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Strategy & Management

Investment Opportunities in Life Sciences, Compliance and Efficiency in Production, Predictive Maintenance in the Chemical Industry

Regions & Locations

China's Regulatory Landscape, Biotechnology in China, Sustainable Development of China's Chemical Industry, Connecting Science with Business in the UK

Innovation

Purification and Modification of Biomolecules, Bioplastics with Advanced Functionality, Circular Side-stream Solutions for the Chemical & Pharma Industry

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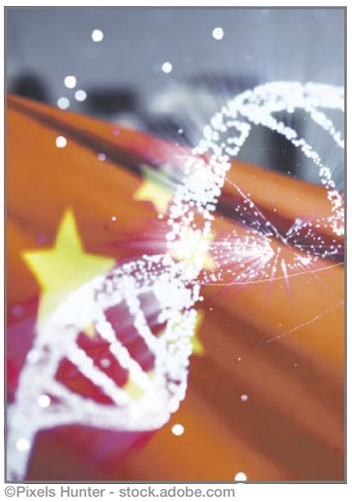

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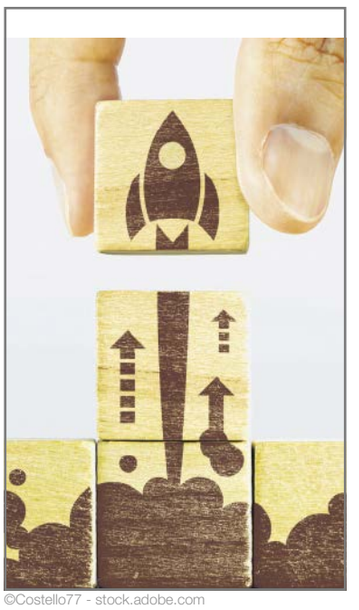

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Markets & Economy

Regions & Locations

Industry 4.0

Innovation

A Close Look at the Fine Print

Selecting the Right European Location for Life Sciences Activities

Agile and resilient: This is how manufacturers in the life sciences industry could be described during the Covid-19 pandemic. As disruption took hold in many other industries' supply chains, life sciences companies moved to rapidly develop new products and build new capacity. They are maintaining this momentum, with pharmaceutical and biotech businesses showing continued interest in expanding existing operations in Europe or starting operations from scratch.

Fully integrated Biopharmaceutical companies and contract development & manufacturing organizations (CDMOs) can be seen developing existing manufacturing facilities or setting up new R&D centers in Europe.

At the same time, "first time launchers"—small biotech companies that are launching products for the first time—are beginning to realize that they do not need large pharmaceutical groups in order to do so. Instead, they are setting up their own distribution networks across Europe, while many are currently looking for the ideal location for their regional headquarters.

Further impetus is provided by climate discussions and the EU's Green Deal, and a resurgence in industrial strategies to stimulate post-pandemic economic growth. These factors are encouraging governments across Europe to attract direct investments in the life sciences industry, which is generally a low-carbon-emitting and high-added-value sector. Tax incentives, grants and loans are all on offer, though it is always advisable to take a close look at the fine print of offers before taking such a big decision such as where to establish business operations.

Against this background, what should life sciences executives look for, and how do the various European jurisdictions compare? It is a simple question with a complex answer. Let us look at some of the contributing factors.

Taxes Are Suddenly Less Interesting

Large businesses that are planning significant capital investments in manufacturing plants or R&D facilities are generally attracted by low corporate tax rates. Life sciences companies, in particular, have typically structured their operating and tax models to benefit from low taxes and government incentive programs such as tax holidays. Such tax planning models have suddenly become far less relevant and will not give the desired return if they are based on an effective tax rate of less than 15%. This is because of moves by the OECD, where on 8 October 2021, 136 member states—representing over 90% of global GDP—agreed on a minimum corporate tax rate of 15% from 2023 on. Host countries are likely to raise tax rates to a minimum of 15% for companies with revenues above a certain threshold and abolish tax holiday schemes.

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André Guedel, KPMG

Loans or grants may become the preferred means of governments to attract foreign direct investments (FDI) instead—though such moves might be restricted by international state aid regulations and anti-subsidy rules. Moreover, governments are connecting their support for greenfield and brownfield projects to job creation and other commitments. Strict 'claw back' rules might apply if the recipient of governmental support does not comply with the predefined objectives.

Sticking Together: Cluster Size Matters

Clusters of life sciences companies are a major plus. They make it easier to attract and create an even larger pool of talent, expertise, and know-how. This in turn supports profitable pipelines. A positive cluster impact is particularly evident when it comes to innovation, as it can encourage a creative environment around a solid academic ecosystem, supporting the development of specialists and the discovery of new drugs.

Site Selection Report

In September 2021, KPMG released the sixth edition of its report "Site Selection for Life Sciences Companies in Europe". It is aimed at life sciences companies of any size that are looking at establishing or expanding operations in Europe, as well as governments seeking to benchmark themselves in terms of attractiveness for foreign direct investments (FDI) in the sector. The report is available for download: www.kpmg.ch/siteselection

Clusters can be victims of their own success, however. High demand for qualified talent, experts and specialists often means a spike in salary levels and increases in land prices and office rents. In many life sciences hotspots, a run on talent results in a rise in staff turnover and higher retention costs.

It can be difficult for life sciences companies to respond effectively to such developments, especially on more extensive manufacturing projects. It is therefore advisable to have a shortlist of locations that have a strong manufacturing industry outside the life sciences sector, such as food production, from where qualified staff may be sourced.

Balancing Salary Costs with Labor Law Flexibility

Salary costs can be an important decision factor when choosing a location. Yet, for life sciences projects, for which access to talent is key to success, this factor should be weighted carefully against the flexibility of labor law and a location's attractiveness to specialists. Countries with flexible labor laws and high educational standards almost always also have high labor productivity which is one of the reasons for higher salary costs. By contrast, jurisdictions with lower salaries often lack the capacity to attract qualified workforce necessary to adequately staff operations.

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Global Talent Competitiveness Index 2020

Country	Global Talent Competitiveness Index 2020[1]	Strictness of employment protection [2]	European Innovation Scoreboard 2021 [3]
	Score	Score	Score
Austria	68.87	1.66	133.62
Belgium	68.87	2.72	143.52
Bulgaria	45.76	n/a	50.06
Croatia	43.53	n/a	78.22
Cyprus	57.47	n/a	106.48
Czech Republic	60.91	3.02	94.41
Denmark	75.18	1.84	147.51
Estonia	61.97	1.89	128.29
Finland	74.47	2.37	151.38
France	64.83	2.45	122.30
Germany	72.34	2.22	137.92
Greece	47.51	2.54	88.49
Hungary	46.62	1.78	76.42
Ireland	70.45	1.98	121.27
Italy	52.91	2.72	108.08
Latvia	54.40	2.64	55.87
Lithuania	53.32	2.25	92.08
Luxembourg	73.94	2.5	136.53
Malta	62.02	n/a	101.76
Netherlands	74.99	2.85	138.50
Norway	72.91	2.27	132.82
Poland	49.48	2.4	65.88
Portugal	57.80	2.85	90.26
Romania	62.14	n/a	35.09
Slovakia	52.08	2.28	70.98
Slovenia	57.42	2.18	100.49
Spain	55.70	2.43	95.99
Sweden	75.82	2.48	156.45
Switzerland	81.26	1.57	162.28
United Kingdom	72.72	1.74	137.55

[1] Insead ranks countries along their attractiveness to international talents and their families. Note: Scores from 1 to 100; 1 beeing most attractive. Source: bit.ly/GTCI2020_CMI0421

[2] The OECD ranking shows the business friendliness of national labor law regulations. Note: Scores from 1 to 3; 1 beeing least strict. Source: bit.ly/OECD_CMI0421

[3] The level of innovation in a country is particularly relevant when a company is looking for a new R&D or manufacturing location. Source: bit.ly/EIS_CMI0421

Saxony-Anhalt to Attract Pharmaceutical Companies

With an annual turnover of more than €1 billion, the pharmaceutical industry is the most important investor in the healthcare sector. The characteristic feature of this industry, which is growing in size in the German federal state of Saxony-Anhalt, is its ability to innovate. Therefore, the state aims to benefit from the restructuring of global supply chains in the pharma sector and encourage companies to move to its centers of excellence.

"The pandemic has revealed the weaknesses of globalization. The government and industry are rightly discussing the benefits of reshoring strategies, which involve returning production to the company's original country, particularly in the pharma sector, with the aim of reducing the dependency of our industry on foreign competitors," said Thomas Einsfelder, managing director of the Investment and Marketing Corporation Saxony-Anhalt (IMG). The state has an established pharma and vaccine industry as well as a long tradition as a location for the chemical industry and is home to research companies, manufacturing facilities and universities. (rk) ■

Chemistry Shapes the Future

Sustainable Development of the Chinese Chemical Industry

China's 2060 carbon-neutrality goal has established long-term emission reduction targets for all industries in China. As a significant energy consumer, it is essential for the chemical industry to set its own targets. The Association of International Chemical Manufacturers (AICM), founded in 1988, represents nearly 70 major multinational companies in the chemical industry of China. CHEManager asked Jeff Zhu, President of Performance Additives and the Asia Pacific region at Cabot, and AICM's Chairman, to discuss the industry's role in helping achieve China's carbon-neutrality goal.

CHEManager: Mr. Zhu, what exactly is AICM's purpose and what is the scope of its activities?

Jeff Zhu: AICM aims to contribute to the development of a harmonious society and the sustainable growth of China's chemical industry. As the representation of the leading international chemical players in China, AICM commits to promote Responsible Care and other globally recognized chemical management principles among all stakeholders; advocate cost-effective, science- and risk-based policies to policy makers; and build up the contributive role of the chemical industry to the economy.

AICM achieves these goals via the activities of its four committees: the Responsible Care Committee, the Industry Policy Advocacy Committee, the Public Relations and Communication Committee, and the Government and Industry Affairs Committee.

Which local organizations and authorities do you cooperate with to realize this shared vision?

J. Zhu: Through its history, AICM has enhanced its reputation and effectiveness by partnering with many local organizations and authorities, such as governments, safety and health management authorities, quality inspection and quarantine administrations, technical institutes, industrial associations, industrial/chemical parks, academia; and media agencies.

Is it difficult to establish or develop Responsible Care principles in China?

J. Zhu: Nationwide, the Chinese government and organizations have made great efforts to improve sustainability and carbon neutrality. During the 13th Five-Year Plan period, the promotion of Responsible Care has made positive progress, and AICM could establish the promotion mechanism for enterprises to practice responsibility subjects.

For example, the RC Committee and its nine working groups have been established and started their regular activities. In addition, the establishment of the "1+6+X" RC standard system has made steady progress in basic work such as online education and our training platform for responsible care.

The 14th 5-Year-Plan also raises the awareness of sustainability of chemical companies and society: It is planned to adjust the energy structure and to accelerate R&D and the promotion of low-carbon technologies to reach carbon neutrality. In addition, the plan includes measures to remediate plastic pollution.

Jeff Zhu, Chairman, AICM

Our challenge in promoting the RC principles in China is mainly to get more and more local chemical companies to participate in this voluntary initiative so that they can embrace these principles, realize their values and benefit from their implementation, like other successful chemical giants in the world. AICM encourages chemical manufacturers to produce their products in a way that protects the environment as well as human health and conserves resources in China.

What is the public image of the chemical industry in China like?

J. Zhu: When chemicals are mentioned, many people first think of explosions, emissions or accidents. But in fact, people cannot live without chemicals. Our lives are so full of chemicals that we cannot ignore them. Therefore, we are trying to improve the public image of the chemical industry.

In times of climate change and resource scarcity, society is becoming aware of the importance of sustainable development, and the chemical industry is the foundation and key to solve the world's most pressing sustainability problems.

However, we are aware that the implementation of RC in China remains a major challenge. There are several reasons for this. There are probably about 300,000 chemical companies in China, and their locations, size, technological capabilities and understanding of RC vary widely. It is difficult to bring them all to the same level of RC.

In a surprise announcement at the COP26 climate summit in Glasgow, China and the US have agreed to boost climate co-operation over the next decade. The Paris Agreement that is binding 196 countries to combat climate change, called countries to submit their nationally determined contributions, or NDCs, to reduce greenhouse gas emissions. Which are China's NDCs?

J. Zhu: China's NDCs do foresee a short-term increase in CO_2 emissions but expects its emissions to decline before 2030. By 2030, China's carbon dioxide emissions per unit of GDP are targeted to fall by more than 65% compared to 2005 levels. Non-fossil energy is targeted to account for about 25% of primary energy consumption. Forest resources are expected to increase by 6 billion cubic meters compared to 2005, and the total installed capacity of wind and solar energy is to reach more than 1.2 billion kilowatts. By 2060, the country aims to achieve carbon neutrality.

