Shell Chemicals

What does the future hold for the C6 aromatics chain?

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Chemicals Strategy Development

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Alexander Farina

Alexander Farina joined Shell in 1990 with a Masters degree in chemical engineering from Munich's University of Technology to take up the role of Quality Manager and later Manufacturing Manager in Shell's automotive supply venture in Germany.

Between 1994 and 2000 he worked in Shell's elastomers business covering roles from research and development to marketing, including Global Business Manager for the Isoprene Rubbers Business. During this time he had postings in Brussels, London and Paris.

In 2000, Alexander was appointed venture manager of Shell's e-business and technology venture capital fund before returning in 2003 to the chemicals business as Strategy Manager for the Phenol and Solvents business.

In 2006, he was appointed as Strategy Manager for Base Chemicals with the focus on restructuring the North American Base Chemicals Business.

Alexander was appointed General Manager Chemicals strategy in June 2009 and joined the Chemicals Leadership Team. He is also responsible for Chemicals technology activities.

Alexander is married with two daughters. He lives in The Hague and his hobbies include horse riding and skiing.

Introduction

Good morning. Today I'm going to try to do four things.

First, I will outline some long-term developments that are changing the marketplace in which we all operate.

Second, I will look at how these will impact demand for C6 value chain products, with a focus on three specific end-uses: food packaging, construction and automotive manufacturing.

Third, I will address some supply challenges.

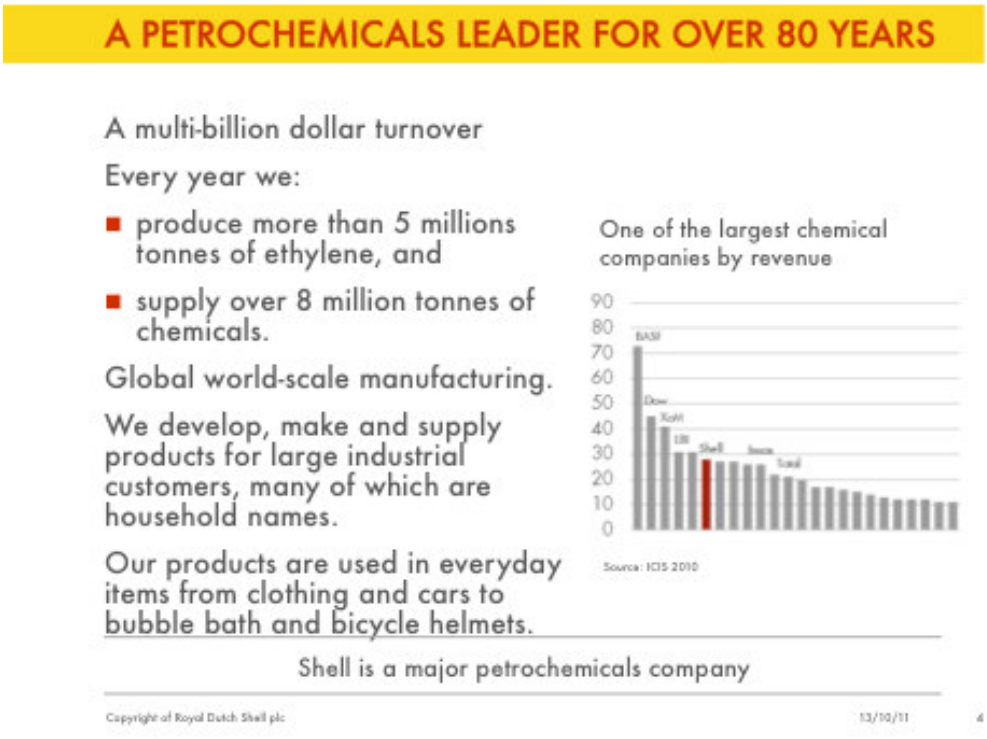
Finally, I will finish with a brief summary of Shell's long-term chemicals strategy.

What I'm not going to talk about is the near-term economic outlook.

If governments, bankers and economists don't know what's happening next week, how can I?

Our common challenge is to deliver sustainable growth at a time of severe economic turbulence. In chemicals, we are all trying to manage increasing volatility in an energy- and carbon-constrained world.

Against this backdrop, stability is critical for long-term planning and for chemicals companies' ability to serve customers across the value chain. For your customers and Shell's customers, that means working with suppliers who can deliver a reliable and competitive supply of products long-term.



At Shell, we want to be loud and clear about our long-range commitment to chemicals, which is underpinned by good long-term growth prospects for our industry's products.

Shell has been making chemicals for over 80 years. We're among the top 10 global companies in today's chemicals sector, and we're still investing billions of dollars in long-term, world-scale petrochemicals projects.

We intend to remain a major global aromatics producer and supplier of benzene, styrene and phenol-acetone, the key C6 chain building blocks.

