Large Industrial Plant Manufacturers' Group

Status Report 2021/22

Decarbonization – Shaping the change with large industrial plant manufacturing

Figure 1

Large industrial plant manufacturing in figures

billion euro

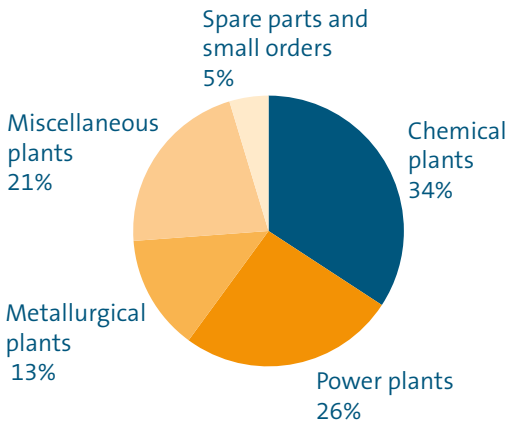
	2017	2018	2019	2020	2021	Change 2021/2020
Order intake (total)	17.8	18.3	18.3	11.9	21.2	78,1 %
Domestic orders	3.8	3.5	3.6	3.2	3.2	-0,9 %
Foreign orders	14.0	14.8	14.7	8.7	18.0	107,8 %
thereof						
Eastern Europe and CIS	1.8	4.3	2.4	2.3	6.9	196,4 %
Industrialized states	4.5	4.1	5.1	2.6	3.8	46,8 %
Asia-Pacific region	3.5	2.2	3.7	1.9	3.6	90,7 %
Near and Middle East	1.4	2.1	1.4	0.6	1.2	90,8 %
Rest of the world	2.9	2.2	2.2	1.2	2.4	102,1 %
Revenue	21.2	18.6	16.3	16.3	13.3	-18,5 %
Export share (in %)	78.9	81.0	80.6	72.7	84.8	
Customer countries	112	111	103	116	118	
Employees (in Germany and Austria)	55,900	54,100	53,800	48,600	50,360	3,6 %

Source: VDMA Large Industrial Plant Manufacturers' Group

Figure 2

Order intake by segments 2021

per cent

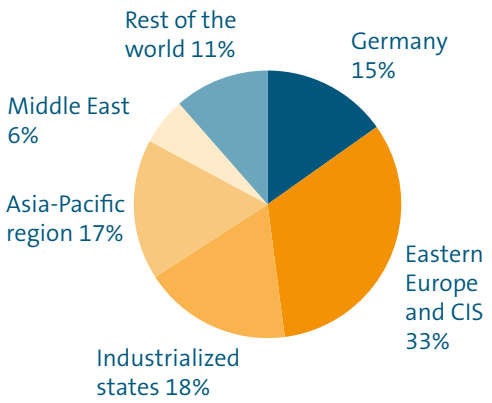


Source: VDMA Large Industrial Plant Manufacturers' Group

Figure 3

Order intake by regions 2021

per cent



Source: VDMA Large Industrial Plant Manufacturers' Group

Large Industrial Plant Manufacturing – Portrait of a global industry

Large industrial plant manufacturers are defined as companies capable of processing one or more large-scale projects a year with a volume of at least 25 million euro each year. They must have the comprehensive expertise necessary to handle all aspects of the entire project, including the planning and engineering of the plant as well as the sourcing of the equipment, along with delivery, installation and start-up. Manufacturers of power stations, steelworks and chemical plants are all good examples for large-scale plant engineering companies. Each project takes an average of between two and three years to complete, with contract volumes frequently over 100 million euro and in exceptional cases even over one billion euro.