To realize its goals of peaking carbon dioxide emissions before 2030 and going carbon neutral before 2060, China will soon release implementation plans of a policy system dubbed „1+N" for peaking carbon dioxide emissions in key areas and sectors. In addition, the launch of a nationwide carbon trading system and the stop of high energy consumption projects are planned.

What challenges do you suspect for the chemical industry with these plans and policies?

J. Zhu: There are two challenges facing the chemical industry as part of this national alignment. Firstly, the roadmap is taking shape, but it is still not clear if these solutions are sufficient, economically viable or available in the supply chain. Secondly, the chemical industry is an initiator of downstream carbon reduction, something regulators are unwilling to understand.

Which steps is the chemical industry taking to support China's goal of carbon neutrality?

J. Zhu: 17 petroleum and chemical enterprises, chemical parks and the China Petroleum and Chemical Industry Federation (CPCIF) signed the Declaration on the Carbon Peak and Carbon Neutrality in Chinese Petroleum and Chemical Industry in January 2021, claiming to realize environment protection and carbon emission reduction during the development of the chemical industry.

Six actions were proposed to reach carbon emission targets, including energy structure adjustment, energy efficiency improvement, product qualification optimization, carbon capture and storage technology, R&D investment, and carbon reduction investment.

What are the most common strategies and practices of AICM members to reduce their CO_2 emissions?

J. Zhu: Based on the information gathered from a survey among AICM members and their sustainability reports, we found that the respondents have integrated their carbon-neutral targets into business development strategies. From technical innovation to progress in improvement, they have adopted a broad spectrum of strategies towards carbon reduction. These strategies fall into four main categories: renewable energy, process improvement, carbon friendly products, and carbon offset methods. According to our survey, some of our members are expected to achieve carbon neutrality by 2050.

The transition to carbon-neutrality may involve high costs. How can smaller companies, in particular, be supported in replacing fossil energy or raw material sources with more sustainable alternatives?

J. Zhu: Smaller companies normally also have smaller carbon footprints and simpler product lines, which make them easier to adjust. So, it is not about the size — every company should and will find their contribution in the common goal.

With the development of the global carbon labeling system, companies can use carbon labels to help achieve high returns and meet carbon emission requirements.

The carbon trading market can accelerate the reorganization of companies and increase the economic value of carbon-neutrality.

The Chinese government may formulate legislation for standard mechanisms in the coming year to help promote new technologies. As the scope and scale of use expands, the cost of some low-carbon, zero-carbon, and carbon-negative technologies will rapidly decline, opening up new opportunities for small businesses.

The government may also enact laws that come with bans and sanctions for companies that do not comply. Is AICM in a position to provide advice or counsel policymakers in China on such aspects of industry policy?

J. Zhu: AICM strongly support the realization of China's goals of peaking carbon dioxide emissions before 2030 and going carbon neutral before 2060. But it is true that China often conducts „campaigns" to implement its policies, which is not a scientific approach. I believe that most companies operating in China have already experienced this, and they all have some contingency plans in place. Our main role at AICM is to constantly communicate to policy makers that „campaigns" do not achieve sustainable results and even have a negative impact on companies that embrace the path of sustainable development. I think that policy makers are beginning to understand this point.

We have observed that China is developing more supporting policies and encourages more companies and industries to invest in low-carbon technologies. With the support from the government, and by leveraging its policies, AICM will continue encouraging its member companies to set their goals and strategies to help reach a carbon-neutral future.

Looking ahead, how do you think the chemical industry in China will develop?

J. Zhu: AICM believes that in the future, the chemical industry in China will use more technical approaches to improve the manufacturing process in order to save energy and enhance energy efficiency, thereby reducing carbon emissions.

Transitions are always associated with challenges. AICM is aware that the chemical industry is still mainly dependent on fossil fuels and that the transition to cleaner fuels can be associated with high costs. Thus, it is not easy for smaller companies to shift to a different energy structure or adopt new technologies. However, we believe that further improvements in technologies and political support can lower the cost of a low-carbon future for companies in the sector.

The efforts made by member companies of AICM are the first step toward a low-carbon future. We believe that technical and political support will create opportunities to improve the low-carbon strategies in the chemical industry. More and more AICM member companies will overcome the existing challenges and together create a carbon-neutral future.

www.aicm.cn

Know the Turf!

Typical Issues in Small- and Medium-sized Private Chinese Chemical Companies

Chinese small and medium-sized enterprises (SMEs) in the chemical and other industries have achieved rapid growth in the past years and are contributing to China's economic development.

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Ralf-Roman Rietz

SMEs, in general, face distinctive problems such as lack of financing, constrained managerial capabilities, low productivity, difficulties in exploiting technology, finding and retaining key talents, and regulatory burdens. Contrarily, SMEs can often be more flexible and responsive to customer needs, and, if well run and innovative not only in regard to products and services but also in regard to internal processes etc., can ultimately improve business performance and sustainably succeed in the market. Two key challenges are, in particular, finding the right growth strategy and implementing suitable supporting processes as the company grows and becomes a more and more complex operation.

Private and Family-owned Enterprises

Private/family-owned enterprises differ from non-family SMEs in terms of the overlap between business and the family environments. The involvement of the family in the management of a company could be extensive in China. The founder or owner, the direct family members, often members of the extended family as well as individuals related by marriage hold top management positions or line-management positions throughout the organizations. Often also friends or "old buddies" (wider social group of the owner—guanxi) could be employed in key management positions.

Such an organizational structure cannot be found only in companies founded by a Chinese entrepreneur but also in foreign-invested companies. For example, one foreign chemical company wanted to set up a company in China and decided to hire a local Chinese general manager. As the general manager started to build the organization, he gave management positions and other positions to his family members including in-laws and close friends mostly ignoring needed expertise. Apparently, the whole process was not sufficiently oversighted by the parent company. As a result, the local company remained to stay rather small compared to international competitors despite the fact that the foreign company entered China relatively early in that particular niche market.

The local business owner puts more importance on the bond of trust rather than on expertise, competency, and qualification; it is easier to do business with closely known people. Positive aspects of building such an organization are, for instance, possible sustainment of the owner's vision by the new generation, if there are no severe intergenerational conflicts, and organizational stability as far as top management and lower management levels are concerned.

Organizational Management Challenges

On the other hand, there are also unique organizational management challenges. This is true especially in the management of non-family employees. Favoritism or nepotism are more prevalent in the family businesses of countries where traditional ties and relations are still intensive, and work life and family life are less separated. Favoring relatives and close friends with respect to performance evaluation, overlook of underperformance, reward, support, and promotion as well as actual non-involvement of out-of-group managers in the decision-making process causes perceived unfairness, decreased job satisfaction, and thus reduced loyalty of non-family and out-of-group members towards the organization.

There is largely a distrust of the system, even if policies and procedures are quite formalized, as essentially decisions are almost always made by the founder in the end. Such favoritism and management lead to an increase in labor turnover rate, decrease in organizational commitment, reduction of work efficiency, lower productivity, drop in quality or services, less knowledge sharing, diminished innovation ability, decrease of competitiveness, declining profitability, and ultimately loss of the enterprise in the long run. If the owner is aware of such challenges, these negative aspects can be reduced.

Besides people management there are other challenges often seen in Chinese local companies. Quite often the planning horizon in SMEs is very short and the business strategy is unclear and changes because an opportunistic pursuit of short-term opportunities has been quite successful in a seemingly ever-growing market. Previous success during a period when productivity and competition were less an issue as the market grew rapidly has given the false impression that a later investment into unrelated businesses would be also unproblematic despite missing expertise.

Fast growth in the past has also been concealing internal management and business process challenges, which will eventually surface. Indeed, family-owned enterprises exist that grew to a substantial size with revenues of billions of Chinese yuan (hundreds of millions of euros) and staff of several hundreds of employees.

An example is a Chinese family-owned chemical company founded in the 1990s. The founder struck luck when he was initially trading chemical products. Today, the company is also manufacturing specialty chemicals. The group has a few subsidiaries and an international joint venture with non-controlling interest in China. The enterprise employs a few hundred people and the annual revenue of the firm excluding the JV is some billion Chinese yuan with net profit in the lower single-digit percentage range. Almost 80% of the revenue is generated by one entity. Practically all products manufactured at the main plant experienced commoditization over the years, and the net profit highly depends on the raw material prices. Contrarily, the net profit of the foreign-managed JV is much higher and more stable. In fact, besides the influx of borrowings and subsidies, the group is living on the profits made by the JV.

Some newly established endeavors and investments in fixed assets do not generate profit, draining money since years. The founder owns a majority of the stocks, and the larger part of the rest is in the hands of the family.

Family members and relatives hold certain key functions and several other positions. Reporting and controlling systems are formal. Employees are being remunerated a base salary plus a limited bonus based on KPIs. Advanced training courses and programs are available but not always effective. The owner sticks with his family and old friends, needed information was not shared with newly hired professional managers, and the owner made decisions bypassing those senior managers, who all left after a short time. Many employees who are not locally bound by their own families also left the firm.

Certainly, the owner is ambitious focusing on expansion. Debt and earnings from the joint venture are financing the investment in fixed assets and growth. Given size, complexity, and age of the business one would expect a delegative management style, yet the founder keeps his directive leadership style—absolute monarchy; it's an imbalance, which creates a serious problem, eventually endangering the future of the firm.

Analysis and Recommendation

The founder fell into two traps: The first one being the danger-of-omnipotence-syndrome (owner tries to grow too fast or runs out of cash) and the second one being the danger-of-omniscience-syndrome (owner is unable to delegate effectively). Indeed, the owner continues to pursuit unprofitable businesses: besides his oldest business that gives him a small profit, and the profit-making JV, all other subsidiaries are not profitable. However, the biggest problem, obviously, is omniscience. The founder is unwilling to give up control which would be necessary to develop a larger and more complex organization. The owner has not made decisions about what to pursue and what not to do and did not develop an effective teamwork among the senior management group that is critical for a delegation-demanding growth stage.

A turnaround approach for the corporation might look as follows:

- Stop money-losing businesses and sell unnecessary fixed assets.
- Add new higher-margin products to the core business to shift away from the old, commoditized product line (product development portfolio).
- Establish an innovation strategy focusing on one dimension at a time, either horizontal or vertical expansion related to the existing business.
- Reconfigure systems for supporting long-term growth and allow effective decentralization while balancing control and nourishing entrepreneurial spirit.
- And first and most importantly, the founder must learn to let go. He could be owner but with no executive duties. Daily operations and strategic planning should be done by a team of professional managers.

Piece of Advice

Attention should be paid by those Western companies, which have already localized or intend to localize many positions in China, to the possibility that the working styles of the local management potentially resemble those in Chinese companies, with the risks outlined above. Headquarters should have knowledgeable managers experienced in Chinese culture and business. Foreign management in China should know the turf.

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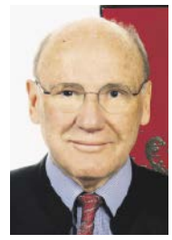
Bioscience Trends in China's New Five-Year Plan

Personalized and Telemedicine, Ecological Transformation, Brain Research and AI are Hot Topics

On 12. March 2021, the Chinese government published its „Draft 14th Five-Year Plan for the National Economic and Social Development of the People's Republic of China, and Vision 2035".