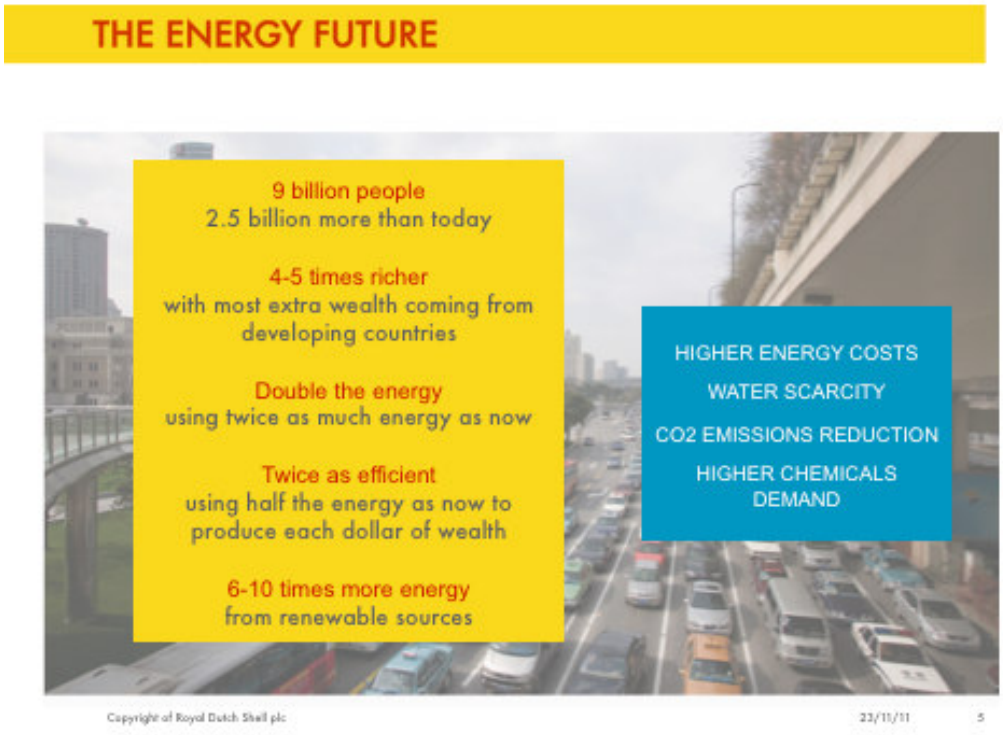
Despite the huge investments we're making, people keep asking us: Why is Shell in chemicals, and in aromatics?

It's simple: Chemicals is a growth industry with a great future, thanks to a growing recognition that our products and our technologies can help to address some of the sustainability challenges facing the world today and in the future.

The chemicals sector has its own challenges - from securing feedstock supply, and remaining cost-competitive, to addressing production emissions.

But for those ready to invest in innovation, the long-term opportunities are encouraging.

Changing Context – A new energy future



In recent weeks, the world's population reached 7 billion. By 2050, there will be 9 billion people, 75% living in cities. An extra 2 billion people will need more clean water, more food, and more power for domestic, industrial and transportation purposes.

The UN estimates almost 50 nations will face water scarcity by 2025. How many more by 2050?

By 2050, 2 billion vehicles may be on the roads. Today there are 800 million.

Energy demand is forecast to double or even triple by 2050, driven by fast-growing, large-population countries like China and India, and increasingly those in Africa, too.

Meeting this demand presents huge challenges. Renewable resources could be 5 to 10 times higher than today, but we'll still be getting 60%-70% of our energy from traditional fossil fuels.

We will need to access harder-to-reach oil and gas reserves, which means higher extraction and transportation costs.

At the same time, we'll need to halve the emissions of CO2 and other greenhouse gases to prevent *catastrophic* climate change.

That means halving the energy intensity of the economy to produce each dollar of wealth.

Meeting the energy, water, food, health, housing and clothing needs of 9 billion people will be a huge challenge. But it's also a huge opportunity for the chemical industry.

We're often called "the industry of industries". That's because there is virtually no area of human life and activity in which our products do not already play an important or essential role.

But to achieve sustainability through 2050 and beyond, the world will need even more innovation and products from the chemicals industry.

Let's look at some recent and near-term chemicals demand growth figures and forecasts.

