The German Chemical Industry 2030

VCI-Prognos Study – Update 2015/2016

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CHEMISCHEN INDUSTRIE e.V.
WIR GESTALTEN ZUKUNFT.
VCI

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Executive Summary

The global economy is faced with new challenges. The growth motor China is stuttering. Large national economies like Brazil and Russia are in recession. Not least, the European Union needs to cope with the refugee crisis and with uncertainty about Great Britain staying in the EU. The debt crisis in Greece is not yet solved, either.

Additionally to these current developments, there are long-term megatrends that influence the global economy. The world population is growing. According to UN estimates, 8.5 billion people will be living on this planet in 2030 (2013: 7.2 billion). This brings a globally rising demand for food, goods and services – and a higher availability of workforce. 90 percent of the population growth takes place in Africa and Asia, while the population is stagnating in industrial countries where societies are ageing fast. The global population growth positively impacts the growth of the global economy but also comes with major challenges for some regions.

Another trend and growth driver is the faster dissemination of technology and knowledge. The technology transfer enables many countries to benefit fast from innovative technologies. In the future, no country alone will be in a position to claim a technological edge for long. This increases the pressure to innovate. Moreover, digitalisation as well as networks and interconnections will fundamentally change the economy in the years to come. Like the steam engine, electricity and computers in the past, now digitalisation is triggering a new phase of the industrial revolution (Industry 4.0). Digitalisation progresses to cover entire value chains and will not stop at chemical companies. This makes cross-sector innovations possible. Such innovations have the potential to widen established and tried and tested business models, but they can also replace them. Thus, the borderline between industry and the service sector is going to blur gradually – this can be observed already today.

Unlike expected by many experts, there will be no shortage in energy and raw materials over the forecasting period. Already since 2014 new production technologies (fracking) and competition between the oil producing countries have brought surplus supplies of oil and gas, leading to a rapid decline of prices for fossil energy sources worldwide. In the medium term, the oil price will rise again. Up to 2030, crude oil remains clearly less costly than had been assumed still in the predecessor study. Overall, this strengthens the competitiveness of chemistry and the growth of Europe.

Against the backdrop of current developments, the VCI updated its study "The German Chemical Industry 2030". The goal is to describe the future of the industry in a realistic scenario and in a dramatically changing world. The guiding questions of the updated study on the future were: What will the global chemical market look like in the year 2030? And how is the chemical-pharmaceutical industry in Germany getting ready for that?

Dynamic growth in the global demand for chemicals

Over the next years, the global economy will overcome its present weak phase. According to current projections, the global economy will have average growth of 2.5 percent p.a. to 2030. This roughly corresponds to the dynamics in the period from 2000 to 2013 – even though this comparison should be put into perspective due to the financial crisis.

However, as compared with the predecessor study the prospects are slightly less favourable. The global economy will grow less strongly than had been forecasted in the first version of the study (+3.0 percent). According to the new calculations, the long-term growth potential has become weaker, mainly for China and many emerging markets. The updated study assumes lower GDP growth for the USA too. In the impacted countries the growth chances have also weakened for industry and thus for the demand for machinery and chemicals.

To 2030 Germany can benefit from global economic dynamics. The gross domestic product (GDP) will rise by 1.3 percent p.a. to 2030. In the future, the by far largest contribution to growth will come from private consumption which will replace foreign trade as the growth driver of the German national economy. The investment weakness will be overcome gradually too. With 1.4 percent p.a. the growth in industrial production will be somewhat higher than GDP growth.

The various regions have different growth drivers. Population growth, prosperity and thus the demand for everyday products will increase in emerging markets – while topics like energy efficiency, environmental protection and renewable energies will gain in importance as drivers in industrialised countries. The changed demand structure leads to vigorous growth in industrial production and, consequently, to a rising demand for chemicals.

In this setting, here the good news from the study: Chemistry is a dynamic growth market. In the forecasting period the global demand for chemicals will rise by 3.4 percent and thus grow faster than industrial production (3.2 percent) or the overall economy (2.5 percent).

Future chances for the German chemical industry

The global market for chemicals is a dynamic growth market to 2030, with chances for the German chemical-pharmaceutical industry to continue the successes of the past – if the framework conditions in the energy policy in Germany and Europe do not further weaken the competitiveness of the industry.

Competition is becoming more intense. Therefore, in its future production the industry needs to give even more emphasis on research-intensive specialty chemicals and pharmaceuticals, in order to maintain and increase its competitive advantage. The industry will drive forward technological progress, and it will use the chances of digitalisation. Positive features of the German chemical industry are high-quality solutions for exacting customers at home and on all foreign markets. In this manner, the industry will continue to grow also in the future – combining pharmaceuticals, basic and specialty chemicals. According to the new calculations, German chemical production will grow by 1.5 percent p.a. in the forecasting period.

Thus, growth is slightly lower than in the predecessor study. This is mainly because of weaker dynamics of important foreign markets. Moreover, the growth environment has changed considerably for basic chemistry. Raw material and energy costs are high in an international comparison, so that German basic chemicals producers cannot supply the world markets from the location Germany. But integrated production (the so-called Verbund, one of the central strong points of German chemistry) is kept up. German and European chemical markets will be supplied with basic chemicals from German production also in the future.

Changing raw material base

Fossil raw materials – mainly the mineral oil derivative naphtha – will remain the most important input of the industry to 2030, however, with a slightly falling share in the raw material base. By contrast, the share of renewables will rise from currently 13 percent to 18.5 percent (2030).

Major research efforts are needed for a stronger integration of renewables into production. For this purpose, new value chains need to be created jointly with other industries. This is an elaborate exercise which does not progress as rapidly as many had hoped. From the present perspective, a significant substitution of fossil raw materials by renewables is hardly likely to 2030. Availability and prices of renewables will remain limiting factors due to competing uses (food versus raw material).

Rising research spending

Research and development are not only needed for change in the raw material base. In the future, especially global competition will necessitate a faster innovation speed overall. There is also the rising demand for research-intensive specialty chemicals. Against this backdrop, the industry will increase its research spending from 10 billion euros (2013) to 16.5 billion euros in 2030. The increase is lower than had been anticipated in the predecessor study, because of generally slower growth in chemical production in Germany and due to stronger competitive pressure on the research location. Other regions and also emerging markets are investing heavily in their chemical research. In some customer industries, more production and research centres are relocating to Asia. German chemical research partly follows this development.

Reserved investment attitude in the chemical industry

The long-term trend growth is low for investments in the German chemical industry. Since 1991 the industry's investments in plants and buildings have risen by only 0.2 percent p.a. – in real terms, investments even dropped by 1.6 percent p.a. The reasons are manifold: Firstly, in the past years the chemical-pharmaceutical industry achieved considerable efficiency gains which allowed production growth with fewer investments. Secondly, there was a rising degree of specialisation away from capital-intensive basic chemistry to other chemical sectors where fewer fixed asset investments are necessary.

But the main reason for the reserved investment attitude was the high price level for energy and raw materials in an international comparison. This is an important location factor, especially for the energy-intensive chemical industry. Therefore, many investment decisions of companies favoured sites abroad. Consequently, for years now their foreign investments have been growing much more dynamically than domestic investments. Since 2012 the German chemical industry has even been investing predominantly abroad.

No fundamental changes are discernible in the energy and climate policies, neither in Berlin nor in Brussels. Therefore, the companies will remain burdened with higher energy and raw material costs in Germany also in the future. Frequently changing energy policy requirements and countless interventions in the energy market by the public administration cause persistently high uncertainty in corporate planning – resulting in cautious investments. This situation will last in the forecasting period.

Intrinsic strengths and a good industrial policy are called for

The update of the 2030 study shows the following: Also in the future, Germany will remain one of the most important chemical industry locations worldwide. But this perspective needs to be worked for strategically. Here the components of a promising strategy for the industry: use the chances of globalisation, focus on specialty chemicals and pharma, launch an innovation offensive, improve resource efficiency, diversify the raw material base, and increase productivity.

The framework conditions under the economic policy are the second prerequisite for the German chemical industry and its products holding their own in global markets. It is true that there are quite positive starting points in Brussels and Berlin with the initiative "Better Regulation" and the alliance "Future of Industry" (Bündnis "Zukunft der Industrie"). But apart from that, very little has improved in the political environment for industrial production. In particular the energy and climate policy remains the proverbial Achilles heal of German industry. This is because energy costs are an important factor in the global competition of locations.

The disadvantages of the location Germany with its energy and raw material costs during the forecasting period dampen the possibilities for development of the German chemical industry. Reliable and affordable energy supplies are a crucial issue for the future of the industry location. Therefore, the VCI speaks for a fundamental reform of the German renewable energy act (EEG) in the next legislative period, in order to bring expansion and pricing in an economically feasible and cost-efficient shape.

Furthermore, there is a need for political action also regarding the ability to innovate. The VCI study on paving the way for innovations ("Innovationen den Weg ebnen") highlights a number of external obstacles that cause unnecessary difficulties in the way of innovative products from the laboratory to the market. Achieving measurable progress in this respect will benefit both companies and customers.

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Introduction

The chemical industry[1] is a key industry. With many of its products this industry is at the beginning of numerous value chains. It develops materials for tiny chips that enable top performances of smartphones or computers, it produces construction materials for houses and other buildings, and it develops medicines. The images of modern TV sets would be much less clear without liquid crystals from the chemical industry. Thanks to chemistry, wind turbines and solar plants generate clean electricity, motorcars and aeroplanes lose in weight, and items of sports equipment (like skis or bikes) perform better and become safer. Therefore, the following holds true: Checking out the weather forecast via smartphone, taking a headache pill, flying on holidays or watching the soccer Bundesliga in high definition at home would be impossible without chemistry!

Over 80 percent of the products from the German chemical industry go to industrial customers. This makes the chemical industry the starting point and the driver of innovation for many value chains in Germany and abroad. Chemical companies closely cooperate with mechanical engineering, the electrical industry, construction and car-making. This partnership brings a high performance capacity and high product quality. The strength of the industrial network makes Germany a leading export nation. As the supplier of high-value solutions, chemistry has a central role for all of the above-mentioned sectors.

Hardly any other industry offers such a wide range of products. Basic chemicals account for roughly one third of the production in Germany. These include fertilisers, industrial gases and other inorganic basic materials as well as primary chemicals (e.g. ethylene, propylene or benzene), organic intermediates and standard polymers. At just under 40 percent, specialty chemicals have the largest share in the chemical production in this country. Specialty chemistry comprises paints and coatings, plant protectants, specialty polymers, additives (e.g. flame retardants), UV protective coatings and food additives, adhesives, soaps, detergents and cleaning products, and cosmetics. Human and veterinary pharmaceuticals make up over one fourth of the chemical production. The close link between pharma, specialty and basic chemistry builds not only on the common basis of molecules for active substances and materials; this link also takes the form of intensive business relations between the companies. Without the products from basic chemistry, it would be more difficult to obtain in Germany inputs for pharma and specialty chemistry. Conversely, basic chemistry depends on other sectors as reliable customers. The wide range of products in the German chemical industry, chemical parks where integrated structures ("Verbund") and synergies are used across companies and, last but not least, the close supply relations between almost all industrial sectors are some of the outstanding strong points of the chemical industry location Germany.

Furthermore, the chemical park concept – a German invention – increases the efficiency of production. Chemical park operators take care of the central environmental protection facilities and look after the complete infrastructure for the companies located in the parks. This service enables integrated structures of the production facilities – with a high level of efficiency for energy, raw materials and residues.

As a primary industry, chemistry is energy- and raw material-intensive. Many chemical reactions require high temperatures. The industry also needs much electricity – not only for electrolytic processes like chlorine production but also for operating the production plants. The chemical sector accounts for one fifth of the energy requirement in the manufacturing industry. The chemical industry also uses energy carriers as raw materials. Chemistry largely builds on carbon compounds. The most important raw material source in Germany is naphtha, a mineral oil derivative. Further inputs are natural gas and renewables from biomass.

The businesses are just as diverse as the products. The public perception is dominated by globally operating company groups. However, most of the over 2,000 chemical undertakings are characterised by mid-sized structures. More than 90 percent of chemical undertakings have fewer than 500 staff. In total, the ca. 1,800 small and medium-sized enterprises provide far over one third of the jobs in the industry. And they are successful in their overall corporate strategies. The so-called "Mittelstand" contributes almost one third to the total sales of the German chemical industry. Such a well-performing "Mittelstand" in chemistry can be found nowhere else in the world. With their specific solutions – mostly fine and specialty chemicals – for customers, our mid-sized businesses are often one step ahead of their competitors. This makes many of them global market leaders in their fields of operation.

Through their sales and investments, large companies and the "Mittelstand" combined decisively contribute to prosperity in Germany. As Germany's third largest industry, the chemical industry realises around 11 percent of German industry sales. Chemistry is capital-intensive. Nearly 12 percent of industrial investments are made by chemical companies. With ca. 463,000 staff[2] the chemical industry is also a major employer.

The eminent position globally of German industry is not least attributable to Germany being a strong research location. With continuous innovations of products and processes the German chemical industry has been holding its own in international competition for over 100 years. Also in the future, innovations will remain a necessary factor of differentiation in the global marketplace. As a supplier to other sectors, the chemical industry is a driver of innovation with a high multiplier effect – with its patents, new products, processes and application know-how. Chemistry (excluding pharma) contributes every fifth patent of cross-sector importance in

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[1] In this study, the term „chemical industry" is invariably understood as the chemical-pharmaceutical industry in its entirety. All key data refer to chemistry overall (unless stated otherwise).
[2] This report uses key data from the Prognos model (unless stated otherwise). The data stem from national accounting. Values are stated in real terms (at prices and exchange rates of 2010). For some individual key data this can lead to deviations from VCI reporting.

Germany. The chemical industry constantly develops and improves materials and innovative inputs and end products.

The growing world population comes with a rising demand for products for climate-friendly energy generation, more food, clean water, medicines, means of communication and environmentally sound mobility. For quite some time, German chemical companies have been orienting their business strategies and research projects to this fact. Its competencies make the chemical-pharmaceutical industry in Germany a central driver of innovation for coping with such global challenges – towards a sustainable development. At the same time, our initiative Chemie[3] contributes to embedding sustainability as a lived ideal in the entire sector. This self-concept relies on these pillars: economic success, ecological responsibility and social justice.

In terms of sales, Germany is the fourth largest chemical nation globally after China, the USA and Japan (2013). There is a strong demand worldwide for chemical products "made in Germany". For many years the German chemical industry has been the "world export champion". The industry opens up global markets not only by way of exports but also with production sites in most countries of the world.[3]

Global competition has accelerated enormously also in chemistry. The Asian countries of China, India and Korea are massively expanding research and science. Already now, 40 percent of all chemical inventions come from Asia. In raw-material rich countries, new production plants are built year by year – mainly in basic chemistry. This brings new competition for German chemistry with its long tradition.

Today, Germany is an attractive and competitive chemical industry location. But the study "Evolution of competitiveness in the German chemical industry: historical trends and future" ("Die Wettbewerbsfähigkeit des Chemiestandorts Deutschland im internationalen Vergleich")[4] by the business research institute Oxford Economics shows that the location Germany has been losing in attractiveness since 2008. This is alarming, because it stifles growth – with investment decisions being increasingly made in favour of foreign locations. Ever more often, the question arises whether German chemistry can remain on the success path to 2030?

Low growth in the German chemical industry over the past years is disquieting too. It is true that German chemistry recovered fast after the global economic crisis 2008/2009. But production has barely expanded since 2011. Can this growth weakness be overcome in the next years? And if so, how? This study also looks into these questions. It highlights the long-term growth potential of the industry in Germany.

This report is an update of the VCI/Prognos study "Die deutsche chemische Industrie 2030".[5] It takes into account the recent developments after 2011, like e.g. weaker growth in emerging markets or the price decline for crude oil. The study provides a comprehensive and consistent long-term forecast for the global economy, the developments in Germany and Europe, and the structural change in the industry down to developments in the individual chemical sectors. The projection of future developments gives the possibility to identify strengths and weaknesses of the German chemical industry and also the chances and risks that come with fundamental economic, societal and ecological developments. Beside these results, a more profound understanding of cause-and-effect relations is important to us.

Elaborating a scenario for the future is always an "if-then" analysis. Initially, this study only updated the basic scenario, alleging a constellation of factors for the chemicals business that is thought the most likely by the VCI and the member companies. Different scenarios are obtained, depending on which assumptions are made for the development of the major drivers in chemicals business.

Already the basic scenario shows a great need for action by the actors – because companies, society and politicians are shaping the future of the chemical industry in Germany. The study wants to provide an orientation framework for this. Entrepreneurial decisions (e.g. on focal points in research or investment) are based on the expectations for the future. Therefore, a well-founded long-term forecast provides the prerequisite framework for optimising the strategic orientation of companies. But the claim of this study goes beyond the chemical industry: Relying on the results, we also want to invite politicians and society to engage in a dialogue on the future of Germany. The political decisions of today are going to impact the overall economy and the competitiveness of German industry. Against this backdrop, the VCI makes – in the form of this study – a contribution that stimulates with sound arguments and figures the dialogue on Germany's future.

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[3] The key data of this study refer to chemical companies manufacturing in Germany (unless stated otherwise). Foreign subsidiaries of German chemical companies are not included in the calculations. Statements on competitiveness invariably refer to the chemical industry location Germany and not to the companies.

[4] „Die Wettbewerbsfähigkeit des Chemiestandorts Deutschland im internationalen Vergleich", VCI 2014, is available at https://www.vci.de/vci/downloads-vci/publikation/bericht-zur-vci-oxford-economics-studie-wettbewerbsfaehigkeit-chemiestandort-deutschland.pdf; the English-language version „Evolution of competitiveness in the German chemical industry: historical trends and future prospects", Oxford Economics 2014, can be accessed at https://www.vci.de/vci/downloads-vci/publikation/vci-oxford-economics-report-evolution-of-competitiveness-in-german-chemical-industry.pdf.

[5] „Die deutsche chemische Industrie 2030", VCI 2013, can be downloaded at https://www.vci.de/vci/downloads-vci/publikation/langfassung-prognos-studie-30-01-2013.pdf.

Global economic environment

The development of the chemical industry in Germany to 2030 is decisively co-determined by global economic developments and economic-political framework conditions. The drivers of development are megatrends; they are not necessarily of an economic nature. Without knowledge and without estimate of the direction that the central drivers will be taking, it is not possible to give an outlook of future developments. Therefore, initially the global megatrends are highlighted in this paper – before the resulting developments of the global economy and the German economy are described.

Global megatrends

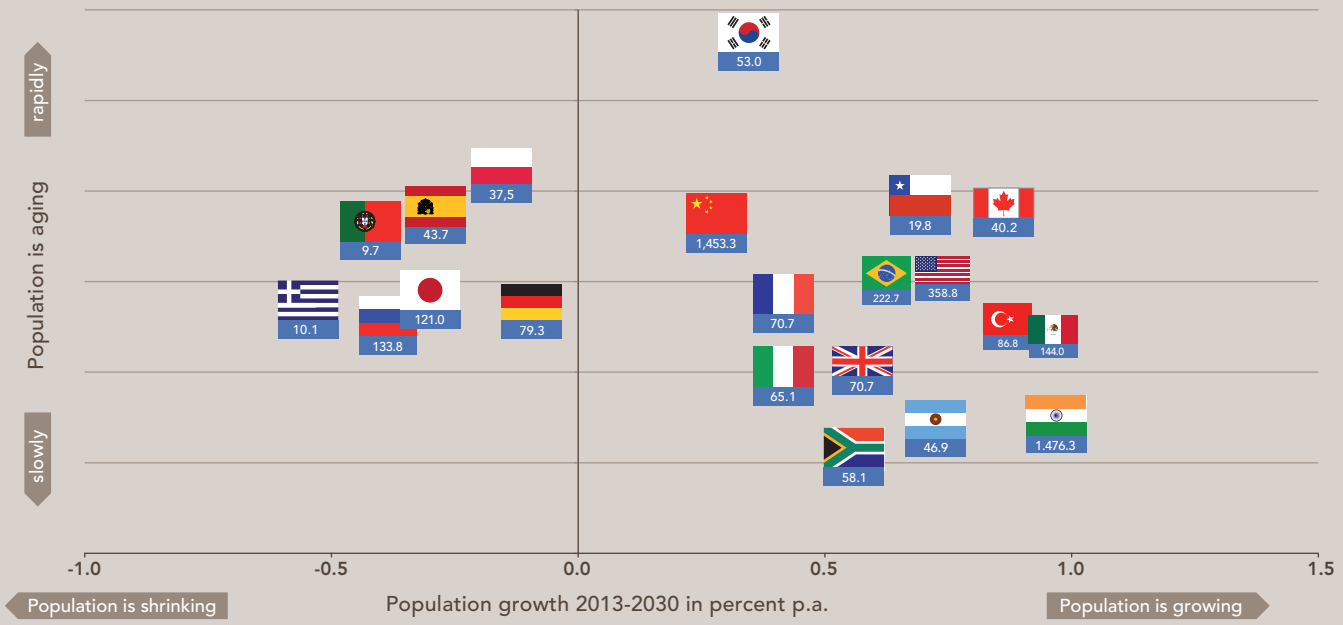
Many forecasts are obliterated by unlikely events with extreme effects – like natural disasters, wars or technological leaps. All the same, the long-term development trends of important economic frame data enable empirically supported statements on the future. For this forecast the current trends, emerging developments, existing studies and expertise were taken as the basis for assumptions on developments of the central drivers, i.e. demography, globalisation, technology and human capital, energy and resources, environment and climate as well as public finance and consolidation. As a result, six megatrends are identified. They are going to decisively influence the development of the global economy in the years to come.

GROWING AND AGING WORLD POPULATION

In the coming years, global population growth will be a central growth driver for the global economy. According to estimates by the United Nations (UN) the world population will increase from 7.2 billion in 2013 to 8.5 billion by the year 2030. This corresponds to an annual growth of 1 percent and will be reflected in a dynamically growing global demand for foodstuffs, goods and services. At the same time, the global availability of labour will increase too. However, because of the simultaneous aging of the world population, that increase in the availability of labour will be less marked.

Global demographic developments in the 21st century will be characterised by dynamics and divergence. Almost 90 percent of the global population growth to 2030 will be attributable to demographic developments in the emerging markets of Africa and Asia. The population is growing particularly dynamically in India. To 2030 the population of India will increase by 1 percent per annum and thus grow to well over 1.5 billion. By contrast, demographic growth is clearly weakening in China because of the one-child policy. Across the entire forecast period, the population in China will only grow by 0.3 percent p.a. In consequence of these contrasting developments, in the next decade India will replace China as the most populous country on Earth. Russia is an exception among the emerging markets. The Russian population is shrinking, so that to 2030 clearly fewer people will be living in Russia than still in 2013.

FIG. 1: THE WORLD POPULATION IS GROWING – HIGHER LIFE EXPECTANCY
Population in the year 2030, in million



The life expectancy is rising in all countries, thus increasing the share of persons over 64 years of age. The world population is mainly growing in the emerging markets. The population is shrinking in Greece, Japan, Russia, Poland, Portugal, Spain and Germany.
Source: United Nations 2015

The demographic development nearly stagnates in the industrial nations[6] (+0.2 percent p.a.). Overall, the share of persons living in industrial nations will fall from currently 17 percent to 15 percent in 2030. Within the group of industrial nations, there are major differences in demographic developments – with visible population growth mainly in the USA and also in Australia, Switzerland or Norway. Because of the large number of immigrants, the US population will grow by 0.7 percent p.a. to 2030. The population in the European Union will only be able to increase by 0.1 percent p.a. Across the entire forecast period to 2030 the population in Japan will shrink. 6.3 million fewer persons than today will be living in that country in 2030.

With a growing life expectancy, the world population will age overall. Today there are around 840 million persons over 60 years of age on Earth. This corresponds to a share of just under 12 percent in the total world population. This share will increase to 16.5 percent to 2030 when 1.4 billion persons will be older than 60 years. There are huge regional differences not only regarding population growth but also concerning the aging of the population. Mainly in the industrial nations and also in China the population will age rapidly, while the share of older persons will increase much slower in the other developing countries and emerging markets.

At the bottom line, it is noted that the population ages faster and barely grows in countries with a high level of prosperity, while the population hardly ages and grows at breathtaking speed in the developing countries and emerging markets. Consequently, the industrial nations are faced with the challenge of a declining labour potential and a threatening shortage of qualified labour. At the same time, the social systems (old-age security, health system, nursing care) have to cope with ever heavier burdens. By contrast, in the developing countries and emerging markets it is getting ever more difficult to reliably supply the population with goods and services. Creating enough jobs for the growing population is even more difficult. Against this backdrop, the North-South divide in per capita incomes will largely persist.

In the coming years the prosperity gap, wars and different population dynamics will continue to trigger migration movements. Their direction and strength are difficult to forecast. Lately, Germany managed to become more attractive as a country of immigration, even though the high immigration of recent years was partly attributable to the only slowly stabilising economic crisis in the euro zone. Also in the years to 2030, the population decrease due to low birth rates can be made up for partly by way of migration. Thus, the perspectives have clearly changed as compared with the initial study. However, the demographic forecasts do not yet include the most recent significant flows of refugees. Within this study it was not yet possible to quantify the impacts of the refugee crisis on the development in Germany. But from today's perspective, it is hardly likely that the basic development trend – as they are discernible today – will change for the labour potential.

Overall, the growing world population will positively impact global economic growth. Many more persons will be living and consuming in the emerging markets – while they will be available to the labour market. The industrial nations will benefit from this development, as they can increase their exports to those regions or purchase more favourable inputs from them. At the same time, immigration from emerging markets can counteract the threatening shortage of qualified staff.

GLOBALISATION IS LOSING IN SPEED

In the past two decades, globalisation was one of the major drivers for a prospering global economy. The international division of labour increased at breathtaking speed since the mid-90s. From 2000 to 2013 global trading grew on average by ca. 4.5 percent p.a. and thus clearly more dynamically than the global economy (2.5 percent). This development was favoured by five special factors:

- The integration of China in the global economy,
- the transformation of the former Eastern Bloc,
- the hunger for resources triggered by the industrialisation process of emerging markets,
- the wealth of raw material countries attributable to resource exports,
- the elimination of trade barriers and of capital transaction controls.