Rolf Schmid, Bio4Business

Xin Xiong, University of Tübingen

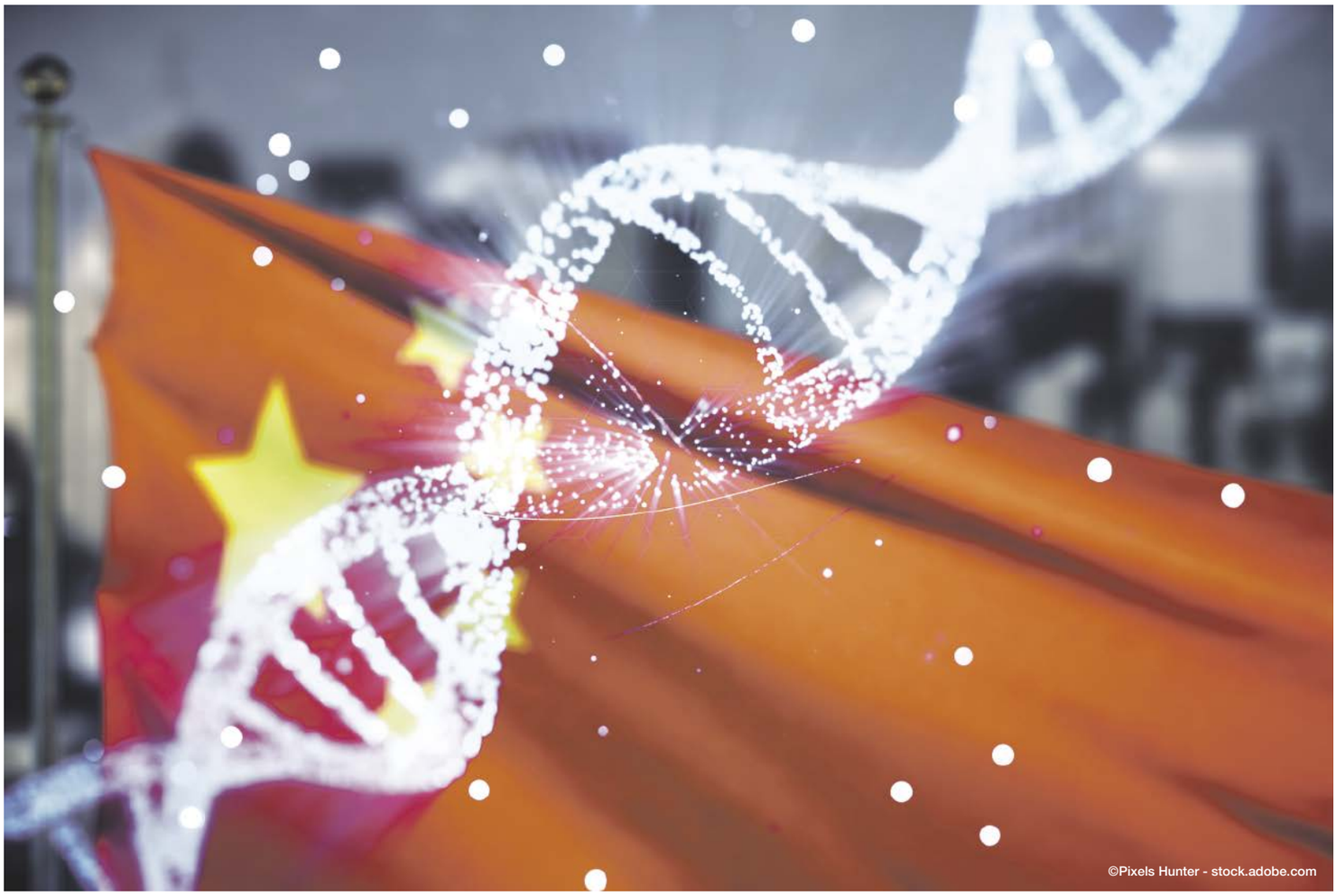
During the preceding period of the 13th Five-Year Plan „135" (2016–2020), China has made an impressive leap. Its gross domestic product increased from ¥74.640 trillion (€10.155 trillion) to ¥101.599 trillion (€12.910 trillion) and now accounts for about 15% of the world's economic output. For the first time, the average per-capita income exceeded $10,000 per year, and per-capita disposable rose by 40%, showing that China has become "a moderately prosperous society".

Almost half of the population now lives in cities and has an average living space of 40 m² per person. Public transport enables a high level of mobility, with high-speed trains covering already 38,000 km. Fiber-optic networks and the Beidou satellite system reach almost every inhabitant. At the end of 2021, over 70% of the global 5G network is located in China and enables rapid digital services in industry, commerce, public health and administration.

China's R&D Landscape and Strategy

Investment in research and development (R&D) is surpassed only by the US. There have been major successes in human spaceflight, space probes and radio-astronomy, arctic and deep-sea exploration. The country has moved into a leading position in supercomputers and quantum communication. China now ranks first both in national patent applications and in international PCT applications, and second, behind the USA, in scientific publications.

The 14th Five-Year Plan "145" suggests that these dynamics are to be maintained and even surpassed. Quantitative targets have already been set for some areas. As in the previous planning period, high priority is given to modernizing the country and the economy through R&D. According to Chinese statistics, 92 million or 6.5% of the population have some scientific or technical education. According to the State Council Information Office, 5.1 million persons are employed in R&D (full-time equivalents), by far the highest number of any country in the world. Spending on R&D was 2.4% of GDP in 2020 and is expected to increase further and will include more basic research. The 14th Five-Year Plan sets as priorities and outstanding goals: quantum com-



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puting, integrated circuits, brain research and artificial intelligence (AI), genetics and biotechnology, clinical medicine, and technologies for space, earth, deep sea and polar exploration.

Three current hot spots of Chinese bioresearch are personalized and telemedicine, ecological transformation, and brain research and AI.

Personalized and Telemedicine

In urban areas, the quality of healthcare in China is no longer much different from Western industrialized countries, but China's rural population is still undersupplied. Rural hospitals usually lack both well-trained medical staff and expensive equipment. Thus, examinations by MRI, CT, etc. often need to be performed in urban hospitals, often hundreds of kilometers away. Here, telemedicine made possible by China's rapidly advancing communication network offers some relief. Therefore, during "135", over 1,000 urban hospitals of the highest class 3 have already assisted hospitals in rural areas with examinations (internet hospitals), and even with tele-guided instructions during surgery.

Service providers such as AliHealth or AnPing Good Doctor provide telemedicine services, which cover over 400 million registered users, 30,000 registered doctors and 1 million registered health care institutions. Users may not only book vaccination services or online emergency consultations, for which they can upload diagnostic images or test reports, but online consultation extends to diagnosis, consultation of more than one specialist, and a wide range of follow-up measures.

While the public health services cover the most frequent diseases, rare diseases are emerging as a new category, which, in a populous nation such as China, provide a rich ground for diagnosis and therapy. Thus, genomic medicine has become a key direction of medical research and includes cancer, where knowledge in its genomic patterns may help therapy.

Among over 200 DNA sequencing companies in China, the two major players are the Beijing Genomics Institute (BGI) in Shenzhen, and Genewiz in Suzhou. A third large center, the National Health Medical Big Data Center in Nanjing, is presently under construction.

BGI has published a study on the whole genomes of some 141,000 Chinese women, based on their NIFTY tests, and a "Chinese genome map" was built on the base of 597 healthy individuals from most areas of China —stimulated by the fact that in Western human genome programs the Chinese population is underrepresented. These efforts are meant to facilitate genetic testing and a personalized medicine and include "gene banks" such as the National Gene Bank in Shenzhen, co-financed by BGI.

Ecological Transformation

Aspects of China's ecological transformation are air and water protection, green energy and greenhouse gas emissions, biodiversity, and sustainable chemical production.

Air and water protection: Like other nations, China experiences much air, water and soil pollution due to its rapid industrialization. Over the past decade, the government has initiated more and more rigorous rules to counteract these developments, such as a Real-Time Air Quality Network with over 1,500 stations in 400 cities. Since 2015, the burning of straw—a major cause of air pollution—is prohibited and provides, in theory, 700 million t of agricultural biomass as a carbon source for fermentation. Some 30% of China's surface are either deserts or covered by sand and stones—a continuing source of dust pollution.

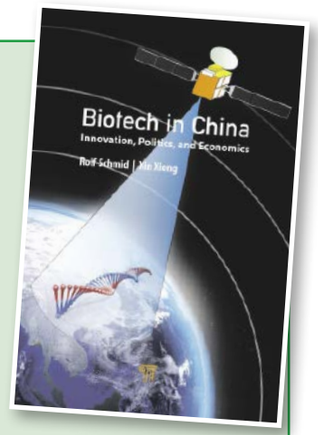
Continued Page 12 ▶

With the "Grain for Green" program initiated in 1999, China has paid 124 million farmers in 25 provinces to plant billions of trees on silting ground. Some 12,000 water monitoring sites across China reveal that only 35% of all probes provide water of good quality, but the 2015 "Water Pollution Prevention and Control Action Plan" ruled that, by 2020, 95% of all urban centralized drinking water facilities produced drinking water of at least class III quality, and the number of biological sewage treatment plants has grown to nearly 2,300. Still, emissions from agriculture result in algal blooms in China's lakes and rivers, and seaweed farming leads to "green tides" along China's 18,000 km coastline.

Green energy and greenhouse emissions: In 2019, 58% of China's energy mix was based on coal, but the combined use of hydropower, nuclear and solar energy and wind power contributed already 29% (2020). Clean energy should supply at least 50% of the electricity in 2025, and China's huge coal, oil and gas reserves are set to become the raw material sources of a gigantic petrochemical industry operating at high environmental standards, because China has vowed to peak CO_2 emissions by 2030 and become carbon-neutral by 2060 at the latest. Presently, China which holds 19% of the global population accounts for 27% of global greenhouse gas emissions. The political agenda, however, points to a more and more stringent control of emissions, monitored by satellites, by China's new EarthLab supercomputer and by comprehensive ecological research centers such as the new Shandong Energy Institute.

Biotech in China

The topics highlighted in this article are excerpts from the book "Biotech in China — Innovation, Politics and Economics". The authors have composed this monograph based on thousands of Chinese publications, news, websites, and blogs. The book begins with brief accounts of China's geography, people, political and administrational structure, economy, finance, infrastructure related to science and technology, and educational system. It presents succinct accounts on biomedicine, diagnostics, agriculture, fermented food, bioindustry, and environmental biotechnology, with reference to government, industry, and academia. Finally, it predicts next steps in Chinese biotechnology for the national agenda and for the Belt and Road initiative, China's ambitious global development strategy.



Biotech in China — Innovation, Politics and Economics
Rolf Schmid and Xin Xiong
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Biodiversity: Extending over many climate zones, China has a rich biodiversity, and a 2021 online catalogue of the Chinese Academy of Sciences (CAS) contains some 7 million records. Since 2017, 11 National Parks covering some 200,000 km² are under mandatory and rigorous protection. Since 1994, the country participates in UN Biodiversity Conferences and implements rules and regulations for eco-environmental protection such as the Cartagena protocol. In October 2021, China was host to a UN Biodiversity Conference and prepared a "Kunming protocol" on extended biodiversity protection. Through its "Belt and Road initiative" (One Belt, One Road), China is providing technological guidance such as satellite monitoring and germplasm storage to developing regions in Asia, South America and Africa to protect these regions' indigenous biodiversity.

Sustainable chemical production: China has become a global leader in the manufacture of bulk biotech products such as amino and other organic acids, vitamins, enzymes or biopolymers. More recently, techniques of a "synthetic biology" based on the integration of molecular genetics, bioinformatics and artificial intelligence have become a driving force for the development of plant- or microorganism-based "smart cells" which produce chemicals such as rubber monomers, antioxidants or drug intermediates from glucose or CO_2 in high yields. Among the Chinese leaders in this field are the CAS Dalian Institute of Physical Chemics and the CAS Qingdao Institute of Energy and Bioprocess Technology.

Brain research and AI: A key feature of China's brain research is the availability of monkey models (macaque and rhesus). China leads the world in the breeding and maintenance of inbred monkeys, e.g., at the Institute of Zoology of the CAS in Kunming, but also at the Chinese Institute of Brain Research, Beijing, and CAS Institute of Neuroscience, Shanghai. An interregional CAS Center for Excellence in Brain Science and Intelligence Technology (CEBSIT) puts a focus on brain anatomy (connectome), brain disorders, and brain-inspired computing methods and devices, based on such monkey models. Recently, the entire brain of a rhesus monkey was mapped at a resolution of 1×1×2.5 microns.

These studies will provide China with an opportunity to play a leading role in studying higher cognitive functions, such as empathy, consciousness, and language. The development of artificial intelligence (AI) will profit from these studies as the brain has much more complex connectivity patterns than present neural networks, shaped by learning over a long time and using extremely large data sets.

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China Sees Huge Bounce in CPhI's Annual Report Pharma Rankings

China's pharma industry has seen a record improvement in its overall score, growth potential and biologics according to the findings of the CPhI Annual Report rankings.

Many international companies are looking for new suppliers in China, as the country's reputation has improved in every category of the rankings from the quality of 'finished dosage' (+2%) and 'API manufacturing' (+3%), to 'growth potential' (+7.5%) and 'biologics processing' (+11%). The research findings also showed that China's 'overall competitiveness' rose 6% year-on-year, with its 'biologics growth potential' increasing by an impressive 10%, and finally, the country averaging rises across all categories of 7.2%—the largest of any country surveyed.

