the Asian region.
Chapter V - Regional Market Analysis – Middle East

Methanol Exports from Middle East, 2015

-000- metric tons

Total Exports: 11,732 thousand metric tons
SAUDI ARABIA

Overview

The Kingdom of Saudi Arabia possesses an oil-based economy with strong government controls over major economic activities. Saudi Arabia, which has a quarter of the world’s proven oil reserves, is likely to remain the world's largest net oil exporter for the foreseeable future. However, Saudi Arabia’s economy remains largely dependent on oil, with late investments in petrochemicals, including methanol, one significant means of adding to and capturing value of the production of hydrocarbons in the Kingdom. Methanol is one such investment, and Saudi Arabia, through SABIC’s fully owned Ar-Razi subsidiary, has provided a role model for its neighbors in the production and export of methanol, teaming up with Asian offtakers, and their own sales to place volumes from the world’s largest single site complex in Al Jubail to the world.

Methanol demand underwent a modest transformation in Saudi Arabia with the onset of acetyl production in the Kingdom, slightly diversifying local demand away from MTBE and formaldehyde, with further breakthrough is expected to occur with the start-up of Mitsubishi Rayon’s MMA facility. Nevertheless, Saudi Arabian methanol exports will continue to provide the home for the large majority of Saudi methanol production to issue in the forecast period.

Market Outlook

Methanol production in Saudi Arabia is dominated by Ar-Razi. Ar-Razi is a 50:50 joint venture between Saudi Basic Industrial Corporation (SABIC - itself 70 percent owned by the Saudi Government, 30 percent by private investors) and Japan Saudi Arabia Methanol Company (JSMC – owned by several Japanese trading houses).

With the completion of its 5th and largest train in 2008, Ar-Razi has the world’s largest methanol production complex in Al-Jubail, Saudi Arabia. In late 2004, the International Methanol Company (IMC) commenced production from their 1 million metric ton per year project, also in Al-Jubail. IMC is a joint venture between Saudi International Petrochemical Company (Sipchem – 65 percent ownership) and Japan-Arabia Methanol Company Ltd. (JAMC – 35 percent ownership). JAMC Ltd., like JSMC, is owned by a consortium of major Japanese companies led by the traders Mitsui & Co., Ltd. (55%), Mitsubishi Corporation, Daicel Chemical Industries, Ltd. and shipper Iino Kaiun Kaisha Ltd. (with the latter three entities taking a stake of 15% each).

However, there is no new investment in methanol production in the Kingdom in the forecast. Methanol project sponsors are being asked to develop more than “just methanol,” keeping value in country via downstream integration. There have been a number of proposed downstream operations, however these have been delayed in the near term with financing and construction costs working against development.
While these factors are expected to swing back in the favor of project development before the end of the study, actual production of methanol from any new Saudi Arabian facility is not anticipated by then.

The next chart summarizes the relatively constant supply and demand picture in the Kingdom. A small but steady increase in methanol demand locally is expected. Net trade will grow with increased output from Ar-Razi 5 in the forecast, with output focused mainly on Asia.

**Methanol Supply and Demand - Saudi Arabia**

<table>
<thead>
<tr>
<th>Year</th>
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<th>Production</th>
<th>Production Capacity</th>
<th>Net Trade</th>
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</table>

**Methanol Derivatives**

The distribution of demand of methanol by derivative in Saudi Arabia is depicted in the chart on the following page. Clearly, MTBE does and will continue to dominate the Saudi methanol derivative picture in the forecast.

*Methyl tert-butyl ether - MTBE*

MTBE production in the Middle East has been dominated by Saudi Arabia, with four producers in Al-Jubail on the Persian Gulf, and one producer in the growing western city of Yanbu (on the Red Sea). Saudi Arabia has eight refineries in the Kingdom, with combined crude throughput capacity of almost 2 million barrels per day, with more being planned. Also slated for upgrading and expansion is the Rabigh refinery in Yanbu. Whatever MTBE is left over for domestic refineries is exported, mostly to other Middle Eastern countries (Egypt, UAE) and Asia (via a SABIC storage hub in Singapore).
**Others**

Formaldehyde derivatives in this country have been produced by the three formaldehyde producers in this country, including the recently expanded Chemanol (formerly Saudy Formaldehyde Chemical). Still related to formaldehyde, towards the end of the forecast, a 50,000 tons per year polyacetal (POM) facility will be built by the National Methanol Co (Ibn Sina), a JV between Celanese and Sabic, in Al Jubail.