After the global economic crisis 2008/2009, world trade recovered fast from the setbacks, but since then it has been growing only slightly faster than the global economy. This is also obvious in the chemical business, as the ratio of global chemical trading to global chemical sales has been stagnating for some years. Local production is gaining in importance with the industrialisation of emerging markets, because the differences in international wage rates have been decreasing. Furthermore, transport costs are hardly falling any further, and the proximity to customers is getting ever more important for innovative products.

Trade policy will have an important role also in the future. But overall, the elimination of trade barriers and of capital transaction controls will be clearly less dynamic than in previous decades. The likelihood has fallen of a comprehensive multilateral trade liberalisation and of a substantial further development of the world trade order. The underlying reasons are, firstly, an increasingly multilateral global economy and, secondly, the expansion of the trade policy playing field by non-economic dimensions. Against this backdrop, to 2030 only a gradual further development of the international trade regime is alleged. This is accompanied by four phenomena that impact world trading in different directions.

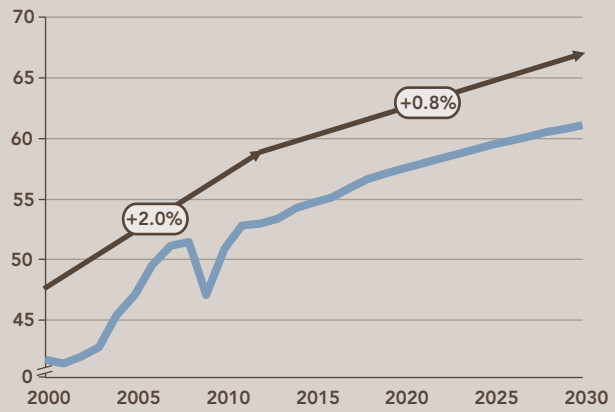
- Regional integration efforts will increase, partly successfully. While integration will deepen pragmatically in the Asian-Pacific region by way of new agreements the EU might fall back, because the advantages of a stronger economic inte-

[6] *In this study, industrial nations are essentially understood as „advanced economies" in the meaning of the definition by the International Monetary Fund (https://www.imf.org/external/pubs/ft/weo/2015/02/weodata/groups.htm), while the study considers China an emerging market. Further countries of this group are Argentina, Brazil, Chile, India, Mexico, Russia, South Africa and Turkey.*

gration are not sufficiently prioritised in the socio-political discourse.

- Weaker growth in industrial nations and some emerging markets, the weakness of multilateral institutions and the stronger weighting of ecological aims over economic goals will become manifest in protectionist tendencies. Even though there should be no protectionism spiral like in the 1930s, this will have a slowdown effect on free trade.
- Technological change, especially through digitalisation, will lead to more trading in knowledge, data and designs instead of finished goods and, moreover, investments will gain in weight. The resulting slowdown in trade dynamics will more heavily impact the manufacturers of components and consumer goods and less so the material technologies like chemistry. Here, trading could even increase through digitalisation – e.g. additive manufacture would depend on high-quality materials. But the exact effects still involve large uncertainties.
- The world order is undergoing dramatic changes. There is the great danger of countries or even regions increasingly becoming involved in wars or civil wars or that "failed states" politically and also economically isolate themselves and largely remain outside the international trading system. This would result in a falling importance of such countries or regions in world trade – as customers and suppliers. The greatest danger of this is in the Middle East and in parts of Africa.
- Compared with multilateral trade liberalisation, bilateral trade agreements will have a greater role also in the future (TTIP, CETA, TPP, several free trade agreements in Asia etc). At present, the outcome of the negotiations about the Transatlantic Trade and Investment Partnership (TTIP) is not yet predictable. Resistance is large to some parts of the negotiation package. In the study, we alleged a successful conclusion of the negotiations. This will animate the trade relations between the USA and the EU and strengthen economic growth. But progress in only small steps is likely in regulatory cooperation and in the elimination of non-tariff trade barriers, so that economic potentials remain unused.

FIG. 2: GLOBALISATION IS LOSING IN SPEED
Share of trade worldwide (exports + imports) in global GDP in percent, CAGR 2000-2013 and 2013-2030



Globalisation will continue. Also in the future, trade will grow more strongly than the global economic performance. But the importance of world trade as a growth driver of the global economy will decrease.

Summing up, we expect that global trading in goods and services will continue to grow faster than the global economic performance. In the period from 2013 to 2030 global exports will grow on average by 3.6 percent p.a. Thus, the globalisation process continues. But the relative speed of expansion (world trade/global GDP) will be no longer on the scale as it was in the years before the financial crisis. The importance of world trade as a growth driver of the global economy will decrease.

FASTER DISSEMINATION OF TECHNOLOGIES AND KNOWLEDGE

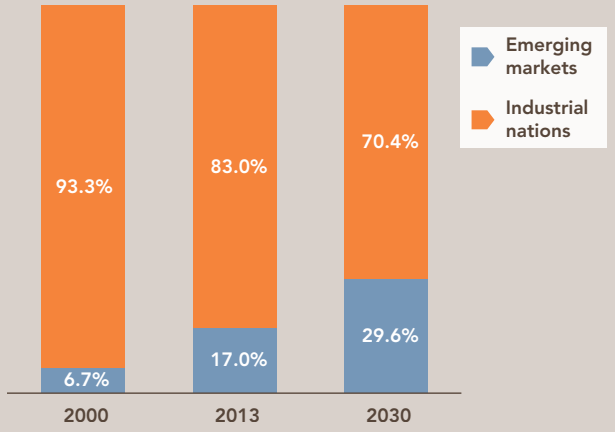
Technological progress and the increase in knowledge remain important drivers for the global economic development. The dissemination of technological innovations around the globe is ever gaining in speed within the growing global division of labour and digitalisation. No country will manage to keep up a technological head start over a longer period of time. In this way, innovations will drive forward global economic growth in many countries.

The level of technological development will constantly rise during the forecast period. Digitalisation (also called Industry 4.0) is among the most powerful drivers behind this development. Its importance is growing in all fields of life and of the economy. Chemistry, too, is facing comprehensive structural change. Digitalisation enables disruptive innovations; they have the potential to expand tried and tested business models or also to replace them. The competitive environment will become fiercer due to faster innovation cycles and new competitors. The latter can be observed already today.

At the same time, new technologies enable the optimisation of processes, the opening up of new fields of business, and the development of new business models. In chemistry it can be assumed that especially data-controlled production processes will further expand. Digitalisation will not lead to technological leaps in chemistry during the forecast period. Rather, steady dissemination in the companies will increase the speed of technological innovations. Consequences are an increase in labour productivity and resource efficiency as well as goods and services with more benefits for customers. Relations between the chemical industry and its customers will become much tighter. Borderlines between products and services will blur more and more. Such hybrid offers are already a reality in agrochemistry.

Industrial nations – first and foremost, the USA and the countries of the European Union – will remain the drivers of innovation in the global economy. But some emerging markets, particularly China, are catching up fast. In the year 2000, 93 percent of the R&D spending fell to the share of industrial nations. In 2013, this figure had already dropped by 10 percentage points. It is estimated that only 70 percent of the R&D spending will still be attributable to the industrial nations at the end of the forecast period. Then, over one fifth of the global spending will come from China alone. Thus, China is ahead of the EU. While the USA should hardly lose any shares in the global R&D spending, the share of the EU – irrespective of increases in the R&D budget – will drop significantly.

FIG. 3: EMERGING MARKETS ARE BECOMING MORE INNOVATIVE Shares of industrial nations & emerging markets in total R&D spending by the overall economy, in real terms in %



The competition of innovations between countries will intensify. In the future, research and development will no longer remain an exclusive domain of industrialised nations. Emerging markets, too, are invigorating their R&D efforts.

All in all, Germany is a good location for innovation, ranking fifth in an international comparison of locations.[7] In view of the demographic development and immigration, the education system will become an increasingly important location factor in the future. Germany has improved its education system over the past years. But a need for action remains in this respect. Also in the future, Germany will have good university and technical college education as well as in-company training; the latter ensures the qualification of skilled workers.

In Germany, participation in the education system and the permeability of the education system will increase during the forecast period. This means that the share of university graduates and highly qualified skilled workers will rise, the dropout rate will fall, and staff will become aware of lifelong learning. Additional potential is generated by the stronger integration of women and older persons in the labour market. A moderate migration of skilled persons will strengthen Germany's ability to perform in the years to come.

However, for the forecast period it is also alleged that Germany does not expand its research promotion by the public administration. The high-tech strategy continues to focus on support for projects, which is carried on without comprehensive budget increases. There are no additional incentives for more R&D spending. No fiscal incentives for research are alleged for the forecast period, either. With these assumptions, the R&D share of the overall economy in the GDP will still remain just under 3 percent also in 2030.

NO SHORTAGE OF ENERGY AND RAW MATERIALS TO 2030

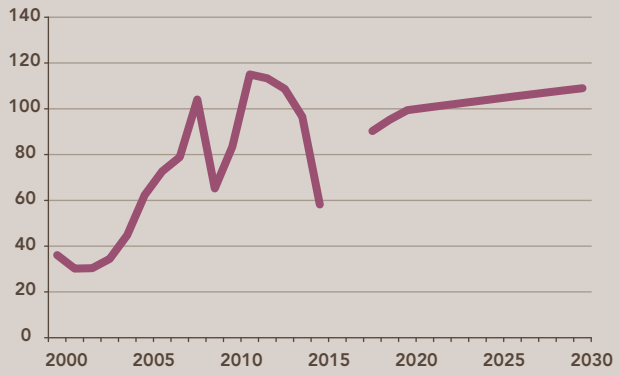
With the economic boom in the emerging markets, the consumption of raw materials and energy sources rose steadily since 2000. Suppliers did not respond with production increases to an equal measure. Until 2008 that drove up the crude oil price. The described upward trend only came to an end in the course of the economic crisis. During the crisis the raw materials on offer exceeded the demand. However, the fast recovery of the economic situation led to another demand increase and, consequently, prices rose again rapidly. While most raw material prices developed more or less constantly in the years from 2011 to 2013, the oil price was record-breaking. That development was intensified by political unrest in the Middle East and concerns about the atomic programme of Iran.

One central assumption in the earlier study was that energy and raw materials would become ever scarcer and thus more costly. At that time, the long-term forecast by the International Energy Agency (IEA) was that the oil price would climb by 2030 to 135 US dollars per barrel in real terms. Nominally, that would have meant an increase to 240 US dollars per barrel. Against the backdrop of current developments at international commodity exchanges, this assumption cannot be maintained.

The main causes of the ongoing price decline for energy and other raw materials are on the supply side. Together with the expectation of scarcer resources, high raw material prices had triggered an investment boom in mining and in the oil and gas industry. Furthermore, technological progress enabled the development of new deposits that could not be exploited economically in the past. With the help of fracking, an economically feasible exploitation of shale gas and shale oil is possible today – not only in the USA. New technologies allow both an expanding offer and an increase in available reserves. For these reasons, this study now assumes that energy and raw materials will be available in sufficient quantities and at relatively favourable prices, irrespective of the rising demand and geopolitical uncertainties.

However: The price decline for crude oil, as is observed since mid-2014, is clearly excessive. Neither the oil industry nor the OPEC countries or Brazil and Russia can permanently make do with oil prices between 30 and 50 US dollars per barrel. The OPEC decision to keep up its production target in

FIG. 4: OIL PRICES WILL ONLY GROW MODERATELY Average oil price per year, in US-Dollar per Barrel (in real terms)



Reasons for the only moderate rise in oil prices: increase of supply (shale oil in the US and Canada, resumption of Iranian oil exports) and increasing energy efficiency.
Sources: Feri, IEA, VCI

[7] *„acatech-BDI Innovationsindikator" 2015*

the years 2014 and 2015 has already caused a drop in investments in the development of new oil and gas sources in the other oil-producing countries. Moreover, production volumes inside OPEC can be increased only in Iran and Iraq. But due to the unstable situation, both countries have problems in mobilising the necessary investments. In the mid-term, the oil price should rise again. Based on the "IEA new policies scenario" (status: summer 2015) an oil price increase to 109 US dollars per barrel by 2030 is alleged for the forecast period. Inflation adjusted to the price development of the US gross domestic product, this results in a nominal price of 145 US dollars per barrel for 2030.

The demand side speaks for moderately rising oil prices too. The worldwide demand for energy and raw materials should further go up in the coming years. But the increase will be much slower than in the past decade. The reason: There will be a weakening of dynamics in the global economy, and more energy and resource-efficient production methods will prevail not only in Europe. Furthermore, after a phase of breathtaking industrialisation China – the country with the largest resource consumption – will more and more grow in the service sector and give a more resource-friendly orientation to production.

But raw material prices remain extremely volatile, due to the investment cycles in the oil and gas business. Economists speak of hog or cattle cycles. There are hardly any investments in times of low prices. Oil fields dry up and the volumes on offer drop, leading to higher prices. Next, rising prices bring expanding investments – until the prices decline once more because of excess supplies. Then, the cycle starts all over again. This volatility of raw material prices is intensified by the financial markets. The ensuing uncertainty in planning is a major risk for industrial companies.

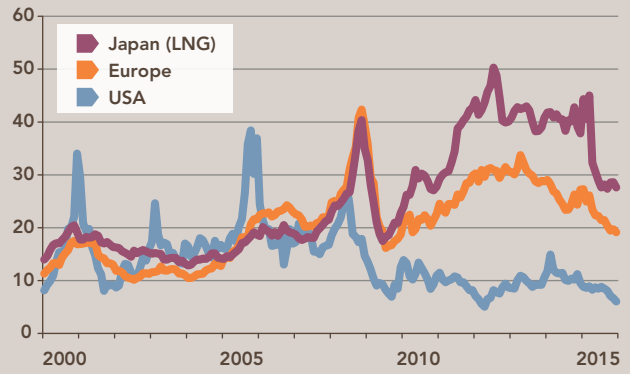
Unlike the oil market, gas prices are so far strongly determined by regional influences. This is a consequence of the high investment costs for large pipelines and liquid natural gas (LNG) supply chains that make the long-distance transport of gas costly and risky in business management terms.

In the USA, up until the 2030s the additional availability of shale gas is likely to bring gas prices that are low in the international comparison as well as growing LNG exports. By contrast, Japan and South Korea – the largest LNG importers worldwide – have a geographical disadvantage. Because of their lack of own resources, they depend on reliable gas supplies at relatively high prices internationally. European gas prices range between the high import prices in Japan and the low gas prices in the USA. Europe benefits from the competition between Russian and Norwegian pipeline gas and the rising LNG offer. Today, gas is three times costlier in Germany than in the USA.

Generally, a lastingly favourable supply situation can be assumed in the global gas market. In the future, rising LNG exports from Australia and the USA will bring a price cap. From today's perspective, this makes a steep price increase unlikely in Europe. But in the long run, Europe and Asia will not reach the low price level of the USA.

There are local differences in the electricity price too. For end customers, the electricity price consists of several components. Additionally to the costs for the generation and making available of electricity also levies, charges and taxes form huge cost blocks. In Germany, the energy transition (Energiewende) and the grid expansion have extremely driven up electricity prices. German industry has to pay ca. 50 percent more for electricity than companies in the USA. Germany also ranks first in the European comparison of prices for industrial electricity. Therefore, companies in energy-intensive industries are granted rebates or compensation for particularly heavy burdens they are saddled with – due to the charges under the German renewable energy act (EEG), the rules on combined heat and power (CHP), electricity taxes and grid fees. Reducing the exemption rules in Germany would bring clearly heavier burdens for energy-intensive industries than in the countries of comparison: because of the intensive expansion of renewable energies and the connected higher overall costs that are allocated. The divergences in electricity prices will persist to 2030. The study also alleges that energy-intensive industries will continue to benefit from exemption rules.

FIG. 5: SINCE 2010 PRICE DIFFERENTIALS FOR NATURAL GAS Price comparison natural gas USA-Europe-Japan, reference prices of trading points in euro/MWh



The shale gas boom brought low gas prices in the USA, while Japan and Europe need to import natural gas at high cost.

Sources: World Bank, VCI

ENVIRONMENTAL AND CLIMATE PROTECTION ARE GAINING IN IMPORTANCE WORLDWIDE

Over the past decade, the growth of the global economy brought an increase in resource consumption and environmental pollution. Particularly the greenhouse gas emissions grew fast in the last years. Mainly greenhouse gases are responsible for global warming. Already now, the climate change that comes with global warming is noticeable in the forms of frequent natural disasters, rising sea levels and extreme meteorological events. The major contribution to the increase in environmental pollution is from the emerging markets. Especially China's breathtaking industrialisation has led to rapidly rising greenhouse gas emissions. By contrast, the link between economic growth and CO_2 emissions is largely broken in the industrial nations because of technological progress and an ambitious climate policy.

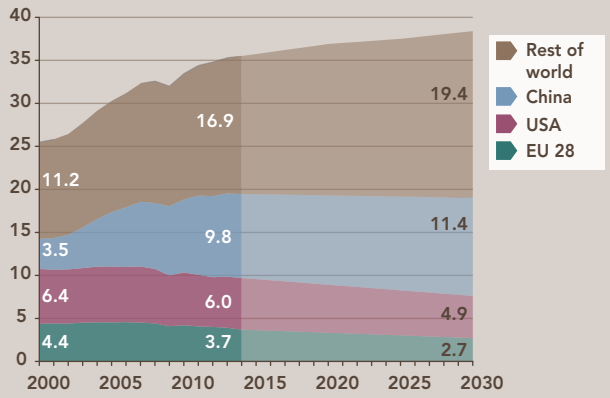
The political and societal value of environmental and climate protection will continue to grow in the forecast period – also beyond Europe's borders. At the UN climate conference in Paris, all of the 195 signatory countries consented on 12 December 2015 to a new global agreement. The Paris agreement and the accompanying decisions constitute an exacting climate regime for the time from 2020 – with universal validity and international law obligations. For the first time, industrial nations and emerging markets agreed to jointly act against climate change. It is true that the industrial nations will continue to shoulder the main responsibility also in the future. But now, burdens are also imposed on developing countries and emerging markets. Thus, the agreement gives consideration to the fact that mainly the very dynamic economic development of many emerging markets has sped up the increase in CO_2 emissions. Already now, China accounts for just under 27 percent of global CO_2 emissions, which makes it the largest emitter worldwide.

Even though the awareness of the need to protect the environment and the climate starts to prevail globally, the asymmetry in implementation persists. Most nations outside Europe only decide for environmental and climate protection if this is justifiable in economic terms. Therefore, the climate agreement provides for industrial nations to support emerging markets and developing countries by way of technology transfer and financial help. From 2020 the industrial nations are to make available 100 billion US dollars p.a. for this purpose.

The EU continues to see itself as a trailblazer in climate protection, setting the most ambitious climate goals worldwide for the European Union. Important climate instruments in Europe are emission trading, energy taxation and the promotion of renewable energies. These instruments have one point in common: They make energy consumption more expensive. Incentives for more energy efficiency are to be provided in this manner. This has a slowdown effect on the European chemical industry. In the energy-intensive industry the high and rising energy prices lead to a reserved attitude in investments and also favour the creation of production capacities in regions of the world with lower energy costs. In order to prevent the relocation of industrial productions away from Europe, there are exemptions for particularly energy-intensive production installations. For the forecast period, it is alleged that the EU and Germany will keep up this policy in principle. At present, an amendment of the Emission Trading Directive for the period from 2021 to 2030 is being negotiated. In the basic scenario, it is alleged that the pursued reform of European emission trading will not bring significant cost increases for companies. Furthermore, maintaining the renewable energy act (EEG) and the exemption rules as well as a phase-out of nuclear power are assumed for Germany.

The growing awareness of citizens for environmental protection and sustainable production increases the demand for environmentally sound and climate-friendly goods and, consequently, accelerates growth in some industrial sectors. For example, mechanical engineering benefits from the strong demand for wind farms, and the automobile industry sees market chances in electro-mobility. Giving impulses for environmental and climate protection, also the chemical industry can benefit from the described development. Based on existing trends, a rising intensity of chemistry can be assumed also in the future in many applications and customer industries, e.g. for the insulation of buildings, lightweight construction concepts, or electric drives in carmaking.

FIG. 6: EUROPE REMAINS A TRAILBLAZER IN CLIMATE PROTECTION Development of energy-related CO_2 emissions by regions, in gigatonnes



China will further increase its CO_2 emissions to 2030. But less growth and a stronger environmental awareness will slow down that increase in the future.
Sources: BP Statistical Review of World Energy, OECD; VCI

PUBLIC DEBT IMPAIRS GROWTH

To a considerable extent the growth of the past decades was financed by private and public borrowing. In view of the high debt – especially of public budgets in many industrial nations – this cannot go on. The highly indebted EU Member States will continue on their taken course of budget consolidation, as a matter of principle. Because of the refugee crisis, the debt crisis (Greece), the status of Great Britain and the rise of populist, EU critical parties on the right and left, there are currently doubts about the future of the European Union. However, our projections are based on the assumption that the EU and the euro zone will last in their current forms to 2030; but there will be no further substantial deepening and expansion.

Greece will comply with the conditions of the creditors and remain in the euro zone. But for this, a debt cut will be necessary in the forecast period. Because of the debt brake, consolidation will be clearly faster in Germany than in many European neighbouring countries. The monetary policy of the central bank with a low interest rate level significantly contributes to budget consolidation, considerably reducing the interest burden of debtors. At the same time, with increasing purchases of government bonds and an extremely low central rate, the ECB makes sure that the EU Member States can resort to fresh borrowing over and again. In economic modelling, a high debt-to-GDP ratio leads to risk premiums on government bonds. But because of the ECB programmes and the bailout fund, these remain low altogether, also for heavily indebted euro countries. Obviously, this reduces the pressure for fiscal consolidation and the zeal for reform. Consequently, the speed of consolidation remains low overall, so that also in 2030 many EU Member States will still have public debt levels

above the upper limit of 60 percent of GDP according to the Maastricht Treaty.

The USA, too, will reduce its debt-to-GDP ratio, even though with less dramatic saving measures than the European countries of crisis. On the spending side, also the US government has already started a consolidation of public finance, and another tightening of the consolidation course is likely. In a comparison of countries, Japan sticks out with immense public debt. As there are mostly domestic creditors and the outstanding money is in yen, the consolidation pressure is correspondingly low. Moreover, because of the zero interest rate policy of the central bank of Japan, the public administration pays hardly any interest. Against this backdrop, the Japanese government tries to stimulate the economy by way of an expansive fiscal policy. Consolidation is put off to the future. The study proceeds on the assumption that Japan will succeed only after 2030 to reduce the debt-to-GDP ratio.

While the industrial nations are heavily indebted, the situation is comparatively good in most emerging markets. On average, their debt-to-GDP ratio is only 40 percent and has remained stable in many emerging markets since the financial crisis. But this finding is deceptive. Firstly, in many countries there is the phenomenon of hidden public debt. Hidden debt arises e.g. when the debt of publicly owned companies is not shown in the public sector. Secondly, the private sector is heavily indebted in many emerging markets. If the countries borrowed in foreign currency – mainly in US dollar – and strongly devaluated their own currencies most recently, the interest payments ensuing from debt are increasingly becoming a problem, especially with the interest rate reversal of the US Federal Reserve.

The recession in Brazil and Russia and weaker growth in China show that the growth model of the past decades is no longer viable. Raw material-rich emerging markets accumulated vast foreign currency reserves in the past, but these are shrinking rapidly because of the low oil price and the weaker demand for raw materials. One of the consequences is that the investment boom of the past years has come to a rapid end in many emerging markets. Also emerging markets are forced to consolidate, because the high debt service – together will dramatically falling foreign currency incomes from the raw materials business – dampens growth. But it can be expected that the impacted countries will stretch their consolidation plans in terms of time, in order to maintain political stability.

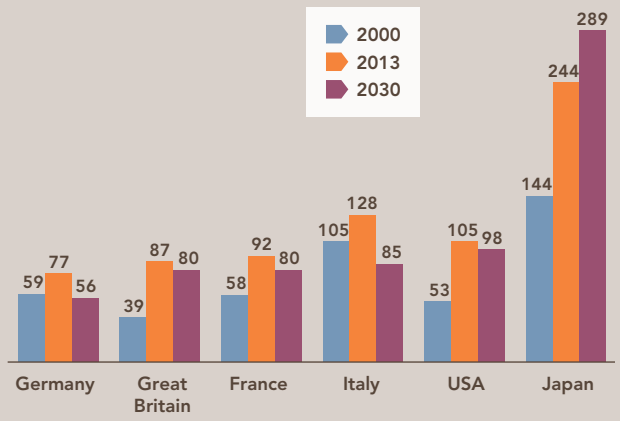
Altogether, the necessity to consolidate impedes global economic growth to 2030 and clearly restrains the scope in financial and economic policies. However, consolidation leads to a sustainable growth path in the long term.

Global economic dynamics are losing in speed

The future development of the global economy will always be measured on its earlier development. For this, the years impacted by the financial crisis are less decisive; rather is the decade before. That decade was characterised by the entry of the former Eastern Bloc and of China in the global market and by a massive increase in asset prices in major industrial nations. These influences were of a singular nature, or they had no lasting effect. Summing up – and irrespective of other country-specific features – they decisively contributed to the comparatively strong growth in most countries in the decade before the financial and economic crisis.

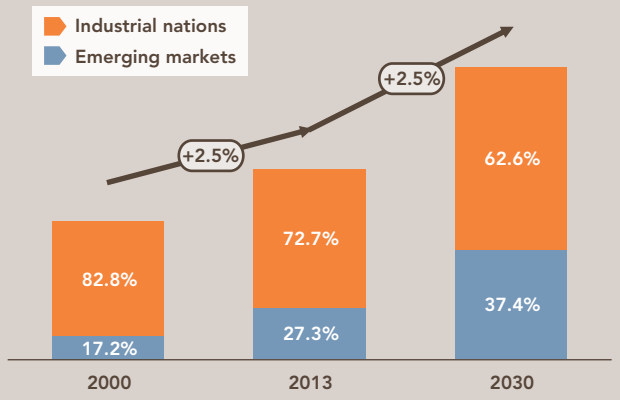
However, the financial crisis 2008/2009 itself caused major slumps in the global economic structures from which most countries recovered surprisingly fast thanks to massive support measures under financial and monetary policies. But that was followed by a weak phase of the global economy. The euro crisis stood at its beginning; it triggered another recession in Europe from which some countries are recuperating only slowly. Moreover, the European Union needs to cope with the refugee crisis and faces uncertainty about Great Britain remaining in the EU. The debt crisis in Greece is still not overcome, either. The growth motor China is stuttering. Emerging markets like Brazil and Russia slipped into deep recession.

