

## What are the important trends affecting the downstream processing industry this year? Executives and experts forecast challenges and prospects that could affect profitability

**Maria van der Hoeven**  
Executive Director  
International Energy Agency

The world is undergoing an era of economic rebalancing toward emerging markets, and that is especially true within the oil market, where shifting patterns in consumption and production further complicate the broader trends. The global energy map is not just shifting east. Traditional producers like Saudi Arabia are seeing booming demand, while heavily consuming markets such as North America are experiencing production revolutions thanks to new techniques and technologies. New trading patterns and technological advances also mean new scope for international market reform — creating a common incentive for market stability and investment promotion. The next five years will consolidate the rise of the non-OECD in virtually every aspect of the oil market, and most of the growth (though by no means all of it) will come from East-of-Suez economies. The idea that the emerging markets and developing economies would eventually overtake the OECD in oil demand is nothing new, but it is happening faster than expected.

One of the consequences of those changes is a transformed global product supply chain. New, non-OECD mega-refineries are challenging OECD refining economics, at least beyond the US. Their expanding reach is accelerating the globalisation of the product market, particularly in the case of refineries geared toward export. With it come the benefit of greater market flexibility in the dispatch of product supply, but also longer supply chains, higher reliance on stocks to meet demand, diminished visibility in inventory levels, increased disruption risks, reduced market transparency and, possibly, greater price variation between key markets and also between seasonal peak and troughs in demand.

The IEA's *Medium Term Oil Market Report 2013*, released in May, offers projections to 2018. As refinery capacity additions are forecast to increase faster than world demand



over the medium term, the persistence of excess refining capacity is expected to weigh on refining margins, severely affecting the less efficient and older refineries in the world. The overall upgrading ratio gradually increases from 44% in 2012 to 47% in 2018 as new refineries focus mainly on heavy crude oil processing, mostly from the Middle East and Latin America. The capacity expansions in Asia and the Middle East, however, represent two different distinct investment strategies. Whereas Asian capacity development is meant to service rapidly rising domestic demand, Middle East exporters (mostly in joint venture with OECD refiners or Chinese companies, and mostly in Saudi Arabia) are climbing the value chain and expanding into products and petrochemicals.

This has put OECD refiners — in particular European ones — into a tight spot. Facing weak demand, tighter regulations, and an aging capital stock, these refiners have little choice but to increase their competitiveness through restructuring and consolidation. The refining sector in OECD Americas is undergoing a complete restructuring, with each regional district trying to optimise its crude slate between light domestic crude oil and heavy imported oil. High sustained margins and the outlook for continued growth pushes US refiners to invest in deep conversion and light oil processing. Recent developments in Spain and Portugal show that investment into deep conversion units can indeed present a profitable alternative to closures. Yet despite these efforts, the overcapacity which exists today is bound to force a continuation of the capacity shut-ins we have seen since 2008. Over that period, 15 European refineries have closed with a total capacity of 1.7 mb/d, and more are expected in the coming years.

Japanese refiners will close a total of around 800 kb/d by next year, in line with government regulations aimed at increasing conversion yields.

Looking out to 2035, *the World Energy Outlook 2013* shows the global refining sector set to experience continued turbulence amidst declining OECD demand and Asian growth. Strains on the refining system are amplified by the changing composition of feedstocks. A growing share of oil supply

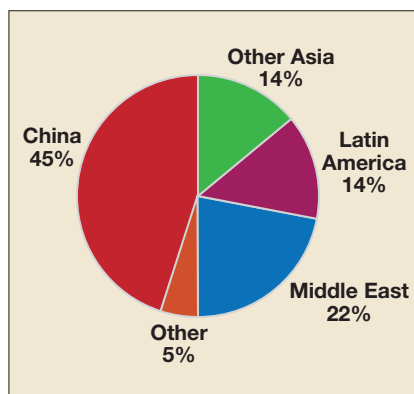


Figure 1 Regional share of CDU expansions

bypasses the refining system altogether, including most natural gas liquids as well as oil products produced directly from gas or coal. As a result, global demand for refined products grows by only 10 mb/d to 2035 — less than the growth in both overall liquids demand (16.8 mb/d) and net refinery capacity additions (13 mb/d). Over-capacity in the sector is therefore a long term phenomenon as well, but prospects for OECD refiners vary.