The addition of Sipchem’s acetyls facility in Al-Jubail has brought a new derivative into the Saudi methanol demand portfolio, adding to the positive growth expected. Later in the forecast, MMA will part of the downstream demand portfolio in this country, as explained in the previous section.
IRAN

Economy and Methanol

For many years, Iran has been attempting to diversify by investing some of its vast oil revenues in other areas, including petrochemicals. In fact, the country has developed significant methanol production capabilities in the coastal, export-oriented industrial zones of Bandar Imam, Bandar Assaluyeh, and Kharg Island. Note that petrochemical investment in Iran requires the use of majority of local engineering and materials; these systems are both overworked and delays in announced startups should be expected. Foreign investment in such schemes have been constrained due to the perceived high levels of political and construction risk in this country, as well as recent UN sanctions brought about by a breakdown in discussions about nuclear programs in Iran. However, in the study forecast, given progress to date on a very large facility (2.3 million metric tons per year) in Bandar Dayyeh, more methanol production capability will issue.

In July 2015, a Joint Comprehensive Plan of Action (JCPOA) was agreed between the E3/EU+3 (UK, USA, France, China, Russia and Germany), the European Union and Iran whereby sanctions imposed against Iran were eventually lifted, in exchange for Iran agreeing to restrict their nuclear programme. Note that pre-existing bans / embargoes of Iranian products in the US were not impacted by the treaty.

While Iran has made, and will continue to make strides in the production of methanol, it still has limited capacity to invest in significant downstream demand, and is forcing exports from sporadically operating plants into Europe and Asia. Sales of methanol continue to be caught up in the international campaign to limit transactions with Iranian banking facilities, and this handicaps Iran’s ability to grow exports in line with its plans to expand. These efforts by the international community intensified through most of 2013, and methanol is one of the products under the microscope. However, a 2015 agreement between the EU should allow some exports of Iran material to return to Europe.

Market Outlook

The Iran National Petrochemical Company (NPC), which is the holding company for several wholly owned production and services companies, set up several methanol production facilities, including Shiraz, the smallest and oldest facility, Kharg, a 660,000 metric ton per year facility on Kharg Island, mainly for export, and Fanavaran, a 1 million ton per year facility in Bandar Imam, which is also located on the Persian Gulf and has jetties enabling export of methanol. Twin large scale facilities for Iran, Zagros Petrochemical Company (Zagros I and II) also started up in 2007 and 2009, respectively. The Zagros facilities are at Bandar Assaluyeh. Some of these facilities have recently been privatized, with materials coming from Kharg and Fanavaran facility are now marketed by separate commercial entity. Nevertheless, from 2012, Petrochmical Chemical Company (PCC), once the dominant marketer for
Iranian products, marketed a significant proportion of product from Zagros. There are more Iranian facilities announced which have not been included in the study balances. Some facilities also mentioned cooperation with Haldor Topsoe as the technology provider. A project of Kaveh Glass, a large privately held Iranian conglomerate, has advanced with a 2.3 million metric ton per year facility to make commercial impact by 2017.

The chart below summarizes the supply and demand picture in Iran. Methanol consumption will remain small and dependent upon MTBE (see next section for more commentary). Note the addition of acetic acid from a 150,000 metric ton plant near Fanavaran, which has started operations in 2007, but has run sporadically. Net trade will grow with increased output in the forecast, with output focused mainly on Asia. More details on methanol, formaldehyde, and acetic acid supply and demand are detailed in tables shown in the appendices of this study.

Methanol Derivatives

As shown in the chart on the following page, demand for methanol in Iran is led by MTBE production and, to a lesser extent, acetic acid. Discussions about the use of methanol in gasoline blending in the country have begun, although at the moment are understood to be only in trial phases. Additionally, several schemes to manufacture refined product substitute based methanol facilities, including DME, methanol to olefins (and polyolefins), and direct blends with gasoline have been touted, but are not considered as viable within the study forecast period.
Certainly conditions are right for MTBE use in this country on paper. Iran has nine aging, but operational refineries with a combined capacity of 1.47 million barrels per day. There have been attempts to increase capacity at all of Iran's refineries significantly, at a cost of several billion dollars. Objectives include increasing gasoline output and reducing Iranian gasoline imports significantly, with gasoline demand growing at around 10%-12% per year. The massive drops in oil revenues in 2009 and 2014 sidelined these plans, although as oil prices recovered, several plans have been tabled. Additionally, Iran’s reliance on imported gasoline continues. Accordingly, MTBE is seen as a positive solution to reducing reliance on imported gasoline. Additionally, the increased use of gasoline in Iran has caused a pollution threat, particularly with respect to ground-level ozone in cities at higher elevation, and the Iranian government proactively endorses MTBE as the mechanism to retain octane value, reduce import dependency, and reduce emissions.