FIG. 7: LASTING CONSOLIDATION PRESSURE
Debt-to-GDP ratio of selected countries



Consolidation pressure persists. Most countries will try to continue on the taken course of budget consolidation and to reduce public debt. This will slow down growth initially.

FIG. 8: EMERGING MARKETS ARE GAINING IN WEIGHT
Global GDP growth, CAGR 2000-2003 and 2013-2030, shares in percent



While the emerging markets, especially China, are gaining in weight, the share of industrial nations in the global GDP is shrinking. However, the US succeeds in defending its leading position.

This weak phase of the global economy can be overcome in the forecast period. From 2013 to 2030, global GDP growth will average 2.5 percent per annum, so that the dynamics prior to 2013 seem to continue seamlessly: From the turn of the millennium to the year 2013 the global economy grew by 2.5 percent p.a. too. But global dynamics were unusually low between 2000 and 2013, due to the global economic crisis 2008/2009. Until 2008, global growth was still at ca. 3 percent p.a. Moreover, prospects have become bleaker compared with the earlier study. In the forecast period, the global economy will grow less strongly than had been assumed in the first version of the study (+3.0 percent).

According to the new calculations, the growth potential has decreased especially for the emerging markets. On average, they will grow by 4.5 percent p.a. in the forecast period, but in the years from 2000 to 2013 dynamics were still at 6.3 percent. This means a weakening of growth by nearly 2 percentage points – while in the industrial nations overall, growth will slightly accelerate from 1.5 percent (2000-2013) to 1.7 percent (2013-2030). As the industrial nations were at a particular risk of slumps due to crisis and as the recovery was visibly slower than in the rest of the world, this acceleration is not as encouraging as it might seem at a first glance. Thus, the future growth of industrial nations has weakened compared with the period before 2008 (+2.5 percent) and also in comparison with the earlier study (+2.2 percent).

At the bottom line, growth dynamics of industrial nations and emerging markets will approximate each other because of the increasing convergence of the prosperity level in both groups and due to the end of the investment boom in China. All the same, the growth differential will remain, so that industrial nations will continue to lose in importance.

EUROPEAN UNION

The European economy has overcome the recession triggered by the euro crisis. Structural reforms have already positive impacts on growth in some countries. The bailout fund works, and the consolidation of the European fiscal and economic policy is progressing considerably too. Most recently, tailwind to the EU economy came from the weak euro and the low oil price. But so far, this recovery is lacking in force, and this is unlikely to change in the coming years. In the forecast period, growth of the European Union (+1.6 percent p.a.) will be slower than in the United States (2.1 percent p.a.). Thus, growth is 0.4 percentage points above the growth of the previous decade (2000-2013). However, this comparison is flawed because of the financial and euro crisis. Before 2008, growth in the EU was ca. 2 percent p.a. and, consequently, much higher than in the forecast period.

Beside low population growth and noticeable aging, in the future mainly the fiscal consolidation will negatively affect growth. Politically motivated discussions about the further existence of the EU and the current threat of Great Britain leaving the European Union additionally slow down growth. But in the study, we generally assume that the EU will retain its present form.

Large differences in economic development will persist between the individual Member States in the forecast period. EU-15 (which currently stands for over 92 percent of the European Union in terms of GDP) will grow, on average, by 1.5 percent p.a. in the forecast period. Growth will be strongest in Belgium and Sweden. Perspectives have become much brighter for Spain and Portugal; the structural reforms of recent years are paying off. One exception is Greece where the pre-crisis level of GDP will not be reached again in the forecast period.

In the accession countries of Central and Eastern Europe, the approximation process will continue with an average growth rate of 2.3 percent p.a – but at a clearly lower speed than in the previous decade. Average GDP growth was still 3.2 percent p.a. in the years from 2000 to 2013. In the forecast period, strongest growth will be achieved by Slovakia and Poland. The share of the accession countries in the EU will rise from currently 7.6 percent to 8.6 percent in the forecast period.

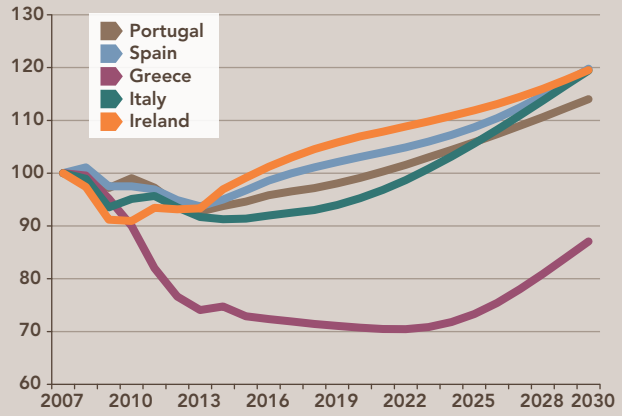
UNITED STATES

According to new calculations, GDP growth will be around 2.1 percent p.a. in the long term. The earlier study still assumed growth of the US economy by 2.8 percent. The most recent turbulences of crude oil prices have highlighted the vulnerability of the US economic model, which is based on shale gas. Irrespective of weaker growth, in the future the US economy will grow more dynamically than the EU, and the US will remain the world's largest national economy to 2030. In this context, the US benefits from a positive demographic development, favourable energy and raw material prices and its existing technology leadership in many fields, e.g. in important markets of the future like information technology.

Furthermore, the US has a large economic area altogether, with the intention of further expansion by way of trade agreements like TTP (Trans-Pacific Partnership) or TTIP (Transatlantic Trade and Investment Partnership). The US also pursues strategic interests. Especially regarding the Pacific region, that boom region of the world should not be left to China alone.

In the long run, the US dollar will remain the global key currency; it is even strengthening its position. The euro is

FIG. 9: REFORMS ARE PAYING OFF
GDP development in European countries of crisis
Index 2007 = 100



Consolidation efforts and structural reforms impede growth in the short term, but they are paying off in the medium run. Only Greece is in a deep crisis that lasts to the mid-2020s.

emitted in an economic region whose growth speed will be noticeably slower than that of the USA, both in the short and long term. Moreover, the public debt crisis in Greece and the construction problems of the euro zone, which become visible as a result, have lowered the trust in the euro. The Chinese renminbi will gain in importance in the Asian region and, after inclusion of this currency in the IMF special drawing rights basket, it will also become more established worldwide. But the renminbi will not be able to replace the US dollar in its role as the global key currency. The United States remain the clearly more attractive destination for international capital flows.

BRAZIL

Brazil will achieve growth of 3 percent p.a. in the forecast period. Here, the forecast assumes that the present problems can be solved in the medium term. By means of social programmes, the current government has made Brazil a more just country. But Brazil's dependence on raw material exports has deepened, and nothing has been done for international competitiveness – i.e. education, security and infrastructure have been neglected. Also, there is no reform of the political system which allows private economy financing of election campaigns. This is the main reason underlying corruption, which is currently spreading considerably.

But the conditions remain good for dynamic growth. Brazil's growing population and an ever-larger middle class are conducive for more industrial products close to consumers and for services, where a rising prosperity level leads to more private consumption. This makes Brazil an interesting domestic market.

Brazil has also huge raw material reserves that the country can use to increase its importance as an exporter of raw materials. In the medium term, Brazil will regain its attractiveness as an investment location and maintain it during the forecast period.

CHINA AND INDIA

With average growth of 5.6 percent p.a., China contributes over one third to the total GDP growth globally to 2030. But in the medium and long term, China will not manage to keep up the high growth speed of the past. Especially demographic problems originating from the one-child-policy of this country will dampen economic growth in the long run. China's existing growth model does not reach its limitations only because of the aging population. The strongly export-driven growth of China will also weaken in consequence of saturation tendencies in capacity building, falling dynamics in the demand from industrial nations, dwindling wage cost advantages, growing environmental problems and a realistic revaluation of the renminbi. In the future, investments should become more return-driven also in China, so that investment activities will decrease overall. This impairs growth in the short to medium term. But in the long run, return-driven investments contribute to stabilising the growth path. Furthermore, a change in the growth paradigm from exports to more domestic demand is forthcoming. This has also consequences for the significance of both consumer-oriented services and services close to industry in the People's Republic. The share of services in GDP will further increase to 2030.

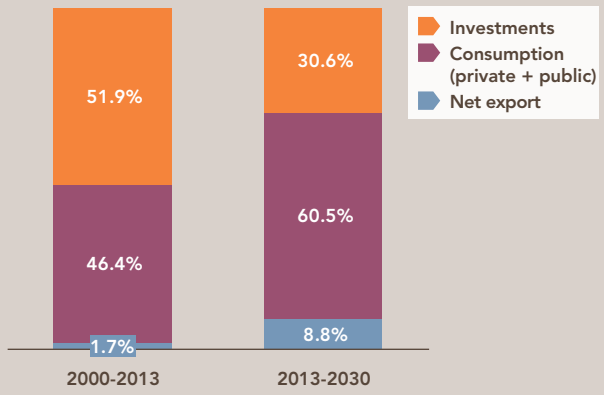
Alongside the cost and time-intensive building of social security systems, it is also important to maintain political stability and to meet the rising demands of a growing middle class regarding political participation, general conditions of living and working, and environmental awareness. It can be assumed that China can largely master this challenges and gain in importance as a consumer market to 2030. But in view of these challenges, growth rates of the Chinese GDP will turn out significantly lower in the course of the forecast period.

In the period from 2013 to 2030, the economy of India will grow by 5.2 percent p.a. Growth rates of India will partly exceed those of China. In the long term, India's favourable demographic development and the resulting larger availability of labour will make themselves felt. The gradual reduction of bureaucracy, infrastructure improvements and the reduction of trade and investment obstacles will give positive impulses for growth in India.

Even though the growth speed of the economies in China and India is more than twice as high as that of the United States throughout the entire forecast period, the per capita income 2030 is still only 21 percent (China) or 5 percent (India) in relation to the US level. The absolute differential will even increase from currently 34,000 to 38,000 euros (China) and from 37,000 to 46,000 euros (India) – i.e. the prosperity differential will further widen in absolute terms.

The diverging developments of the individual countries during the forecast period lastingly change the economic map. Most industrial nations – ahead of all the countries of Western Europe and Japan – are losing shares to the up-and-coming emerging markets. China's share in the GDP of all countries included in these considerations will climb from currently 12.4 percent to 20.4 percent in 2030. India can increase its share in global GDP from 3.3 percent to 5 percent. By contrast, the share of the European Union will drop from 28 percent to just under 24 percent. Germany's share, too, will fall by one percentage point to little less than 5 percent. The expansion speed of the United States is not sufficient to maintain

FIG. 10: CHANGING GROWTH MODEL IN CHINA
Use structure of Chinese GDP, in percent



Future growth in China will more strongly rely on consumption. Also, investments in China will be more return-driven. This will result in lower investment activity overall.

the US share in global economic output – it will fall from 26 percent to 24.4 percent.

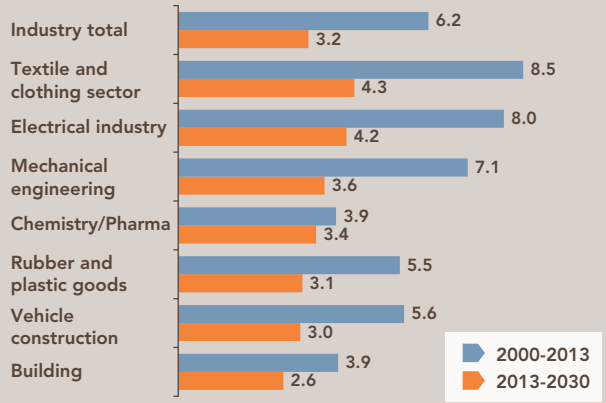
Industrialisation of emerging markets continues

The demand structures on global markets will change considerably to 2030. In emerging markets, the demand mainly relies on population growth and rising prosperity. In the industrial nations, the demand changes because of new requirements regarding better energy efficiency, growing environmental awareness of consumers, the use of renewable energies – and also due to the aging population. The participation of new consumer groups in global consumption and the changing demand structure necessitate the creation of more capacities in industry. To 2030 and across all 42 countries, industrial value-added will grow (+2.9 percent p.a.) more strongly than GDP, i.e. the total value creation of all countries. These above-average growth dynamics of industry at the aggregate level can be explained almost exclusively by the strongly increasing weight to 2030 of those emerging markets which have a comparatively high industry share at the present time. By contrast, the individual country level is dominated by cases with a falling share of industry in the total value creation of the respective country. Here, positive examples are mainly countries with a heavily shrinking population where exports relative to domestic demand – and, consequently, also the export-oriented sectors of industry – are gaining in importance.

Global industrial production[8] will grow by 3.2 percent p.a. to 2030. Growth leaders with growth rates of just over 4 percent p.a. are the textile and clothing sector and the electrical industry. Global dynamics of these sectors mainly ensue from the strong and further growing weight of China. Also with above-average growth rates, mechanical engineering and the chemical industry rank third and fourth. Alongside the great dynamics of emerging markets, growth in global chemical production is attributable to a rising chemical intensity of customer industries.

The international division of labour will further intensify. Value chains become more international. The integration between national economies will further progress in Asia. Growth of industry is particularly dynamic in these countries. The economic crisis made many nations realise that an industrial core is an essential constituent of a national economy. Against this backdrop, North America and Europe are becoming more successful than in previous decades in remaining locations of industrial activities and in revitalising industry. Industrial nations will increasingly focus on high-quality products, slowing down the further shift of value chains in the direction of Asia and Latin America. At the bottom line, the shift of industrial growth centres to emerging markets will last to 2030, but at a clearly lower speed than still in the past decade.

FIG. 11: SLOWDOWN IN ALL SECTORS
Global development of real production by sectors, 2013-2030, CAGR, in percent



Industrialisation is progressing. Globally, industry continues to grow faster than the overall economy. But growth dynamics become clearly weaker with the general slowdown of the economy.

TEXTILE AND CLOTHING SECTOR

The textile and clothing sector is close to consumers. Here, growth will weaken somewhat in the coming years, as compared with the past decade. All the same, growth remains strong. Textile production will increase by 4.3 percent p.a. Global textile production is mainly driven by the strong demand from final consumers in emerging markets. By contrast, in the industrial nations the trend goes toward environmentally sounder textile products.

Global production dynamics mainly result from the development of emerging markets and developing countries. Their share in global textile production will rise from currently just under 72 percent to 84 percent in 2030. China's share will be 66 percent in 2030, even though textile production is gradually relocating to other Asian countries with lower staff costs. The textile industry is growing dynamically in India and Turkey – while China endeavours to supply the home market mainly from domestic production.

RUBBER AND PLASTIC GOODS

In the forecast period, also the production of rubber and plastic goods will be somewhat less dynamic than it was still in the past decade. But compared with other sectors, this sector continues to grow dynamically, even though growth is slightly below the average of industry. To 2030, the production of rubber and plastic goods will expand by 3.1 percent p.a. The production of rubber and plastic goods is strongly linked with industrial production overall and thus with the customer industries. With a share of just under 53 percent in global production, emerging markets will have a significant role in 2030. A driver of the global production development is, inter alia, the lastingly strong need to catch up in consumption in emerging markets. The per capita use of rubber and plastic goods in emerging markets is still clearly below the use rate in Europe or the USA. Even in China with its strong growth, use density remains at a lower level than in Europe. The trend of innovation and substitution lasts in the industrial nations. Especially in Europe, there is also a rising demand from the building sector due to energy requirements.

[8] *Growth rates in production are above those of (gross) value added, i.a. because of a rising input ratio*

MECHANICAL ENGINEERING

Mechanical engineering will improve by 3.6 percent p.a. to 2030, so that economic dynamics are slightly above the average of the manufacturing industry. But a comparison with the period 2000 to 2013 shows that economic dynamics are becoming somewhat weaker also in mechanical engineering.

Production increases in mechanical engineering are driven primarily by the expansion and renewal of capacities in industrial production, also within the further progressing automation of production. Moreover, increasing urbanisation together with infrastructure expansion (i.a. of water and waste water systems, pumping technology, road and rail networks) bring further production growth in mechanical engineering. In the industrial nations, the demand for mechanical engineering products is driven, inter alia, by the expansion of renewable energy generation.

An examination by countries shows that dynamics are strong in mechanical engineering in Asia, too. This sector is growing dynamically in India and China. In the future, a large part of the Chinese domestic demand for machinery will be covered from domestic production. Mechanical engineering in China will grow, on average, by 5.4 percent p.a. in the forecast period. Thus, growth in China is clearly weaker than in the previous decade but still remains significantly higher than global growth.

Regarding mechanical engineering, India's role cannot be compared with that of China but India will see dynamic growth of 5.4 percent to 2030. Consequently, India will have a share of roughly 3 percent in global machinery production. By contrast, China will have a share of 46 percent in this sector. With the other emerging markets combined, the share amounts to ca. 57 percent. With an increase by 2.2 percent p.a. mechanical engineering in the European Union grows faster than in the period from 2000 to 2013. However, this development is distorted by the global economic crisis 2008/2009 when mechanical engineering was particularly hard hit.

VEHICLE CONSTRUCTION

At 3 percent, economic dynamics in global vehicle construction are slightly below the average of industry. Thus, growth is clearly slower than in the period 2000 to 2013 when annual production increases amounted to 5.6 percent.

Vehicle construction will be faced with huge change in the coming decades. New markets are forming. China, India and Brazil will be the markets of the future, not only in terms of consumption but also regarding production. Southeast Asia has great potential too. Traffic density in those countries is clearly lower than in the industrial nations. Also, incomes are growing more strongly and so does the potential target group. A comparison of regions shows that vehicle construction is expanding dynamically, especially in the emerging markets where this sector benefits from a growing middle class which increasingly buys cars. Consequently, these countries can gain additional shares in the world market.

All the same, also in 2030 over 60 percent of global vehicle construction will take place in the industrial nations. The demand for vehicles continues to rise here, too. But the buyer groups are changing. For example, in the growing middle class the wish to pursue a career increasingly delays the time of family planning; this more and more pushes the purchase of a family-friendly car into the future. Especially in large cities, the trend moves away from the driving license. Car sharing is a possible solution. This opens up new business fields like alternative options of mobility, connected vehicles or, in the future, also driverless driving. Stricter environmental laws and higher safety requirements bring not only rising costs. There is a demand for innovations in alternative drive technologies and for passenger cars with lower consumption.

ELECTRICAL ENGINEERING

Irrespective of a slowdown compared with historical growth, also electrical engineering grows dynamically (+4.2 percent p.a. on average). Thus, electrical engineering can further expand its share in global industrial production.

Rising prosperity in emerging markets brings a rising demand for consumer electronics. Furthermore, the spreading of mobile telephone systems and of the internet is progressing with global intercommunication and the use of digital media (e.g. social media, mobile internet, cloud computing). Also small and medium-sized vehicles increasingly have support systems. The interconnecting of vehicles is increasing considerably (connected cars, connected driving). All this leads to a stronger demand for electrical engineering products.

Even more than in other fields, performance improvements in electrical engineering bring continuous innovation (e.g. for displays and semi-conductors), replacing established technologies. One example from the most recent past is the replacing of the classic TV tube by LCD television sets, with the latter being ousted by LED TVs after just a few years. Now OLED technology is ready to take over, even though it is currently used preferably in smaller television sets. Comparable – and partly disruptive – innovations can be expected also in the future.

Electrical engineering is growing particularly dynamically in the Asian countries (China, India, South Korea). The share of these three countries in global production will be 54 percent in 2030. Irrespective of a drop in growth compared with the previous decade, the USA remains a major location of the electrical engineering industry. US electrical engineering will still grow, on average, by 3.1 percent p.a. in the forecast period. Its share in global production will fall from currently 18 percent to 15 percent but, after China, the US will still be the second important producer of electrical products.

Chemical industry globally

The global demand for chemical products will continue to rise during the forecast period. However, dynamics in demand growth will be lower than in the earlier study. This is because lower growth of the global economy – and thus of customer industries – is now anticipated.

But the trend drivers remain the same in the demand for chemicals. Firstly, the demand from emerging markets will go up – especially from Asia where the growing population and increasing prosperity of the middle class have a driving role. Secondly, the demand for chemicals will rise in industrial nations, too. There is lower volume growth but rather a shift in demand towards high-quality and more costly innovative chemicals. Furthermore, the chemical industry can benefit

from the chemical intensity of end products rising over time in many customer industries. For example, through electro-mobility and lightweight construction the automobile industry will need more specialty chemicals in the future. Because of more insulation of buildings, chemical products are gaining in importance in the construction sector. The stronger use of solar cells will drive up chemical intensity in electrical engineering. Chemistry is needed for environmentally sound electricity generation, too. No high-performance wind turbine could work without chemical innovations. Finally, the growing and ageing world population needs innovative medicines. This opens up growth chances for the pharma industry. Altogether, against this backdrop the chemical industry will maintain – and partly even expand – its position as an important supplier of inputs.

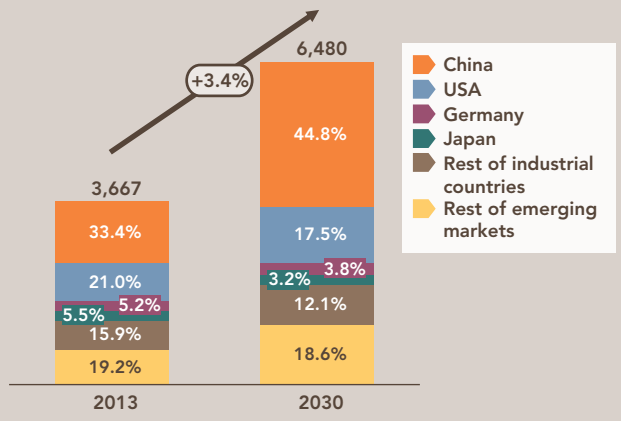
Thanks to the good demand development, global chemical production will grow on average by 3.4 percent p.a. in the years from 2013 to 2030, so that chemical production will still grow more dynamically than industrial production overall. Also in future, new production capacities will continue to be built in regions with strong demand growth – particularly in wide parts of Asia. In geographical terms, production largely follows the demand, but it is also oriented to the availability of raw materials. Consequently, the coming years will see much capacity creation in raw material-rich countries, e.g. in the Middle East, the raw material-rich countries of Latin America and in the USA. The shale gas boom brought strong capacity creation in the US; that boom will last in the years to come, albeit in a somewhat weaker form. In total, chemical production in emerging markets will grow on average by 4.8 percent p.a. and will be much faster than that in industrial nations (+1.9 percent p.a.).

The forecast period shows a clear shift in the structure of countries. In consequence of its massively rising demand for chemical products and the concurrent expansion of own capacities, China will gain further shares in global production. Chemical production in China will grow on average by 5.2 percent p.a. to 2030. Already today, China is the largest chemical producer worldwide. Toward the end of the forecast period, China will dominate the global chemical business even more clearly: with a share of just under 45 percent. Because of China's dominant position, the other emerging markets will gain only few additional shares, irrespective of their historically high capacity creation.

China's increase in importance is essentially to the detriment of industrial nations. Regardless of losses in shares, the USA and Germany will remain major chemical producers also in 2030. In the future, the USA will increasingly benefit from shale gas production and from the dynamic growth of domestic customers. US chemical production will grow by 2.3 percent p.a. and this will be more dynamic than average production growth in industrial nations. The loss in shares to 2030 amounts to somewhat over 3 percentage points, i.e. in 2030 the USA will still have a share of 17.5 percent in global chemical production and remain the 2nd largest chemical producer worldwide. The chemical industry in Japan will barely grow in the forecast period. Consequently, this country will clearly lose in world market shares. In 2030 Japan's chemical industry will only be the 5th largest producer of chemicals and pharmaceuticals. By contrast, the chemical industry of India will grow vigorously by 5.4 percent and gain in world market shares, advancing to rank 3 in 2030. Germany will maintain its position 4.

Globalisation of the chemical industry will continue in the years to come. Also in future, foreign trade in chemical products will remain highly important. Irrespective of capacity creation, many emerging markets will not be able to cover their strongly growing demand for chemicals from domestic production. This brings growth chances for the industrial nations who can thus make up for low demand growth in their own countries. For this reason, industrial countries will remain major chemical industry locations overall.

FIG. 12: CHEMICAL INDUSTRY OF CHINA GAINS FURTHER SHARES Global chemical and pharma production in billion euros, shares in percent, CAGR 2013-2030



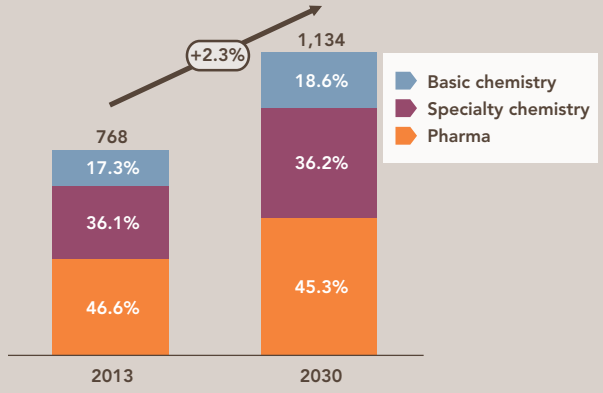
Because of its strongly rising demand for chemical products, China can gain further shares in global production – mainly to the detriment of industrial nations.