The outlook for the United States is helped by the increasing availability of local crude, but the benefits to refiners vary by location thanks to new supply sources and ongoing infrastructure constraints. Still, as the net North American requirement for imported crude all but disappears by 2035, the region becomes a large exporter of oil products. On the other hand, medium term European difficulties are compounded to 2035 by declining local crude production (particularly from the North Sea), product demand that is heavily skewed towards diesel, and disappearing export markets for gasoline.

For the non-OECD, the longer outlook period also reveals new trends. Middle Eastern refining capacity additions, initially focused on boosting product exports and adding value to oil otherwise exported as crude, turns to domestic needs as regional demand rises to 2035. And in Asia, the region emerges as the unrivalled centre of global trade, drawing in a rising share of crude not only from the Middle East, but also from Russia, Africa, Latin America, and Canada. Massive additions to refining capacity are still not sufficient to meet regional demand, and both China and India are net oil product importers in 2035.

The changes occurring in the refining balance are reflective of both the traditional refining model — in which increasingly consumptive countries prefer to import crude and refine it for domestic production — and also a new phenomenon in the rise of global refining centres. The increase of product trade reflects a desire of some exporters to capture the added value of exporting refined product, and also an effort to diversify into highly specialised industries such as petrochemicals. While some export oriented refining capacity additions in the Middle East could be needed to meet growing regional demand after 2025 or so, the trend could catch on in North Africa, West Africa, Brazil, or Russia — with even greater implications for the future of OECD refining as global product trade increases more substantially. And all of this could also have implications for global oil security — a core mission of the IEA — as countries consider how best to manage strategic oil stock balances and emergency policy. Longer and more specialised product trade routes can also render supply disruptions more acute. Like with globalisation more generally, increasing international oil trade will also mean the increased need for international cooperation to secure and manage that trade — and thus the need for the kind of international energy governance provided by the IEA.

**Daniel M McCarthy**  
President, CB&I's Technology  
Operating Group  
Member, Board of Directors, Chevron Lummus  
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**T**he powerful impact of technology changes in today's energy markets has created major paradigm shifts in barely 10 years. As a result of these technical innovations, billions of dollars in investments are now moving to the sources of new energy supplies with somewhat surprising results and consequences.



Some may call these 'disruptive technologies', but forward thinkers will realise they are opportunities to improve productivity. As an example, the planning of large, new olefin or liquefied natural gas capacity in the United States is no longer considered so radical, now that the economical natural gas feedstocks are produced and available in the US.

This is good news for refining, petrochemical and energy markets as we regularly see examples where a technology innovation can dramatically shift products or businesses. In some cases, it may take 20 or 30 years for the technological changes to work through the system and be fully implemented. Chevron commercialised Isodewaxing catalysts to produce higher quality Group II and III lube base oils 20 years ago, but solvent dewaxed Group I lube oils are still common today. For new technology deployment to be rapid, its scale and benefit must be very large and widespread.

The deployment in the US of new hydraulic fracturing (fracking) technology for shale oil and gas deposits has been both rapid and widespread, generating enormous growth in new oil and gas supplies. We could assume that other countries such as Russia, China and Argentina, with similar or even greater shale assets, would also be candidates for such rapid growth. However, in these countries the investment capital and technology deployment have been slow and limited, not rapid and widespread. These three markets should eventually catch up to the new shale technology deployment, but probably not in this decade.

The discovery and production of oil and gas from shale has generated a new dynamic and neither oil producers, refiners, nor petrochemical operators are sheltered from its ripple effects. The rush to purchase and produce attractive shale oil assets has been predicated on US crude oil prices of approximately \$100/bbl for West Texas Intermediate (WTI) crude oil. The current production rates have driven crude oil prices below \$100/bbl. Further rapid increases in supply levels through new oil producing wells or oil associated with gas produced for LNG could cause WTI to fall to \$80/bbl or less, resulting in a significant reduction in new drilling and curtailment of supply growth.