CPhI Annual Report expert, Bikash Chatterjee, CEO of Pharmatech Associates—a USP company, commenting on the surge in China's 2021 scores and the interest from


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international markets in sourcing from suppliers, added: "China's recovery is not surprising. Since they make the chemical precursors for API as well as supply it, the simplest approach for any drug sponsor is to identify multiple suppliers. Chemical precursors are not always involved in the GMP portion of the API synthesis and can easily be incorporated from third-party suppliers. For drug sponsors looking to qualify additional suppliers as part of their resiliency strategy, having numerous low-cost alternative suppliers makes sense." (rk)

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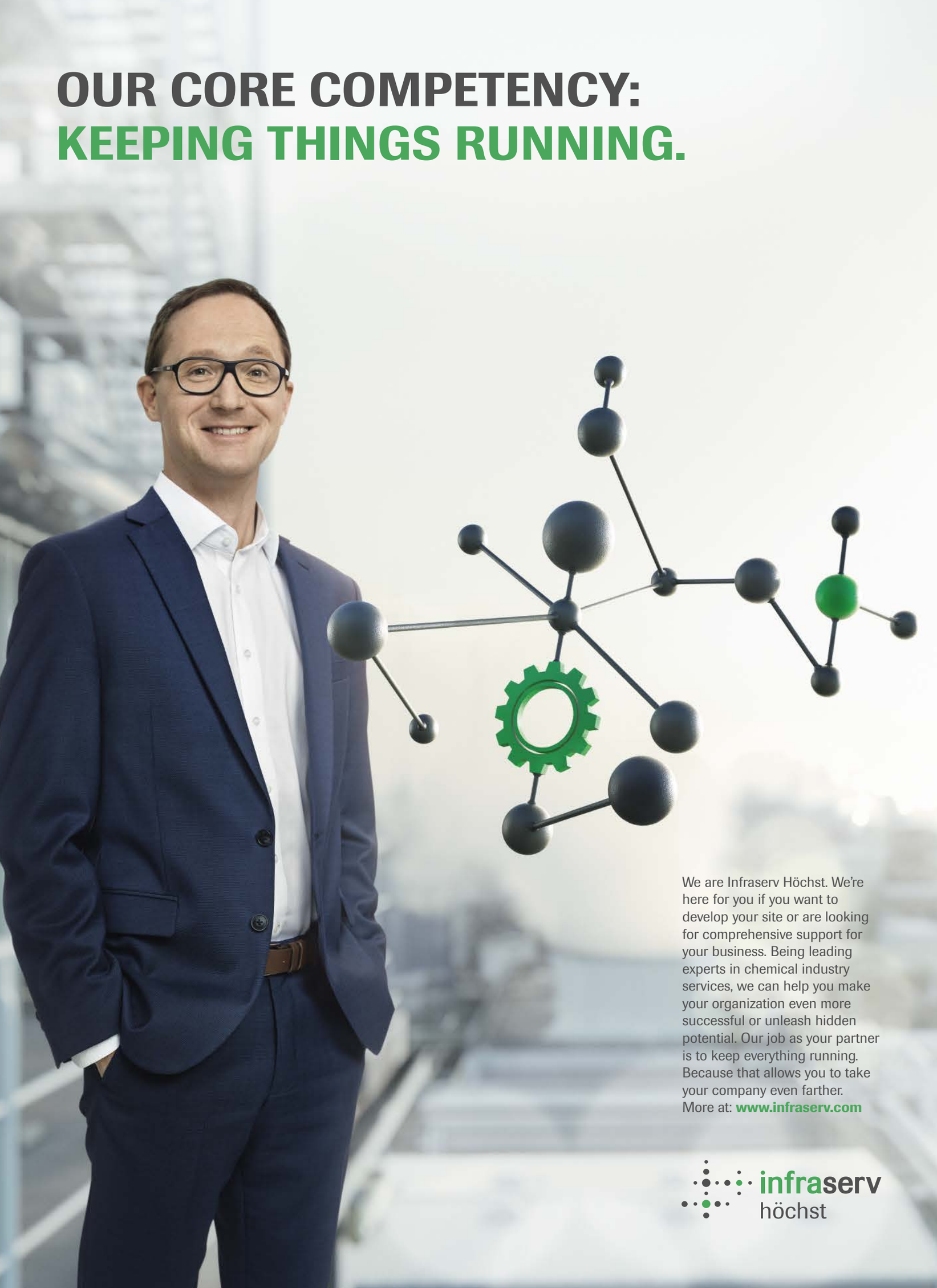

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Environmental Reform of China's Chemical Industrial Parks

Chemical Companies Need to Ensure Compliance and Mitigate Business Interruption Risks

The Yangtze River Protection Law and other recent legislation aimed at the chemical industry in China are reshaping industrial safety, land use, and environmental practices by phasing out low-tech and high-polluting industries. The devastating 2019 factory explosion at Tianjiayi Chemical plant in Jiangsu province has also spurred new policies and regulations, with important implications for chemical industry operations and factory locations. Looking ahead, carbon emissions regulations are also expected to impact the cost structure of China's chemical industry.

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Harmony Eberhardt, Horizontal 8

In the past 20 years, the chemical industry in China has grown rapidly and today accounts for close to 40% of worldwide chemical-industry revenue. Understanding environment-related regulatory and policy shifts now in full swing in China is critical to ensuring compliance and reducing business interruption risks for chemical companies either operating in or sourcing from China.

Yangtze River Protection & Industrial Transformation

The Yangtze River Protection Law went into effect in March 2021 and aims to clean up chemical factories within 1 km from the river, offering important new protections to the largest river basin in China. At 6,300 km in length, the river flows through eleven provinces and is home to a third of China's population. Tens of thousands of multinational corporations (MNCs) have their sites or suppliers located within the region. The Yangtze River Economic Belt currently produces close to half of China's GDP, effectively making it the third largest economy in the world.

The Yangtze River Protection law is designed to coordinate national efforts to restore ecology, mitigate pollution, and transform industrial activity throughout the region. This includes new levels of oversight for phasing out high-polluting and high-energy consuming industries, shutting down sites with repeated safety and environmental violations and prohibiting the construction of new factories.

Most dramatically, the new law also accelerates the reorganization of hundreds of industrial parks into sector-specific megasites, to be located at least 1 km from the Yangtze river and its major tributaries. Even before this law, in 2019, it was reported that 197 factories would be reconfigured into five major parks/zones in this area.

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Emergency Actions Led by Jiangsu Province

The coastal province of Jiangsu is one of the leading chemical production provinces in China and has an industrial infrastructure that provides steady demand for a wide range of chemical products as raw materials.

On Mar. 21, 2019, a massive explosion erupted at Tianjiayi Chemical factory in Xiangshui Ecological Chemical Industrial Park, one of over 60 such parks in Jiangsu province. The blast was caused by the combustion of illegally-stored nitrified waste and was equivalent in force to a magnitude-2.2 earthquake. It killed 78 people, hospitalized 640, and caused water, soil and air contamination in the vicinity of the explosion. To demonstrate the seriousness of this offense, fifty-three people judged responsible for the Tianjiayi blast were sentenced to prison in November 2020.

According to the official accident report issued by the State Council, Tianjiayi Chemical factory had repeatedly violated safety and environmental codes and the factory had experienced other on-site explosions. Despite its record of violations, Tianjiayi was a second-tier chemical supplier for several major multinational companies.

Following Tianjiayi, the central government issued a "Three Year Action Plan for National Work Safety Remediation" aimed at addressing substantial gaps in safety implementation and modernizing governance capabilities for MNCs and Tier 2 and Tier 3 chemical suppliers. In 2020, Jiangsu's provincial government

rolled out plans to remediate chemical industrial parks and that year, 772 chemical companies located in Jiangsu along the Yangtze river were closed.

Recommendations for Chemical Industrial Parks

Recent carbon policy documents published by China's central government outline steps within the petrochemical and chemical industries that need to be taken to reduce carbon emissions, in line with national goals of peaking emissions by 2030 and achieving carbon neutrality by 2060. One EHS manager interviewed by Greenment who works for a large chemical multinational, stated that they expect carbon policy to bring significant changes to chemical sector operations:

"Recently, [the] carbon issue [has] become a hot topic. We have not implemented any measures in response to the carbon goals announced by China, but we are paying close attention to the carbon policy. The chemical industry is a key carbon-emission industry, and we expect increased cost of raw materials supply in the future due to carbon reduction requirements."

Kevin Liao, managing director of Celanese chemical company in China, recently shared with the American Chamber of Commerce in Shanghai how growing focus from the central and provincial governments are re-shaping the chemical industry in China in important ways:

"With the changes in [Environment, Health & Safety] EHS regulations, chemical manufacturers are paying more attention to safety training and have to upgrade their sites to meet these regulations. As for the environment, chemical emissions are one of the key focus areas. For example, there is a regulation in Jiangsu province, that if you want to apply for one ton of emission quota, you need to reduce two from the existing site."

Liao added: "There's also an increased focus on quality and safety standards from the [central] government. We brought our best technology and best in class standards when we built our plants in China. The enhancement of EHS regulations has helped to filter out those small producers who are not in compliance. In addition, the Chinese government also has strict regulations on chemical transportation, which means increased costs for some small producers. [W]ith the continuous focus on environmental and safety standards in the industry, the permitting process for new chemical projects is expected to take a longer time and the cost for operation may also increase."

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One of OMVs chemical sites in China.

For chemical companies with supply chain or operations in China, the following steps are recommended for preparing for the new opportunities and risks associated with shifts in environmental, safety and land use standards:

- Know the regulations: Independent and/or professional validation of correct interpretations of potentially-applicable regulations and standards;
- Choose the right site: A site selected in alignment with current and expected land use planning and environmental policy directions is a key first step to ensure its long-term viability;
- Choose the right industrial park: An industrial park with low environmental or safety infrastructure/performance can bring sudden changes in regulations in the future, and may influence the ability of the site to operate safely;
- Verify viability of key suppliers: Assess the extent to which suppliers have engaged in regulatory applicability analysis and industrial park and/or site selection prudently;
- Stay ahead of new carbon regulations: Plan early to reduce direct and indirect carbon footprint, reduce business impact of new regulations and/or gain a competitive advantage;
- Optimize industrial production process and facility: Avoid any industry type or operation subject to phase-out, reduce pollutant and carbon emissions;
- Perform or contract for regular self-inspections: Monitor environmental, health and safety performance to determine issues and risks, carry out mitigation measures immediately; and,
- Gather ground-level intelligence: Maintain close connection and communication with local government as well as similar industrial enterprises to be alerted about EHS requirements and political trends early.

Industrial and chemical zones have been pivotal to China's rapid development and economic growth over the past several decades, with little consideration for long-term environmental and safety impacts. The consequences of this growth are now being reckoned with in important and far-reaching ways. In addition to changes in safety, environmental and land use standards, carbon policy will continue to further reshape the chemical industry. It will be critical for chemical companies with supply chains or operations in China to stay abreast of local, provincial and central government guidelines in order to mitigate risk and effectively adjust to these important industrial transformations.

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Multinational Companies in China's Chemical Industry

Study Reveals: While many Chemical MNCs Are Present in China, the Extent of their Presence Varies Substantially

Many Western chemical companies highlight the importance of China for their business, as evidenced by examining statements from 10 such companies (c.f. box on opposite page). There are several obvious reasons for this focus on China.

The first and probably most important one is the large share that China has of the global chemical sales—with 41%, this share is substantially higher than that of NAFTA and the EU combined.

Second, China is not only the biggest but also still among the fastest-growing markets. For example, BASF forecasts a 2021 increase of chemical production of 6.3% in China compared to an increase of 2.5% in advanced economies. And CEFIC predicts that by 2030, China's share of global chemical sales will have risen to 49% from its current 41%.

A third factor that is becoming increasingly important is that China is taking the center stage for innovation in several industries that are key customers of the chemical industry. This includes sectors such as automotive (shift to EV, growing importance of engineering plastics), energy (solar, wind), bioplastics and electronics.