SHALE GAS BRINGS A RENAISSANCE OF US CHEMISTRY

The real production volume of the US chemical industry will increase by 48 percent from 768 billion euros in 2013 to 1.1 trillion euros in 2030. With average growth of 2.3 percent p.a., chemical production will grow more dynamically than industrial production (+2 percent) or the overall economy (+2.1 percent). Thus, growth in US chemistry will gain in speed compared with the period 2000 to 2013. Shale gas triggered an investment boom which initially substituted old industrial plants in the most recent past but will bring new, clearly more efficient and larger plants in the future. This expansion will be largely completed in the early 2020s, and growth rates in investment will return to normal. The availability of favourably priced energy clearly improves the competitiveness of the chemical industry – especially in the more energy-intensive basic materials sectors. Production in basic chemistry will expand by as much as 2.7 percent p.a. in the forecast period.

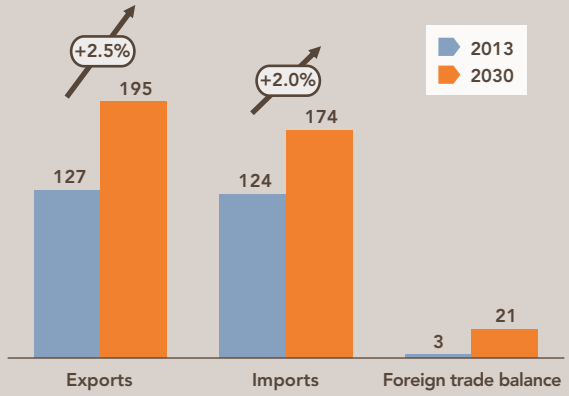
Favourable energy prices will also benefit the other sectors of industry. The manufacturing industry will grow by 2 percent p.a. on average in the forecast period. Growth will be particularly dynamic in major customer industries of chemistry, e.g. carmaking or electrical and mechanical engineering. This will bring a strong rise in the domestic demand for chemicals.

FIG. 13: EXPANSION OF US BASIC CHEMISTRY
US chemical production in billion euros, shares in percent, CAGR 2013-2030



Within the shale gas boom, the US chemical industry is expanding basic chemicals production. Favourably priced energy clearly improves competitiveness – especially in the more energy-intensive basic materials sectors

FIG. 14: US CHEMICAL INDUSTRY BECOMES MORE COMPETITIVE Foreign trade of the US chemical and pharma industry in billion euros, CAGR 2013-2020



US chemistry does not produce for the domestic market only. Especially basic products are in strong demand worldwide. In the forecast period, exports of basic products will rise more dynamically than other chemical exports.

But US chemistry does not produce for the domestic market only. Because of high competitiveness, exports in real terms are rising from 127 billion euros to 195 billion euros in 2030. This corresponds to a growth rate of 2.5 percent p.a. Especially basic chemicals are in strong demand worldwide. In the forecast period, exports of basic products rise more dynamically (+3.2 percent p.a.) than other chemical exports. Most of these products go to Latin America and Asia.

Imports, too, will increase because of the robust domestic demand. The USA mainly imports specialty chemicals and pharmaceuticals. In real terms the import volume of chemical products rises, on average, by 2 percent p.a. from currently 124 billion euros to 174 billion euros in 2030. As exports are growing more dynamically than imports, the US will expand its foreign trade surplus for chemicals from currently 3 billion euros to 21 billion euros. The strongest increases will be in the field of basic chemicals, but the surplus will also increase for specialty chemistry. By contrast, the deficit will grow for pharmaceuticals.

In the year 2013 the US chemical industry employed over 1.2 million staff, corresponding to a share of 0.8 percent in the overall economy's workforce and 8.3 percent in the workforce of US industry. Employment will drop by 0.3 percent p.a. in the forecast period, but in 2030 over 1.1 million persons will still have jobs in US chemistry.

EU CHEMICAL INDUSTRY GROWS, THANKS TO INNOVATIVE SPECIALTY CHEMISTRY AND PHARMACEUTICALS

In the European Union – like in the other industrial nations – particularly the demand for higher-quality chemicals is growing. Beside a growth effect through higher-quality chemicals, the chemical intensity in some customer industries is increasing, too, so that the demand from these industries will rise also in terms of volume. Altogether, the domestic demand in Europe will grow less strongly than the global demand for chemicals.

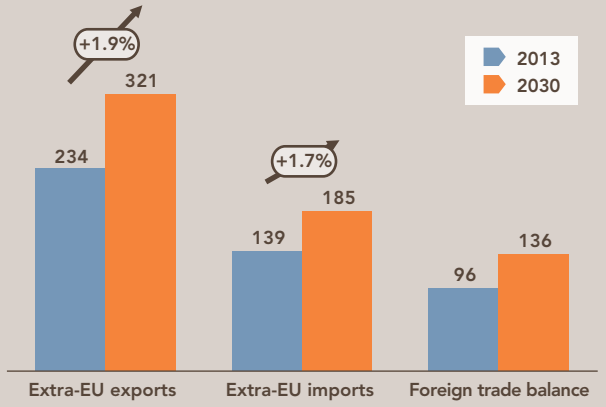
Many European national economies are well-integrated in international trade. Consequently, they also benefit from the demand growth in emerging markets and in the USA. In the forecast period, chemical exports to countries outside the European Union (extra-EU) will increase by over one third to 321 billion euros in real terms in the year 2030. This corresponds to growth by 1.9 percent per year.

In a global comparison, the chemical industry in the European Union will holds its own with annual growth by 1.7 percent. In the coming years, it will continue to lose in world market shares (- ca. 5 percentage points); its share will be just under 17 percent in 2030. But the drop will not be as strong as in the years from 2000 to 2013 when the European Union lost 7.2 percentage points.

Integrated structures ("Verbund") across national borders bring competitive advantages for the EU chemistry. Efficiently integrated sites or regionally integrated productions in clusters or chemical parks help to make up partly for the competitive disadvantages that follow from higher energy and raw material costs. Also in the forecast period, the chemical "Verbund" will be preserved overall. Meanwhile, existing plants have largely paid off. It is true that the industry continuously invests in maintaining and moderately expanding existing plants (debottlenecking). But new, large and more efficient world-scale plants are not built in the persistent energy political environment. This is a disadvantage in global competition.

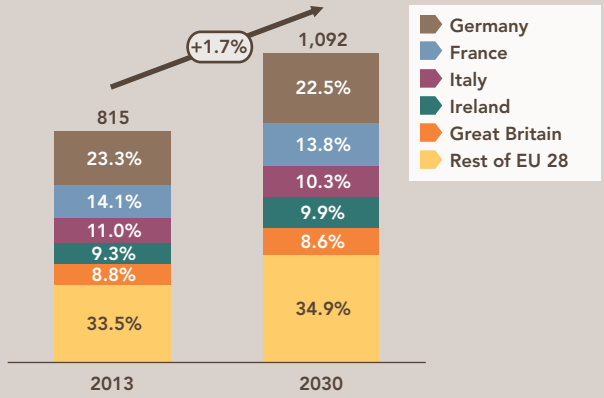
An examination by sectors shows that particularly basic chemistry is strongly losing in competitiveness. This sector can only grow by 0.5 percent per year in the forecast period. High raw material and energy costs – combined with strong competitors in the USA and in the Middle East – lead to a low growth potential in the medium term. The competitiveness of this sector will remain under constant pressure also in the future, inter alia, due to the highly ambitious climate policy. For European basic chemistry, this means low export

FIG. 15: FURTHER GROWING FOREIGN TRADE BALANCE OF EU CHEMISTRY Foreign trade balance of the EU chemical and pharma industry in billion euros, CAGR 2013-2030



European chemical sites are well-integrated in international trading, so that they benefit from the global demand growth. By contrast, import pressure clearly rises in basic chemistry.

FIG. 16: NO CHANGE IN THE "TOP 5" IN EU CHEMISTRY Chemical and pharmaceutical production in the European Union in billion euros, shares in percent, CAGR 2013-2030



In 2030, Germany will still be the major chemical producer in the European Union. But as the other countries are growing more dynamically, Germany will lose in shares.

dynamics and rising import pressure. To 2030, exports of basic chemicals from the EU to countries outside the European Union will only rise by 0.3 percent per year. Some part-sectors of basic chemistry will even see falling export volumes (petrochemicals and standard polymers) – while imports of basic chemicals from outside the EU will clearly go up by 1 percent per year. Moreover, basic chemicals from the Middle East and partly also from North American production are increasingly pushing on the European market. The foreign trade balance will remain positive in the forecast period, but it will clearly drop. Basic chemicals production in Europe is predominantly for the domestic market.

By contrast, the production of specialty chemicals develops positively. Here, the forecast assumes dynamic growth by 1.9 percent per year to 2030. More research-intensive and higher-quality specialty chemicals will gain in importance in the future. These are usually low volume and innovative chemicals and preparations which are developed in close contact with the customer industries. Innovations – a strong point of European chemistry – are the drivers in this sector. High foreign trade dynamics and much lower import pressure than in basic chemistry enable a growing foreign trade surplus and, consequently, dynamic developments in production. The surplus in foreign trade with countries outside the EU rises, in real terms, from 29 billion euros to 40 million euros in 2030.

The pharma business – another strong point of European chemistry – will expand dynamically too. The globally growing and aging population brings a stronger demand for pharmaceutical products. More prosperity and the growing middle classes in emerging markets result in a higher spending on medicines and life science products. European pharmaceuticals are in demand worldwide. Extra-EU exports can improve dynamically (+2.4 percent per year) in the forecast period. Imports – mainly of inputs – will only go up by 2 percent. In consequence, the foreign trade surplus will rise by over 60 percent to 2030.

A comparison of countries shows dynamic growth in the Eastern European Member States of the European Union, where growth rates in many countries are above the EU average. Over the years, partly serious competitors for the "classic" chemical nations have developed there. All the same, growth is weaker than in the previous decade. After the successful transformation of the Eastern European countries, dynamic capacity building is gradually nearing its end.

Regardless of the differences in growth between the European countries, the structure of countries will remain comparatively constant to 2030. Compared with the present situation, nothing changes in the "top 5". With a share of just under 23 percent, Germany will remain by far the major chemical producer in 2030 – followed by France, Italy, Ireland and Great Britain. Belgium can climb two ranks to rank 6; Spain and the Netherlands drop one rank each to ranks 7 and 8, respectively.

EU chemistry is and remains an important employer. In 2013, the European chemical industry had ca. 1.7 million staff. This corresponds to a share of 5.5 percent of employment in industry or 0.8 percent of employment in the overall economy. The by far largest number of staff work in the German chemical industry. In 2013, they had a share of 27.2 percent in EU-wide chemical industry employment – followed by Great Britain (12 percent) and Italy (10.4 percent). With increases in productivity, employment in the European Union will fall by 0.6 percent per year in the forecast period, so that somewhat over 1.5 million persons will be working for the European chemical industry in 2030.

Development in Germany to 2030

Germany's long-term development is determined essentially by demographic change, the global economic environment, raw material and energy costs, and international competitiveness. As the European Union remains the most important trading partner, progress of the German economy is closely linked with the development of the neighbouring countries and of the European Union. Uncertainty is strong about the future of the EU and of the common currency, due to the debt crisis in Greece and the referendum on Great Britain remaining in the EU. Moreover, because of border controls the refugee crisis puts at risk the smooth functioning of the internal market. Developments in Germany, as they are described in the following, presuppose the further existence of the European Union and of the euro as well as a functioning internal market.

Domestic economy gains in importance

According to the new projections, the German economy will grow on average by 1.3 percent per year to 2030. Compared with the previous 13 years, growth will even accelerate by 0.2 percentage points. All the same, dynamics will remain low as compared with the developments before the global economic crisis and in comparison with the growth dynamics of other European national economies. In the future, Germany will be far from being the growth driver in Europe.

A glance at the demand component of the gross domestic product shows that the growth model of the German national economy has changed fundamentally. Before 2013, Germany owed almost half of its growth to its export successes – but the external contribution will grow much more slowly in the forecast period. Public consumption, too, contributes less to growth than in the previous decade. By contrast, the domestic economy gains in importance. Future growth mainly relies on an increase in private consumption and on a slight expansion of investment activities.

The foreign trade surplus will further increase, but the times of two-digit growth rates are over. Regarding exports, particularly the lower growth dynamics in emerging markets have negative impacts. Neither the moderate growth in Europe nor the demand development in the USA can make up for this. Imports are rising with the same dynamics as exports, so that only low contributions to growth can be expected from the external contribution.

The contribution from public consumption to GDP growth will be low in the future too. Here, structural changes in the public budget are assumed. Because of the good labour market situation, consumption spending by the public administration can be used partly to finance the dilapidating infrastructures. Because of budget consolidation and the "debt brake", Germany's debt/GDP ratio will fall from currently ca. 75 percent to 55 percent in 2030. Thus, the scope remains limited for the fiscal policy.

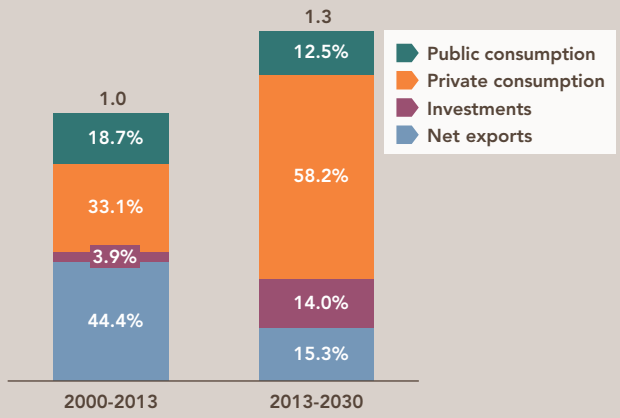
Investments are becoming more important for growth, albeit at a very low level. Investments in equipment barely grew in Germany from 2000 to 2013. A considerable investment backlog, especially for the transport infrastructure, built up during that period. That backlog will be remedied gradually in the future. However, the investment weakness persists. To 2030, investments will rise slightly more dynamically than in the past decade. The share of investments in GDP will fall from currently just under 20 percent to around 18 percent (2030).

The persistently inadequate framework conditions and the global growth perspectives also slow down private investment activities. Irrespective of this, some private investments are increasing, e.g. in housing construction. New housing will be lacking nationwide in Germany to 2030, with the exception of rural areas. The reason: The demand for single apartments and the numbers of persons moving to large cities will last. Public investments remain weak. The federal government's initiatives for more investments in the transport infrastructure will only have short-lived effects. The decline in population once more dampens public infrastructure investments toward the end of the forecast period. All the same, on average the value of investments will exceed the value of depreciations. Overall, this results in capital stock growth in Germany.

Private consumption will be the growth driver no. 1 in the future: it will account for almost 60 percent of economic growth in Germany. The favourable development of private consumption relies on low interest rates, the dissaving of an aging population, real incomes that tend to rise, and more purchasing power because of low oil prices. Because of this, the consumption rate will increase overall.

The baby boomer generation will more and more cancel its financial investments. The majority of future pensioners will need to resort to their savings. Because of the aging society, the ability to perform of statutory pensions is shrinking; increasingly, this needs to be made up for by private retirement provisions. Moreover, older people will spend more on leisure activities or on nursing care. But private consumption also benefits from another consequence of the demographic

FIG. 17: FEWER IMPULSES FROM ABROAD
GDP growth in Germany, in percent per year, growth contributions from components, in percent



The domestic economy gains in importance in Germany. Private consumption becomes the main pillar of growth for the overall economy. Irrespective of weak dynamics, investments are becoming more important too.

development: The availability of labour is falling in Germany, so that real incomes tend to rise. Unemployment will drop to under 4 percent in 2030. Over the past years, the increases in remuneration exceeded inflation. This trend will last during the forecast period.

But demographic change will also have a slowdown effect on the development of the German national economy – because a labour gap threatens for German economy. By 2030, a considerable part of today's workforce will retire, and the number of new entrants in the labour market will be clearly lower. The number of working-age persons will fall from 53.1 million to 49.3 million, i.e. there will be a drop by 0.4 percent per year. It is expected that the ensuing labour shortage will be countered by suitable measures, e.g. increasing the share of women in the workforce, strengthening the offers for education and, in particular, labour market-related, substantial net immigration. The present refugee crisis is not yet included in the forecast calculations, because it is currently totally unclear to what extent it will be possible to integrate the migrants in the labour market. Also, it cannot be predicted how far advancing digitalisation will impact the quantity of human work time required by the labour market.

With these assumptions, the working population will only fall by 0.2 percent per year to 2030. This corresponds to a drop by 1.2 million persons. The volume of work in the overall economy will decrease only slightly, because rising working hours have been assumed particularly for existing part-time jobs. But it is and remains a central task of politicians to provide the prerequisite framework conditions (e.g. for childcare) and to counteract counterproductive fiscal incentives in this respect. The smaller workforce in the overall economy means for industry that the demand for staff can be no longer covered everywhere. But there will be a staff shortage in the service sector too, e.g. in education or nursing. Already today, the police and the German army cannot fill all vacancies.

Moreover, the requirements to workforce members will change. The work environment is not changing solely for staff to be newly hired; it is doing so particularly for persons who already have a working life. Especially digitalisation and the interlinking and networking of the economy – through new business models and technological progress – create new jobs with changing requirement profiles, while conventional jobs are lost elsewhere. This calls for a high degree of flexibility and readiness to change of companies and staff. Without the necessary changes at the workplace and in education and training, there is the threat of a qualification "mismatch" which might intensify the labour shortage. The importance of retraining is rising too.

But the aging of society brings not only a labour gap, it also leads to rising ancillary wage costs in real terms: In 2030, there will be two working persons for one old-age pensioner, as compared with still 2.5 working persons today. Moreover, a rising spending of health funds and nursing care insurances can be assumed with an aging population. In this environment, especially the social partners have a great responsibility for the development of employment and competitiveness. The forecasts assume that unit labour costs will remain largely stable in German industry. This means that the increase in wages will not exceed the increase in productivity.

Industry remains the central pillar of the German economy

Germany's comparatively positive growth perspectives in the long term are mainly attributable to the strong industrial core. In this country, industry's share in GDP (over 23 percent) is nearly twice as high in the USA, France or Great Britain. It is also worth noting that almost all sectors are present in Germany; their companies rank among the top internationally. Because of their high quality, industrial products "made in Germany" are appreciated worldwide. Germany is a popular location for industrial production and also attracts foreign businesses.

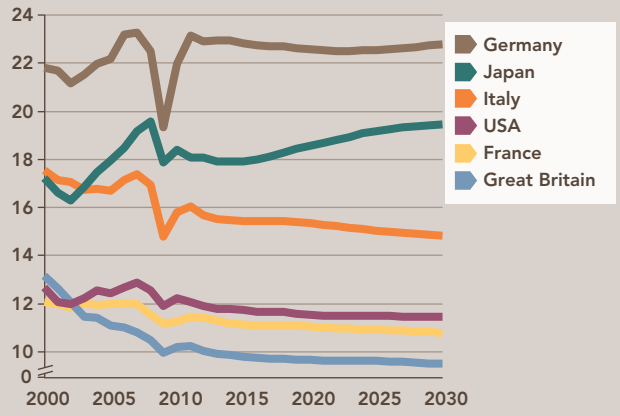
German industry has achieved a very strong position in many fields of growth like energy and resource efficiency, mobility and logistics, climate and environmental protection as well as health. Beside the openness of the national economy, decisive success factors of German industry are its high innovation and research activity and its strong industrial network and interlinkage. So far, this has enabled German industrial companies to successfully hold their own in an increasingly competition-intensive environment.

Over the past years, the share of manufacturing in the overall economy's gross value creation has remained more or less stable at ca. 23 percent. It is clearly higher than in other industrial nations like e.g. France, Great Britain or the USA where this share is between 10 and 12 percent and, obviously, already now clearly lower than in Germany.

Also during the forecast period to 2030, industry's share in total gross value creation will be more or less stable at ca. 23 percent in Germany. This means that the importance of industry for economic growth will remain high in this country. Industrial sectors see significant losses in shares e.g. in France, the USA and Great Britain, even though these losses are no longer as high as they used to be in the past.

By contrast, the share of manufacturing in the overall economy's workforce has fallen in the past and currently amounts to ca. 18 percent. This trend will last moderately in

FIG. 18: GERMANY – FUTURE THROUGH INDUSTRY
Shares of industry in gross value added of major countries, in percent



Germany's strength is its industrial base. Industry has maintained its high share in total gross value creation. With this, Germany will be taking a different way from that of many industrial nations also in the future.

the forecast period. The share in the total number of persons employed will drop to somewhat under 16 percent in Germany. The capital intensity of production will increase and lead to progress in productivity in mathematical terms.

Manufacturing has a dynamic role in foreign trade. It is true that the share of services in the total trade volume has risen noticeably in the past years. All the same, trading in goods continues to dominate the picture. The share of manufacturing in exports is nearly 80 percent; the share in imports is just under 70 percent.

Due to the falling workforce potential and fiercer competition, the companies will invest more in production-increasing processes and technologies and in the training and advanced education of their staff. This is reflected in the forecasted growing demand for highly qualified staff in the sectors and in the high share of manufacturing in the spending on research and development (R&D).

The long-term demographic, climatic and technological trends will bring more dynamic developments in the fields of energy and resource efficiency, mobility and logistics, and climate protection and environment. In Germany, this can benefit in particular mechanical engineering, vehicle construction, the electrical industry, the chemical-pharmaceutical industry and plastics processors.

These lead sectors are the drivers of industrial production in Germany. They are characterized by high international competitiveness. To 2030, they will see a productivity increase by 1.9 percent per year, while industry overall will grow by 1.4 percent per year. Altogether, growth of industry will remain somewhat higher than growth of the overall economy.

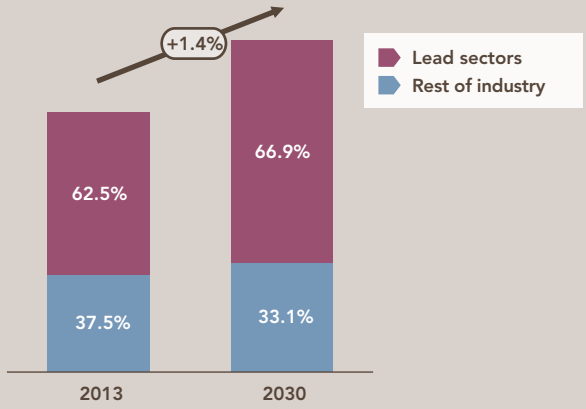
The most dynamic growth will be achieved in the electrical industry, followed by vehicle construction and mechanical engineering. The electrical industry benefits from a rapidly growing demand – particularly from China – for high-quality electrical products and from the rising number of novel applications in computer-controlled technology, inter alia, within digitalisation. Vehicle production is boosted not only by its ability to innovate but also by the production of rail vehicles. Here, the global demand increases through the growing importance of environmentally sounder transport options and the dynamic development of cross-border trading.

The sales position of the innovative pharma industry improves with the advancing aging of the German and global population. However, there is competitive pressure, inter alia, from generics manufacturers and from countries with lower production costs. Also in the future, the chemical industry and mechanical engineering will hold their own in an increasingly competitive environment – because of their innovation skills and their high degree of production specialisation.

To 2030, especially the electrical industry and vehicle construction will expand their shares in value creation in the manufacturing industry. Thus, in vehicle construction a development continues that had been observed already before 2013. The share of value added in mechanical engineering will also rise to 2030. By contrast, the shares in the chemical industry and in plastics processing remain constant. Altogether, regarding the contribution to gross value added in the manufacturing industry, vehicle construction will remain the most important sector of German industry also in the future, followed by mechanical engineering and the electrical industry. Chemistry is on rank four.

An increase in value added will be generated, irrespective of a drop in the workforce: In 2030, staff numbers in all sectors will be lower than they were back in 2013, so that a trend from the past continues.

FIG. 19: LEAD SECTORS ARE SETTING THE PACE
Industrial production in Germany. CAGR 2013-2030. Shares in percent



The growth drivers of German industry are its lead sectors – vehicle construction, electrical industry, mechanical engineering, chemical and pharma industry, plastics processing. The importance of these sectors will increase.

Growth chances for German chemistry

In real terms, the production volume of the German chemical industry rises by 30 percent from 190 billion euros in 2013 to 246 billion euros in 2030. With an average increase of 1.5 percent per year, thus chemical production grows rather more dynamically than industry or the overall economy. However, growth will weaken somewhat as compared with historic developments. From 2000 to 2013, German chemical production still rose by 1.8 percent per year. In the forecast period, German chemical production cannot keep up with global chemical growth either: To 2030, chemical production worldwide will improve by 3.4 percent per year. Irrespective of a loss in shares by 1.4 percentage points, Germany will remain the world's fourth largest chemical producer.

The German chemical industry is internationally competitive with its strong pharma sector, innovative specialty chemistry and highly efficient production plants for basic chemicals. Its strong points include, in particular, a high ability to innovate, interlinked production (Verbundproduktion), chemical parks, and the strong German industrial network. At present, the Federal Republic is the export world champion in chemical trading and one of the few countries with a foreign trade surplus in the chemical sector: In 2013, it amounted to 51 billion euros in real terms, so that the chemical industry significantly contributed to Germany's overall foreign trade surplus. Chemistry ranks among the core sectors of German industry. In the "Verbund" with other industrial lead sectors, it ensures growth and prosperity for the German national economy.

Also in the future, Germany will benefit from the strong growth of global chemical markets. Chemical exports from Germany will rise by 1.7 percent per year to 2030. But due to weaker growth globally, export growth will be less marked than forecasted in the earlier study. The domestic demand for chemical products will climb somewhat slower (+1.5 percent per year) than exports. In consequence, the export dependency will increase during the forecast period: Back in 2013, 82 percent of total production was exported while 84 percent will go into exports at the end of the forecast period. Beside the export quota, also the absolute export volume will increase by 51 billion euros to just under 207 billion euros in 2030.

However, these figures also show that the chemical industry location Germany has competitiveness problems. Already in the past, German chemical exports rose less strongly than exports from other countries. Consequently, Germany lost shares in global chemical exports, which was mostly attributable to Germany's falling attractiveness for chemical production. The main underlying reason was the high cost of raw materials and energy in the international comparison. In the future, this is unlikely to change fundamentally. Therefore, chemical exports from Germany will continue to grow slower than global chemical exports. As a result, to 2030 Germany will continue to lose shares in global chemical trading, irrespective of its export successes. This shows that there is a persistent need for action under the industry policy.