Since 2003, the impact on refining is equally dramatic

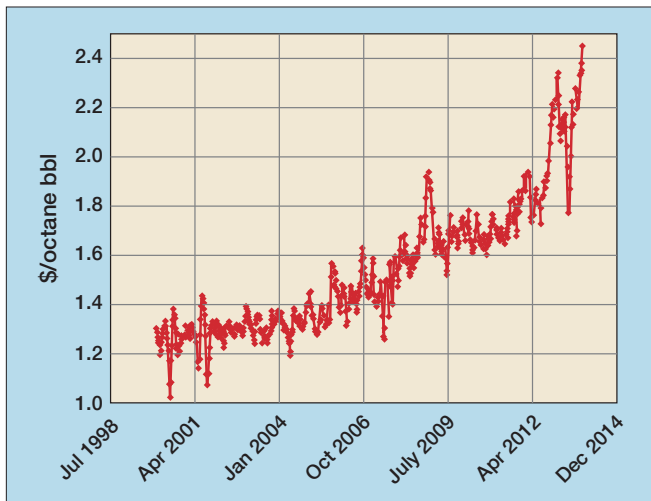


Figure 1 US retail Octane Index Barrel (OIB) price

as light paraffinic crude oils from shale have displaced more naphthenic crude oils in the refiner's diet. Combine this crude oil supply quality change with declining gasoline demand in the US and Europe and the cost of gasoline octane has risen to historic levels. As illustrated in Figure 1, the cost to raise one barrel of gasoline by one octane point has almost doubled in the past 10 years. We expect this to drive scientists and engineers to develop new gasoline reforming technology and catalysts.

The worldwide petrochemical industry accounts for feedstock demand of about 6% of the total natural gas and liquid fuels produced worldwide. The petrochemical industry represents a value of roughly \$3 trillion in economic output. This sector also feels the economic ripples from growing US shale oil and shale gas production. We have already mentioned how primary olefin demand is driving producers to secure low cost supplies of ethane and LPG from shale gas. For petrochemical producers securing feedstock from refineries, the changes are equally dramatic.

US aromatic derivative petrochemical producers have typically purchased high octane gasoline blending streams containing benzene, toluene and xylene (BTX) as feedstocks for aromatics extraction and manufacture of aromatic polymers such as polystyrene, and chemical derivatives such as paraxylene. As seasonal gasoline demand would rise or fall, the price and supply of high octane BTX would follow along to meet the octane demand of the gasoline market. As seasonal gasoline demand dropped off, excess BTX streams would be available at lower prices for aromatic chemical producers, until recently.

Figure 2 shows the trends of US mixed xylene and gasoline prices. They generally track each other. From 2004 to 2010, the average price spread was approximately \$30/bbl but as octane demand and value have increased since 2011, the spread has increased to about \$50/bbl. This change has made it more expensive for aromatic petrochemical producers to secure feedstocks. It has forced producers to secure less expensive feedstocks elsewhere and in turn made aromatic polymers less competitive with olefinic

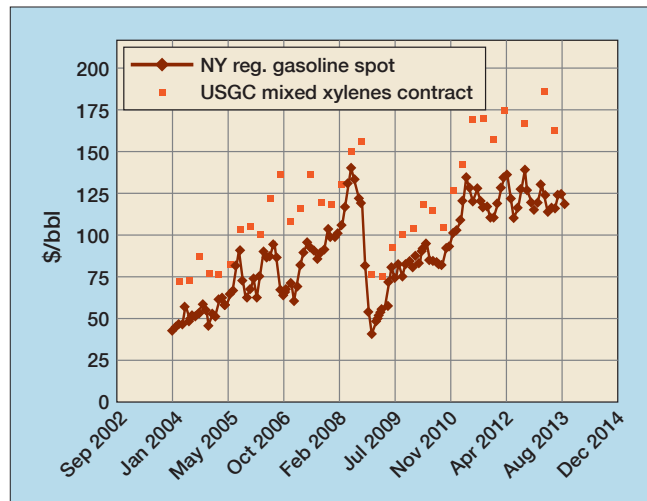


Figure 2 Mixed xylene pricing vs gasoline

polymers. If this trend continues, new reforming and aromatics extraction capacity will be constructed in locations with cost competitive feedstocks.

There are many examples in our own research and development activities where we expect and search for breakthrough technology innovations that can dramatically change fuels and petrochemical products and markets. Some future breakthrough technologies may include producing ethylene and propylene directly from methane, direct coupling of methane derived methyl groups into hydrocarbons, full hydrocracking conversion of petroleum residues to light clean products, biofuels innovations, and more cost efficient polymers and specialty materials.