In fact, until the 2004 start up of the 500,000 metric ton per year Bandar Imam plant of NPC, Iran had been importing MTBE from Saudi Arabia, Iran, and Qatar. NPC started up a smaller 80,000 metric ton per year MTBE facility in Mahshahr in late 2005. Iran had been a small net exporter of MTBE, until local oil refineries began to incorporate much needed local MTBE production for the gasoline pool. NPC has plans for a duplicate (or slightly bigger) MTBE facility in Bandar Imam, although with ongoing delays, this is not expected to be complete before the study period. Notably, very little formaldehyde production is forecast for Iran, although there should be a market there, especially given the size of its ammonia industry.
QATAR

Overview

Qatar's policy of economic diversification, which led to a surge in investment in projects for the export of LNG and petrochemicals, has slowed as energy prices have collapsed. The government seeks to earn more per barrel of crude oil produced through export of refined products and petrochemicals, and also to create private sector jobs in a country which has been heavily dependent on government to provide employment for the population. The success of attracting LNG investment put on hold opportunities for future investment in methanol, especially as the cost of natural gas for methanol projects increased with the rise in LNG prices globally.

Market Outlook

Qatar Fuel Additives Company (Qafac), who already has methanol production in Qatar, has postponed a Qafac II Project, which would be the largest methanol plant globally, at 2.3 million tons of methanol production per year. The project was to be implemented by a joint venture entity with the same partners in Qafac I. The move reflects increased capital costs for construction of new facilities, along with a more bullish sentiment on the value of natural gas by owners. As such, this additional capacity has not been considered in the forecast years of this study.

MTBE from Qafac is consumed by Qatar Petroleum (QP) Refinery which is used as a lead replacement for gasoline. Additional material is exported to mainly to Europe...
and the Middle East. The chart on the next page summarizes the relatively stable supply and demand picture forecast for Qatar. Almost all local demand for methanol is in the production of MTBE. Net trade also remains stable, although this varies with production quantity and the operations of downstream MTBE. In 2015, operations in Qatar appeared to be well above nameplate capacity, which is possible given revamps and catalyst refreshing, allowing greater exports. More details on methanol, formaldehyde, and acetic acid supply and demand are detailed in tables shown in the appendices of this study.
OMAN

Economy and Methanol

Oman continues to be heavily dependent on oil revenues, which account for around 75 percent of the country’s export earnings and almost 40 percent of its gross domestic product (GDP). Prompted by the maturation of its oil fields and the recent drop in oil prices, the Omani government continues to press for diversification in the country’s economy, making it a top policy priority. This bode well for the methanol industry, with two major methanol projects having started up in 2007 and 2010. Further investment here will likely be focused downstream, with jobs and value addition a priority.

"Omanization,” a program designed to increase the percentage of Omani citizens working in the private sector, has also fostered relatively small investment in methanol consumption downstream in the form of formaldehyde production. However, in the forecast, most Omani methanol will continue to be exported, mostly to Asia, with opportunities to Europe increasing in the wake of Iranian sanctions by the EU.

Market Outlook

The Oman Methanol Company L.L.C. (OMC – a special purpose entity of Methanol Holdings (Trinidad) Limited (MHTL), Oman Methanol Holding Company and MAN Ferrostaal Aktiengesellschaft) was the first for the country, and is based on associated gas. The Sohar facility, with a production capacity of 1 million metric tons per year of methanol, successfully and completely started up in late 2007. Another project of 1 million tons in Salalah, sponsored by Oman Oil, also started up in mid 2010. The Salallah facility is located on the southern coast of Oman, closer to Yemen, and will have its own storage and jetty for export.

The chart on the next page shows that most methanol production from Oman will be exported, with only a small amount of the output from the new facility going to a new formaldehyde facility in Sohar. Operating rates dipped in 2014, but have largely recovered. Through the end of the forecast, Omani methanol operating rates are expected to be extremely high.

More details on methanol, formaldehyde, and acetic acid supply and demand are detailed in tables shown in the appendices of this study.
Chapter V - Regional Market Analysis – Oman

Methanol Supply and Demand - Oman

[Graph showing Methanol Supply and Demand trends from 2011 to 2021E]

- Total Demand
- Production
- Production Capacity
- Net Trade

[Legend for graph]

[Data points for each year from 2011 to 2021E]
OTHER MIDDLE EAST

Overview

Bahrain and Turkey are two major Middle East countries of note with respect to methanol. The outlook in the forecast period remains clouded by the civil unrest that first occurred in 2011. Otherwise, having developed a regional financial services center specializing in offshore banking, Bahrain remains intent on further diversifying its generally liberalized economy. The country remains heavily dependent on revenues from the oil sector, which make up about two-thirds of export earnings. And like other Persian Gulf countries, unemployment is also becoming a growing economic and political problem. It is likely that large scale investment in methanol production facilities are not expected to impact commercially in the study period.