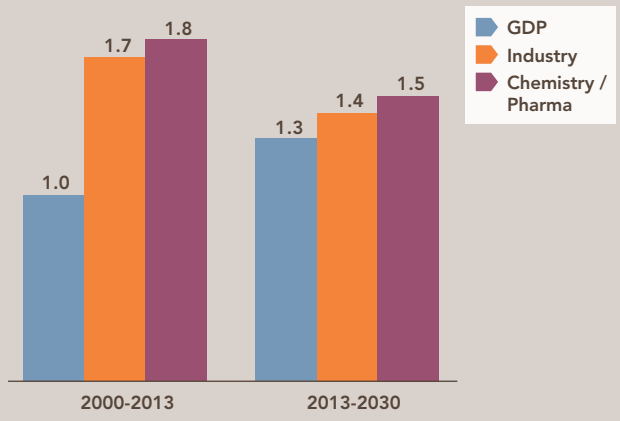
A glance at chemical imports gives a similar picture. There are new additional competitors especially in the emerging markets, and the reinvigorated US industry is getting ready to increasingly push on the European market. In this setting, import pressure on Germany will rise to 2030. For example, in the forecast period the import volume of chemical products will grow from 105 billion euros to somewhat over 138 billion euros, corresponding to an increase by 1.7 percent per year. This means that imports and exports will be equally dynamic. The share of imports in supplies at home in Germany is on the rise. The import ratio goes up from 75 percent in 2013 to 78 percent in 2030.

Irrespective of growing competition, the German chemical industry will hold its own on global chemical markets also in the future. Germany's trade balance in chemical products remains positive in the forecast period. The foreign trade balance can even be further expanded slightly, rising by 34 percent to well over 68 billion euros to 2030. But that will be mainly thanks to the pharma business, while the falling trade balance for basic chemicals will turn negative to 2030.

At present, the most important foreign customers for German chemical products are the European countries and the USA. To 2030, German exports to China will grow strongly, so that the People's Republic will become the third largest customer for German chemical products behind the EU and the USA. In fact, China will be able to cover a growing share of its demand for chemicals from domestic production. However, the growth rates of the Chinese economy are high in the international comparison. This open up growth chances for German chemical exporters – particularly for pharmaceuticals and specialty chemicals. But the export structure will retain its strong focus on Europe. In 2030, just under 57 percent of chemical exports from Germany will go to the Member States of the European Union.

The increasing importance of foreign trade is not the only change in the use structure of German chemical production. The structure of domestic use is changing too. While the share of investments in domestic use remains more or less the same, to 2030 the importance of private consumption will rise

FIG. 20: ABOVE-AVERAGE GROWTH OF CHEMISTRY
Average annual growth rates of GDP, industrial and chemical production, in percent



To 2030, growth in the German chemical industry will be weaker than in the past. But growth rates will still be above the average growth of industry and higher than GDP growth.

with the demographic development. In 2013, one fifth of the domestic demand for chemical products came from private households. To 2030, this share will climb to one fourth. Out of this, roughly 70 percent fall to the share of pharmaceuticals. Public consumption will also become more significant. Its share will grow by 1 percentage point to 10 percent, due to the rising demand for pharmaceuticals in the health sector.

Because of the close intertwinement inside German industry and the rising chemical intensity in many customer industries, the demand from industry for chemical products will increase overall, with the domestic demand remaining by far the most important use for German chemical production. However, its share will drop from currently 53 percent to 50 percent. This minor loss in importance is attributable to weak growth of some chemical-intensive sectors, e.g. metal production and processing and also paper manufacture. Moreover, there is also more competition from abroad in sales to industrial customers.

The intertwinement inside the chemical industry also decreases slightly, due to rising import pressure for basic chemicals. All the same, also in the future the industry's domestic demand will primarily come from the chemical industry itself. Here, the integration of chemical sectors between themselves is a special German feature and should be seen as a central competitive advantage. To 2030, Germany will remain one of the few countries that have both a strong basic chemistry and a strong specialty chemistry – which enables close coordination and cooperation between the chemical sectors. This development is facilitated by chemical parks and integrated locations (Verbundstandorte) where different companies or operations can cooperate and benefit from the effects of such integration (Verbundeffekte).

Beside the demand from chemical companies themselves, there is a large-scale demand for chemicals also from plastics processing and vehicle construction. Chemical products are gaining in importance in vehicle construction with the rising share of electronics and the increased use of polymers. But higher chemical intensity is not limited to vehicle construction alone; it is also found, inter alia, in the construction of buildings and in electrical engineering. For example, chemistry is becoming ever more significant in building construction because of the stronger insulation of buildings. The chemical intensity in electrical engineering is driven up by the progressing use of solar and fuel cells. Furthermore, new fields of use and a new demand emerge in climate and environmental protection. The rising share of renewable energies in electricity supplies in Germany is possible only with high-quality chemical products for the production of wind energy plants and photovoltaic modules.

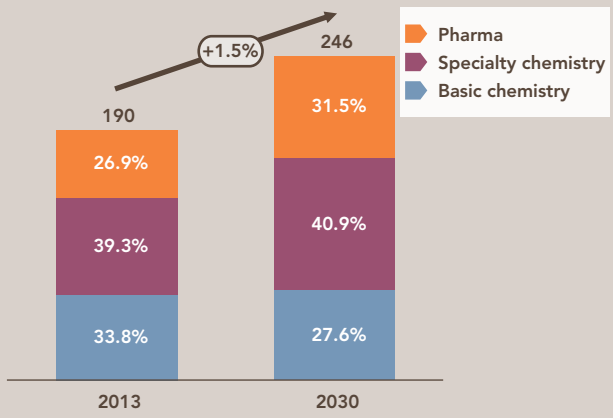
The German chemical industry produces chemical products at quite different levels of value creation. Basic chemicals as well as specialty chemicals and pharmaceuticals are manufactured in Germany. Basic chemicals account for just under 34 percent of the total chemical production. Specialty chemicals have a somewhat higher share of 39 percent, while pharmaceuticals have the lowest share (27 percent).

The various chemical sectors have different growth potentials. Future dynamics will be strongest for the pharma business. But there are also good growth prospects at home and abroad for manufacturers of innovative specialty chemicals. By contrast, regardless of highly efficient plants, basic chemistry has a problem with energy and raw material costs; this results in stronger import pressure. Therefore, basic chemistry can only slightly expand its production in the forecast period. Against this backdrop, the importance of specialty chemicals and pharmaceuticals will increase during the forecast period in German chemical production – while basic chemistry is losing shares. Irrespective of this specialisation, also in 2030 the German chemical industry will still be diversified and active at all stages of production.

PHARMA

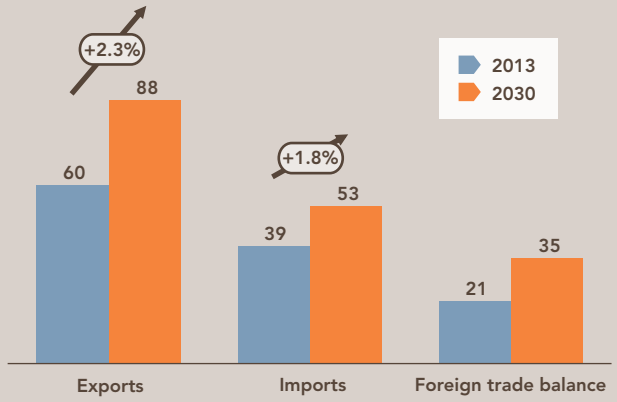
The pharma sector will have the greatest growth potential in the chemical industry. The strongly aging population in

FIG. 21: FOCUS ON SPECIALTY CHEMISTRY AND PHARMA
Production value in real terms, German chemical industry, in billion euros, shares of sectors in percent, CAGR 2013-2030



There will be shifts in the chemical industry's production structure. Basic chemistry will lose in importance. Shares in the production value will increase for specialty chemistry and pharmaceuticals.

FIG. 22: WORLDWIDE DEMAND FOR PHARMACEUTICALS
Trading in pharmaceutical products from Germany, in billion euros, CAGR 2013-2030



The global market for pharmaceuticals grows dynamically. This can benefit the German pharma industry with its strong ability to innovate. Its products are in demand worldwide. The foreign trade balance is rising.

industrial nations and the growing and also aging population in emerging markets will bring a rise in the global demand for pharmaceutical products to fight e.g. Alzheimer's disease and arthritis. Furthermore, the changing lifestyle and progressing urbanisation in emerging markets are conducive to the spreading of civilisation diseases like diabetes, hypertension and adiposity. Cancer and cardiac diseases will become major causes of death also in emerging markets. Furthermore, especially in industrial nations there is rising health awareness in wider layers of the population. Consequently, the demand e.g. for food supplements and care products can be driven up.

More prosperity and the growing middle classes bring a higher health sector spending in emerging markets. Governments are faced with rising costs. For this reason, there will be more public administration efforts to curb the costs in the health sector. This puts pharmaceutical manufacturers under pressure. On the other hand, governments, health funds and other cost payers will increasingly urge consumers to give more focus on prevention. This creates new business fields for the life science sector.

Given its strong orientation to innovation and its high competitiveness, the German pharma industry can benefit from the described developments. In 2013, a production volume of 51 billion euros was achieved with pharmaceuticals. In the forecast period, German pharma production will rise by 2.5 percent per year on average, so that its growth will be more dynamic than overall growth of the industry. Until the end of the forecast period, the production volume will go up to nearly 78 billion euros. Consequently, in 2030 the importance of pharmaceuticals will be greater than that of basic chemistry.

German pharma products are in demand worldwide. Exports grow vigorously by 2.3 percent per year. The domestic demand also improves dynamically by 2 percent per year – while imports are climbing somewhat less. This reduces the import pressure on the pharma industry, and the foreign trade surplus increases visibly.

SPECIALTY CHEMISTRY

Research-intensive and higher-quality specialty chemicals will be gaining in production shares in the future. Specialty chemistry includes special plastics (e.g. polycarbonate or man-made fibres), consumer chemicals (detergents, cleaning agents, personal care products), paints and coatings as well as plant protectants. However, the largest part-segment consists of the group of "other specialties". These are low-volume, innovative chemicals and preparations which are developed specifically for industrial customers. This makes innovations the essential drivers of specialty chemistry. The knowledge edge of the German chemical industry secures its competitive position for specialty chemicals. High foreign trade dynamics and lower import pressure than in basic chemistry enable high foreign trade surpluses and dynamic developments of production volumes.

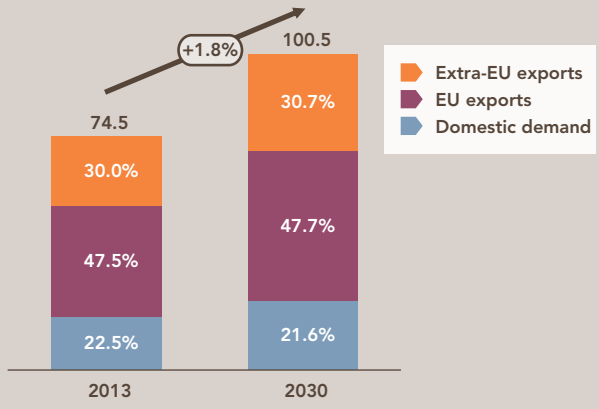
Beside large businesses, which predominantly produce specialty chemicals in integrated structures (Produktionsverbund) with basic chemicals, specialty chemicals are found in many small and medium-sized enterprises (SMEs). They can respond particularly flexibly to changing customer requirements. There are many "hidden champions" among chemical SMEs: they are world market leaders in their specific market segments. SMEs depend on supplies with high-quality basic chemicals, and they prefer to purchase their inputs from German and European suppliers.

In 2013, German specialty chemistry achieved a production volume of 74.5 billion euros. In the forecast period, specialty chemistry will grow by 1.8 percent per year on average, i.e. more dynamically than chemistry overall. The production volume will climb to 100 billion euros to the end of the forecast period.

In the forecast period, German exports of specialty chemicals will increase by 1.8 percent per year on average, as specialty chemicals "made in Germany" are in demand worldwide. Many specialty chemicals have been optimised to meet the needs of German industry. Industrial customers benefit from high-quality and innovative chemicals with which they subsequently produce high-quality products. In these integrated innovation structures (Innovationsverbund), many industrial customers remain loyal to their specialty chemicals manufacturers in Germany even if they themselves have productions abroad. In this way, German specialty chemistry can benefit from the globalisation of German industrial companies. However, this presupposes for the future that the customers will continue to develop their products in Germany, together with the chemicals suppliers.

With average growth of 1.6 percent per year, the domestic demand will develop dynamically too. At home in Germany, the German producers benefit from the closely integrated structures (Verbund) of industry; this ensures the geographical proximity to customers and, consequently, sales. With an increase by 1.6 percent per year, imports climb just as strongly as the domestic demand, so that the import pressure on specialty chemicals remains relatively low. The foreign trade surplus will grow by more than 45 percent to 33 billion euros.

FIG. 23: DYNAMIC GROWTH OF SPECIALTY CHEMISTRY
Production values of specialty chemicals in real terms, Germany, in billion euros, shares in percent, CAGR 2013-2030



Special chemicals production will grow above-average to 2030, with the demand from the domestic market and from Europe remaining greatly important for this sector. Extra-EU exports will grow even more dynamically.

BASIC CHEMISTRY

German basic chemistry is by no means a homogenous group. It includes inorganic basic chemicals, petrochemicals, organic intermediates, standard polymers and fertilisers. Organic intermediates are by far the most important segment within German basic chemistry. This sector accounts for ca. 45 percent of basic chemistry production. Basic chemicals are manufactured in closely integrated production structures (Produktionsverbund), which often extend across several companies. Thus, basic chemistry benefits, in particular, from chemical parks and from the inclusion in integrated structures of companies (Verbundunternehmen). The geographical proximity to other chemical enterprises or plants is helpful too. The high resource efficiency resulting from the "Produktionsverbund" is a central strength of German basic chemistry.

Unlike for specialty chemicals, the growth potential to 2030 is low for basic chemistry in Germany. This is mainly due to the fact that energy and raw material costs are high in the international comparison. Gas and industrial electricity are much more favourably priced in North America and in the Middle East than in Europe. This production cost advantage has not only triggered an investment boom in the oil and gas industry in raw material-rich countries; it has also brought a vigorous expansion of production capacities for energy-intensive basic chemicals. Production in the above-mentioned regions exceeds their domestic demand and is pushed on world markets. For German basic chemistry, this means lower export dynamics, more import pressure and lower growth generally.

For German and European basic chemistry, this problem is intensified by an ambitious energy and climate policy which tries to force efficiency increases in industry through higher energy costs. In order to make up for this disadvantage, many energy policy instruments provide for exemptions for energy-intensive industries engaged in international competition. In the past, this approach successfully prevented a shrinking of basic chemistry in Germany. For the forecast, we allege that this industry policy will last also in the future. Consequently, there will be no relocation of basic chemistry to 2030, either.

Back in 2013, the production volume of basic chemicals totalled 64 billion euros. Toward the end of the forecast period, the production volume will have risen by 6 percent to 68 billion euros. This corresponds to an average increase by 0.3 percent per year. Thus, basic chemistry will not only grow clearly slower than German chemistry overall; its growth will also be much more restrained than that of global basic chemistry.

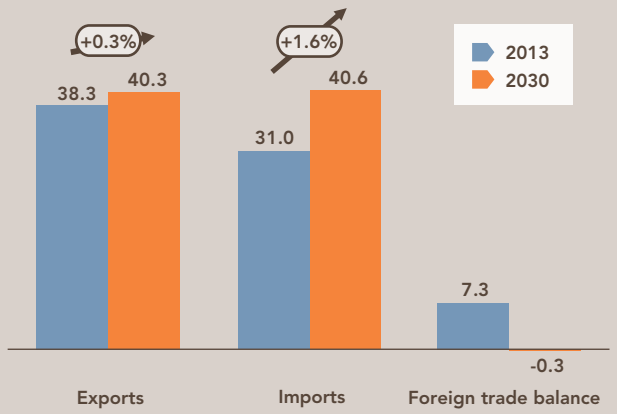
High raw material and energy costs in the international comparison are responsible for German basic chemistry barely benefiting from global economic dynamics. The export business hardly grows due to increasing competition from raw material-rich countries. To 2030, German exports of basic chemicals will merely rise by 0.3 percent, while import pressure will intensify. To 2030, imports of basic chemicals into Germany will go up by 1.6 percent per year to nearly 41 billion euros. The impacts of this reverse development are reflected in the foreign trade balance. Germany's foreign trade surplus for basic chemicals of 7 billion euros will turn into a deficit of 300 million euros to 2030.

The future demand for basic chemicals in Germany follows the expected growth of customer industries in this country – which is low in an international comparison. The domestic demand for basic chemicals will only grow by 1.1 percent per year to 2030. Dynamics are barely higher in the European neighbouring countries. German basic chemistry will produce predominantly for German and European chemical companies with their integrated structures.

But basic chemistry in Germany has a major role for the processing sectors of chemistry and industry: It supplies a wide range of sectors with the inputs needed for their productions – for processing in close geographical proximity. At the current moment in time, a substitution of basic chemistry in Germany or Europe by exports from non-European countries would be hard to imagine. The reason is that the decisive value creation steps of basic chemistry take place in integrated production. Another relevant point is that many products from basic chemistry (ammonium, olefins) are gaseous and, therefore, difficult or simply costly to transport. Individual production steps and processes cannot be removed from integrated production without harming chemistry as a whole. This is highlighted by the example of polyvinyl chloride (PVC).

PVC is a standard polymer. It is well-known, inter alia, for use in floor coverings or window profiles. Ethylene and chlorine are needed for PVC production. Ethylene is a petrochemical produced in steam crackers. Chlorine is an inorganic basic material; it is produced electrolytically from cooking salt. Both components are highly reactive and gaseous. This makes them difficult to transport across large distances. Initially, vinyl chloride (an organic intermediate) is formed from chlorine and ethylene. Next, the thus obtained vinyl chloride is polymerised. Further specialty chemicals, e.g. stabilisers or colour pigments, are needed to enable the use of PVC. If the electricity price is high – so that chlorine production is no longer profitable – PVC production is rather unlikely to continue. This also impairs the business of stabiliser or colour pigment manufac-

FIG. 24: HIGH IMPORT PRESSURE IN BASIC CHEMISTRY
Trading in basic chemicals from Germany, in billion euros, CAGR 2013-2030



Basic chemistry in Germany is increasingly coming under pressure. Imports are rising while exports are stagnating. The foreign trade balance is turning negative. German basic chemistry predominantly produces for the domestic market.

turers. Probably, no PVC floor coverings would be produced domestically any longer; they would be imported. As described, the value chain extends into customer industries.

In contrast to the above, both the raw material oil (naphtha) and many end products from the chemical industry (liquids or polymer granules) can be transported easily and at favourable cost. As rising transport costs are rather to be expected in the future, the trend toward cluster formation should intensify – both in the market and at the oil well.

Another special feature of chemical production is that specialty chemical products are not manufactured "just additionally" to large-volume basic chemicals: they are inseparably linked with them in their production, as specialty products stem from basic chemicals. This means that innovative specialty products and standard products, which have remained largely unchanged over decades – do not stand in opposition to each other. Quite the contrary, the trend toward higher-quality products/substances also strengthens the demand for basic chemicals. Furthermore, it allows sufficient capacity utilisation in production plants.

The chemical industry remains an attractive employer

In the year 2013, the German chemical industry had 463,400 staff which makes it one of the largest and most attractive employers in Germany. The industry provides well-paid jobs with good working conditions and safety for the future.

In comparison with other industries, the chemical industry pays above-average remunerations. The chemical industry's remuneration level is almost 25 percent above the average of industry overall. In particular, qualified staff from the natural science-technical field are the capital of the industry. Traditionally, the chemical industry attaches great value to securing qualified staff for the future. Therefore, systematic investments are made in the vocational and advanced training of junior staff. In this way, the chemical industry continuously secures and enhances the qualification levels of its jobs. Efforts also include funding for natural science education, which has been promoted by the chemical industry fund Fonds der Chemischen Industrie since the 1950s in schools and universities.

Furthermore, the companies themselves provide vocational training for the qualified staff of the future. In total, some 20,000 young people undergo vocational training in the chemical and pharmaceutical industry. With the three-year duration of training, this means around 6,500 new apprentices per year. The collective agreement on "a future through training and entry in careers" ("Zukunft durch Ausbildung und Berufseinstieg") between BAVC[9] and IG BCE[10] was revised in 2014. The agreement prescribes a high number of vocational training positions which was even exceeded regularly in the past years. After successful completion of their vocational training, over 90 percent of youngsters are retained for further employment by the companies. Thus, the chemical industry offers excellent career prospects once the dual vocational training is over.

However, the past 25 years saw falling total staff numbers in the chemical industry too. In the early 1990s, jobs were lost, firstly, due to plant closures in East Germany after German reunification and, secondly, because of the outsourcing of employment-intensive fields from the core companies (outsourcing of canteens, logistics, cleaning and IT services etc). In consequence, the latter jobs now fall in the statistics of other industries. That downtrend in employment has been stopped since 2000. It is true that another drop in job figures was recorded in 2009 due to the crisis. However, in the chemical industry that drop was below the overall industry's average, and it was fully made up for by employment increases in the subsequent years. Today, employment exceeds the pre-crisis level. Irrespective of slow business, the chemical industry has created over 30,000 new jobs since 2009, inter alia, to counteract the threatening shortage of qualified staff.

The above-described job increases are not going to last in the forecast period. Technological progress and more efficient structures, some individual further outsourcing of corporate functions and also the advancing digitalisation and digital interlinking will lead to a moderate loss in employment (on average by 0.8 percent per year) in the chemical industry to 2030. But with just under 401,000 staff, the chemical industry will remain one of the major employers in Germany.

A differentiation by basic chemicals, specialty chemicals and pharmaceuticals shows that job losses are not spread equally across these three sectors. The largest drop in employment will be in basic chemistry. This can be attributed primarily to weak growth. Competitive disadvantages in energy and raw material costs dampen the growth potential for basic chemicals where production will barely expand to 2030. Moreover, shutdowns of some individual production facilities, the upscaling of existing plants and technological progress increase productivity in this sector. To 2030, productivity will rise in specialty chemistry and in the pharmaceutical industry too; inter alia, digitalisation and interlinking makes themselves felt here. Also, the outsourcing of operational processes to service companies continues. However, as both sectors will considerably expand production in the forecast period, there will be hardly any decline in employment.

In the future, there will be fewer qualified applicants per vacancy in the chemical industry. This does not so much impact the large chemical businesses near conurbations; small and medium-sized enterprises in less urban areas are more affected. Also, comparatively few staff shortages are threatening for university graduates. In fact, the increasing specialisation of the industry – together with the connected research intensity – brings a stronger demand for graduates in chemistry. But the high numbers of university entrants are promising, particularly in natural science subjects. Consequently, marked shortages of chemists and other natural scientists are unlikely. The picture is different for engineers where shortages are thought probable.

In the future, the German chemical industry will increasingly require higher numbers of junior staff with a non-university background. In particular, this includes jobs in production (e.g. "Chemikanten"/chemical assistants in production processes) and in the crafts/technical sector (e.g. industrial and plant mechanics, electricians, mechatronic technicians). At

[9] *German Federation of Chemical Employers' Associations*
[10] *Mining, Chemical and Energy Industrial Union*

present, every year around 6,500 young people start their vocational training in the German chemical industry. For this, chemical companies need apprentices with a good school education. But today, the companies find that the school qualification of many applicants is not sufficient. For the forecasts, we allege that the German school system will provide a sufficient educational qualification for the applicants of the future. In particular, this applies for the so-called MINT subjects which are of special importance to industry (MINT = mathematics, informatics, natural sciences, technology).

German chemistry: ever more efficient

Chemistry is energy-intensive. Many chemical processes need high temperatures. For example, the so-called "steam cracking" (a process at the beginning of many chemical value chains) takes place at temperatures of up to 800°C. In such plants, important primary chemicals – e.g. ethylene, propylene or benzene – are obtained from naphtha. Chemical processes also require electricity. Electrolytic processes like the chlor-alkali electrolysis, where cooking salt is converted into chlorine and caustic soda with the help of electricity, necessitate huge amounts of power. Here, energy is an integral constituent of production, with a chemical-physical determination of the energy requirement. Often, the products from such chemical processes are richer in energy than the input materials. Many chemicals store a considerable part of the energy fed into them in synthesis.

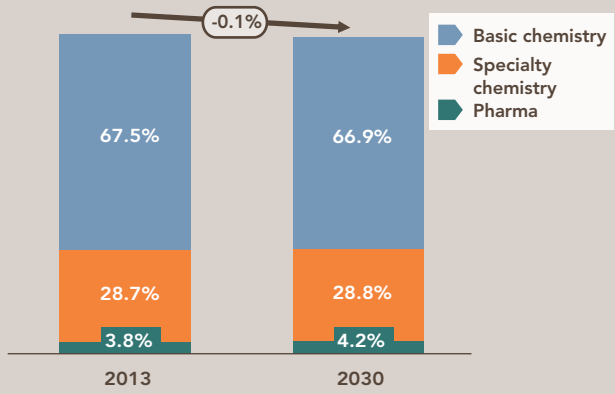
Furthermore, the chemical industry needs energy as an operating consumable for lighting, the running of electrical plants and safety systems, for cooling, heating etc. In basic chemistry, the proportionate share of such energy costs is clearly lower than that of the costs of energy used directly in chemical processes. The situation is different in specialty chemistry and in the pharma industry, where energy costs are incurred mainly for the running of production plants. The amounts of energy needed for the chemical processes as such are comparatively stable.

Energy consumption involves high costs. In the 10 years before 2013, the share of energy costs in gross value added rose from ca. 11 percent to nearly 15 percent. This is due to rising energy prices, which have a top position in an international comparison. In Germany, the prices of industrial electricity and gas are around 50 percent respectively 200 percent higher than in the USA. By means of more efficient production processes, the German chemical industry can only partly make up for such huge disadvantages in energy costs. For this reason, energy unit costs in the German chemical and pharma industry are roughly 30 percent above those of US competitors. These impacts are reflected in investment statistics: While the industry is currently experiencing an investment boom stateside, investments in chemical plants have been stagnating for over 20 years in Germany. Instead, German chemical companies prefer to invest abroad.