In the oil industry, the Hubbert peak theory is named after American geophysicist M King Hubbert, who in 1956 observed that the amount of oil under the ground is finite; therefore the rate of discovery which initially increases quickly must reach a maximum and decline. This theory has worked very well worldwide describing declines in oil output until the fracking revolution pushed new reserves into the equation and pushed out the date of peak oil by many years. Such breakthroughs are not common. However, when they occur, they create many new opportunities and are a welcome reward for those who drive change.

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### Rajeev Gautam President & CEO UOP LLC, A Honeywell Company

Looking back on 2013, it was an impressive and eventful year for the refining, petrochemicals, gas processing, and renewables industries.

Global production of heavy crudes and diesel demand continued to grow, as did demand for polyester, plastics and detergents. And this has been the case especially in developing economies





where refiners look for methods to increase production of petrochemicals. Technological advancements in natural gas have made the economical development of shale and offshore gas resources possible to a greater extent than ever before. Meanwhile, regulation, technology and economics are creating incentives for producers to ramp up production of renewable fuels.

But 2013 was not immune to challenges. While some of these will continue into 2014, increased population growth and middle class expansion will create higher demand for energy sources such as natural gas, coal and oil.

Government regulations will mean even tighter fuel specifications and higher renewable content. And the market will continue to demand higher yields at lower costs. While these challenges will vary by region, the whole world will feel the impact.

In nearly every case, process technologies provide the most economical, efficient and sustainable solutions to directly meet these challenges.

Within refining, heavy crude production will continue to grow and demand for low value residual fuels will decline. There will be a growing need for technologies such as UOP's Uniflex process — a slurry hydrocracking technology that converts low quality residue streams to high quality transportation fuels while minimising byproducts, achieves a maximum conversion of 90%, and produces an attractive feedstock for subsequent high quality diesel production.

In addition to maximising the yield from every barrel of oil, refiners are looking for ways to increase petrochemicals production to meet global demand.

The global propylene gap will continue to grow as traditional crackers shift to lighter, lower propylene feedstocks such as ethane. There is strong demand for propane hydrogenation technologies such as UOP Oleflex process, which produces on-purpose propylene from propane — at a very high yield — with the lowest cash cost of production and the highest return on investment.

In areas with limited availability to conventional olefin feedstocks, cheaper, more abundant feedstocks such as coal will help producers address demand in new ways. The UOP/Hydro Methanol-to-Olefins (MTO) process converts methanol derived from non-crude oil sources — such as coal or natural gas — to ethylene and propylene at very high efficiencies.

Natural gas not only will become a more common ingredient for high value petrochemical feedstocks, but it is on track to become one of the world's top energy sources.

Global unconventional gas resources are estimated to yield 250 years of supply. Efficient contaminant removal, purification and liquids recovery will be essential steps to efficiently monetise natural gas resources.

The UOP Russell product line offers modular plants that enable shale and conventional natural gas producers to remove contaminants and recover high value natural gas liquids used for petrochemicals and

fuels. UOP is continuously improving techniques for gas treating and contaminant removal to ensure that the gas can be cleaned to liquefied natural gas specifications.

In addition to natural gas, new, more efficient alternative energy resources are on the horizon. These renewable fuels and chemicals will support growing global energy needs, while also addressing environmental concerns.

UOP's first Ecofining unit for renewable diesel production is on-line, with more units in design and construction. This technology is preferred by refiners due to the 'drop-in' nature of the fuel product and the ability to leverage existing infrastructure.

In 2014 and beyond, the oil and gas industry will be driven by the development of global technologies that are highly efficient, use cost advantaged resources and provide compelling environmental benefits.

### **Eric Benazzi** **Vice President Marketing & External Communication** **Axens**

**A**t the end of the year 2013, our future seems uncertain. Contradicting economic indicators are preventing professionals from identifying a clear trend for 2014.

Global GDP growth should reach 3.6% in 2014. This indicates that the global economy continues to recover post-2013, where growth should settle at 2.9%. However, after a boost in capital inflows, emerging economies are facing a difficult situation. This monetary abundance led to the formation of credit bubbles in Brazil, Russia, India, China and Turkey, which increased inflationary pressures.

The necessary resorption of financial imbalance in emerging nations has led to a slowdown in their domestic demand and activity, which was exacerbated by a decrease in world trade due partially to Europe's poor economic health. To measure the decrease in trade intensity it can be noted that exports as a share of the world GDP, which rose steadily from the mid-1980s to 2008, has remained stable since, slightly above 30%.