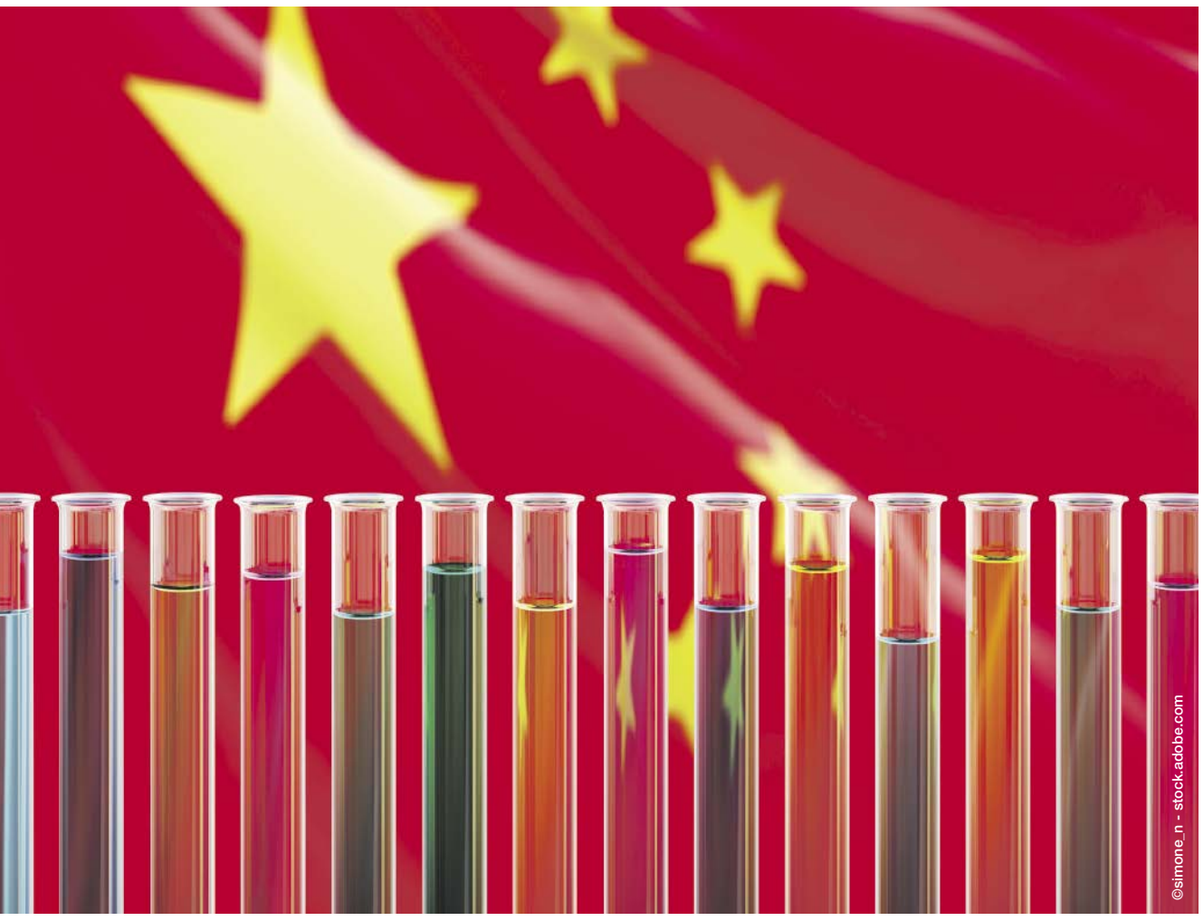
However, at least the first two reasons—substantial market size and high growth—are hardly very new. It is therefore of interest to check how the various company statements about the importance of China match with reality—the actual presence of these companies in China. Unfortunately, relevant data is relatively patchy as there is no established format for companies to describe their China presence, and public information about the relative profitability of the Chinese businesses are almost completely unavailable. Still, the limited data available for the 10 companies cited above allows for some general conclusions.

Kai Pflug, Management Consulting – Chemicals

China Share of Global Revenue

For the companies for which this data is publicly available, this share ranges from 8% for Evonik to 24% for Wacker, with many companies in the range of 10–15%. For a few companies for which older and newer data is available, the China share of sales has typically only increased relatively modestly (by 1–3%).

Overall, these China shares seem relatively modest given China's 41% share of the global chemical market. Arguably, a perfectly global chemical company would thus also have 41% of its chemical sales in China, a value not even closely approached by even those companies (like Wacker) for which China is their biggest market. Also, the relatively limited increase in the China share over the past decade or so is somewhat surprising and an indication that the appreciation of China as an important chemical market alone may not immediately bring an increase in the relative share in the country.



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China Share of Employees

For all companies for which relevant public data is available, the share of employees in China is lower than the share of sales, with typical values ranging from 7–10% and only in rare cases substantially exceeding this share (e.g., Covestro with 18%). This is an indication that for most of these multinational companies (MNCs), China is still more of a secondary location with limited importance for support functions such as R&D, administration etc. It also suggests that the companies still to a substantial extent rely on imports of products into China (and thus a comparatively lower share of production employees in China). Covestro is a bit of an outlier in this regard as China is both a huge production site for the company and the location of the headquarters of a business unit, polycarbonates.

China Sales Growth

China sales growth figures of the companies examined tend to be relatively modest, reaching annual compound growth rates (CAGR) of between 4–7% or in a few cases even negative growth, though these figures may be misleading as they have not been corrected for divestitures and acquisitions. In any case, given that the China chemical market grew at

a CAGR of 12.9% in the period from 2009 to 2019, the sales growth figures of multinational chemical companies in China are low. They clearly indicate an overall loss of market share of the MNCs in China.

Number of Production Sites in China

Unsurprisingly, most companies examined now have a substantial number of production sites in China, typically at least three, though for BASF, the number of production sites in Greater China is as high as 29. Number of China Sites: Typically, several (often around ten), lower for smaller players, more for big ones (e.g., BASF: 29 in Greater China). The sites tend to include major sites with multiple plants (e.g., of Celanese in Nanjing) along with smaller sites elsewhere, some of which are the results of M&A rather than of a deliberate site extension strategy.

Investment in China

Most companies continue to invest heavily in China. While this investment is particularly strong in expanding local production capacity, additional investments include those in R&D centers and acquisitions of local companies. BASF—with its current $10 billion investment in a new Verbund site at Zhanjiang, Guangdong—clearly takes the lead regarding investment size. Most recent investments by other companies are much smaller (range between $50 million and $300 million). Still, these investments indicate a willingness to spend resources on strengthening market positions in China.

China Strategy

While explicit statements on China strategies of individual companies are rare, general company statements on the importance of China (see above) indicate that China is indeed regarded as strategically highly important.

China's importance for Western chemical companies

Allnex:
"China has become Allnex's largest single country market and strategic base in the world."

Arkema:
"As the second largest national market for the Group, the Chinese market plays a pivotal role."

BASF:
"The major part of all the growth globally is China, with other countries not contributing much."

Celanese:
"Celanese is committed to expanding its leadership position in the region."

Clariant:
"China, where the future of our company will be decided."

Covestro:
"China and Asia are central to our global strategy."

Dow:
"Dow has the vision to grow China into Dow's largest market."

Evonik:
"Evonik regards China as one of the driving forces of the global economy."

Lanxess:
"Asia, and in particular China, is a key growth region for Lanxess."

Wacker:
"China has become Wacker's top market worldwide."

China Organization

Generally, the companies observed are—as it is the current fashion—organized primarily by global businesses rather than by countries. In theory, this should allow for a stronger rather than for a weaker focus on China, as each individual business should be able to spend a large share of its resources on the promising Chinese market. In reality, the effect may be the opposite, as most businesses still have their headquarters located in Western countries, and the leaders at these HQs may be reluctant to move certain functions away from the HQ location and into China.

Conclusion

While chemical MNCs show a strong verbal commitment to China, the real situation is somewhat underwhelming. Sales and sales growth are both substantially below the potential of China's chemical market, and most of the recent investments are of a scale unlikely to drastically change this picture.

A recent study by the American Chamber of Commerce in China—which included 19 chemical companies—hints at some reasons for this underperformance. 74% of the chemical companies stated that local competitors are faster at bringing products to markets. In addition—and quite likely related—the chemical companies involved in the study were the least confident among all industries in their headquarters having a sufficient understanding of the opportunities available in China.

On the other hand, the survey also highlighted the good perspectives for foreign chemical companies in China, demonstrated both by the substantial rise in operating margins from 2019 to 2020 and the high share of chemical companies (58%) expecting China revenues increasing by 11% or more compared to global revenues in the next three to five years. This should be incentive enough to tackle the issues that currently slow down the growth of foreign chemical companies in China.

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Space for Big Ideas

The New Knapsite Offers Perfect Conditions for Sustainable Production

The chemical industry has been represented on Knapsack Hill near Cologne since 1906 — and has undergone some changes since then. Now another site is available to investors there, right next to the existing chemical park. Yncoris has been marketing the site since September — and is deliberately focusing on sustainability.

The 13-hectare site offers investors attractive conditions for sustainable production under the name "The New Knapsite — Space for Big Ideas". The area is centrally located in the Rhineland, the economic heartland of the European Union (EU). Nearly 150 million people live within a radius of 500 km. This represents 30% of all consumers and 45% of the purchasing power in the EU. More than 230 chemical companies with a total of about 65,000 employees have settled in the region around Cologne.

"Our location in the middle of an industrial network of processing companies from almost all value chains, R&D facilities and a high potential of skilled workers gives investors access to one of the most important sales markets for the chemical industry", explains Pierre Kramer, Head of Site Development at Chemiepark Knapsack. The Ruhr metropolitan region is also less than an hour's drive away. In the future, several hundred jobs could be created on the site.

Strong Interest from Domestic and Foreign Investors

Even though there have not yet been any opportunities for interested parties to actually view the site and have personal face-to-face talks on what the economic situation of the companies will be like in future due to the pandemic, the interest is great.

"Companies have used the last one and a half years to get to grips with the topics of 'Green Deal' and sustainability," says Kramer. Many are strategically realigning themselves, developing technical concepts and now seeing an opportunity to reposition themselves in key technologies such as the use of CO_2 as a material or industrial biotechnology.

Yncoris is therefore already in initial talks with companies in the fields of CO_2 utilization, plastics recycling, hydrogen production and battery production. The market in the field of electromobility is also growing, not just in terms of the production of batteries, but also in terms of the disposal of energy sources and reuse of valuable recyclables. The topic of "green manufacturing" plays a major role here.

"Politicians, but also many companies, are increasingly focusing on sustainable chemistry, where production processes use renewable energies," says Kramer. "Smart solutions are also increasingly coming to the fore in recycling, for example allowing old plastics to be recycled into equally high-quality plastics." Kramer's experience is that projects tend to be smaller and strongly technology-driven. The needs of traditional chemical companies are also covered.

"Our location […] gives investors access to one of the most important sales markets for the chemical industry."

Pierre Kramer, Head of Site Development at Chemiepark Knapsack

Companies whose production deals with recycling and sustainability can benefit from interesting subsidies. The federal government is supporting structural change in the Rhenish mining area with up to €14 billion. "This funding is also available to companies that are on the verge of commercializing their idea. We assist these companies in selecting and apply for these funds, because the topic is confusing and complex," Kramer knows. There are also CAPEX and OPEX subsidies from the EU for particularly sustainable production concepts.

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Unique Opportunities

The New Knapsite has superb road and rail links due to its connection to the chemical park. The chemical park's own public container terminal acts as a satellite to the Cologne-Eifeltor multimodal freight transport center as well as to the major terminal at the Port of Cologne-Niehl, 20 km away. All important supplier companies can be found in the neighborhood. The chemical park has an exceptionally good energy situation — even though prices are currently rising everywhere: three different energy suppliers alone, including EEW Energy from Waste, with whom Yncoris operates an RDF plant, pro-

duce electricity and process steam here. "This enables us to offer comparatively favorable prices, flexible sales volumes and particularly high availability," says Kramer. "This security is important and even essential in some cases for companies in the process industry." Users also benefit from an efficient media supply, including compressed air, nitrogen and water, waste disposal and the strong regional pipeline system for raw materials and intermediate products at Chemiepark Knapsack.

Extensive Support

To enable investors to concentrate fully on production, the operator has also developed a "plug and play concept" in which customers can not only access the entire infrastructure but also services from the franchise department, engineering and maintenance. The chemical park management advises its customers on the topics of safety, logistics and energy supply as well as permit management. Most companies at the site also use the experience of the industrial service provider for maintenance and servicing tasks. Yncoris has been looking after many plants for years.

The chemical park operator offers start-ups support for the upcoming large-scale implementation of their process if they are aiming to commercialize their idea and have already provided proof of concept on a laboratory scale. "Many aspects do not play a part on a laboratory scale, but they do influence a plant operator's economic success," says Kramer.

Anyone wanting to bring a process to production maturity that falls under the Federal Immission Control Act, or the Major Accidents Ordinance can especially benefit here from the experience of the chemical park operators. Kramer continues: "Because the requirements are complex, even established operators of large-scale plants use the support from our permit management."

In Close Contact with Authorities and the Public

Planning for the new site has been underway since 2016. During the complex development plan procedure, the company was in close contact with the city of Hürth and its residents. The development plan takes comprehensive compensatory measures for the site into account and incorporates the issues of nature conservation and landscape management as well as soil and groundwater. "We are proud of the traditionally good unneighborly relationship at the site, our dedicated employees, the high safety standards and the constructive cooperation with authorities and public institutions," says Kramer. "We want to keep it that way in the future. Which is why it was important for us to also take these aspects into account accordingly." The intensive and open dialogue with authorities and the public has often had a positive effect on how long projects have taken in the past—a real economic advantage for investors.