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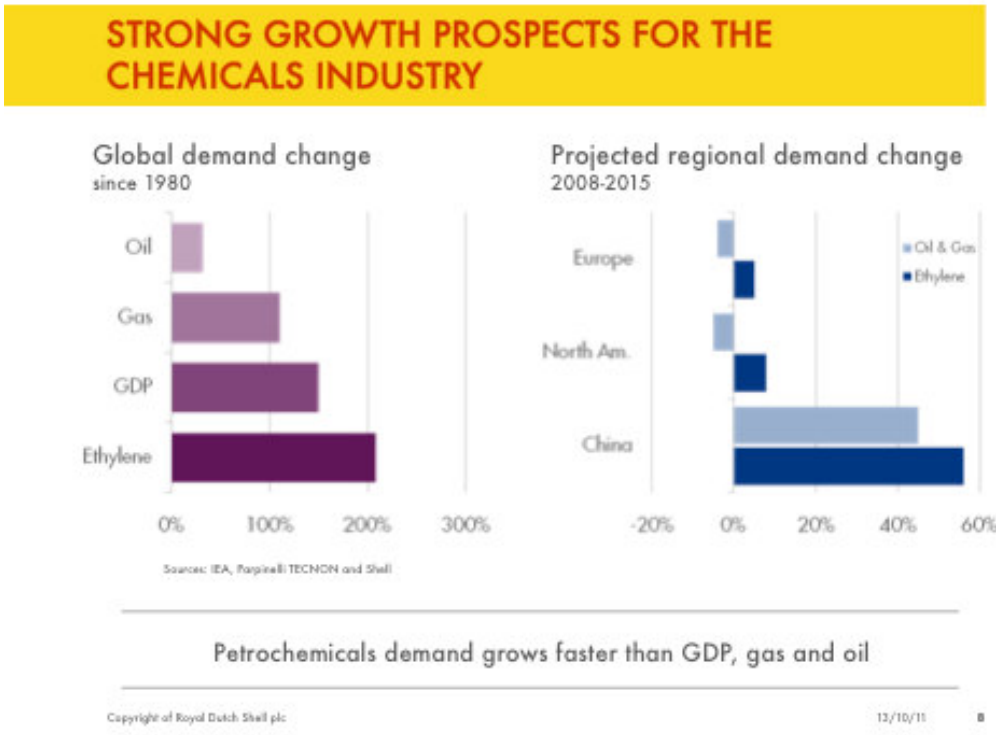


This shows how much chemicals demand has grown over the last 30 years.

Since 1980, global ethylene demand has grown over 200% - and continues to grow around 5-6% a year. This far outstrips oil and gas demand and GDP growth over the same period.

Between 2008 and 2015, ethylene demand in Europe and North America is projected to grow steadily, while oil and gas demand is set to contract.

In China, the chemicals business is really booming, with ethylene demand forecast to increase by a massive 60%.

The developing world – countries like China and India - will certainly drive increased chemicals demand, which some commentators suggest could double by 2050.

For example, today's per capita consumption of polyester in the most developed nations is about 20 kg. But in India it is only about 1.5kg, and just under 9 kg in China. That suggests a huge market potential.

Today's average cars contain about 150 kg of plastics and composites.

In the US today, 800 people in every 1000 own a car. But in India, with 1.2 billion people, less than 20 in every 1000 own a car. In China, around 40 people in every 1000 own a vehicle, but that's double the number 10 years ago. By 2030, estimates suggest this could rise close to 270 per 1000.

In a 2050 world with 2 billion more people, these two examples indicate something of the growth potential for chemicals and explain why those of us in the C6 value chain should have confidence in the long-term future of this sector.

Our challenge is to provide sufficient cost-competitive supplies of our products while developing innovative ways to make and use them.

Evidence for C6 demand growth

Having touched on some general long-term drivers for chemicals demand, I want to drill into three sustainability-related application areas with strong C6 demand growth potential.

- Food packaging – preventing waste, saving energy

Did you know that plastic shrink-wrapping can increase a cucumber's shelf life from 3 to 14 or more days by preventing water loss and handling damage?

According to UK packaging association, Incpen, the developed world currently wastes only about 3% of its food output during transfer from field to consumer. Packaging makes a big contribution to minimising food waste.

But in the developing world, 50% of food produced is wasted.

To me, that suggests a huge market opportunity in the developing world, for packaging to prevent waste, and cut energy use and CO2 emissions in food production, transportation and storage.

One estimate (*Denkstatt report for Plastics Europe*) suggests that if plastic packaging saves 10%-20% of the food it wraps, then the overall C02 emissions savings are between 4-9 times higher than those generated making the packaging.

Polystyrene (PS) has long been a preferred food packaging material. Today PS products range from meat, vegetable and fruit trays, to yoghurt pots, beverage cups and film wrap. They keep food fresh, secure, hot or cool, prolong shelf life and prevent waste.

According to the American Chemistry Council, EPS cups are up to five times lighter than similar paper packaging products. This means lower transportation emissions.

Making a polystyrene cup uses half the energy needed to make a coated paperboard cup and corrugated sleeve.