The large industrial plant manufacturing industry is a major sector of the German economy with an average annual order volume of 17 billion euro (average 2019 to 2021) and a world market share of roughly 15 percent. The branch has 50,000 high-qualified employees in Germany and Austria, and it generates also valuable impetus for the medium-scale mechanical engineering sector as a whole: subcontracted services and supplied components account for around 75 percent of its total volume and there are more than 100,000 additional jobs at subcontractors depending on the different projects. The large-scale plant engineering contractors in the VDMA maintain business ties with customers in all parts of the world and in recent years they have delivered around four fifths of their output abroad. China, Russia, the US and India are at the moment the key customer countries. Opening up new markets, the large industrial plant engineering industry contributes considerably to the expansion of Germany's international economic relations. Frequently, the branch is pioneer as to the emerging markets' industrial development and at the same time pathfinder for the succeeding export industry.

Large-scale industrial plant manufacturers build facilities for many different industries, including the installations upon which we depend for our basic daily needs. These are factories for food, textiles and construction materials, power stations, drinking water plants and sewage treatment plants. Plants for the extraction and processing of the minerals make it possible to make industrial use of raw materials. Modern, high-end infrastructure and industrial manufacturing facilities provide the foundations for economic progress and prosperity. Large-scale plant engineering contractors also build factories for manufacturing advanced industrial products like pharmaceuticals, semi-conductors, energy storages and renewable fuels.

In all industries companies of the VDMA Large Industrial Plant Manufacturers' Group set the standards for productivity and energy efficiency, and for both integrated and end-of-pipe environmental protection. The companies active in this sector all have a strong focus on technology and are highly globalized. They are operating both on markets with constant and with increasing demand. Hence, large plant engineering is – in the long run – a value-creating branch that is influenced only to a minor degree by short-lived trends as frequently observed in the consumer goods industry or on financial markets.

Members of the VDMA Large Industrial Plant Manufacturers' Group

(Status: May, 2022)

ABB AG	Mannheim
ACHENBACH BUSCHHÜTTEN GMBH & CO KG	Kreuztal
AIR LIQUIDE GLOBAL E&C SOLUTIONS GERMANY GMBH	Frankfurt on the Main
ALD VACUUM TECHNOLOGIES GMBH	Hanau
ANDRITZ AG	Vienna, Linz, Ravensburg
BOSCH REXROTH AG	Lohr on the Main
BMA BRAUNSCHWEIGISCHE MASCHINENBAUANSTALT AG	Braunschweig
CATERPILLAR MOTOREN GMBH & CO KG	Kiel
CHEMIEANLAGENBAU CHEMNITZ GMBH	Chemnitz
CLAUDIUS PETERS PROJECTS GMBH	Buxtehude
COPERION GMBH	Stuttgart
DIEFFENBACHER GMBH MASCHINEN- UND ANLAGENBAU	Eppingen
DÜRR SYSTEMS AG	Bietigheim-Bissingen
FRIEDRICH KOCKS GMBH & CO KG	Hilden
GE BOILER DEUTSCHLAND GMBH	Stuttgart
GE POWER SYSTEMS GMBH	Mannheim
HUMBOLDT WEDAG GMBH	Cologne
JUNGHEINRICH LOGISTIKSYSTEME GMBH	Moosburg
JOSEF MEISSNER GMBH & CO KG	Cologne
KRAUSSMAFFEI EXTRUSION GMBH	Hannover
KRONES AG	Neutraubling
KUKA SYSTEMS GMBH	Augsburg
LINDE GMBH, LINDE ENGINEERING	Pullach
MAN ENERGY SOLUTIONS SE	Augsburg
MARTIN GMBH FÜR UMWELT- UND ENERGIETECHNIK	Munich
MITSUBISHI POWER EUROPE GMBH	Duisburg
OERLIKON MANMADE FIBERS	Remscheid
OUTOTEC GMBH & CO KG	Oberursel
PRIMETALS TECHNOLOGIES AUSTRIA GMBH	Linz
REEL MÖLLER GMBH	Pinneberg
SIEMENS AG, PROCESS INDUSTRIES AND DRIVES	Erlangen
SIEMENS ENERGY GLOBAL GMBH & CO. KG - SOLUTIONS	Erlangen
SIEMPELKAMP MASCHINEN- UND ANLAGENBAU GMBH	Krefeld
SMS GROUP GMBH	Düsseldorf, Hilchenbach, Mönchengladbach
T.EN ZIMMER GMBH	Frankfurt on the Main
TGE GAS ENGINEERING GMBH	Bonn
THYSSENKRUPP INDUSTRIAL SOLUTIONS AG	Essen, Dortmund, Bad Soden
VOITH GMBH & CO KGAA	Heidenheim
ZEPPELIN SYSTEMS GMBH	Friedrichshafen