The growth of emerging nations' import volumes may therefore continue to decline, as it did in 2012, holding back the driving force behind world trade if this crisis was not curbed.

While writing these lines, GDP in the US is forecast to grow 2.6% in 2014. Exploration and development of unconventional gas and oil resources gave the US a competitive advantage allowing them to stimulate their petrochemical industry while having cheap energy.

However, the latest episode in the US budget crisis raises concerns about a possible recovery in 2014.



Indeed, America's debt ceiling has only been raised for a few months. Lack of a compromise in February would lead to a destabilisation of the US economy that would compare to the 2008 subprime mortgage crisis. Such a scenario was deemed unthinkable given its devastating consequences.

So, which indicators can we reasonably count on?

The global fuel and petrochemical demand should experience growth, sustained by a growing world population and its aspiration to a greater mobility and lifestyle. Growth in the demand for refinery products could increase by 1.1 million b/d, to reach a 2014 global oil demand of about 92 million b/d. On-road diesel will continue to drive the demand, calling for additional hydroprocessing capacities.

Product specifications and environmental quality standards will continue to tighten worldwide calling for advanced technologies and innovative solutions. Impulse, our latest hydroprocessing catalyst technology and Symphony, our latest reforming catalyst, are the result of a long term commitment to clean fuels and our answer to market trends.

Feedstock and streams produced in refining, petrochemical sites and natural gas fields are continuously requiring solutions to remove contaminants subject to stringent requirements and emission limits. As a result, we deliver a complete range of technologies and products and Claus catalysts enabling the removal of all kind of contaminants such as Cl, F, As, Si, Hg, H<sub>2</sub>S, RSH, and so on.

Demand in main petrochemical products should keep growing at a rate of 4% to 5%. In regions where demand is high or resources abundant, the construction of mega scale complexes integrating refining and petrochemical units will allow recovering valuable products from low value heavy feeds and reaching higher profitability. Regarding projects where multiple technologies are involved, Axens' Integrated Process Solution is nowadays a must.

Those integrated mega scale complexes will continue to require the latest technologies to convert the bottom of the barrel and to maximise motor fuel yields, notably diesel. VR ebullated bed hydrocracking plants combined with solvent deasphalting or cokers units and VGO hydrocrackers will play a key role as well as scheme combining AR/VRDS and RFCC units when naphtha/gasoline production is targeted.

In Europe, where refineries are facing strong competitive pressure, energy costs represent more than 50% of operating expenses, so any improvement in this field will improve competitiveness. Many new refining entrants on the market have invested in the assets and developed their ability to process a higher number of crudes. In order to help EU refiners on this path, Axens' revamping offer helps improve and upgrade their existing assets and assists in improving process energy efficiency in order to increase competitiveness at a minor risk.

Innovation will continue to be the best tools to respond to market changes and to improve profitability.

**Roberto Penno**  
Chief Executive Officer  
Global Engineering & Construction Group  
Foster Wheeler



We are certainly seeing robust activity in all of the hydrocarbon related business sectors in which Foster Wheeler's Global Engineering and Construction Group operates: onshore and offshore upstream oil and gas, midstream/LNG, refining, chemicals, and power, as well as seeing continued investment in pharmaceuticals, power, environmental and minerals and metals, where we also operate.

This year there has been a very strong focus in the industry on North America, with more projects moving forward in both petrochemicals and chemicals and in LNG liquefaction and more emerging too. Asia and the Middle East also continue to see strong project activity.

I would like to highlight a number of key themes we are seeing which also underpin our company's E&C strategy going forward.

Local service delivery has always been important to us and is becoming increasingly important to our clients. We have continued to develop operations in key local markets, both organically, in joint venture, and through M&A. Key markets in which we have recently strengthened our ability to deliver the global Foster Wheeler brand and quality locally include Saudi Arabia, Mexico, and China, to name just three. I will add to this the US, where we are already strong and

## Product specifications and environmental quality standards will continue to tighten worldwide

well known but have continued to enhance our presence and capabilities. Our Houston operation has had a great year with major wins, especially in chemicals, and we acquired construction specialists Yonkers Industries at the end of 2012.