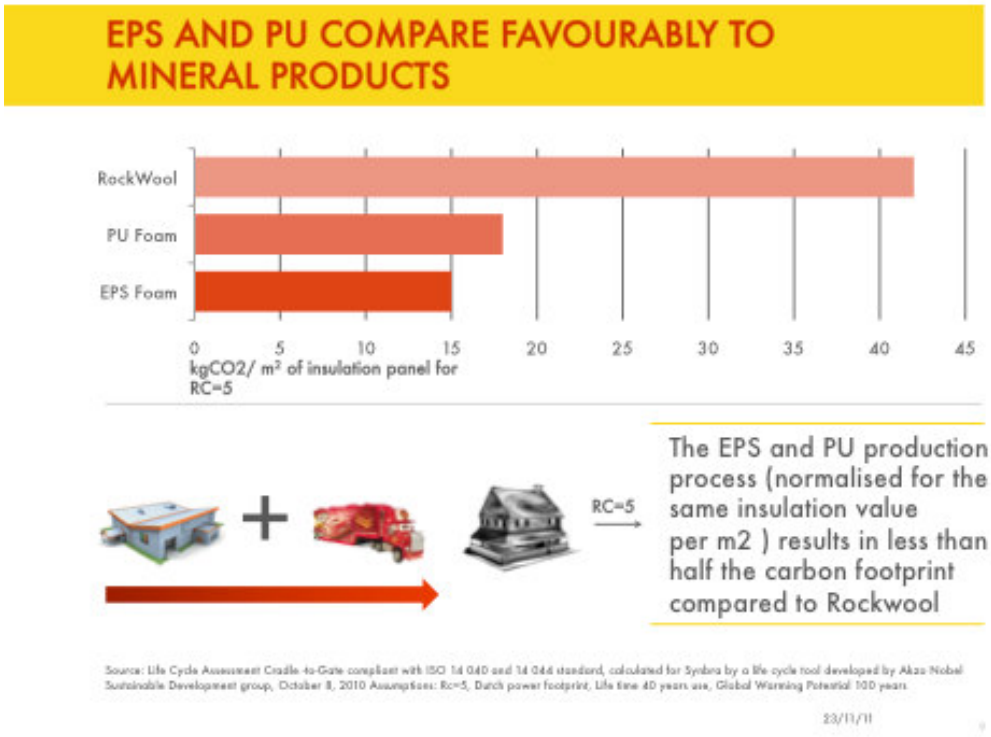
Polystyrene is increasingly recycled. Recycling most single-use, coated paperboard food packaging is uneconomic.

One estimate suggests that if plastic packaging saves 10%-20% of the food it wraps, then the overall C02 emissions savings are between 4-9 times higher than those generated making the packaging.

However, we and our customers do face challenges on the use of styrene-related product applications. From recent regulatory activity in both the US and Europe, the styrenics chain continues to be in focus. Yet, governments the world over, from the US through Europe to Japan, have regulated and approved the use of polystyrene in safe food packaging for over 50 years. The industry should continue collaboration with governments and industry bodies, supporting a scientific-based approach to regulations. At Shell, we believe that working with regulators, customers, industry groups and key stakeholders is the right way forward.

My next C6 demand growth example is building insulation.

- Insulation – saving energy, conserving resources



Here, the outlook for polystyrene and polyurethane insulation products – in both new builds and refurbishments - is really encouraging.

Where it's cold, they help buildings to retain heat, reducing energy consumption and costs. In hot climates, they help keep buildings cool, cutting energy consumption, CO2 emissions and costs.

It has been estimated that energy used to produce polystyrene foam insulation for a typical house is recovered in just one year through energy savings.

As buildings account for about 40% of global energy use, the contribution of insulation to energy efficiency and reduced CO2 emissions is significant. Some estimates suggest that 20% of current world energy consumption could be saved if all new buildings were energy efficient.

In manufacturing, chemical insulation products also compare favourably with mineral insulation products. For example, one study - by Synbra using an Akzo lifecycle tool - has shown that the carbon intensity in the manufacture of EPS and standard polyurethane insulation panels is less than half that for Rockwool equivalents.

According to the 2009 ICCA report "Innovations for Greenhouse Gas Reductions – a life cycle quantification" high-performance insulation materials primarily made from polystyrene and polyurethane were delivering net emissions savings in 2005 of almost 2.4 gigatonnes of CO2 equivalent. That's over 40% of the net emissions savings enabled by chemical industry products. (5.16Gt)

- Automotive light-weighting – saving energy, conserving resources

Demand for C6 products is also set to grow in the automotive sector, where their low weight, strength and flexibility offer significant energy and design advantages.

INCREASED USE OF C6 PLASTICS IN AUTOMOTIVE PARTS

	1968	2008	2050
			
Global car population	170 m	530 m	+ 1 b
Kg plastics per car	27	150	?