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Precision – Passion – Patience

Nurturing a Perfect Rose Garden Can Teach Lessons about Predictive Maintenance

The positive impacts of Predictive Maintenance are broad and should be considered holistically. No one ever said that nurturing a perfect rose garden was simple, but the results can be dramatic. So what are "the rose garden rules" for predictive maintenance (PdM) in the Chemical Industry and how can they deliver a beautiful outcome?

Erik Weytjens, Efeso Consulting

Sebastian Grundstein, ROI-Efeso

- **Patience**: Prize winning roses do not grow quickly and there are not many quick wins in PdM. Hard work is required upfront, results don't come immediately, so patience is required and expectations must be managed.
- **Precision**: In your garden you would not put the same (expensive) flowers everywhere. In the same way it's imperative to get the right balance between the business case and model complexity. Know how deep to go into modelling your equipment and how much is needed to show Proof of Value. That's the key to choosing the right PdM strategy.
- **Passion**: To make your garden flourish you will have to invest yourself and be open to learn new things around soil etc. Also, in the case of PdM there will be a need to develop new skills, so look for staff who are capable of bridging maintenance, data and human dynamics.
- **Hire A Gardener?** You might not want to do everything in the garden yourself because of skill/cost and effect. So, you should consciously choose which skills you want to have in-house for PdM and use open-source for Proof of Value before selecting partners.
- **Talk to the Flowers**: This is about leveraging domain knowledge and empowering the people who possess that knowledge. Explore data availability, estimate business value and make sure everything is process driven and technology enabled. It's people first, IT second.

Follow these rules and the strong business case you'll develop will convince everyone to move forward to higher productivity, lower costs and lower capital employed.

The costs of predictive maintenance have dropped dramatically since it was first introduced into the chemical industry over 20 years ago. Sensors and data storage are now far cheaper, data is far more widely available, and connectivity and processing power are far greater. It all adds up to a powerful case that PdM will deliver real benefits for your production, maintenance and management teams. These include higher productivity through fewer unplanned breakdowns and interventions and an increase of OEE. Lower costs through better scheduling of planned activity, an increase in wrench time and less need for spare parts. And less capital employed through longer equipment lifetime and a reduced inventory of spare parts.

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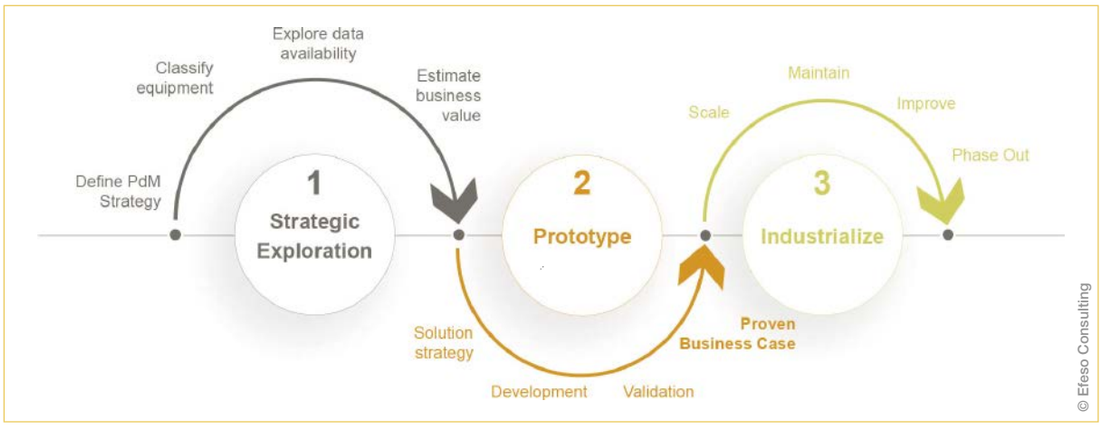
Challenges for Chemical Companies

One of the biggest challenges is that unlike many industries, the chemical industry is not built on standard equipment. Each plant is designed for a particular chemical process, so it involves a lot of custom design. Scaling up is also more difficult because there aren't identical machines at every site. That's why Proof of Value is so vital because the business case can go in many different directions depending on the equipment involved—from highly standardized to completely custom-made and everywhere in between.

Phases of the Predictive Maintenance Journey

- **Phase 1**: Explore your options. There is not one single type of predictive maintenance, there are different levels and that's why it's vital to classify your equipment first because this will help you identify whether it's best to spend more time on a complex approach or a simple approach.
- **Phase 2**: Answer the question: Make or Buy? It's a wide market and you have to select what's right for you, how much you want to retain inside and how much you will rely on outside help. That's why it is imperative to do a Proof of Value first which will help you decide the way to go. A lot of chemical companies are better suited to building their own predictive maintenance program rather than buying one in.
- **Phase 3**: Industrializing your predictive maintenance, upscaling it across the initial site and then across other sites. Start with one site and just one area of that site. When you classify your equipment select the machines that provide the most benefit to you if you scale it across the sites and will therefore benefit most from PdM.

Predictive Maintenance is an ongoing program. You have to do maintenance every year. You can't simply buy a



The journey from defining your predictive maintenance strategy to phasing it out.

ready-made PdM solution and implement it. You can only start, learn, improve and grow and grow. You should also avoid trying to optimize further and further. There is an optimal point beyond which the marginal benefit of further optimization no longer outweighs the costs.

Bring together Your Best and Brightest

Predictive Maintenance is not simply an IT project. You have to integrate your process and maintenance teams with your data science skill and ensure that the project is process driven, not IT driven. Your maintenance expertise is the most important factor and that needs to be translated into the IT solution. A predictive maintenance project is about enhancing human capabilities and not replacing them, so the human dynamics involved are critical.

You will also have to fight against the perception that predictive maintenance will make actual maintenance unnecessary. It's called PdM as it still involves actual maintenance—just done smarter.

Making Predictive Maintenance Simple and Rewarding

Efeso's focused, agile Proof of Value approach is the key to a successful partnership. It makes it easier for companies who are not quite sure where to begin and for companies where projects are getting stuck because they didn't manage expectations.

Erik Weytjens, Principal, Efeso Consulting, and Sebastian Grundstein, head of the Analytics practice, ROI-Efeso

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Easy Access Control

Can We Afford Not to Follow Norway's Example?

With a steep decline in the labor force, it's time to ask the hard questions: Why, in 2021, is there still a line outside my gate? How efficient is our staffing process? Are we wasting the time of the increasingly limited number of professionals we have left? Who is picking up the bill for the people waiting outside the gate? And finally, why do you never see a line outside the biggest industrial park in Norway, Herøya?

Patrick Ramberg Singler, Munio

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Aerial view of Herøya Industrial Park.

Herøya has not always had one of the most streamlined and efficient learning and access systems in Europe. You only need to go back five years to see an access system full of manual steps. In addition, every plant inside the park had its own set of courses and access requirements. Moreover, the parking lot was full of people waiting at every turnaround or even scheduled maintenance on a smaller scale. Something had to be done, and hard questions had to be asked.

In comes Munio. A long-time e-learning partner with more than 15 years of experience working with the process industry. A task force was created, its members including Munio and the major players with locations in Herøya, like Bilfinger, Nippon Gases and Yara. Its task: to analyze the entire operation of getting the right person with the right skills to the right place on time.

What needed to be done was to automate and harmonize the entire process. The task force deconstructed every part of the process and the existing courses. Together, they asked the key question for each part: Do we need this? If yes, why? And how can we make this more efficient? A new set of requirements had to be worked out and a new system had to be built to handle the requirements.

But was it possible to harmonize the e-learning content when the sites and companies were so different? Well, after analyzing all the needs of each different party, it was a pleasant surprise that the majority of all e-learning could be covered in general courses. After all, gravity, ignition temperature and terminal velocity were roughly the same at every site. All this general learning could be covered in individual modules and gathered in a mandatory course package, Munio Access to Industry. In addition, all company-specific e-learning needs would be produced in a smaller "local module" to be added on to the more general part of the course.

To handle the automatization and manage the new e-learning requirements, the system Munio Access was born three years ago. It is a system tailored to digitize and automate all the old processes. A system that allows the industrial park and the factories inside to put specific requirements on different zones based on the dangers and tasks unique to that specific zone. At Herøya, it took the number of manual steps to get one worker into the park from 28 down to just 4.

The system allows a subcontractor to tell it where they want to go, and the system will automatically generate a complete list of requirements to get there, and allows the worker to take most of the needed courses and upload any required certifications well in advance of entering the park.

Patrick Ramberg Singler, VP Sales Europe, Munio, Horten, Norway

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- https://munio.no

CHEManager INTERNATIONAL

INNOVATION PITCH

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Functionalized Bioplastics
Sustainable Compounds for Healthcare and Engineering

PEC Linker Technology
Purification and Modification of Novel Peptide Therapeutics

Wastewater Processing
On-Site Circular Solutions for Industrial Side Streams

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Making Demanding Applications Bio-Based

Functionalized Bioplastic Compounds for Healthcare and Engineering Applications

Biovox was founded in 2020 to enable more sustainability through renewable bioplastics even in difficult applications such as consumables in healthcare or machine parts. The founders, a team of three who studied Mechanical Engineering at Technical University Darmstadt, Germany, have a holistic approach: First, the requirements of application and production processes are thoroughly analyzed together with the customer. Then Biovox produces the most ecologically and economically sustainable material system from a wide range of polymers and additives and helps with implementation. Julian Lotz, Carmen Rommel and Vinzenz Nienhaus explain their motivation and growth strategy.

Biovox founders (left to right): Vinzenz Nienhaus, Julian Lotz, Carmen Rommel

CHEManager: There are various fields where bioplastics can replace fossil-based plastics, why did you pick tough applications like healthcare consumables?

Carmen Rommel: Currently, bioplastics are mostly used for packaging and low-tech consumer goods. In such applications recycling can often have more impact than switching to bio-based materials. However, approximately one quarter of hospital waste is plastics, and the vast majority of it is burned due to possible contaminations. These applications are not addressable for the recycling processes currently used. A huge amount of fossil carbon is emitted subsequently, over 3 million tons per year in Germany alone. Hospital plastic waste exceeds the amount of plastic waste from online retail by about 50%. Using 100% bio-based plastics in these applications reduces carbon emissions drastically.

We also have projects in application areas where huge amounts of microplastics are set free. With a bioplastic formulation that fully and quickly degrades in various ecosystems, we can eliminate permanent microplastic pollution.

What is your approach to developing a bio-based material for an industrial or medical application?

Julian Lotz: First, we are analyzing the requirements together with our customer, and we do it along the complete lifecycle. This is part of our consultation packages customers often book when they just started their journey from fossil-based to bio-based materials. After learning the requirements and the life cycle in detail, we are proposing feasible and sustainable material systems, including all masterbatches and additives needed. We are creating a roadmap for the transition together with the customer's operations department. On top, we provide scientifically proven sustainability benefits to the customer's marketing team. That prevents them from accidentally greenwash the product or handing out false claims. In especially demanding applications we usually start with the simplest product available to quickly create a success story for our customer.

And the challenges you are facing?

Vinzenz Nienhaus: Customers usually want to have an "out of the box" solution for their problem. But such solutions do not always exist. Since we are mostly working on applications with special requirements, there seldomly are samples of semi-finished products, like foils for thermoforming, readily available. The cost to make prototypes from a new material composition is sometimes high due to the need for significant production machinery. Customers do not always plan budget for that. In about half of the cases we can help by 3D-printing prototypes from the actual serial production material variants. Luckily, in this area I could gather plenty of experience in the past.

What are the next steps planned to grow your start-up?

V. Nienhaus: We are currently preparing our bio-based and biodegrad able antimicrobial additive for the biocide approval process. This will be a major step for its use, for example in machine parts in the food production industry. And we are always looking for new polymers and regional feedstock and are extending our production partner network for injection molding and processing to offer qualified production partners to our customers.

C. Rommel: Besides the production network we are also partnering with sustainability strategy consultants to support our customers even further in their transition process. For true sustainability you cannot "just swap the material", a holistic view on the company is needed to grant lasting effects.

J. Lotz: In addition to that, we are in the middle of a financing round to fund our further growth and the development of new materials. ■

Personal Profiles

Julian Lotz, CEO of Biovox, holds a PhD in Mechanical & Process Engineering from Technical University (TU) Darmstadt. His studies in the field of product development methodologies soon became the basis for the structured material counselling he provides now. He has been working with fiber-reinforced plastics for over a decade but shifted his focus from carbon fiber epoxy systems to sustainable thermoplastic compounds with second-generation biomass. Before founding Biovox, he managed a program team at Voith Turbo.