Many clients with upstream and downstream businesses are allocating more and more of their planned capital spend to the upstream sector. This sector, both onshore and offshore, remains a strategically important market for us and one in which we have continued to develop our skills, service portfolio and geographic presence, with acquisitions in the last 12-15 months in additional early consultancy capabilities, in SAGD with the acquisition of Three Streams Engineering in Canada, and in on-going asset support.

We see more and more clients looking to develop

long term strategic relationships with a limited number of E&C contractors to ensure availability of high quality resources. For a number of years we have had a strong focus on developing long term relationships with clients, working with them wherever in the world they invest. We aim to match our skills and geographic footprint development to align with our clients' long term investment plans, so that we are well placed to meet their needs right through the project lifecycle, across their entire project portfolio and wherever in the world they plan to invest. We have seen a significant number of key wins in 2013 coming from both long standing relationships and also strategic relationships that are more recently established.

Projects also keep on growing in size and complexity, strengthening the requirement for contractors like Foster Wheeler who have the global horsepower and track record, technical expertise, and regional and local knowledge to design and execute these projects safely and successfully.

Competition remains strong. We focus on opportunities where we believe we have differentiators, such as our technologies; our know-how; our client relationships; our global presence and our ability to work with clients from the very earliest phases of projects to help them shape their investments; and our proven track record of safely delivering technically complex and very large projects, often in challenging locations.

## Charles T Drevna

President

American Fuel & Petrochemical Manufacturers

From my vantage point in Washington, DC, I cannot help but see the year ahead as one filled with many policy challenges for the refining and petrochemical industry.

A year ago, I was cautiously optimistic that US President Barack Obama would work to advance the 'all of the above' energy strategy that he so often and adamantly talked about during his run for re-election. But during his February State of the Union address, and then with the release of his climate change plan in late June 2013, it became clear that the anti-fossil fuel sentiments of this Administration will continue into 2014, and throughout the remainder of his presidency.

Among the many expected battles ahead is finding a palatable solution to the sour Renewable Fuel Standard (RFS). Progress was made in late 2013 when EPA recognised the potential adverse effects on consumers of increasing the ethanol volume in the fuel supply and reduced the 2014 mandatory volumes. Even with the cut, greater reductions in the biofuel mandate are necessary if consumers are to avoid all the detrimental



impacts of the statute. Opposing sides in this battle will undoubtedly continue to draw lines in the sand until Congress repeals this broken law or finds another solution that considers the impact of this pernicious policy on consumers, today and into the future.

But, our challenges do not end there. The industry will continue to face a growing number of climate regulations that conflict with one another. Research has shown that the RFS increases ozone and greenhouse gas (GHG) emissions and is in conflict with CAFE Standards, as well as other Clean Air Act regulations; while Tier III regulations result in greater greenhouse gases, thus contradicting EPA's GHG regulations. These conflicts could leave many facilities across the country questioning how they will meet some requirements without violating others.

Finally, one of the largest challenges may come with

## We are currently witnessing the beginnings of a far reaching manufacturing renaissance

the Obama Administration's recent Executive Order (EO) that adjusted the metrics by which all Federal agencies assess the costs of carbon emissions, known as the social cost of carbon (SCC) calculation. This recent EO is comprised of subjective metrics that were developed to try and quantify the alleged societal benefits of reducing only greenhouse gas emissions.

Unfortunately, the Social Cost of Carbon scheme will only add additional burdens on the consumer because it inflates the potential benefits of regulatory actions in a manner that hides the true economic and societal costs of new rules. Applying these calculations to assess the costs and benefits of regulations could erroneously be used to justify discontinuing the use of traditional, affordable energy sources through overly stringent regulations in future rulemakings.

Although the challenges ahead are great, the future holds enormous opportunity for the refining and petrochemical industry and the United States. We are currently witnessing the beginnings of a far reaching manufacturing renaissance brought on by the recent increase in domestic oil and natural gas production. Today more than \$100 billion in new manufacturing infrastructure has been announced and is expected to be developed throughout the United States during the next decade.

We are the most fortunate manufacturing region in the world today with advantaged raw materials, advanced infrastructure and expertise along the entire supply chain. The petrochemical industry is on the verge of an exciting expansion, but it can only materialise if the federal government stays out of the way and allows the market to work. My industry will work tirelessly to advance this development throughout 2014 and well into the future.