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Preface

Returning to growth, the global economy had to overcome numerous obstacles, such as restrictions on the freedom to travel, increasing geopolitical tensions and rising prices for energy and raw materials. In many countries, however, the pre-crisis level was reached again faster than initially thought possible. In this environment, the members of the VDMA Large Industrial Plant Manufacturers' Group (AGAB) were able to book orders worth 21.2 billion euro at their European headquarters in 2021, an increase of 78 percent compared to the previous year (2020: 11.9 billion euro), which was very weak due to the pandemic.

The driving force behind this upswing was foreign demand. Numerous large orders for power stations, chemical plants and steel mills triggered a rising demand for skilled workers. Russia, a core market for large-scale plant construction, was the most important customer country worldwide in 2021 with bookings of 6.3 billion euro. Following the outbreak of the war between Russia and the Ukraine and the unforeseeable further developments in economic and political relations with Russia, the implementation of many large-scale projects is however significantly in question.

The large-scale plant engineering sector is a major supplier to many greenhouse-gas intensive industries, such as the chemical, steel and cement sectors, which together are responsible for over 20 percent of global CO_2-emissions. This offers members of AGAB opportunities to bring new industrial plants and technologies to the market to encourage customers to use raw materials more efficiently. Large-scale plant construction is thus a catalyst of the global energy and mobility transition and makes a significant contribution to the socially desired goal of sustainability.

A major challenge for the industry remains the high speed of change in the global economy. The increasing competition with Asia and the huge financing needs for climate transformation are offset by a rather slow adjustment of the regulations for export and project financing. The VDMA Large Industrial Plant Manufactures' Group therefore supports the German government and the EU in their efforts to fundamentally reform the OECD consensus and offers its practical expertise to join forces at European and international level to establish a level playing field.

Frankfurt, May 2022

Spokesman

Jürgen Nowicki

Managing Director

Thomas Waldmann

Executive summary

Economic situation 2021

- The members of the Large Industrial Plant Manufacturers' Group (AGAB) registered orders worth 21.2 billion euro at their headquarters in 2021. This is a growth of 78 percent compared to the previous year's level of 11.9 billion euro, which was very weak due to the pandemic.
- The driving force behind this upswing was the export business. Foreign orders rose by 108 percent to 18.0 billion euro (2020: 8.6 billion euro). A large part of this volume was due to major orders. In the reporting period, there were 125 major projects worth 13.7 billion euro (2020: 70 projects worth 5.5 billion euro).
- Domestic demand stagnated at 3.2 billion euro. Demand for power plants even fell to its lowest level in decades. The nuclear phase-out, the foreseeable end of coal-fired power generation and the uncertain future of natural gas as an energy source are major reasons for the reluctance to invest in thermal power generation.

General market environment

- Competitive pressure in the market for large-scale plants eased last year due to the improved order situation. China is considered the most important international competitor; In particular, companies from the People's Republic are increasingly exporting plants for the generation of renewable energies.
- Shortages of supplies and tensions in global supply chains are leading to delays in project execution. The large-scale plant construction industry is reacting to these bottlenecks by readjusting its supply chain and turning to procurement markets that have received little attention so far.
- Stringent climate policy frameworks offer opportunities for large-scale plant engineering to bring resource-saving plants and technologies to the market. Examples include plants for CO_2-free energy generation, for the recycling of reusable materials and for synthetic fuels. The industry is thus a pioneer of the global energy and mobility transition and makes significant contributions to society's goal of sustainability.