Carmen Rommel, COO of Biovox, holds a master's degree in mechanical engineering from TU Darmstadt with a focus on sustainability. During her studies she contributed to a research project developing cellulose-based building materials and improving sustainability assessment of production lines. After completing her studies, she worked on replacing fossil plastics with recycled plastics and bioplastics in automotive applications at Daimler. There she learned sustainability key factors as well as the pain points that companies face transitioning towards green materials.

Vinzenz Nienhaus, CTO of Biovox, is an expert for 3D printing with plastics. He studied mechanical engineering at Technical University Darmstadt, where wrote his dissertation about FFF printing, and he worked on the creation of biopolymer-based bone replacement materials. He loves production processes and metrology, two competencies he acquired in various industrial research projects. With this know-how he develops compounds and additives at Biovox and ensures a reliable material qualification.

Business Idea

Bioplastics for More Than Packaging

Biovox helps its customers making their demanding products more sustainable. Today, many complex or regulated applications of plastics are not covered by recycling. The start-up's mission is to contribute to a more livable world by reducing carbon and microplastic emissions from industrial and healthcare applications. The team uses an holistic approach, including support in sustainability assessment, product development, production process optimization and marketing support.

Using a variety of industrial-scale biopolymers like PBS, PHB, PLA and drop-ins, Biovox creates functionalized material systems, mainly for industrial and healthcare applications.

Special features of Biovox' material systems:

Bio-based and fully biodegradable biocidal additive (submitted to registration): it keeps products clean from bacteria, molds and certain viruses while not accumulating in ecosystems.

Especially well compostable regiogradable compounds, up to 100% bio-based. Using regionally sourced secondary biomass from agro or food production waste for compounds grants best life cycle assessment. They also help to create unique designs and tell a story, too. The biomass can be chosen individually.

Color master batches, partly from natural pigments, are tailored for various base polymers and certified for composting and food contact safety.

Barrier coatings that prevent odors and flavors as well as oxygen and water passing through the bioplastics are used if the inherent barrier effects are not sufficient or if a compound with a high proportion of secondary biomass is used.

FDA-approval is an inherent feature of many of the material formulations. ISO 13485 will follow soon.

Transition & innovation support: Biovox helps customers to start and successfully implement the use of renewable resources instead of fossil-based plastics.

Together with our supplier network, we provide our solutions as regional as possible. Furthermore, we are also contributing to the UN Sustainable Development Goals (SDGs) 3, 12, 13, and 14.

■ Biovox GmbH, Darmstadt, Germany
www.biovox.systems

BIOVOX

Regiogradable compounds have an excellent footprint, outstanding sustainability, unique looks, and can tell an upcycling story.

Elevator Pitch

More Sustainability Now

With every kilogram of fossil-based plastic waste that is burned, over 3 kg of CO_2 are released into the atmosphere — over 3 million t/y just from Germany's hospitals' plastic waste. Non-biodegradable plastics are polluting the oceans, food and water — the average human consumes about 5 g of microplastics per week, equaling the plastic amount of 52 credit cards per year.

The team at Biovox wants to solve these pressing problems. There are many plastics applications that are not covered by recycling systems and that have complex requirements. Bioplastics are not commonly used in these applications yet. With expert knowledge in material formulation and choice, processing, LCA and regulatory affairs (medical device regulation, food safety) Biovox is a one-stop-shop for bioplastic systems.

The Darmstadt, Germany-based start-up develops new bioplastic compounds that have advanced functionality like inherent antimicrobial activity, barrier properties against oxygen and water vapor, or the release of bioactive substances. At the same time, they are environmentally friendly: bio-based, microplastic-free, biodegradable and with lower carbon emissions.

Milestones

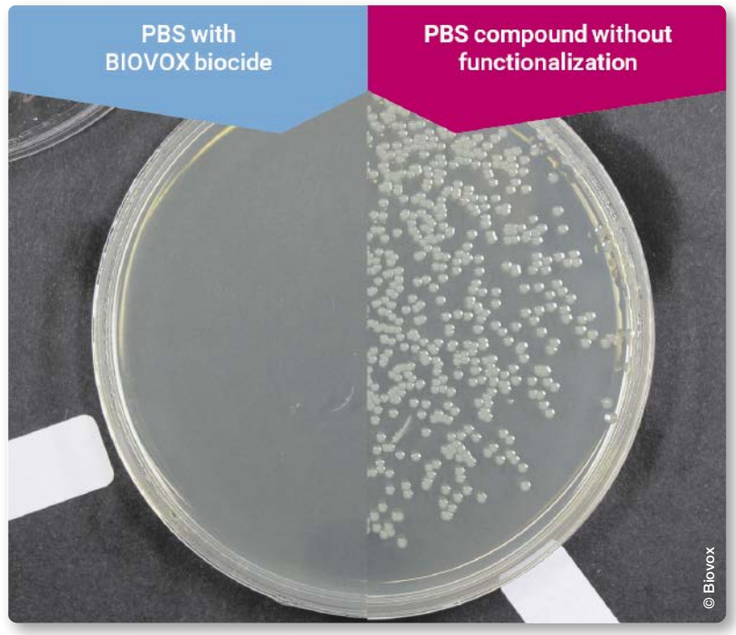
2020:
- Founding of Biovox

2021:
- Market entry of regionally sourced, well compostable bioplastic series Regiogradable
- Prototyping process (3D-printing) for injection-molding and extrusion materials set-up
- Fully compostable and food safe color masterbatches certified and market-ready
- First medical device development projects started

Roadmap

2022:
- Authorization of Biovox antimicrobial additive
- Seed round funding completed
- Onboard Biovox-certified injection-molding and extrusion contract manufacturers
- ISO 13485 certification

2023:
- Release of first Biovox-developed material system for class-II-a medical devices
- Further business expansion



Successful ISO 22196 test of fully biodegradable polybutylene succinate (PBS) functionalized with Biovox biocide against E.coli.

Enabling the Best Possible Drug

Facilitating the Research, Development, and Production of Novel Peptide Drugs

Belyntic is a Berlin-based chemistry-for-healthcare start-up with an innovative peptide manufacturing technology called Peptide Easy Clean (PEC). The company offers the world's first broadly applicable peptide purification kits and services for custom solutions targeting purification and modification of novel peptide therapeutics. These help to develop more complex molecules, personalized medication, and generate productivity gains in pharmaceutical R&D and manufacturing. Oliver Reimann and Andreas Regnery, two of the company's co-founders, explain the idea and the strategy behind Belyntic.

Oliver Reimann, Belyntic

Andreas Regnery, Belyntic

CHEManager: How did it all start?

Oliver Reimann: Robert Zitterbart, Dominik Sarma, and I studied chemistry together at Humboldt University. By the end of our PhD, we asked ourselves what options we had for our professional career? The idea of founding a company popped up. We liked the idea and attended founding classes where we developed the concept of an alternative way of purifying peptides. The status quo using chromatography was everyday business in our research, and we knew its drawbacks: it is slow, consumes an incredible amount of solvent, and requires extensive method optimization. So, our mission was clear: We needed to change that and applied for a federal fund called „EXIST Forschungstransfer" to develop Peptide Easy Clean, short PEC. We got the grant and completed our founders team with economist Andreas Regnery. Today we have five additional employees.

What makes PEC so unique?

O. Reimann: First, it's essential to understand that the purification of chemically synthesized peptides is vital during production. It adds a significant amount of cost and time to the overall process of manufacturing R&D peptides, clinical-grade peptides, and approved peptide drugs. Hence, the HPLC bottleneck applies along the whole value chain. PEC is an entirely new way of purifying peptides. It relies on a proprietary linker molecule to catch the target peptide from its crude mixture with a covalent chemical bond on a solid purification media. The user then washes off impurities and can even apply solid-phase modifications. The molecule is tracelessly cleavable, whereupon the purified peptide is released. This concept is called catch-and-release. Now, in contrast to HPLC, the user can run this method in parallel, for example, in 96-well filter plates, opening doors for high-throughput manufacturing of purified peptides during drug discovery. The modification feature can help to speed up optimizations of the drug candidate. Moreover, PEC reduces the amount of solvent by more than 75%.

What's your biggest challenge to master?

Andreas Regnery: We currently see no generally applicable, alternative catch-and-release system on the market. Therefore, the biggest obstacle is to convince people to switch to another technique than they are used to. Our customers have used HPLC for decades. The method, even with the related drawbacks, is an integral part of their processes. This challenge holds true for custom synthesis service providers as well as for manufacturers of peptide drugs.

How do you plan to turn your innovation into a new standard?

A. Regnery: We have a strong focus on the R&D market. That is, we try to establish the technology early in the value chain. A potential candidate will then mature alongside a beneficial use of PEC for its manufacturing. We see a strong pipeline of new peptide drugs in preclinical stages and hence are confident that we will diffuse into the later stages of the value chain effectively. Additionally, we have launched projects to create novel peptide vaccines to showcase our technology's platform character and market matureness in the pharmaceutical value chain.

How did the Corona crisis hit your business?

O. Reimann: When the first cases of Covid-19 occurred in Europe in February 2020, we increased the home office hours for our lab staff where possible and switched to virtual meetings.

We also tried to anticipate the scientific discourse and evolvement of the vaccine pipeline. And indeed, we identified a perfect match: Peptide-based vaccines must be delivered together with an immune-potentiating agent—a so-called adjuvant. Coupling the adjuvant to the peptide and forming a self-adjuvant peptide can significantly improve the efficacy. However, until today, peptide and adjuvant are typically added in a mixture because conjugation was a major synthetic obstacle, leading to insufficient immunogenicity. We knew that our modification approach could solve this problem, and we started working on PEC as a platform to generate better antiviral agents. We recently secured funding of €700,000 to use the platform technology for developing a peptide-based therapeutic vaccine against a rare, but fatal disease called progressive multifocal leukoencephalopathy (PML).

Personal Profiles

Oliver Reimann, co-founder of Belyntic, studied chemistry at the Free University of Berlin and completed his PhD under Prof. Christian Hackenberger at the Leibniz Institute for Molecular Pharmacology Berlin. Partially funded by the Fonds of the Chemical Industry, he was working in the very dynamic field of Alzheimer's Disease related research in the area of peptide & protein chemistry. At Belyntic, Reimann is responsible for the PEC-Linker production and he is leading the ImmunoPEC platform development.

Andreas Regnery, co-founder and one of the managing directors of Belyntic, studied business administration with a minor in electrical engineering at TU Kaiserslautern which he completed with a diploma thesis on the compatibility of sustainability and shareholder value. After that, he worked for several years as a consultant and lecturer for an SME-focused management consultancy. Regnery therefore brings in-depth experience in corporate finance, strategic business management and business model development. He is leading the financial and HR activities of Belyntic.

Business Idea

A Unique Razor & Blade Model

Belyntic is a chemistry-for-healthcare startup from Berlin, Germany. It aims to transform the discovery, development, and manufacturing of better peptide-based therapeutics with its proprietary and unparalleled peptide manufacturing technology Peptide Easy Clean (PEC).

PEC relies on a single first-in-class cleavable molecule, developed and patented by Belyntic: the PEC-Linker. Its use grounds on a revolutionary catch-and-release concept to purify and modify chemically synthesized peptides.

Customers can benefit from significant time and cost savings using PEC in their processes, from R&D to production.

- Parallel peptide purification in high throughput enables validation of drug discovery hits and fast, affordable manufacturing of neoantigens for personalized anticancer immunotherapies.
- Complex peptide modifications become feasible, enabling companies to develop the most efficient drug.
- PEC saves a significant amount of organic solvents for the larger-scale manufacturing of peptides, cutting down the overall costs and improving the ecological footprint of peptide drug manufacturing.

A Mature Plaftorm Technology

Belyntic has built a high-level expert team in peptide chemistry during its seed financing stage since the foundation in May 2018.

Belyntic builds its business model on selling the PEC-Linker for peptide manufacturing along the entire pharmaceutical value chain. The easy integration of the PEC-Linker into process workflows and instruments allows quick and low-cost implementation of PEC in the customer's manufacturing setup („Razor"). To run his operations, the customer purchases the PEC-Linker as a consumable („Blade").

For fast business growth within the market segments of R&D and production of peptide-based drugs, Belyntic has established a strong global sales network with distribution and OEM partners.

- Belyntic GmbH, Berlin, Germany
  https://belyntic.com

Belyntic

Elevator Pitch

Enabling the Best Possible Drugs

The exploration of peptides has led to many life-saving therapeutics. Moreover, as the building blocks of viral protein envelopes and particular antigens on cancer cells, peptides have become an essential part of the research and development (R&D) for immunotherapeutic treatments.