Source: ACC, ACEA

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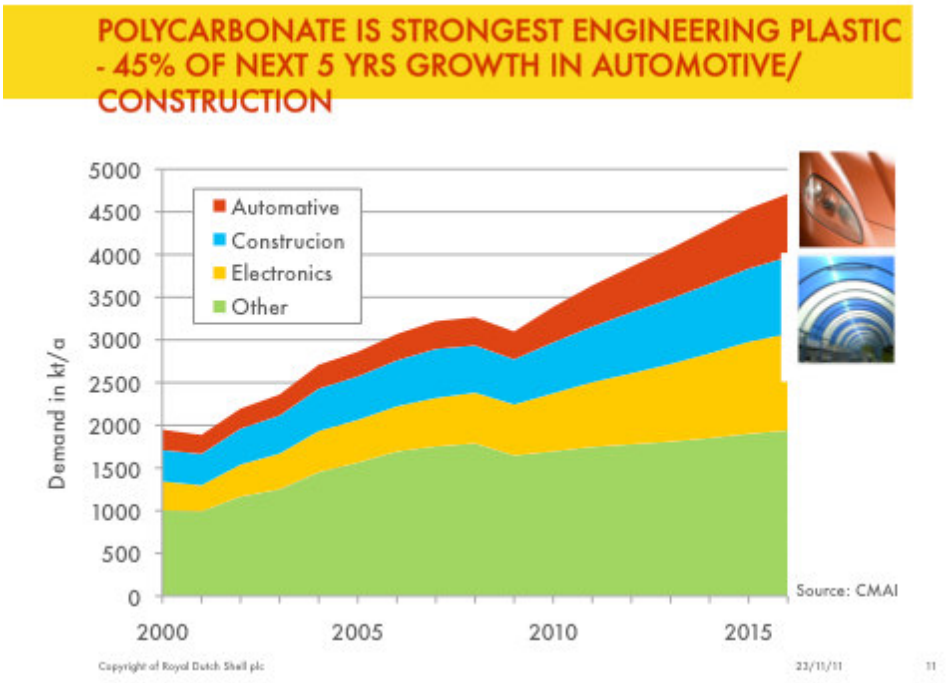
Shell estimates auto manufacturing consumes around 15% of C6 derivatives.

Today, my car contains over 150 kg of plastics and polymer composites. But 40 years ago the average car contained under 30kg.

Today, these materials account for over 50% of my car's volume but 10% of its weight.

They are also steadily replacing metal and glass in a welter of auto applications, thanks to weight, cost and, in some cases, strength advantages.

In the US, it's reckoned plastics and composites help to reduce annual passenger car fleet energy consumption by 90 million barrels of oil equivalent, saving around 30 million tons of CO2 emissions.



One C6-derivative – polycarbonate - is seeing significantly increased automotive application thanks to performance characteristics ranging from strength, low weight, and thermal stability to excellent polymer clarity.

Automotive glazing demand is really fast growing.

Walking around my car, I see polycarbonate in the headlamp, fog lamp and tailgate lenses. In some cars it's used in fixed side windows and the roofing.

Polycarbonate is already used for weight and safety in motorcycle windshields, and some car makers expect it soon to be used in car windscreens.

New scratch resistant multi-layer polycarbonates are finding increased uses in automotive manufacturing and construction.

Currently, global polycarbonate demand is around 3 millions tons, and forecast to grow 6 per cent a year.

Supply challenges

Up to now, I've focused on long-term C6 demand drivers. But there are also supply side challenges to consider such as the availability and cost competitiveness of C6 derivatives.

Over the past decade, benzene supply has tightened significantly. Today, output is mainly determined by gasoline manufacture and naphtha cracking, which generate benzene as a by-product.

Current estimates suggest benzene capacity may rise by about 2% a year, but annual demand growth will be about 3%.

New capacity has come on-stream, mainly in Asia Pacific and the Middle East and only as by-product. By 2015, new Asia Pacific steam crackers and aromatics plants would have added around 4.5 million tons of capacity, while the Middle East is expected to have added 1.2 million tons, 75% of which will be refinery-derived.

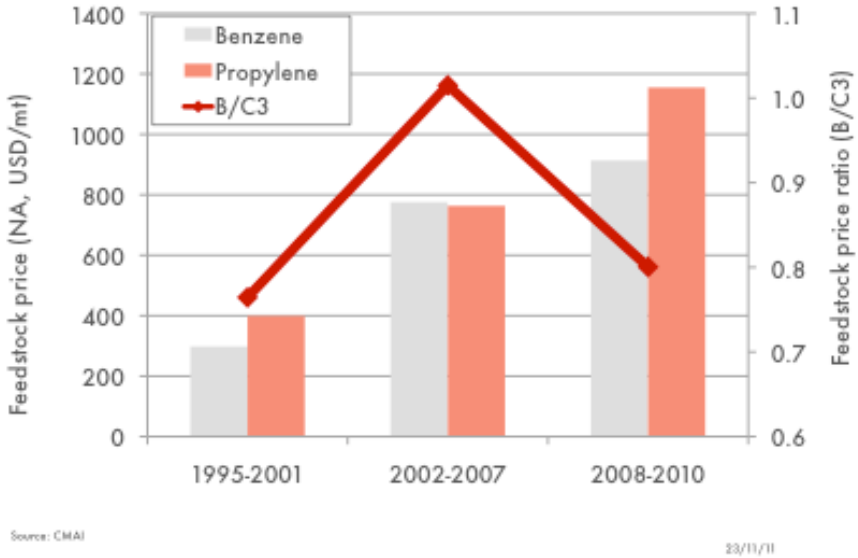
Aromatics feedstock has also been impacted by the shift towards lighter cracker diets, relatively poor polyolefins demand through late 2008 and 2009, and falls in gasoline demand.