There are many reasons underlying the high energy efficiency of the German chemical industry. One important component is the integrated system (Verbundsystem). The concept of chemical parks or integrated companies (Verbundunternehmen) – a German invention – increases the efficiency of production. Chemical site operators take care of central environmental protection facilities and of the complete infrastructure for the companies and plants at a given location. This enables the integration (Verbund) of production facilities, resulting in high efficiency for energy and raw and residual materials. Furthermore, electricity generation in CHP (combined heat and power/co-generation) contributes to resource efficiency and climate protection. This also ensures optimal supplies of industry locations according to their heat and electricity requirements.

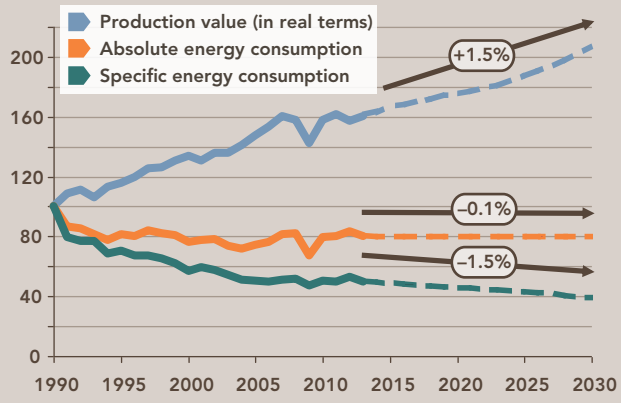
Irrespective of good efficiency, high energy costs remain a threat to the competitiveness of the German chemical industry. This concerns not only the energy-intensive basic chemistry. Far over 50 percent of goods produced by German chemical companies go to domestic customers inside their own industry. Thus, along the value chains the energy prices

FIG. 25: FURTHER INCREASE IN ENERGY EFFICIENCY
Energy consumption of the chemical industry, by sectors, shares in percent



Efficiency increases are possible particularly in specialty chemistry. Irrespective of production growth, energy consumption is not rising in this sector. By contrast, hardly any efficiency potentials can be realised in basic chemistry.

FIG. 26: NO EFFICIENCY LEAPS
Energy consumption of the German chemical industry since 1990, index 1990=100, CAGR 2013-2030



No fundamental changes are emerging in the energy and climate policy. Ensuing weak investment dynamics hamper the realisation of efficiency leaps.
Sources: German Federal Statistical Office, VCI

also affect businesses in specialty chemistry or the pharma industry. Beside the energy costs for operating their production plants, the high electricity and gas prices also make inputs from basic chemistry more expensive. Moreover, high energy costs adversely impact the competitive conditions for important domestic customer industries; additionally, they reduce the purchasing power of end consumers. In the described manner, this limits the sales possibilities for all chemical and pharma companies on their home market.

In total, at present the German chemical industry annually needs some 53.5 terawatt-hours of electricity, 80.4 terawatt-hours of gas and 63.4 terawatt-hours of other energy sources like coal and mineral oil products. Gas and electricity will remain the major energy sources to 2030. Therefore, regional price differences will strongly influence the competitiveness of the various chemical nations also in the future.

The price gap will close somewhat, but Germany will remain at the top end. Electricity continues to be costly in Germany too. Renewable energies (like wind power generation and solar energy) tend to reduce the prices at electricity exchanges, because additionally generated kilowatt hours do not cost anything. All the same, the electricity price will rise. Price risks are mainly due to costly grid expansion, which is allocated to the prices, and because of the transfer of brown coal power plants into the power plant reserve. Even when assuming that the burden-easing rules for the renewable energy act (EEG), the electricity tax and emission trading are maintained for the energy-intensive industry in Germany, the German chemical industry will have to expect energy prices that are above the international average.

Costs will rise, even though energy consumption in the chemical industry will no longer increase to 2030. Thus, a development continues that set in around 1993/1994. Since then – apart from minor fluctuations – absolute energy consumption of the industry has been stagnating. Mainly the weak production growth in basic chemistry will lead to stagnating energy consumption in the future. Energy efficiency (i.e. the ratio of production to energy consumption) is improving only slightly in basic chemistry. Major efficiency increases cannot be expected, either. A large share of energy consumption in these chemical sectors is not variable. For example, technical progress will not change the situation where chemical processes need given temperatures. Basic chemistry will always require the energy that is necessary for them.

By contrast, energy efficiency will improve by 1.8 percent per year in specialty chemistry. Unlike in basic chemistry, chemical processes in this sector require not so considerable but fixed amounts of energy. Here, the proportionate share of total energy costs for heating, cooling etc. is clearly higher, and efficiency potentials can still be realised in these respects. Consequently, absolute energy consumption will not continue to rise, either – even though specialty chemistry production will grow much more dynamically than production in basic chemistry. Irrespective of the industry's increasing focus on specialty chemistry in the forecast period, specialty chemistry will continue to consume under one third of energy in 2030.

No change in paradigm in the German or European energy policy is expected for the forecast period. Politicians continue to rely on making energy more expensive, in order to create incentives for energy efficiency increases. Ambitious targets will even increase the pressure on energy costs. This has two effects: Firstly, chemical companies will further intensify their efforts to optimise their existing plants, because the exemption rules only apply for small parts of their businesses. This brings constant but moderate energy efficiency increases. Secondly, the described energy policy leads to more adverse location conditions in Germany, making this country less attractive as a production location for chemistry. Therefore, more and more investments will go abroad.

The resulting weak investment dynamics at home in Germany – especially in basic chemistry – hamper the development of energy efficiency. Real energy efficiency improvements can be realised only by way of new plants. A glance at the past shows this. The last leaps in energy efficiency in Germany date back to the years from 1990 to 1993/94, when the chemical plants on the territory of the former GDR were replaced by state-of-the-art facilities. A comparable development is currently observed in the USA. The shale gas boom and a policy with incentives for investments lead to the construction of modern plants. Low energy costs stateside bring climate-friendly, energy efficient and competitive large-scale installations.

Diversification of the raw material base is driven forward

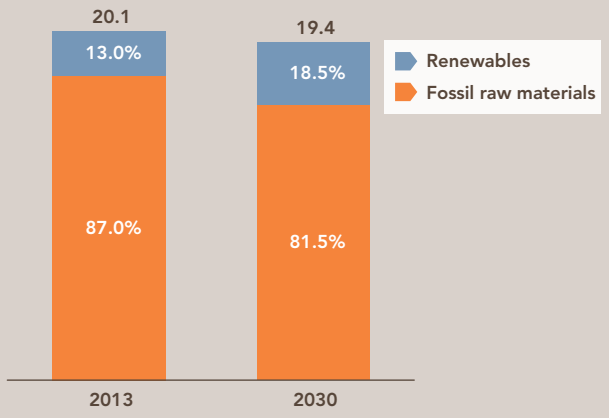
As a basic materials industry, chemistry is also raw material-intensive. In this study, the term "raw material" only sums up those substances that the chemical industry obtains from other industries. It does not include chemicals processed in chemistry. Since Germany as hardly any own raw material sources, most raw materials need to be imported at world market prices. Essential raw materials for the chemical industry are sufficiently available in the forecast period. Consequently, raw material supplies are ensured also in importer countries like Germany. However, raw material prices will be back on the rise in the future.

In chemistry, it is differentiated between three groups of raw materials: mineral, fossil and renewable raw materials. Mineral raw materials are mainly used in the chemical sector of inorganics. Important mineral raw materials are, for example, potassium salts and phosphates used in fertiliser production, or sodium chloride (cooking salt) from which the industry obtains the major inorganic basic materials of chlorine and caustic soda.

After conversion into basic chemical components, fossil raw materials open up a large number of possibilities for synthesis. The mineral oil derivative naphtha is the most important fossil raw material for the industry. Coal, heavy oils or natural gas are currently used only to a low extent in Germany. Fossil raw materials are mainly needed in petrochemistry. The basic components obtained from fossil raw materials are subsequently processed into organic intermediates or polymers.

Renewables are obtained from plant or animal biomass. These are mostly starch, cellulose, sugar, oils and fats as well as pharmaceutically active substances. Renewable raw materials are long-established in the chemical industry. They are used in the production of plastics, fibres, detergents, cosmetics, colours and paints, printing inks, adhesives, construc-

FIG. 27: MORE RENEWABLES
Resource consumption in organic chemistry, in million tonnes, shares in percent



The share of renewables increases to 2030. This requires major research efforts. In basic chemistry, the use of renewables is limited by availability and prices.

tion materials, hydraulic oils and lubricants, ranging to medicines. Thus, their main field of application is specialty chemistry.

Raw materials are interchangeable in chemistry, as a matter of principle. By contrast, consumption volumes can be influenced only minimally. Chemical production cannot be decoupled from the raw material base. This turns the diversification of the raw material base into the central element of the chemical industry's raw material strategy. This trend will not be slowed down by less strongly rising oil prices.

It is barely possible any longer to cut costs by way of efficiency increases. For economic reasons, the companies have been processing their raw materials highly efficiently for a long time: For many decades, the companies have been optimising their processes and – wherever possible – incorporated them in integrated structures. Wastes are avoided or recovered where this is feasible. Here, very few or no additional synergy effects can be realised.

All the same, to 2030 the chemical industry will manage to lower its resource input totally by nearly 0.7 million tonnes. But only a small part of this reduction is brought about by more raw material-efficient production; it is largely attributable to weaker growth dynamics in basic chemistry which clearly needs more raw materials than specialty chemistry. Today, specialty chemistry only accounts for ca. 7.5 percent of all raw materials. Obviously, the companies in this sector need production inputs too. For production purposes, specialty chemistry largely resorts to pre-products, i.e. chemicals from basic chemistry. The latter are not counted as raw materials. Needless to say, along the value chains also the raw materials indirectly enter the products from specialty chemistry.

In order to widen the raw material base, renewables are the obvious choice in organic chemistry. Already now, renewables are used where they bring technical and economic advantages. Against this backdrop, currently ca. 13 percent of the raw material base relies on renewables. The chemical industry will be able to increase this share to 18.5 percent. Large parts of these raw materials will be used in specialty chemistry.

The chemical industry will have to make major efforts in research and development to open up new fields of use for renewables. For novel applications and products, not only new markets need to be found; also, entirely new value chains have to be built together with the various actors. These challenges were frequently underestimated in the past, so that developments in many fields were not as dynamic as had been hoped.

But broadly speaking, organic chemistry will continue production on a fossil basis. At the current moment in time, a significant substitution of fossil raw materials by renewables does not seem likely in basic chemistry. Here, availability and prices of renewables are the limiting factors. In 2030, still 81.5 percent of organic chemistry will be produced from fossil raw materials.

Therefore, for basic chemistry the price relation between mineral oil and natural gas remains a central element when it comes to competitive raw material prices: While organic chemistry in Germany is oil-based (at present, only 11 percent of organic chemistry builds on natural gas), production e.g. in the USA is mainly based on gas. In the future, the weaker price increase for mineral oil will positively impact the competitiveness of basic chemistry in Germany, but for US gas only a moderate price increase is expected too. Moreover, both prices are becoming increasingly volatile. The German chemical industry will continue to diversify its fossil base, wishing to better cope with fluctuations in price relations. A stronger use of coal is not desirable, neither under environmental protection aspects nor in the public opinion or for the chemical industry. For this reason, the importance of natural gas will grow to 2030.

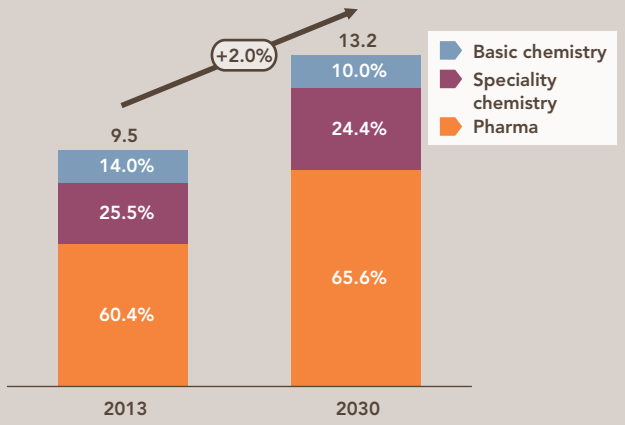
Higher research budgets

Chemistry is among the most innovative industries of the German economy. It is true that R&D investments are higher in the automobile and electrical industries, but no other industry gives more impulses to innovation than chemistry. Ideas and application know-how from chemical companies are often the starting points for further innovations in downstream value chains. Thus, chemical innovations are frequently the guarantors of success for the processing industries.

In 2013, the chemical industry spent ca. 9.5 billion euros on research and development (in real terms, prices of 2010). Pharmaceutical manufacturers account for some 60 percent of the spending. Nearly 26 percent fall to the share of specialty chemistry, while 14 percent go to basic chemistry. The research intensity (i.e. the share of R&D spending in the production value) was just under 5 percent in the industry. With over 11 percent, the pharma sector was particularly research intensive. Research intensity in the other chemical sectors is currently at 2.7 percent – with stronger research intensity in specialty chemistry than in basic chemistry. Research efforts in basic chemistry focus on process innovations.

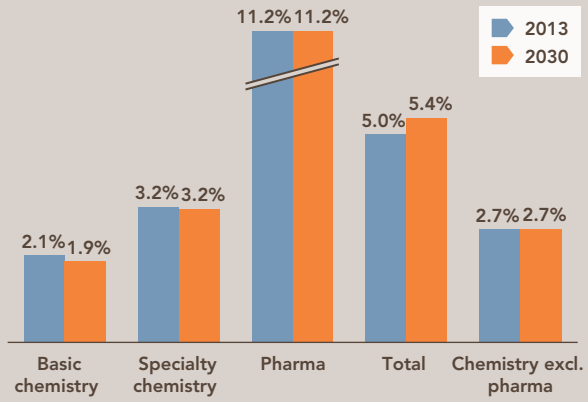
A differentiation by individual chemical sectors shows that the research intensity is particularly high for pest control and plant protection agents, followed with a gap by consumer chemicals and other specialties. While a slight drop in research intensity was observed in the past 10 years in the

FIG. 28: HIGHER RESEARCH BUDGETS
Research spending (in real terms) of the German chemical industry (internal & external) in billion euros, CAGR 2012-2030



The chemical industry will further expand its orientation to innovation. Because of the good growth prospects for these sectors, research budgets are rising in specialty chemistry and in the pharma industry.

FIG. 29: SLIGHT INCREASE IN RESEARCH INTENSITY
Research intensity of the German chemical industry, research spending in percent of production value



Thanks to intensified research and development efforts, R&D intensities of the sectors can be maintained. With the stronger weight of pharma in 2030, R&D intensity is rising for the industry overall.

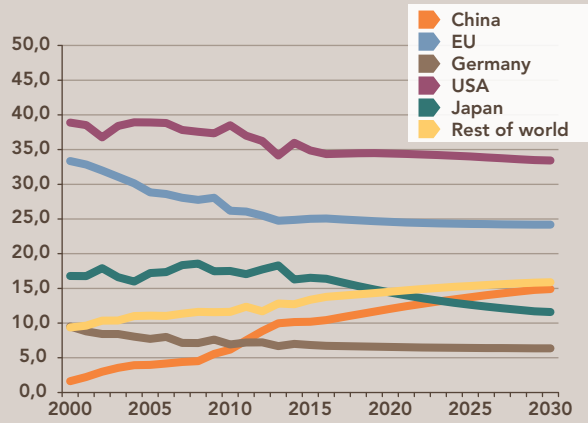
pharma industry, the intensity remained more or less constant in chemistry.

In an international comparison, Germany is the fourth largest research location for chemical and pharma products – following the USA, China and Japan. Regarding research intensity, the industry ranks in the upper middle internationally. Also in an international comparison, chemistry (excluding pharma) even holds a top position. With its R&D efforts, its innovative strength and – in a comparison of countries – good location conditions for innovations, the German chemical and pharma industry has a good starting position to meet the challenges of the future.

Competitive pressure will increase on the research location Germany. The international race for innovations is becoming fiercer. Competitors are not only from the industrial nations; the emerging markets, too, are massively investing in R&D. In some customer industries, centres of production and research are shifting to Asia. Already now, chemical research partly follows this trend. In Germany, moreover, regulations (e.g. complex approval procedures and the REACH requirements) hamper the innovation process in the chemical industry. This is shown by a topical study.[11] More incentives for innovation would be needed under fiscal law too. In particular, Germany still lacks fiscal incentives for research. Furthermore, the capital market in its current form is only insufficient for start-ups. Beside politicians, also the companies are called upon to become active. According to the above-mentioned study, the companies will have to adapt their innovation strategies – in order to reduce internal obstacles. Especially, the companies should give more scope to researchers, and they should have more courage and patience to try new things. This includes the following points in marketing: faster action, a stronger customer orientation, more flexibility.

In view of the global challenge of fiercer competition, the German chemical industry will continue on its path oriented to innovation. Research budgets of German chemical companies will rise by 3.7 billion euros (in real terms) by 2030. This corresponds to an annual increase by 2 percent – with a stronger focus on specialty chemicals and pharmaceuticals, because this is where the industry has growth potentials. The spending will remain constant in basic chemistry. In nominal terms, this means an increase in the industry's R&D spending by 3 percent per year from currently 10.5 billion euros to 16.5 billion euros in 2030. The companies will also intensify their

FIG. 30: CHINA AND OTHER EMERGING MARKETS: EVER MORE INNOVATIVE
Shares in global chemical/pharma research in percent



Competitive pressure will increase for the chemical industry location Germany. Emerging markets are intensifying their research efforts. But Germany can maintain its position as the 4th largest research location.

[11] *„Innovationen den Weg ebnen" (Paving the way for innovations), Cologne Institute for Economic Research, Santiago Advisors, VCI, 2015.*

research efforts, striving to reduce internal barriers in research and development.

The research spending in specialty chemistry and for pharmaceuticals will rise in the forecast period. But the intensities in the sectors will remain constant at best. Also, domestic obstacles to innovation, moderate growth forecasts for Europe and the growth forecasts for non-European countries are brakes to higher investments in R&D at the location Germany. Due to the weak production performance and the lower orientation to innovation, intensities will even fall in basic chemistry. This development emphasises and accelerates the specialisation of German chemistry.

To the end of the forecast period in 2030, the research intensity for the entire industry will rise from 5.0 to 5.4 percent. The underlying reason is the changed production mix in 2030, with a higher share of pharmaceuticals. Excluding the pharma sector, the intensity remains constant at 2.7 percent.

Through additional investments in R&D, Germany can maintain its top position among the leading chemical nations – even though the shares in global R&D spending will continue to fall. Back in 2013, Germany accounted for 6.7 percent of the global internal R&D spending of the chemical and pharma industry. This share drops to 6.4 percent in 2030. But with this, Germany will still remain the 4th largest research location for chemical and pharmaceutical products.

Emerging markets will gain further shares. Especially China continues R&D building. The past years already saw an increase in China's shares in global chemical research. In 2000 the share of China amounted to 1.6 percent, as compared with 10 percent at present. This share will climb to 15 percent in 2030. This is largely to the detriment of Japan; the losses for Europe and the USA will be much lower. The USA will further expand its technology leadership in many fields. In particular, the US benefits from digitalisation. The low loss in shares for Europe is attributable to the strong pharma spending. For chemistry excluding pharma, Europe would lose more shares than the USA.

The strong dynamics in the global competition for innovation highlight the importance of good framework conditions for the research location Germany. Obstacles to innovation need to be eliminated urgently. The basis for innovations in chemistry consists of science and research and, most importantly, qualified personnel. Digitalisation and the growing demand in the fields of specialty chemistry and pharmaceuticals will not only change the qualification profiles for R&D staff; requirements to vocational training and to other personnel with a university background will increase too. Specific knowledge will become ever more important in the competition process.

Reserved attitude lasts in investments

The chemical industry is capital-intensive. By way of investments, the industry enhances its future production potential and secures its competitiveness. However, the long-term trend growth of investments by the chemical industry has been low for some time at home in Germany: Since 1991, investments in plants, equipment and buildings have been falling by 0.2 percent per year on average – in real terms, investments have even dropped by 1.6 percent per year.

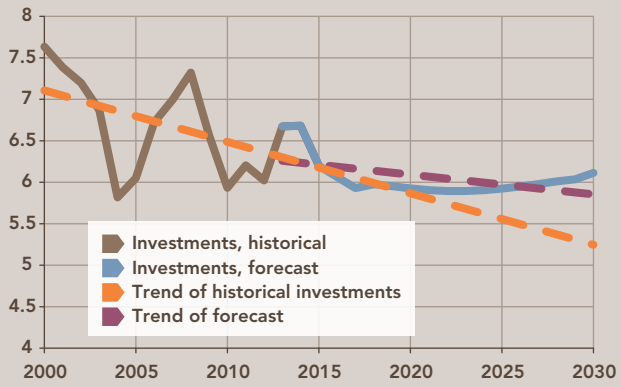
There are various underlying reasons. Firstly, technical progress allows production expansion with less productive capital. Secondly, an increasing specialisation is emerging in the industry. Investment-intensive basic chemistry is losing in importance, as compared with specialty chemistry. The main reason for this is the energy-political environment in Germany. Consequently, investments in basic chemistry dropped – while investments in the other chemical sectors and also in the pharma industry increased, but it is worth noting that the latter require fewer fixed asset investments.

However, the main cause of the reserved investment attitude was the low market growth. In the last years, growth of the European sales market was lower than that of other sales markets. Often, decisions were made in favour of other locations: In the past, foreign investments increased clearly more dynamically than domestic investments. Since 2012, foreign investments have been exceeding investments in Germany. The main motivations for foreign investments are the opening-up of markets and the geographical proximity to customers. But cost reasons increasingly have a role too.

The weak investment dynamics of the past will last in the forecast period. Investments drop by 0.5 percent per year, as the causes underlying the reserved investment attitude persist. In the forecast period, investments in basic chemistry will fall significantly by -1.3 percent per year. This is due, firstly, to the low demand which leads to a production increase of only 0.3 percent per year (in real terms) in basic chemistry.

Secondly, there is considerable uncertainty in planning. Within the energy transition (Energiewende), important exemption rules are repeatedly put into question, especially for basic chemistry. This hampers investment, particularly for the long investment cycles in this sector. For example, obsolete plants are replaced over the course of time, but no new additional capacities are built. Furthermore, from today's perspective the digitalisation of the chemical industry is unlikely to bring an investment boom, either: Both the demand situation and the framework conditions are not conducive to this.

FIG. 31: PERSISTENTLY RESERVED INVESTMENT ATTITUDE Real investments of the German chemical and pharma industry in billion euros



The long-term trend of chemical industry investments points downward. Investments will not widen to 2030. Growth impulses and planning certainty through reliable framework conditions are lacking.

The digitalisation of the production process will be taken into account in planned investments. This improves the efficiency of investments overall.

Investments in specialty chemistry will rise by 0.2 percent per year in real terms, because of higher growth. As specialty chemistry is less investment-intensive, it will be possible to achieve the production increase with almost constant fixed asset investments. The strongest investment increase will take place in the pharma sector (0.5 percent per year in real terms). This is because of good growth potentials. Structural change in the sector is accelerated by investment decisions.

While the weak investment development in Germany is a continuation of the trend from the past, the now weakened dynamics in global investments mean a turning away from the developments of the last years.

This is because with the beginning of the new millennium, worldwide investments in the chemical industry had grown vigorously – especially in chemical plants. Growth was mainly driven by high investment dynamics in China where the ongoing industrialisation (with a special focus on the chemical industry) led to a proverbial investment explosion. Investments also went up considerably in other emerging markets, especially in the Middle East.

By contrast, investment dynamics were restrained in the industrial nations. Growth prospects – especially in Europe – were clearly less positive than in the emerging markets, so that investment decisions often favoured the latter. Many industrial nations saw a change away from basic chemistry toward specialty chemistry with a much lower investment propensity in fixed assets. In the early 2000s the USA even experienced a de-industrialisation when the chemical industry, too, lost shares in value creation.

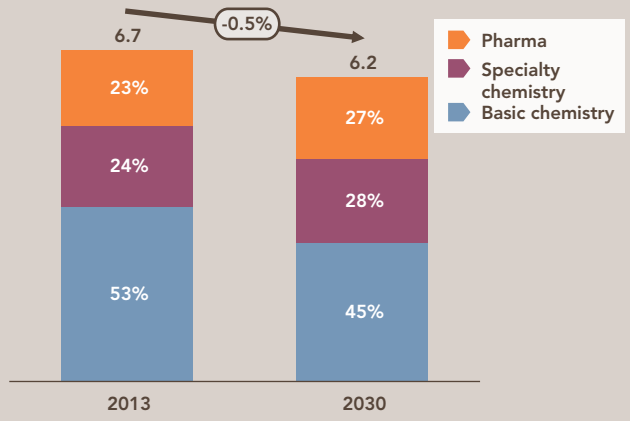
The shale gas boom brought a trend reversal stateside, whereas weak investment activities lasted in the other industrial nations also in the most recent past.

In the forecast period, investment dynamics will become weaker in all countries worldwide. Global investments in the chemical and pharma industry will only grow by 0.7 percent per year. A difference persists between the dynamics in emerging markets and industrial nations, respectively, but the remaining differential between the various growth rates is low. For example, investments grow by just under 1 percent per year in China and by 0.5 percent in the USA, while they drop by 0.7 percent in the European Union. Thus, the weak investment dynamics in the German chemical industry are also seen globally in the forecast period.

Altogether lower growth dynamics are felt in the emerging markets too. Demand growth weakens. There are – partly considerable – existing overcapacities. Also in the emerging markets, specialty chemicals and pharmaceuticals are gaining in importance; this lowers the general investment propensity.