Yet, high-throughput manufacturing during drug discovery and chemical modification for enhanced drug efficacy are unsolved critical-to-success challenges.

Belyntic offers a proprietary technology that can help overcome this bottleneck to unlock the full potential of peptide development.

Milestones

2016:
- The founders secure €700,000 pre-seed money from the EXIST Transfer of Research program to develop the PEC technology

2018:
- Foundation in May by Oliver Reimann, Robert Zitterbart, Dominik Sarma and Andreas Regnery

2019:
- Completion of €1.3 million seed financing round with public funding from Investitionsbank Berlin (IBB) and equity contributions from High-Tech Gründerfonds (HTGF) and business angel Till Knorr

2020:
- Belyntic is one of the winners of the Innovation Award Berlin-Brandenburg

2021:
- The Federal Agency for Disruptive Innovation (SPRIN-D) finances the development of a peptide-based antiviral therapeutic vaccine against progressive multifocal leukoencephalopathy (PML) using Belyntic's platform technology

Roadmap

2022:
- Develop strategic alliances to ramp up PEC-Linker sales
- Provide proof-of-concept for PML vaccine

2023:
- Establish new industry standards through PEC-assisted, regulated production processes
- Complete preclinical studies with PML vaccines

2024:
- Break-even with PEC-Linker sales
- IND-filing for PML vaccine

The Belyntic team in front of the headquarters in Berlin-Adlershof. The company's vision is to transform discovery, development, and production of novel peptide therapeutics for a healthier life.

Belyntic's Peptide Easy Clean (PEC) technology relies on a proprietary single first-in-class cleavable linker. It uses a revolutionary catch-and-release concept to purify and modify chemically synthesized peptides.

Providing Circular Side Stream Solutions

Purifying Water and Recovering Materials with Mobile and Modular Installations

InOpSys, created in 2015 as a spin-off from the KU Leuven University, Belgium, is committed to providing on-site circular side stream solutions for the chemical and pharmaceutical industry, by building and operating mobile & modular purification installations on the customer site. Using a train of selective technology combinations, the start-up company efficiently closes water and material loops and helps the industry reach their sustainability goals by reducing waste and CO_2 emissions. The customers are unburdened as InOpSys takes ownership from start to finish and offers its service in a CAPEX-free way. Steven De Laet, founder and CEO of InOpSys, talks about his past and future journey.

Steven De Laet, InOpSys

Personal Profile

Steven De Laet, CEO and founder of InOpSys, graduated as a Master of Science in Chemical Engineering at the KU Leuven University in 2000. During his professional career he worked for companies like Bayer, BASF, ArcelorMittal, and Mondi. He also gained an executive international MBA at the Vlerick Management School (2008–2010). In 2012 he started taking his first entrepreneurial steps towards solutions for a more sustainable chemistry, with the creation of AvoRe. This was the foundation for the birth of InOpSys in 2015 which originated within the Flemish Catalisti spearhead cluster..

CHEManager: You founded InOpSys six years ago. What was your motivation to start the company?

Steven De Laet: During my career, for a large part in the chemical industry, I realized that linear destruction is a common way of processing waste or side streams. During industrial production, hazardous and toxic streams are produced. Incineration of these streams is often considered the best available technology. Imagine; we are facing global water and material scarcity and increasing pollution, and yet streams are integrally incinerated, putting extra pressure on our environment. We believe that both the water and valuable elements can be recovered by introducing circular solutions. We refused to accept the status quo and wanted to make a difference.

What is the USP or differentiating feature of InOpSys?

S. De Laet: InOpSys offers solutions that reduce CO_2, waste and associated costs and create value by the recovery of materials, e.g., precious metals like palladium or platinum.

We chose a decentralized model, creating installations on-site, close to the side stream source. This enables us to work with unmixed and defined streams, and to avoid transport as a plus.

We finance the installation via a pay-per-use model, which spares our customers an investment which is not interesting enough according to their own return-on-investment guidelines. At the end of the contract period, we take back the mobile installation and reuse it for another project.

InOpSys is a one-stop shop for the industry, because we do not focus on a single technology, but on a hybrid combination of different technologies.

What kind of support did you receive, and which obstacles did you have to master so far?

S. De Laet: At the time of the spin-off in 2015 we had the support of our first shareholders, who also provided the starting capital. The InOpSys concept originated within the Flemish Catalisti spearhead cluster, built on partnerships with research institutes, companies, the Belgian Chemical & Life Sciences Association and governments. This was an interesting ecosystem for InOpSys.

Financing the model, which requires a lot of capital and R&D, was a challenge because we had not yet been able to prove our technology on a large scale. Convincing the first customer to work with InOpSys on a circular project was also a big hurdle, because the chemical and pharmaceutical sectors are risk-averse in terms of new processes and suppliers.

When did the company enter the growth phase, and where are you now?

S. De Laet: Ever since our first successful installation at Janssen Pharmaceuticals—part of J&J—in Geel in 2017, which was awarded with the first prize at the Belgian Business Awards for the Environment in 2018, the ball started rolling faster. Thanks to this reference, we could convince new customers like Ajinomoto Bio-Pharma Services that we have the required expertise. We currently have five long-term installations running at different locations of two multinational customers. This obviously had a positive impact on our turnover, which has approximately doubled year by year.

> *"We refused to accept the status quo and wanted to make a difference."*

In 2018 and 2020, new rounds of investment funding took place, when we welcomed new shareholders. By 2018 our headcount had risen from two to seven, and currently we are 16.

In 2020, we expanded our R&D facilities to the BlueChem Incubator in Antwerpen, using state-of-the-art laboratories and extra office space.

What have been the most exciting projects so far?

S. De Laet: After our first award-winning project in 2017, we have developed five other installations for multinational customers. A number of these projects are focused on a combination of active-pharmaceutical-ingredient removal and metal recovery—e.g., precious metals—from water and solvent streams. The newest and biggest installation removes 23 APIs out of the process streams of a large formulation site for different medicines. This project was attributed the "Solar Impulse Efficient Solution" Label in 2021.

What will be the next steps to develop InOpSys?

S. De Laet: Today, InOpSys has taken good steps forward and is ready to expand to other European countries. Because we work for multinational companies, we must follow them wherever they have a presence. We are also excited about an interesting shift, where an existing customer has entrusted us to build an installation for the treatment of a product stream instead of a waste stream. This opens a completely new market for us.

Business Idea

Missing Link to Close the Loop

InOpSys is committed to providing circular waste or side stream solutions for the chemical and pharmaceutical industry by building and operating mobile and modular purification installations on the customer site. Using a train of selective technology combinations, the company efficiently closes water and material loops, thus, helping the industry reach their sustainability goals by reducing waste and CO_2 emissions.

The costs associated with waste and emissions can, thus, be reduced and value can be created by the recovery of materials, e.g., precious metals like palladium (Pd) or platinum (Pt).

InOpSys uses a decentralized model, creating installations on-site, close to the side stream source. This allows working with unmixed and well-defined side streams and avoids transport as a plus.

The Belgian company is a one-stop shop for the industry, because it does not focus on one single technology, but on a hybrid combination of different technologies. Thanks to this "relay team" of technologies, very high removal rates can be achieved in a more efficient way compared to mono-technology solutions. This also allows InOpSys to remove pollutants in a selective way, leaving easily biodegradable components untouched.

The experts tailor each installation to the specific aspects of the side stream. Every project starts with an in-depth analysis of the challenge by the InOpSys chemists, who determine the applicable technologies at lab scale, with a proof of concept as a result. Afterwards the Engineering team takes over, who eventually ensure that the mobile unit gets built, operated, and maintained on-site.

The customers are unburdened as InOpSys takes ownership from start to finish and offers its service in a CAPEX-free way. InOpSys finances the installation via a pay-per-use model, which spares customers an investment not interesting enough according to their internal return-on-investment guidelines. In summary: InOpSys designs, builds, finances, operates, and maintains (DBFOM) the circular solution.

- InOpSys NV, Mechelen, Belgium
  www.inopsys.eu

INOPSYS
SIDE STREAM SOLUTIONS

Elevator Pitch

Not Accepting the Status Quo

InOpSys was founded in 2015 in Belgium with the ambition to create an alternative to linear destruction, which is a common way of processing industrial waste or side streams. In times of water and material scarcity and increasing pollution, InOpSys—by now a scale-up company rather than a start-up company—wants to do better by introducing solutions to recover both clean water and valuable materials. InOpSys builds and operates mobile and modular purification installations on the customer site, helping the industry reach their sustainability goals by reducing waste, water consumption and CO_2 emissions.

Milestones

2015:
- Creation of InOpSys NV
- First round of investment funding with Gemma Frisius fund and Innovation Fund

2016-2017:
- First contract with J&J
- First installation operational

2018:
- First prize at the Belgian Business Awards for the Environment
- Round of investment funding: entry of new shareholders VMH/PMV
- Headcount increased from 2 to 7

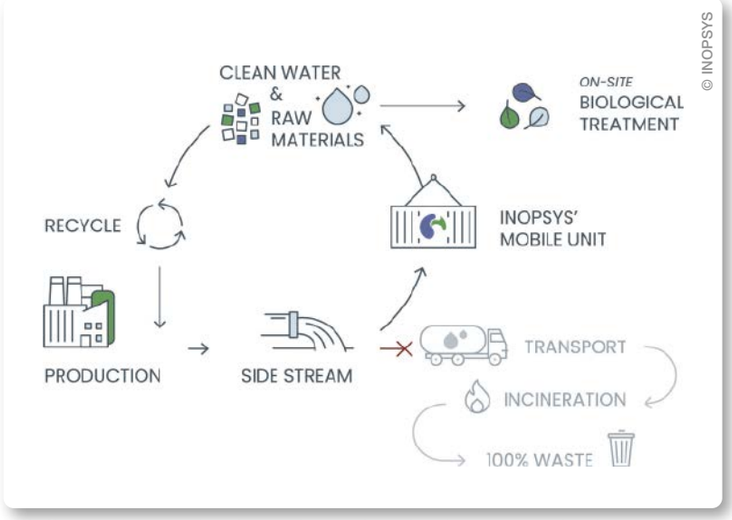
2019:
- Two new installations operational

2020:
- Expansion to the BlueChem Incubator in Antwerp, Belgium
- Round of investment funding: entry shareholders ALIAD (Air Liquide) and Telos Impact

2021:
- Headcount increased to 16
- New API removal (PIE free) installation operational: largest one so far
- "Solar Impulse Efficient Solution" Label for latest API-removal installation

Roadmap

2022-2023:
- Creation of entities in other European countries (e.g., Switzerland)
- New round of investment funding to support global growth
- Roll-out of existing concepts to other countries
- Development of new concepts (e.g., removal of PFAS, EDC)



InOpSys has the ambition to create an alternative for linear destruction, providing circular side stream solutions for the industry, by building and operating mobile installations.

One of the running on-site installations recovers valuable palladium, used as a homogeneous catalyst by the customer, and purifies the wastewater, closing the loops.

ChemOutsourcing 2022

ChemOutsourcing, to take place on February 7–8, 2022, in Parsippany, New Jersey/USA, is the largest USA-based API show. It focuses on API development spanning early drug discovery through chemical development and commercial supply. Attendees are executive scientist "buyers" from pharmaceutical companies responsible for sourcing starting materials, intermediates, active ingredients, and commercial supply and experienced in working with CDMOs.
www.chemoutsourcing.com

Specialty & Custom Chemicals Show 2022

The event owned by the Society of Chemical Manufacturers & Affiliates (SOCMA) and organized in collaboration with Chemicals America will take place at Fort Worth, Texas, on Feb. 28–Mar. 2, 2022. It features almost 1,300 attendees and more than 200 exhibiting companies. The show welcomes participants across the full specialty and custom chemical supply chain, while featuring exhibitors with manufacturing, service or sales operations based within North America.
https://texas.chemicalsamerica.com

Achema 2022

Achema, to take place on April 4–8, 2022, in Frankfurt, Germany, is the world forum for chemical engineering, process engineering and biotechnology. Manufacturers and service providers from over 50 countries present their products for chemical, pharmaceutical and biotech research and manufacturing as well as energy and environmental services. The accompanying congress features scientific lectures and numerous guest and partner events.
www.achema.de/en

Chemspec Europe 2022

Chemspec Europe is to take place from May 31– June 1, 2022, in Frankfurt, Germany. The event is the key platform for manufacturers, suppliers and distributors of fine and specialty chemicals to showcase their products and services to a dedicated audience of professionals in the industry sector. The product portfolio of this event covers fine and specialty chemicals for various industries. Conferences presenting the latest results of ongoing R&D projects round-off the show.
www.chemspeceurope.com

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