This supply tightening means benzene tends to quickly move from short to long or vice versa, depending on demand for olefins and transport fuels.

In combination with high and fluctuating crude prices, the knock-on effect has been to markedly increase benzene price volatility, making life difficult for everyone.

However, there are encouraging developments.

BENZENE HAS REGAINED COST COMPETITIVENESS OVER PROPYLENE

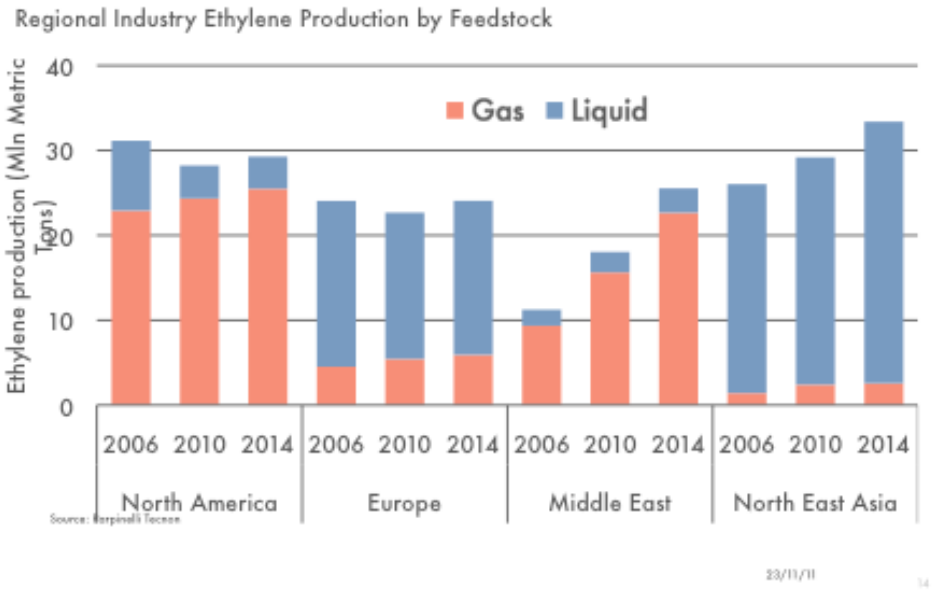


Since the recession, benzene has benefited from the increased cost competitiveness of polystyrene against polypropylene, and substitution of PS by PP in some applications seems to have reached a plateau.

Substitution is not a threat to construction market-focused PS products – particularly insulation – where long-term demand outlook is good in both new build and refurbishment. There are other uses – such as snap-off multipacks for foods like yoghurts – where PS is clearly the material of choice.

Styrene is currently long, resulting in average industry operating rates at about 86 per cent. But as little new capacity is expected on stream, operating rates could recover steadily through 2012 and beyond.

CHEAP GAS BASED ETHYLENE IN US HAS ENABLED STYRENE EXPORTS TO EUROPE



US styrene producers, however, have also seen a turnaround in their competitiveness as a consequence of a significant fall in ethane costs, enabling the revitalization of some underused capacity and significant exports to Europe. Currently, virtually all Middle Eastern styrene is absorbed by Asia Pacific, primarily China.

Phenol has suffered since 2008, at one point seeing global industry average operating rates near 75 per cent. But the market has improved and, longer term, phenol demand is expected to grow around five per cent a year, mainly on increased demand for BPA for polycarbonate and epoxy resins. New capacity additions will, however, mean fierce competition.

Industry developments and competition constantly drive structural changes in our industry, with older, small-scale units closing and some established players selling businesses or spinning them off into new, stand-alone structures. Overall, the balance of manufacturing is shifting from the West to Asia Pacific.

Before concluding, I want to look briefly at Shell's chemicals strategy, and revisit the question I asked earlier: Why is Shell in chemicals? Hopefully, I've explained the long-term demand reasons underlining Shell's commitment to the C6 chain.

Now, I also want to explore the internal strengths and synergies underlying Shell's long-term commitment to base petrochemicals production and supply.

Shell Strategy

Shell chemicals companies supply around 8 million tonnes of chemicals a year, and generated earnings over $1.5bn in 2010.

Our petrochemicals business enables us to convert hydrocarbons beyond fuels into higher-value products that extend our value chain.

Our global chemicals experience and capabilities also give us a competitive edge in partnering with major resource holders wanting to add value to oil and gas reserves.

Co-location of chemicals manufacturing with upstream and refining facilities gives us feedstock flexibility and cost competitiveness, which makes Shell a strong petrochemicals player.

Shell continues to make very significant investments in its global chemicals manufacturing network – both in upgrading existing facilities and in new world-scale production assets – and we have also streamlined our commercial footprint.