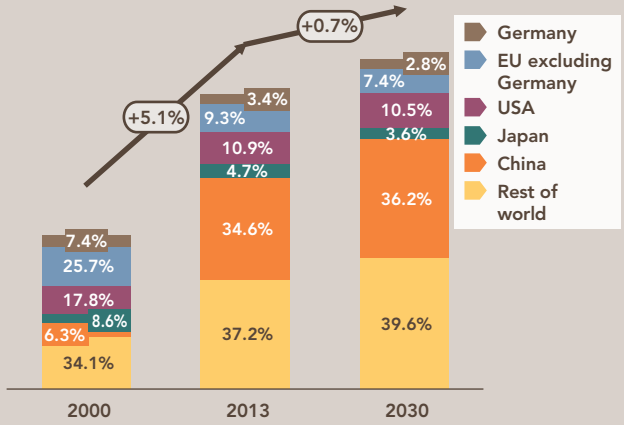
Structural change progresses in the industrial nations. Basic chemistry is losing in significance in many countries. Import pressure increases due to overcapacities in emerging markets. Growth from industrial nations cannot make up for weakening growth in the demand from emerging markets. Consequently, there is no need to build additional capacities. Digitalisation takes place within regular investments, but this does not lead to a leap in investment activities. The shale gas effect is gradually petering out in the USA. After that, investment activities will return to normal. Against this backdrop, the strong shift in the shares in investment will not continue.

FIG. 32: FEWER INVESTMENTS IN BASIC CHEMISTRY
Real investments of the German chemical industry in billion euros, shares in percent, CAGR 2013-2030



Real investments of the German chemical industry will fall by 0.5 percent per year to 2030. Investments will drop in basic chemistry, while they will slightly increase in the other sectors of the chemical industry.

FIG. 33: END OF INVESTMENT BOOM IN CHEMISTRY
Shares in global investments of the chemical and pharma industry in billion euros, shares in percent, CAGR 2013-2030



Investment dynamics are changing globally. The past decade saw a worldwide investment boom in chemistry. In particular, this was attributable to investment dynamics in China. The boom will not last.

Conclusion

The German chemical industry recovered fast from the setbacks of the global economic crisis 2008/2009. In early 2011 the production had returned to the pre-crisis level, and the industry was optimistically looking ahead to the future. Then, there was another blow. Europe slipped into recession due to the euro crisis. Germany as a country was in a comparatively good position but European industrial production dropped, so that the demand for chemicals declined in the German chemical industry's home market. And the companies reduced their productions. That weak phase was overcome in 2014, as the European economy was recovering. But already in 2015 things became difficult again for the global economy – with bad news from the emerging markets. Brazil and Russia fell into a deep recession that impacted the neighbouring countries too. Economic growth also weakened considerably in China. Overall, there has been hardly any growth in German chemical production since 2011.

Here the good news from this study: The German chemical industry will be able to continue its past successes to 2030. In a global perspective, the chemical business is a dynamic growth market with good chances for development also for German chemical companies. In the forecasting period the global chemical demand will rise by 3.4 percent p.a. and thus grow faster than industrial production (3.2 percent) or the global GDP (2.5 percent).

By 2030 the real production volume of the German chemical industry will rise from 190 billion euros p.a. to 246 billion euros (30 percent). With average growth of 1.5 percent p.a. the chemical production will grow somewhat more dynamically than industry as a whole or the overall economy. In the forecasting period the German chemical industry will not be able to fully keep up with global chemical growth, but the growth differences between the major chemical nations will become less marked than in the predecessor study. In this setting, Germany will lose fewer world market shares and remain among the most important chemical producers globally also in the future.

The strong points of the German chemical industry mainly include strong integrated structures (the so-called Verbund) with the resulting resource efficiency and the high ability to innovate – not only in this industry but in the German economy overall with its strong "lead industries". However, chemical companies are aware that success will not come easy. Quite the contrary: International competition will become more intense. Here, the companies rely on the well-known strategies:

- Use the chances of globalisation: The emerging markets of Asia are the growth centres in the demand for chemicals. The globalisation strategy includes not only the export business but also an expansion of production capacities abroad.
- Focus on specialty chemicals and pharma: In the future, basic chemicals will be produced predominantly to cover own needs in Europe – while the industry can do well at home and abroad with specialty chemicals and pharmaceuticals.
- Launch an innovation offensive: Mainly product and process innovations but also new business models offer future chances for the German chemical industry. The industry is significantly increasing its research budgets. Companies are working to reduce internal obstacles to innovation and to bring innovative products faster to the market. In these efforts, they are increasingly including disruptive technologies that were often neglected in the past.
- Improve resource efficiency: Chemistry is a raw material and energy-intensive industry. Already for economic considerations, chemical companies are striving for resource-efficient production. Also, companies are committed to sustainability; for this reason, they are continuously improving their resource efficiency. However, the investments required for this purpose need to be viable in international competition. Another prerequisite for investments are reliable political framework conditions which are not given at the present time; this applies in particular to the energy and climate policy. Uncertainty in planning is attributable especially to the Energiewende (energy transition) and to emission trading.
- Diversify the raw material base: The optimisation of the raw material base continues. In the future, the industry will use more biomass as a raw material. But basic chemistry cannot make do without fossil raw materials in the forecasting period. Limited cultivation areas and high prices, as compared with fossil inputs, are obstacles to an expansion of renewables. Irrespective of great efforts, there has not been a technological breakthrough as yet in this respect.
- Increase productivity: The industry will drive forward technological progress, and it will also use the chances of digitalisation.

There is much confidence, but it should not be forgotten that the development paths quantified in this study rely on assumptions which do not rule out quite different developments. For example, it is by no means certain whether European integration will continue or whether the Economic and Monetary Union is stable. It is also uncertain whether the German chemical industry will successfully cope with the chances of digitalisation and of networks and interconnections (Industry 4.0).

Things can turn out very differently. The developments described here might be influenced by exogenous shocks or by how the course is set in economic policies. In order to show this, the predecessor study highlighted – with the help of alternative scenarios – that the German overall economy, industry and chemistry can have a successful future only if, firstly, this is made possible by the economic-political framework conditions in Berlin and Brussels and, secondly, if the global economy as a whole remains on the growth path.

According to current estimates, both prerequisites are still met for the future. It is true that the growth perspectives have become less favourable – especially for emerging markets but also for many industrialised countries. In consequence, at 3.4 percent p.a. the global chemical growth to 2030 will be clearly lower than had been anticipated in the old basic forecast (+4.5 percent).

But all in all, the German chemical industry can live well with such weaker growth. The speed has become slower also in this country, but the slowdown is far less marked than in the global economy. The consequence: In the future, the German chemical industry will lose fewer shares in the world market and in global trading than it still did at the beginning of this millennium. According to the new calculations, Germany's share in global chemical production will fall to 3.8 percent by 2030. It is worth noting that the predecessor study assumed a drop to 3 percent.

In the past years, global chemical business saw dramatic changes resulting from new production technologies in the oil and gas business and from China's economic miracle. This is shown by a glance at the investment developments worldwide in the chemical industry. In a global perspective, the last 13 years saw an investment boom in chemistry. In real terms, investments rose by 5.1 percent p.a. New plants were built in raw material-rich countries and in the up-and-coming emerging markets, with China ahead of all. China's share in global chemical investments rose from 6.3 percent in the year 2000 to 34.6 percent in 2013. With altogether weakening dynamics of the global economy and given the high capacity utilisation in China, the USA or the Middle East, the growth in global chemical investments will slow down and the differences in growth rates will become less marked. Thus, there will be only minor shifts in the respective shares during the forecasting period.

In the predecessor study, the second prerequisite for a successful future of the German chemical industry was: The framework conditions must be right under the economic policies in Berlin and Brussels. The new forecast is confident also in this respect, because – during the global economic crisis – it became quite clear that a strong industry is indispensable for growth and prosperity in Germany. In the industrial policies of Berlin and Brussels, the first consequences have been drawn from this recognition. Positive starting points are discernible – for example, the alliance "Future of Industry" (Bündnis "Zukunft der Industrie") or the initiative "Better Regulation".

But so far, the economic-political framework conditions have barely improved for industrial production. Here, a lot of convincing is still to be done. In particular, the energy and climate policy remains the proverbial Achilles heal of German industry. This is because energy costs are an important factor in the global competition of locations. Frequently changing energy policy requirements and countless interventions in the energy market by the public administration cause persistently high uncertainty in corporate planning, resulting in cautious investments. If the costs of the Energiewende run wild, for chemistry – as an energy-intensive industry – the risk increases that internal value chains might break. That would also have major adverse affects on the industrial network as a whole. Currently, we are not expecting such a development: because the study assumes that the energy and climate policy will continue to give consideration to energy-intensive companies engaged in competition. Also, the gap between Germany and the competitors in the USA will not widen any further regarding the energy costs.

All the same, during the forecasting period the major disadvantages of the location Germany will persist for energy and raw material costs. This dampens the possibilities of development for the German chemical industry, as is substantiated by the economic research institute Oxford Economics for the VCI. The competitiveness of the chemical industry location Germany has decreased since 2008, mainly due to the growing disadvantages in raw material and energy costs. The combination of having low gas prices in the USA or in the Middle East and oil prices of around 100 US dollars per barrel at the same time as well as the Energiewende rendering industrial electricity ever more costly, caused losses in the export business and brought rising import pressure, especially in German basic chemistry.

It is true that most recently the decline of the crude oil price has significantly reduced the competitive disadvantage for German basic chemistry. But a return to rising oil prices should be expected for the future. In the forecasting period, the disadvantages in energy and raw material costs will largely persist for the German chemical industry, as compared with competitors in North America and the Middle East. By contrast, in a comparison with China – the world's largest chemical producer – German chemistry will not have any competitive disadvantages in the future, either, where energy and raw material costs are concerned.

But to continue on the road of success, the need to take action remains for entrepreneurs and politicians. The study on paving the way for innovations ("Innovationen den Weg ebnen") shows that companies have to increase their innovative strength. For example, this means that internal obstacles to innovation processes need to be eliminated and that the innovation culture should be improved. Here, the companies require support from the political side, because a number of external obstacles cause unnecessary difficulties in the way of innovative products from the laboratory to the market. The most recent projections have already alleged an improvement in the framework conditions under industrial and innovation policies. This is where politicians still need to deliver, so that the identified development paths can become reality.

Then, the following will apply: A sustainable development of the global economy depends on more chemical products. The German chemical industry can supply high-quality solutions for exacting customers at home and abroad and benefit on all foreign markets. Thus, this industry will continue to grow also in the future – with a combination of pharma and basic and specialty chemistry. Therefore, it pays to invest in German chemical companies.

Alternative scenarios: Things can turn out the other way

The basic forecast of the study "The German Chemical Industry 2030 – Update 2015/2016" generally shows positive future perspectives for the German chemical and pharma industry. In the global picture, chemical business remains a dynamic growth market that offers good development potentials also for German chemical companies. However, success does not come without effort. The industry location Germany – and thus also the chemical and pharma location – is faced with immense strategic and structural challenges.

Firstly, the competition environment is changing for chemistry in Germany. Demand growth for chemical products in Western Europe will be only moderate in the future. Growth chances are greater in the emerging markets of Asia, South America and, in the longer term, also in Africa. German companies and international competitors are investing in these markets, replacing exports by local productions. But local producers are expanding their production capacities too. Moreover, new petrochemical plants are built in the USA or in the Middle East because of favourable energy and raw material costs. This brings a huge offer of basic chemistry products at comparatively low prices on the world market, involving the risk of overcapacities in basic chemistry.

Furthermore, demand structures and societal objectives are changing fundamentally. A sustainable management style and sustainable consumption increasingly gain in importance. This is reflected e.g. in the pursuit of higher resource efficiency, greenhouse gas-neutral production, a further expansion of renewable energies or a stronger use of renewable raw materials.

THE CHEMICAL INDUSTRY IS FACED WITH FUNDAMENTAL CHANGE

The intensification of global competition and the changes in demand structures and customer preferences have far-reaching consequences for product portfolios, process technologies and value chain structures of the chemical industry. Consequently, the industry is faced with fundamental change. In order to be successful in the future, the companies need to review existing business models and develop new ones; where necessary, they might have to adopt a new strategic orientation. Here the components of a promising strategy for the German chemical industry: use the chances of globalisation, focus on specialty chemicals and pharmaceuticals, launch an investment offensive, increase resource efficiency, diversify the raw materials base, improve productivity, and drive forward digitalisation and networks.

Good politico-economic framework conditions in Germany and in the European Union are an important prerequisite for the German chemical industry and its products holding their own on global markets also in the future. It is true that positive starting points are discernible in Brussels and Berlin with the initiative "Better Regulation" or the alliance "Future of Industry". All the same, up until now the politico-economic framework conditions have barely improved for industrial production. Innovation promotion progressed only selectively and in small steps. Research promotion is still lacking in such a form that is open to all technologies and all companies, even though meanwhile many political parties advocate this approach.

At the same time, the competitive position is deteriorating for German industry where energy prices are concerned. Energy costs are an important factor in the global competition of locations. The USA, the Middle East and also many emerging markets are tempting with their low prices for oil, gas and electricity – while German industry is burdened with higher energy costs than many competitors due to the energy transition (Energiewende), the European emission trading system (ETS) and national energy taxation.

Like hardly any other country globally, Germany owes its prosperity to a strong, diversified and competitive industry. In Germany, the share of industrial value added in GDP is nearly twice as high as in the USA, Great Britain or France. This wrongly induces to overestimate industry's ability to perform. The redirecting abroad of new investments by energy-intensive sectors shows that meanwhile the energy cost issue is at breaking point. Moreover, certain hostility to industry is noted at the level of municipal administrations or some German federal states. So far, this attitude becomes manifest mainly in building and planning regulations. This has prevented or delayed investments, particularly by SMEs.[12]

Over the past years, growth of industrial production in Germany was weaker than overall economic growth. From 2012 to 2016 annual GDP growth averaged 1.4 percent, while industrial production increased by 1.0 percent. In the period under review, chemical and pharma production also rose by only 1.0 annually.[13] Chemical production even declined when excluding the pharma business. If this trend persists, the "stability anchor" industry will gradually lose in importance.

A correction of the politico-economic course is needed. The urgent question arises how to bring politico-economic framework conditions in a better shape, so that the chemical industry can remain the innovation and growth driver of the industry location Germany also in the future, making an essential contribution to prosperity in our country.

Wishing to look into the industrial policy scope and to highlight interconnections and, most importantly, for creating a fact base for the political discussion, the VCI and Prognos jointly appraised and assessed the industrial policy alternatives to the "business-as-usual scenario" (basic scenario). A "scenario of chances" describes future development paths in an investment- and innovation-friendly environment, with expansion of innovation promotion by the public administration and in an efficient regulatory framework that strengthens

[12] *VCI Investment Report 2016, https://www.vci.de/die-branche/zahlen-berichte/vci-statistik-grafiken-bericht-investitionen-chemische-industrie-gesamtwirtschaft.jsp*

[13] *Different source Destatis. The growth rates cannot be directly compared with the data from the Prognos model. The Prognos model uses data from national accounting, with real prices and exchange rates of 2010.*

price competitiveness. Next, a "scenario of risks" examines the impacts of a less favourable industrial policy environment, compared with the basic scenario. Inter alia due to an interventionist energy and climate policy, the "scenario of risks" brings rising regulatory costs and more uncertainty for companies in corporate planning.

Chance scenario

The chance scenario describes future development paths of the chemical-pharmaceutical industry in an investment- and innovation-friendly environment. In Europe, and particularly in Germany, investment-related public spending for improving infrastructures and promoting/funding research and education is gaining in weight – as compared with consumption-related spending. Fiscal incentives available to all companies, promotion of networks and cooperations, easier access to venture capital and private-public partnerships for pilot projects stimulate investment.

The political side tries to avoid preventive over-regulation; instead, it primarily lets the market forces act and puts trust in industry. Supporting legislation is oriented equally to the precautionary principle and the innovation principle. Existing regulation is examined as to whether it impairs investment and drives forward innovation. Regarding future regulatory plans, it is ensured that they do not stand in contradiction to other regulation. The political side strives to create a consistent and reliable regulatory framework, to harmonise laws and regulations across Europe, and to reduce duplicate regulation.

In the field of climate and energy policy, consideration is given to the industry – which is engaged in international competition – also in the future. The emission trading system and the expansion of renewable energies are further developed in a cost-efficient way, and inevitable burdens are shared with a stronger orientation to the economic performance principle.

Chance scenario – Overview of assumptions

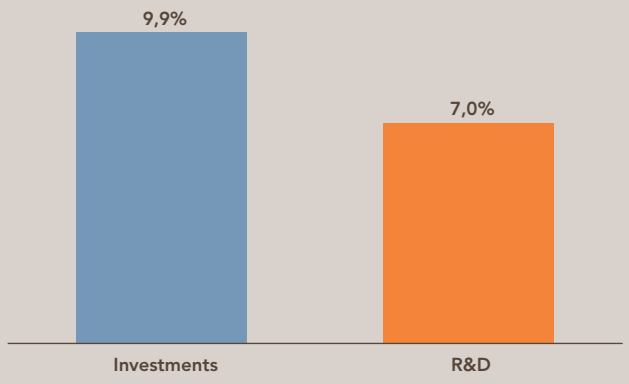
- Energy policy: The energy transition (Energiewende) and the expansion of renewable energies become more efficient. Competitiveness is maintained; no additional burdens due to the Energiewende (e.g. cap of EEG charge or funding from the budget). Grid expansion is successful; the status quo is kept up for existing plants.
- Industrial policy: Investment- and innovation-friendly environment, less but more efficient regulation, reduction of innovation obstacles, planning security, introduction of fiscal incentives for research, project funding with openness for topics. Focus: wide range of promotion/funding, no limitation to SMEs.
- Public investment in infrastructures/schools/education is gaining in weight, compared with consumption-related spending.
- More investments in Europe, expansion and broad application of the European investment programme EFSI (European Fund for Strategic Investments, also the Junker Plan), reliable planning in the energy sector.

This enables reliable investment planning by the corporate sector.

The change of industrial policy framework conditions in Brussels and Berlin – towards an altogether more innovation- and investment-friendly environment – benefits, in particular, the chemical and pharma industry. Production conditions improve, as competitiveness is strengthened. At the same time, faster economic growth brings a stronger demand for chemicals, and companies benefit from better market conditions in Germany and in the EU.

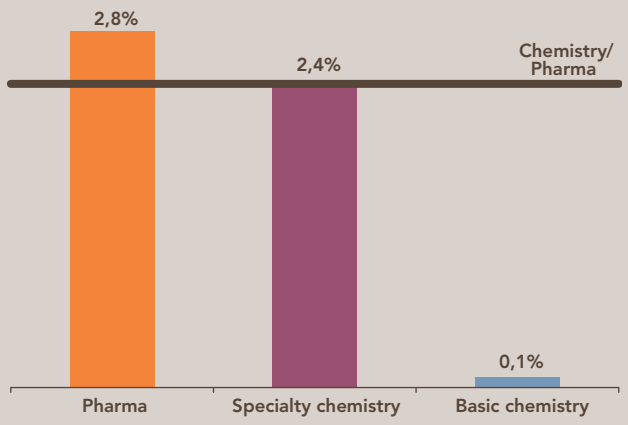
As an industry with strong innovation, chemistry benefits from the new research policy. The broader approach of promoting/funding measures – concerning both the absolute

FIG. 34: HIGHER INVESTMENTS AND MORE RESEARCH & DEVELOPMENT
Differences in investments and R&D expenditure of the German chemical and pharma industry in 2030, compared with the basic scenario



Changed framework conditions are directly reflected in higher fixed asset and R&D investments. The chemical industry location Germany is becoming more attractive; competitiveness increases.

FIG. 35: BENEFITS – PARTICULARLY FOR PHARMACEUTICALS AND SPECIALTIES
R&D expenditure of the German chemical and pharma industry, CAGR 2013-2030



Particularly pharmaceuticals and specialty chemistry benefit from the changed framework conditions. R&D budgets clearly increase in these sectors.

upper limit for funding and the funding eligibility of research projects – brings a strong increase in the industry's R&D spending. This development particularly benefits specialty chemistry.

FISCAL INCENTIVES FOR RESEARCH STRENGTHEN SMES

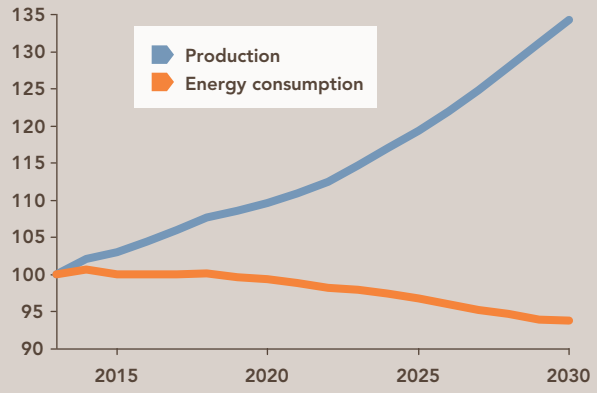
Research & development generally has a more significant role in specialty chemistry than in basic chemistry. It is important to constantly develop new and innovative solutions for customers. At the same time, specialty chemistry is strongly characterised by SMEs where project funding in its conventional form frequently did not take effect. Now, the introduction of fiscal incentives makes it easier for SMEs of specialty chemistry to invest more in R&D. In the pharma industry, too, the heavy focus is on research and development. Developing new medicines tends to become ever more work and cost-intensive. More efficient regulation in the pharma sector – e.g. faster approval procedures and sufficient remuneration for innovative drugs – drives forward research activities. As there is no limitation of funding measures to SMEs, these measures now benefit all companies alike. This enhances the incentives for more R&D not only among SMEs but also for large businesses. Overall, R&D budgets are increasing visibly and R&D intensities are rising too.

This changing environment is also reflected in fixed asset investment. Improved production conditions thanks to reliable energy costs, more reliable planning and the reduction of regulation allow companies to make investment decisions for the location Germany. At the same time, location conditions in Germany further improve through more public investment in infrastructures, schools and education. As an industry with strong exports, the chemical industry depends on functioning infrastructures. The availability of qualified staff also has a role in location decisions, especially in view of the challenges from digitalisation. Now, public investment improves both the transport situation and the skills of qualified staff. Thus, corporate investments at the location Germany become investments in the future. Investments by the chemical and pharma industry will expand by 2030. The investment attitude will become much less reserved in basic chemistry. Investments in specialty chemistry and pharmaceuticals are rising significantly.

But higher investments and more innovations can be realised only if the demand goes up too: the changed industrial policy influences not only chemistry but also the customer industries. In total, annual growth in the industry is on average 1.6 percent higher than in the basic scenario. Generally, the importance of the industry to the German economy remains high. Now, the industry has a permanent share of 23 percent in value creation. Leading industries with strong research benefit even more from this favourable environment than the rest of industry. This also increases the demand for chemical products.

The production value in the chemical and pharma industry increases with the higher demand on the one side and improved production possibilities on the other. The industry's growth rises to 1.7 percent p.a. Growth is particularly dynamic for specialty chemicals (+2.1 percent p.a.), while basic chemistry growth is clearly lower (+0.4 percent). Structural change accelerates – away from basic chemistry towards specialty chemistry. The pharmaceutical production value continues to grow dynamically (2.6 percent p.a.).

FIG. 36: CONTINUOUS EFFICIENCY INCREASES IN PRODUCTION OF THE GERMAN CHEMICAL INDUSTRY
Real production value and energy consumption in the German chemical and pharma industry; index 2013=100



With rising real production value, energy consumption is falling in the German chemical industry. This is possible through, firstly, investments in new plants and, secondly, faster structural change away from energy-intensive basic chemicals towards specialty chemistry.

Innovative products also improve the competitiveness of the industry vis-à-vis competitors from outside Europe. This is reflected in trade. Chemical and pharma products "made in Germany" remain in good demand. Exports grow by 1.8 percent p.a. The stronger demand in Germany also brings higher imports (+1.7 percent p.a.). In consequence, the already high foreign trade balance rises from currently 51 billion euros to ca. 70 billion euros in 2030 (+1.9 percent p.a.). In this setting, the strong export activity is largely limited to specialty chemicals and pharmaceuticals. Basic chemistry continues to produce mainly for the domestic market. Exports of basic chemicals are near stagnation. Import pressure remains high, irrespective of improved production conditions (lower costs than in the basic scenario). The foreign trade balance in basic chemistry is slightly negative.

Real term increases of the production value might not be enormous when compared with the basic scenario. But additionally, the type of growth changes towards more qualitative growth. With its innovative products, the German chemical industry is well-prepared for the challenges of the future, and growth becomes more sustainable. The chemical industry location Germany is secured in the long term.

Furthermore, the investment climate improves energy efficiency – not only in specialty chemistry. Investments in new, state-of-the-art plants and the rising R&D spending enable more efficient production. With the real production value rising by 2.1 percent p.a., energy consumption falls by 0.3 percent annually.

Energy-intensive basic chemistry becomes more efficient too. The production value in basic chemistry increases somewhat by 2030 because of industry-friendly framework conditions. But growth remains so low that it does not bring high

investments in new plants. However, the investment-friendly climate constantly leads to improvements in existing plants. This also allows improvements in energy efficiency but – unlike in specialty chemistry – there are no major leaps.

ENERGY CONSUMPTION DROPS THANKS TO MORE EFFICIENT PLANTS

Overall, energy consumption in the industry drops slightly by 2030. Falling energy consumption is also attributable to faster structural change – away from basic chemistry towards more specialty chemistry. Basic chemistry grows slightly, but the shift in shares intensifies towards specialty chemistry.

Irrespective of stronger production value growth, the consumption of fossil and renewable raw materials remains almost constant to 2030. This is mainly because of the rising share of specialty chemistry, which requires fewer fossil raw materials – while the raw materials input is barely variable in basic chemistry. But the share of renewables in production increases by 2030. This is enabled particularly by specialty chemistry where investments are made in new plants and new products are developed.

The positive impacts of the changed industrial policy are not limited to the chemical and pharma industry. Industry overall benefits, so that growth of the manufacturing sector increases to 1.6 percent p.a. and German industry in its entirety grows by 1.5 percent p.a. Investments and the foreign contribution somewhat gain in weight as compared with the basic scenario. But private consumption remains the main driver.