Market Outlook

The GPIC facility in Bahrain provides the balance of the region’s methanol supply. There is a fairly diverse set of uses as well, although generally small in nature, led by the production of MTBE. These uses are expected to grow modestly and less net exports from the overall region are expected in the forecast. The outlook for supply and demand is shown below, followed by derivative demand breakdown on the next page. Note that Bahrain has also been used in the past as a location for re-exports of methanol.

Detail behind these charts can be found in the appendices of this study.

![Methanol Supply and Demand - Other Middle East](chart_image)
Turkey has become a significant consumer of methanol, albeit small, and mostly for formaldehyde. Additionally, Istanbul based Turkish panel producer KASTAMONU has opened a second MDF-line at its Russian woodworking site in Alabuga. On completing the pre-commissioning activities, the site’s production capacity will surpass 1 million m³ of panel boards per year. In 2016, the company expects to start chipboard production of 725,000 m³ per year, and in 2017-2018 OSB production of 575,000 m³ per year. Total capacity of the KASTAMONU plant in the SEZ Alabuga is slated to reach 1.8 million m³ per year, the largest wood processing facility in the broad Europe/Russia region.
AFRICA

Overview

Little direct demand for methanol exists in this region of the world, and thus the majority of methanol production is exported. Given this structure, the region’s economies will not impact the demand side of methanol greatly. Most of the countries in this region are resource rich, but have little means of developing these resources. Since 2011, ongoing civil unrest in Libya has thrown a wrench in the outlook, with two methanol producing facilities there having mostly shut down. Methanol production in Egypt has also been hit by unrest and occasional restriction of natural gas supply to the facility. Despite much discussion of opportunities in Algeria, Nigeria, and Mozambique, little to no methanol production capacity is envisioned in the forecast.

Market Outlook

Methanol

The scant demand for methanol in the African region will grow only marginally in the forecast, with no real downstream investment planned. Current demand for methanol comes mostly from a limited set of formaldehyde producers.

Methanol production in the region is currently led by EMethanex in Egypt and AMPCO in Equatorial Guinea, and followed by SIRTE in Libya (As indicated above, this facility is crippled by an ongoing civil war, and the facility has run only sporadically, contributing to low operation rates). All of the EG production is
exported, as is the majority of Libyan production. The region is expected to slowly expand its role as a large net exporter, as shown in the chart here:

Methanex and the Egyptian Petrochemicals Holding Company (Echem), a group charged with promotion and development of that countries’ petrochemical industry, have started up a 1.3 million metric ton per year project near the Damietta Port area. The project was planned to be integrated with a DME facility of 200,000 metric tons per year, with the DME to be used in LPG blending facilities nearby. The DME project, which had the potential to consume as much as 290,000 metric tons of methanol, is on hold. Until then, most Egyptian production is targeted at the European continent, although operation rates have been crippled by a lack of supply of natural gas in a country which is structurally short of natural gas supply.

One large project involving a methanol-to-olefins process is envisioned for Nigeria. This project is not expected to make a commercial impact before the end of the study period, however, if it does, is expected to remain dedicated for olefins production. A second Nigerian project sponsored by ELEME PC, an Indorama subsidiary, is in development but only likely to start after the study period, if at all.

Other plans in Algeria, Ghana, Tanzania, and Mozambique have met with significant competition for natural gas feedstock and are also not expected to impact by the end of the study period.

Distribution of methanol consumption by derivative type in Africa is depicted in the chart on the next page, and highlights the anticipated impact of DME supply:
Methanol Derivatives

Formaldehyde

Formaldehyde use in the African region is limited to basic and traditional uses in resins. Key market data for formaldehyde is depicted in the chart on the next page:
Most chipboard and other wood panel manufacturers in the region rely on imported urea formaldehyde (UF) and other resins for the bonding of the particles in their products.
Acetic Acid

Only small facilities in South Africa and Kenya make acetic acid, and none use methanol.

Demand and demand growth for acetic acid is immaterial relative to global demand.
Methyl Methacrylate - MMA

Lucite International operates a 5,000 metric ton per year MMA facility in Durban, South Africa.

Methanol Trade

In 2015, just over 1.3 million metric tons of methanol was produced in the African region, mostly from Equatorial Guinea and Egypt. The total exports from this region were slightly more than 1.1 million in 2015, as depicted below. The material from the Equatorial Guinea material was sent to both the United States and (with slight major portion) to Europe. Egyptian production sagged in 2015, which exports from Africa significantly. Egypt exports were targeted for Europe via the Mediterranean and Rotterdam, as this market normally provides the best netback returns from sales. However, with increased production in the US, increased trade to Asia from Egypt is possible in the forecast. The future of the Libya facility is uncertain as of this writing, although as mentioned, attempts to restart continue.

Methanol Exports from Africa, 2015

-000- metric tons

Total Exports: 1,124 thousand metric tons