Co-locating chemicals production with refining or locating assets at the source of advantaged gas reserves gives Shell both feedstock flexibility and cost-competitiveness. Two good examples of this are the joint venture refining and petrochemicals complex we are developing in China, and our gas-to-liquids joint venture in Qatar, which gives us petrochemicals options.

We have also continued to invest in our proprietary process technology and catalysts. So, while Shell may not be involved in developing new applications or characteristics for C6-derivatives, we are focused on ensuring our process technology remains highly efficient and competitive.

Before looking at three examples illustrating Shell's commitment to petrochemicals and the C6 value chain, I want to talk about our customers. Without them, we don't exist!

Shell's chemicals strategy is predicated on adding value – for Shell and for its customers - through hydrocarbon chains. Our role in the C6 value chain is to supply quality, competitive feedstock in the right quantities at the right time and place.

We all like to think we do the best for our customers, but Shell's aware we can always do better. We're certainly working hard to improve reliability, to be more transparent, and to communicate better and faster with customers when we have supply disruptions.

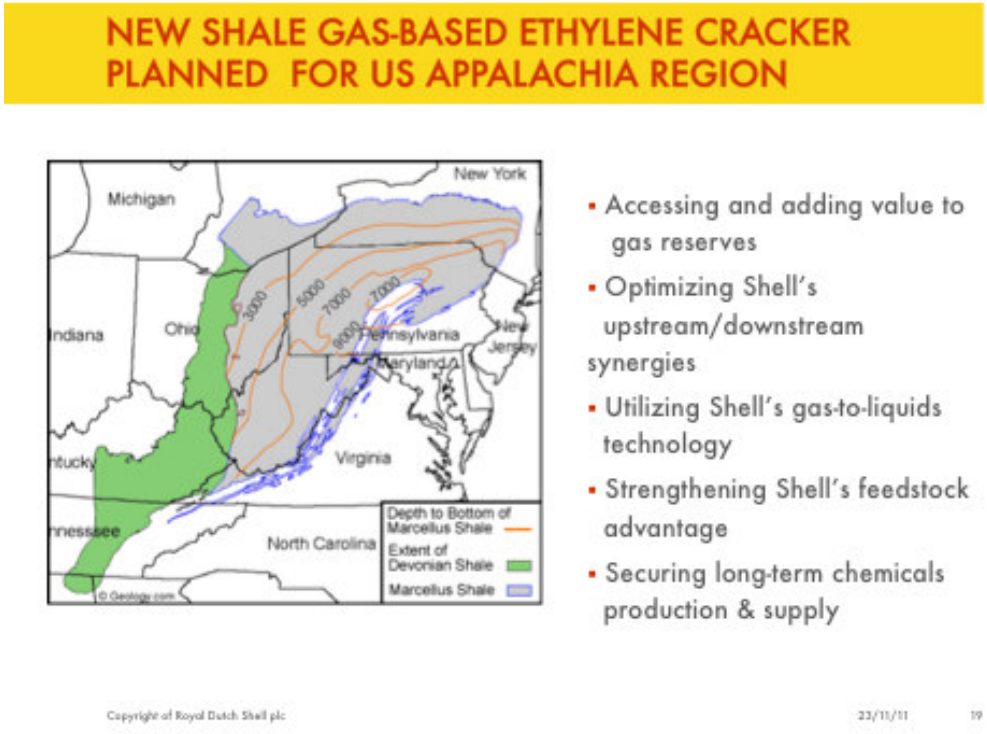
We are also working hard to improve our flexibility and to make it easier for our customers to do business with Shell by better understanding what they need in terms of overall service. We want Shell's chemicals business to be profitable and we want our customers to prosper, too.

Shell certainly feels that strengthening customer partnerships with a focus on medium-to-long-term market developments is essential for success whatever economic conditions prevail. This way, we can identify potential service enhancements and new sources of value to be shared.

Before I conclude, I'd like to offer you three examples of how Shell is:

- Continuing to invest in chemicals production for the long-term
- Benefiting from being a strong, global integrated oil, gas and petrochemicals producer, and
- Continuing to invest in innovative technology to remain competitive and extend the value we can offer customers

New US cracker shale gas (hydrocarbon integration)



Earlier this year, Shell announced plans to build a world-scale ethylene cracker with integrated derivative units in the Marcellus shale gas region of the United States.

This multi-billion dollar project can unlock significant gas production by providing a local outlet for the ethane.

It also fits well with Shell's strategy to strengthen our chemicals feedstock advantage and enable us to help meet increasing demand for petrochemicals.

This project also highlights the synergies available to an integrated energy group. Shell is a leader in gas technologies, and has an array of long-term options to monetise natural gas, which include developing shipping solutions for LNG; proprietary gas-to-liquids technology to produce fuels, lubricants and chemicals; and gas-for-transport in markets focusing on heavy-duty vehicles, marine and rail transportation.