The growth of industry also increases the public revenue. This can secure the refinancing of the higher public spending on measures regarding infrastructures, schools and education. Furthermore, the extra growth even allows to reduce public debt. The debt-GDP ratio of the state drops, as compared with the basic scenario.

The positive effects of the changed industrial policy in Brussels and Berlin are not limited to Germany alone. The assumed measures from Brussels for more investment in Europe and more reliable planning also benefit the other European Member States. GDP development becomes more dynamic in almost all countries. The changed industrial policy – as compared with the basic scenario – improves the price competitiveness of the chemical and pharma industry in the European countries. Consequently, also their production value growth turns out more dynamic than in the basic scenario.[14]

Risk scenario

But things can turn out the other way if the course is not set in an industry-friendly manner in essential points. The risk scenario looks into the economic impacts of a relative worsening of regulatory framework conditions, as compared with the basic scenario.

The companies need reliable framework conditions especially in the field of energy and climate policy. In the risk scenario, we allege that the ambitious climate goals will be implemented with the same instruments like so far. Consequently, energy costs keep rising for industry. Moreover, burden-easing provisions increasingly come under pressure; they are important for energy-intensive companies. Cost for grid expansion, the necessary reserve power plants and the further expansion of renewable energies are passed on to electricity consumers. The German renewable energy sources act (EEG) is reformed in regular intervals. But promotion under this act is still not open to all technologies. Moreover, it is assumed that wrong incentives and inefficiencies in this set of rules are eliminated only insufficiently. At the European level, this scenario alleges a growing tightening of the emission trading system. The introduction of further instruments to increase CO_2 prices make climate protection even more expensive and reduce planning certainty among chemical companies.

MORE UNCERTAINTY IN PLANNING

Industrial policy overall becomes more interventionist, more selective and thus more difficult to predict. Increasingly, only individual companies, sectors and technologies are driven forward with specific regulations or subsidies. This reduces reliable planning for companies. But most eminently, the rise in regulatory costs – that comes with that regulatory approach – puts at risk the price competitiveness of individual processes. In consequence of these developments, energy-intensive companies shut down production plants. This impacts the value creation structures of German industry.

Most recently, the EU Commission finds in a study[15] that meanwhile the costs stemming from chemical industry-relevant regulation not only eat up a considerable part of value creation by European chemical companies; the study also notes that regulatory costs have doubled over the past years. In the risk scenario, the regulatory costs increase clearly in Germany and in the other EU Member States. Contradictory sets of regulation, ever new requirements in approval procedures and changing rules make reliable planning impossible for companies and drive up the costs at the production location Germany. Consequently, companies are taking a more reserved attitude in their domestic investments. This also adversely affects the spending on research & development, stifling technological progress.

The impacts of this selective industrial policy are clearly felt in the chemical industry. Not only the rising costs of the energy transition (Energiewende) but also uncertain planning due to "slimmed down" burden-easing provisions brings problems for the companies. In combination with rising energy costs, this causes a drop in domestic investments. As it also affects investments in modernisation and replacement investments, the reserved investment attitude leads to reduced production capacities and thus to higher production costs. This adversely impacts price competitiveness, and local producers lose market shares. Without adequate burden-easing provisions, individual production plants are shut down. This has far-reaching consequences for the value crea-

[14] *Impacts of the Brexit were not considered in the development of the alternative scenarios, in order to ensure comparability with the basic scenario. It was too early to foresee the Brexit at the time when the basic scenario was prepared.*

[15] *Cumulative Cost Assessment for the EU Chemical Industry – Final Report: http://ec.europa.eu/docsroom/documents/17784/attachments/1/translations/en/renditions/native*

tion structures in their entirety, with domestic producers additionally losing market shares to foreign competitors.

Particularly in basic chemistry, where competitiveness decisively depends on energy and raw material costs, sites are shut down in the described environment. In this scenario, the production value of basic chemicals "made in Germany" declines by 1 percent annually. The remaining production is only for the domestic market. Exports fall every year. Basic chemicals are increasingly imported. For many basic chemicals, the import pressure rises strongly. Germany becomes a net importer of basic chemicals.

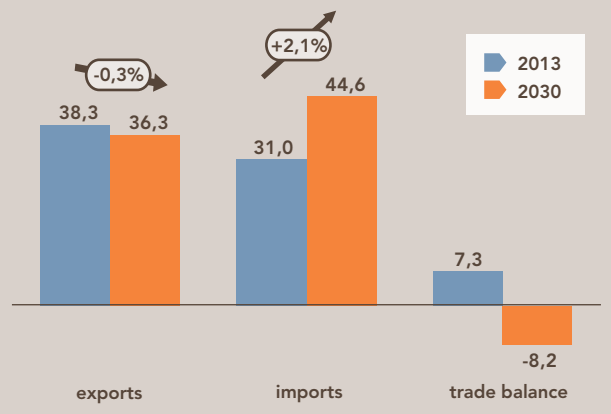
SUPPLY SHORTAGES IN BASIC CHEMISTRY

The production decrease in basic chemistry also dampens production growth in specialty chemistry, where inputs become more expensive due to lower production capacities for basic chemicals in Europe and because of additional transaction costs when buying from overseas. Even supply shortages cannot be ruled out for some individual basic chemicals. These developments impair the price competitiveness of German and European specialty chemistry.

The chemical industry is not only characterised by large business groups with plants worth billions. In Germany, there are around 2,000 SMEs. Many of them are highly specialised manufacturers of specialty chemicals. They offer secure jobs, and they have good perspectives for the future in their niche markets. But in the risk scenario, these perspectives are impaired for chemical SMEs – because the market withdrawal of some important basic chemicals suppliers adversely affects the profitable relations between large businesses from basic chemistry on the one hand and specialty chemistry manufacturers in Germany on the other, with SMEs being characteristic of the latter.

At the same time, foreign locations not just expand their basic chemistry activities. They also intensively drive forward the production of specialty chemicals, as the necessary basic chemical inputs are available locally in near-unlimited volumes and at favourable cost. This considerably increases the import pressure in specialty chemistry, too. Overall, the dependence of SMEs on foreign suppliers becomes stronger. This is a threat to the stability of the supply chain in the coming years.

FIG. 37: LOSS IN COMPETITIVENESS IN BASIC CHEMISTRY
Exports, imports and foreign trade balance of German basic chemistry, in billion euros. CAGR 2013-2030 in percent



The unfriendly environment for industry causes major problems particularly for basic chemistry in Germany, with decreasing competitiveness. Import pressure rises rapidly, and the foreign trade balance turns negative.

Risk scenario – Overview of assumptions

- Energy policy: The EEG remains inefficient, the EEG charge rises, burden-easing provisions come under pressure, costs for grid expansion and reserve power plants are passed on to consumers.
- Industrial policy: No additional incentives for research; the regulation density increases. Obstacles to innovation due to uncertain planning and rising costs.
- Hardly any additional public investments in infrastructures/schools/education.
- No efficient investment incentives in Europe. The European investment programme EFSI ("Juncker Plan") fails; unreliable planning due to ETS.

Potential growth of specialty chemistry in Germany is lower, as compared with the basic scenario. In the risk scenario, the production value of German specialty chemistry only rises by 1.2 percent per annum – against 1.8 percent in the basic scenario.

The negative effects of this scenario are not limited to the chemical industry alone. Firstly, problems in chemistry also impair downstream industrial customers. In the future, they need to cope with rising prices for inputs. Moreover, supply shortages cannot be ruled out here, too. Secondly, competitive pressure increases for industry overall; for many sectors, real competitors from emerging markets are entering the stage. Germany also falls behind other industrial nations. The consequence: More and more products from industrial customers of German chemical businesses are manufactured abroad. This means that Germany's success formula – a tight intertwining of industries and industrial sectors – is at stake. Value chains tear, and the integrated structures (Verbund) of industry in Germany are weakened.

The example of plastic materials highlights these correlations. The oil and gas industry stands at the beginning of the value chain. Basic chemistry provides petrochemical inputs obtained from gas or naphtha. In a downstream step, plastics are produced from these inputs by way of polymerisation. Next, the plastics processing industry manufactures beverage bottles, window profiles or dashboards for vehicles. Other industries need plastic products for manufacturing their own articles. This strong "Verbund" within the plastics sector in Germany is increasingly coming under pressure.

Regarding petrochemicals, Germany has a clear competitive disadvantage in energy and raw material prices – compared with the raw material-rich regions of the Middle East or countries like the USA with shale gas. Because of favourable energy and raw material costs, investments in new petrochemical production plants are rising in those regions and countries. Quite often, basic chemicals are processed locally into plastics. So far, plastics from the Middle East are exported mainly to Asia. As growth will weaken in Asia, these plastics will increasingly enter the European market in the

future. Without new plants, the domestic plastics industry has little chance of coping with such competitive pressure. Domestic basic and polymer chemistry loses market shares. The consequences are the shut-down of individual plants, production relocations abroad and narrower product portfolios.

This means for plastics processing companies that they have higher expenses for inputs than their competitors abroad. Some inputs are no longer produced in Europe; they need to be imported at great cost and effort. Moreover, plastics processors increasingly set up business in raw material-rich regions and countries with their good competitive position for plastic materials. In the USA this effect is clearly visible already today: Because of shale gas, the US has a considerable cost advantage for raw materials over Europe; this advantage will last up until 2030.

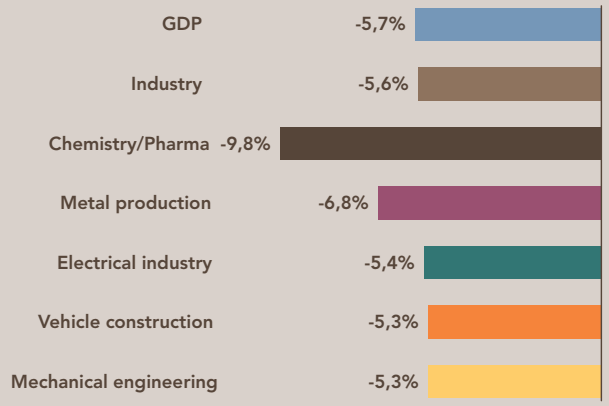
INDUSTRIAL PRODUCTION "VERBUND" IS AT RISK

Developments are not limited to the plastics industry: All industries and sectors are adversely affected in the risk scenario. Total growth of the German manufacturing industry is merely 1.1 percent annually. The chemical and pharma industry is hit particularly hard by the less favourable framework conditions. The production value of the industry only rises by 0.9 percent per annum – 0.6 percentage points slower than in the basic scenario.

But in an environment with weaker growth and high competitive pressure, Germany can only hold its own if the industrial production "Verbund" is kept up. This is no longer safeguarded in the described scenario.

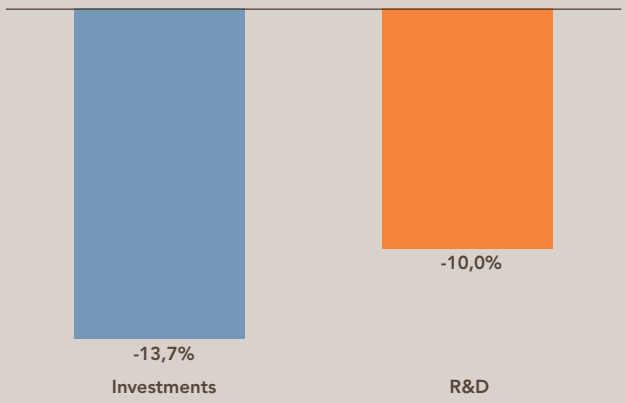
The regulatory uncertainty assumed in the risk scenario affects, in particular, small and medium-sized enterprises. Already now, many SMEs are complaining about long and tedious approval procedures and ever more complex building regulations. The negative attitude towards industrial plants, as is already felt in practice, should further intensify in the future. This renders investments at the location Germany even more difficult. Many SMEs do not have the financial and staff resources for complying with more and more new requirements and regulations, coping with day-to-day business and getting the company fit for the future with digital transformation.

FIG. 38: ALL INDUSTRIES AND SECTORS ARE ADVERSELY AFFECTED
Differences in GDP and production figures for selected industries in 2030, compared with the basic scenario; in percent



All industries and sectors are impacted by less favourable framework conditions. Growth is clearly lower in many industries/sectors, compared with the basic scenario.

FIG. 39: LOWER INVESTMENTS IN THE FUTURE
Differences in investments and R&D spending in the German chemical and pharma industry in 2030, compared with the basic scenario



Compared with the basic scenario, investments will turn out lower in the future – both in fixed assets and R&D. The chemical industry location Germany will become much less attractive, with decreasing competitiveness.

Therefore, in the risk scenario the industry not only grows slower. Moreover, high regulatory costs and uncertain planning lead to reduced fixed asset investments. The R&D spending, too, does not expand to the extent that would be necessary to face the manifold challenges of the coming years.

In order to get fit for the future and to keep on employees, novelty products are not enough: perfectly new business ideas are called for. For this, the companies need scope and capital. But against the backdrop of a hardly future-oriented industrial policy, the R&D spending drops at all levels compared with the basic scenario. Thus, the industrial policy reduces the companies' ability to adapt. In consequence, the trends of the future become a threat for companies – even though these trends basically hold out chances for growth.

Lower R&D budgets and the bad investment climate have negative impacts on energy efficiency, too. Unlike in the basic scenario or in the "scenario of chances", the industry can make clearly less progress in efficiency. In many plants there are barely any efficiency increases due to the investment weakness. In absolute terms, energy consumption of the industry will fall to 2030. But this is almost entirely due to the weaker production development and the shutdown of basic chemical plants.

Globally, the energy consumption of industry will further rise also in basic chemistry. The production drop for basic chemicals in Germany is set off abroad. Therefore, a national energy policy that reduces exemptions for energy-intensive

industries does not bring about a reduction of energy consumption in the chemical industry worldwide.

In total, the selective and interventionist industrial policy causes considerable welfare losses. Industry as a whole grows more slowly, and GDP growth will become much less dynamic than in the basic scenario. This threatens jobs in industry overall. Rising energy costs and more stringent regulation make the companies inflexible.

NEED FOR INDUSTRIAL POLICY ACTION

Primarily, the companies are called upon. They need to face up to ever more intensive global competition and set the course for a successful future: by way of innovations in products, processes and business models. But most importantly, they should see and use the chances of digitalisation and networks. The same applies for the circular economy with its potentials for innovation and growth.

But a successful future also needs good industrial policy framework conditions. The various scenarios, as jointly calculated by Prognos and VCI, show that speed and structural change and also the competitiveness of the German chemical and pharma industry strongly depend on economic and industrial policy framework conditions.

In the risk scenario, growing uncertainty in planning – as a result of an interventionist energy and climate policy combined with excessive strains on the energy-intensive industry – is harmful to the industry's network and slows down growth of the overall economy. In particular, this impacts the energy-intensive chemical industry. Growth of the industry is only 0.9 percent annually. There is even shrinkage in basic chemistry, because the production of certain basic chemicals is no longer profitable and individual plants are shut down. This is not without consequence for the value chains; the production "Verbund" in chemistry threatens to fall apart. Weaker competitiveness of the German chemical-pharmaceutical industry impacts other industries, too. The chemical-pharmaceutical industry can no longer fulfil its role as innovation driver in the usual manner. Funds are lacking to sufficiently increase the industry's R&D spending to the necessary extent: It only rises by 0.5 percent per annum. This also impairs the ability of other industries to launch new products. But not only long-term growth of the manufacturing industry turns out clearly lower at 1.1 percent annually. Growth of the overall economy weakens significantly to just 1 percent p.a. Welfare losses are considerable for Germany. Beside the need for ever more borrowing, in the year 2030 the per capita GDP is ca. 2,400 euros lower than in the basic scenario. Moreover, there are around 1 million fewer persons in employment.

By contrast, an innovation-friendly environment – with efficient regulation and an energy and climate policy with the

TAB. 1: SELECTED INDICATORS FOR GERMANY IN THE 3 SCENARIOS

	Basic scenario	Scenario of chances	Risk scenario
Growth gross domestic product (GDP), 2013-2030, percent per annum	+ 1.3	+ 1.5	+ 1.0
Per capita GDP in the year 2030, in €	42,189	43,272	39,799
Persons in employment in Germany in the year 2030, in million	41.0	41.1	40.0
Debt-GDP ratio in the year 2030, in percent	55.5	53.3	65.5
Production growth in the manufacturing industry (production value), 2013-2030, percent per annum	+ 1.4	+ 1.6	+ 1.1
Production growth in the chemical-pharmaceutical industry (production value), 2013-2030, percent per annum	+ 1.5	+ 1.7	+ 0.9
Exports of the chemical-pharmaceutical industry, 2013-2030, percent per annum	+ 1.7	+ 1.8	+ 1.4
Imports of the chemical-pharmaceutical industry, 2013-2030, percent per annum	+ 1.7	+ 1.7	+ 1.8
Foreign trade balance of the chemical-pharmaceutical industry in the year 2030, in billion €, in real terms	68.3	71.3	54.5
Growth of R&D investments by the chemical-pharmaceutical industry, 2013-2030, percent per annum	+ 2.0	+ 2.4	+ 1.4
Growth of fixed asset investments by the chemical-pharmaceutical industry, 2013-2030, percent per annum	– 0.5	+ 0.1	– 1.4
Energy consumption growth in the chemical-pharmaceutical industry, 2013-2013, percent per annum	– 0.1	– 0.4	– 0.7

right sense of proportion – could release additional forces for growth: with major gains not only for the industry but for the overall economy. Economic dynamics accelerate in the "scenario of chances". Up to the year 2030, the GDP grows by ca. 1.6 percent annually. This directly benefits the population. In 2030, the per capita GDP (more than 43,000 euros) is around 3,500 euros higher than in the risk scenario. Improvements in the innovation environment result from a changed research policy. These improvements release innovation impulses in chemistry, with positive effects for all industries in this country. Industrial production grows faster; improved location conditions help not only industry. Germany can enhance its attractiveness as an innovation location. Rising tax revenues give a solid basis to the federal budget, enable stronger debt reduction and allow additional spending in the fields of infrastructures, schools and education. The positive effects of a changed industrial policy in Brussels and Berlin are not limited to Germany alone. More investments combined with more efficient – and thus better – regulation also benefit the other EU Member States.

The chemical industry has the potential for contributing to a sustainable development in Germany, supporting Germany's long-term economic success and safeguarding jobs. But this perspective needs to be prepared strategically: This means strengthening the innovation ability of the industry, using the chances of globalisation and digitalisation and working for sustainability.

The industrial policy scenarios highlight starting points for political action. The economic policy framework conditions are the basis for the German chemical industry with its products holding its own on global markets. The scenarios clearly show that it is possible to shape the future. Today's political decisions influence the growth potential of the German national economy and of industry and chemistry.

Project approach and methodology

This study was elaborated in close cooperation between the economic research institute PROGNOS and the German chemical industry association Verband der Chemischen Industrie (VCI). The study was largely prepared in 2015; the base year for the forecast is 2013. This corresponds to the current margin of official statistics at the time of model calculations.

The project goal was to update the long-term forecasts for the German chemical industry to the year 2030. Based on the comprehensive and detailed forecast and simulation models of Prognos AG and relying on the expertise from the VCI member companies, regional and sector associations and from European chemical industry organisations, a detailed picture of the chemical industry's future has been drawn successfully. Like in the earlier study, we approached the forecast in two ways:

Firstly, with the help of a top-down approach (PROGNOS model "VIEW"), which approaches the chemical industry from the top and represents the macro-perspective. Proceeding from the global megatrends, it enables a detailed forecast of the global economy down to the developments in the individual industrial sectors. This approach adequately takes into account the strong integration and interconnections of the chemical industry.

Secondly, with a help of a bottom-up approach (VCI-Prognos industry-specific model "Chemistry"). Proceeding from the individual product groups, this micro-perspective enables the taking into account in the forecast of diverging developments inside chemistry and of changes in the competitiveness of chemical industry locations. Furthermore, the industry-specific model "Chemistry" also provides – beside forecasts for production and trade streams – developments for other sector indicators (e.g. employment, research budgets, investments or energy consumption).

The Prognos macro-model VIEW

With VIEW, Prognos AG has a global forecast and simulation model which depicts – in a detailed and consistent manner – the future development of the global economy. The model explicitly covers and models the interactions and reactions between the various countries. For this reason, its informative analytical value goes far beyond the isolated country models with exogenously given, global economic framework conditions. In the recent version, VIEW comprises the 42 most important countries worldwide and thus over 90 percent of the global economic performance.

Starting from central, exogenously given assumptions (e.g. demography, future development of the international oil price or consolidation requirements for national budgets), VIEW elaborates forecasts for the global economy and for individual countries. These assumptions are based either on forecasts by other institutions like the United Nations and the International Energy Agency (IEA) or on appraisals by experts from the oil industry.

VIEW is composed of individual country models which interact with each other through their foreign trade variables. The countries included in the model can be roughly subdivided into two groups: the models for the 32 leading industrial nations (EU24, Norway, Switzerland, Canada, USA, Japan, South Korea, Australia and New Zealand) have the same build-up in terms of structures. They comprise ca. 330 macro-economic variables and a multitude of foreign trade parameters (import demand from other countries, price-wage relations, exchange rates etc). The models for emerging markets are similar in their structures, but – due to the less favourable data situation – they have a lower degree of detail. Developments of economic sectors are determined in submodules of the country models; these submodules are based on dynamic input-output tables. In an extended version of the model, it is also possible to give a differentiated picture of the trade streams between the countries; these are broken down in 27 groups of goods.

As regards the various economic schools, the underlying model philosophy cannot be fully categorised. Summing up, the decisive functional correlations can be described as follows: The development of the current output of a country is driven by the spending decisions in the four sectors – private households, companies, public administration, rest of world – and limited by the (in the short term) existing production capacities. If the real output is above the level that can be realised with normal production capacity utilisation according to the given trend, the growth of the wage and price level accelerates and, consequently, this also raises the interest level. This leads to a dampening of the real use and to a return of the real output to its trend level. As the (in the short term) existing production capacities are the result of the previous spending – more precisely: investment decisions – the current output and the trend output mutually influence each other in the medium term. For example, a longer lasting weak phase in the models will also dampen the trend growth of a national economy. Due to investments not made, the capital stock is smaller, older and, therefore, also less productive. Moreover, also its structural component gains in importance with rising unemployment. Within the country models, the monetary and fiscal policy of a country is determined based on the Taylor Rule, respectively, on an exogenous setting of the target debt-GDP ratio.

The VIEW model was further developed by PROGNOS, as compared with the version used in the earlier study. Essentially, this brought the following improvements:

- Integration of a proxy for the long-term growth potential of a country, in order to take into account the long-term impacts of the financial crisis 2008/2009 on the potential growth of the national economies;
- taking into account the institutional framework conditions with the help of regulation indices;
- taking into account the impacts of the R&D spending on the export performance;
- stronger differentiation for public finances, respectively, the fiscal policy;
- taking into account the impacts of changes in income distribution on consumption dynamics.

VCI-Prognos industry-specific model "Chemistry"

Building on the results from the macro-model, the developments of the chemical industry in Germany, in the USA and in the European Union were examined in detail in the so-called bottom-up process.

For analytical purposes, chemistry was subdivided into 11 product groups. For this report, these products groups were subsumed into three chemical segments (basic chemistry, specialty chemistry and pharma). But the analysis was made at product group level. Production, export structure, imports and domestic demand were known for each product group. Moreover, further indicators (e.g. research intensity, energy consumption or raw material input) were estimated with the help of sector experts – where such data were not available in the official statistics.

The model enables a forecast of the production development of individual product groups in dependence on the growth dynamics of customer industries in Germany and abroad. The dynamics of the chemical markets were included in the industry-specific model: in the form of the result from the macro-model. Now, the industry-specific model additionally allows the taking into account of changes in the location quality for individual product groups. For example, energy cost disadvantages have stronger impacts on energy-intensive basic chemistry than on specialty chemistry. In the model, deteriorations in the location quality were modelled as rising import pressure and lower export dynamics (e.g. "carbon leakage"). This approach takes into account the fact that the competitive environment can develop differently for different product groups.

With the help of the macro-model, initially the domestic demand for individual product groups was derived from the growth of the most important customer industries. Next, for each product group the export demand was calculated from the specific export structure of the product group. Here, the changes in competitiveness were included in the calculations too. For Germany, a further differentiation was made between the demand from the European Union and from the rest of foreign countries. The reasons behind this subdivision:

- differences in transport costs;
- differences in competitiveness between the target markets;
- differences in the importance of the target markets for the individual product groups.

Chemical imports are another significant factor for the derivation of production. For each product group, they were calculated from the development of the domestic demand and from the future import pressure. In this manner, the competitiveness of individual chemical sectors is included on the import side too.

By bringing together the domestic demand, chemical imports and foreign demand (exports), it was possible to calculate the production growth for each product group.

The production development in the individual product groups was the basis for the derivation of further indicators. Beside employment and energy and raw material consumption, also the spending on research and development and fixed asset investments were derived. Assumptions on efficiency increases (productivity, energy and raw material efficiency, improvements in R&D processes etc) were in the foreground of the calculations.

Both approaches – i.e. the top-down and the bottom-up approach – were plausibilized together with sector experts and linked with each other in a final step. In the described manner, the model-supported overall economic forecast was supplemented by sector-specific and product group-specific developments of the chemical industry. In the result, this forecast slightly deviates from the Prognos basic forecast (published as Prognos Weltreport).

TAB. 2: PRODUCT GROUPS OF THE CHEMICAL INDUSTRY
Basic chemistry
Inorganic basic materials and industrial gases
Petrochemicals
Organic intermediates
Standard polymers
Fertilizers
Specialty chemistry
Engineering Polymers
Consumer products
Paints and coatings
Pesticides and other plant protectants
Other specialties
Pharmaceuticals (incl. animal health)

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CHEMIE 3
THE SUSTAINABILITY INITIATIVE OF THE GERMAN CHEMICAL INDUSTRY

An initiative of:
Wirtschaftsverband VCI,
Gewerkschaft IG BCE and
Arbeitgeberverband BAVC

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