We're also continuing to invest in aromatics for the long-term, too, and benefiting from our global manufacturing capabilities. My next example also explains how Shell's manufacturing strength and commitment to aromatics enabled us to turn a potential threat into a great opportunity and keep customers supplied and satisfied.

Securing Deer Park aromatics production

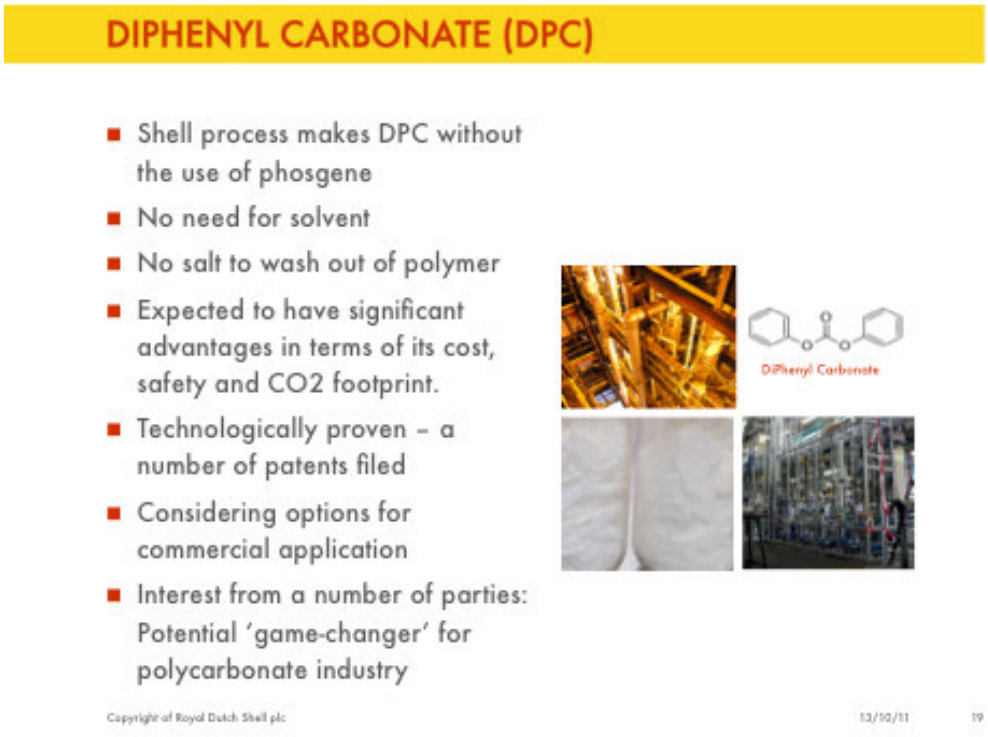
Back in 2009, Shell's US Gulf Coast crackers switched to lighter feeds to take advantage of competitive gas prices, which meant reduced availability of aromatics feedstock.

We considered shuttering our aromatics assets, but opted to keep running by securing feeds and investing to restart idled units.

Today, all our aromatics processing is done at Deer Park, Texas, and we're the largest 3rd party Gulf Coast purchaser of aromatics feeds, and possibly in North America, too. But we're also processing crude C5s from our Moerdijk, Netherlands cracker, and supplying all the benzene for our cumene units.

My third illustration of Shell's chemicals strategy relates to our continuing investment in process technology, which is where our strengths lie.

- DPC - Chemistry with a clear technological advantage



Shell has developed an advantaged process for a more sustainable phosgene-free route to diphenyl carbonate (DPC), a key raw material for polycarbonate.

In this new process, carbon dioxide, phenol and propylene oxide react to produce propylene glycol and DPC. Ethylene oxide can replace propylene to give ethylene glycol instead of propylene glycol.

Efficient catalysts help achieve high conversion rates in a single pass, with over 99% selectivity and impressive yields. We also expect the new process will have significant advantages in terms of its cost, safety and CO2 footprint.

In Shell's newly-patented supply chain, DPC is blended with acetone to allow for liquid shipping, thereby providing customers with both raw materials.

Commercial non-phosgene DPC technologies exist, but they are energy intensive and cumbersome, which is why we think Shell's new DPC is a potential 'game changer' for the polycarbonates industry.

We're already developing options for commercial applications.

Conclusion

So, on that optimistic note, I'd like to sum up.

The global drive for sustainability is creating strong, long-term growth opportunities for the whole of the C6 value chain. Our products can help reduce energy demand and emissions, and help conserve food and water for a world with 9 billion people.

The keys to a successful C6 future are enhanced process efficiency and increased product applications, which will depend on the industry's commitment to invest in innovation.

Shell Chemicals certainly believes in the strength of long-term growth.

Our strategy is to continue to make investments in world-class global-scale manufacturing assets that optimise group synergies and strengthen our feedstock access and advantage.

We aim to maintain and strengthen our global manufacturing platform and ensure long-term and reliable supplies to our customers in the C6 value chain. Our success depends on their success. Thank you.

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