Trends in the companies

- The members of AGAB set themselves ambitious sustainability goals: In addition to their headquarters and subsidiaries, the supply chain should also become climate neutral. Since the share of suppliers in large-scale plant construction is over 50 percent on average for all projects, there is still a lot of potential in the global supply chain to become more sustainable.
- The way projects are handled has changed fundamentally over the past two years. Technology-driven solutions have emerged as an alternative to face-to-face contact: Remote commissioning, remote maintenance, virtual audits and virtual customer journeys as well as the use of robots and drones on construction sites are the new normal and could become even more important in the future.
- Currently, the large-scale plant engineering sector employs 50,400 people at its headquarters in Austria and Germany, which is around 1,800 more than in the previous year (2020: 48,600). In addition, there are another 55,000 employees abroad. To be successful in recruiting skilled personnel, various strategies are used. In addition to classic approaches such as in-house training, job fairs and the use of head-hunters, some companies have been successful by addressing career changers or university dropouts.

Policy Positions

- The war against Ukraine is already having a considerable impact on the project business of large industrial plant manufacturing in Russia, but also in Belarus and Ukraine. The consequences of the national and international sanction packages, which are also supported by the VDMA, in terms of new business and the processing of old orders cannot yet be predicted with any degree of certainty.

- A major challenge for foreign trade promotion remains the high speed of change in the global economy. The increasing competition with Asia and the huge financing requirements for climate transformation are still being offset by the slow development of export credit insurance and financing regulations. The VDMA Large Industrial Plant Manufacturers' Group therefore supports the German government and the EU in their efforts to fundamentally reform the OECD consensus: a level playing field on the world markets must be created quickly with combined European and international forces.

- For years, the VDMA has been pointing out the increasing risk of double taxation. The German government now wants to expand withholding taxes to reduce this risk - in practice, however, this measure usually has the opposite effect, especially when it comes to the taxation of technical services. The Companies already face additional burdens because Germany does not offset the same amount of withholding taxes already paid in the project country when taxing foreign projects on the basis of the previous double taxation agreements. The VDMA therefore calls on the German government to eliminate the discrepancy between tax payments and tax credits.

- Furthermore, the 12-month period for construction and assembly permanent establishments proposed in the OECD Model Convention is a decisive factor for the competitiveness of companies. While most foreign permanent establishments last up to 18 months, there are many terms of six to 12 months in medium-sized plant manufacturing. A reduction of the time limit would not only trigger a shift of German tax revenue to the countries of operation but would also mean an enormous increase in organisational costs for affected companies and increase the pressure to relocate entrepreneurial activities to the target countries.

Outlook 2022

- At the beginning of the year, companies were still confident that the recent positive market trend would continue in 2022. Almost all members of AGAB expected constant or even rising sales and order intake.

- One the one hand, this optimism was based on the fact, that in the current market environment solutions for more sustainability are particularly important. On the other hand, owners of large-scale plants are increasingly asking for services. Many members are taking advantage of the resulting opportunities and expanding their service business, which already contributes 30 percent to turnover.

- The global turning point caused by the Russian attack on the Ukraine and the serious consequences of the mutual economic sanctions could mean that the forecast from January prove to be too optimistic. Right now, around three quarters of all large-scale plant manufacturers are reporting interruptions in ongoing projects in Russia and Ukraine and the loss of important suppliers. This dampens expectations regarding order intake until the end of 2023.

Business development

In 2020, the VDMA's large-scale plant engineering sector recorded the sharpest drop in orders since statistical surveys began in 1969. In 2021, the situation has improved noticeably. The members of the Large Industrial Plant Manufacturers' Group (AGAB) registered orders worth 21.2 billion euro at their headquarters in Germany and Austria, an impressive increase of 78 percent compared to the previous year (2020: 11.9 billion euro), which was very weak due to the pandemic.

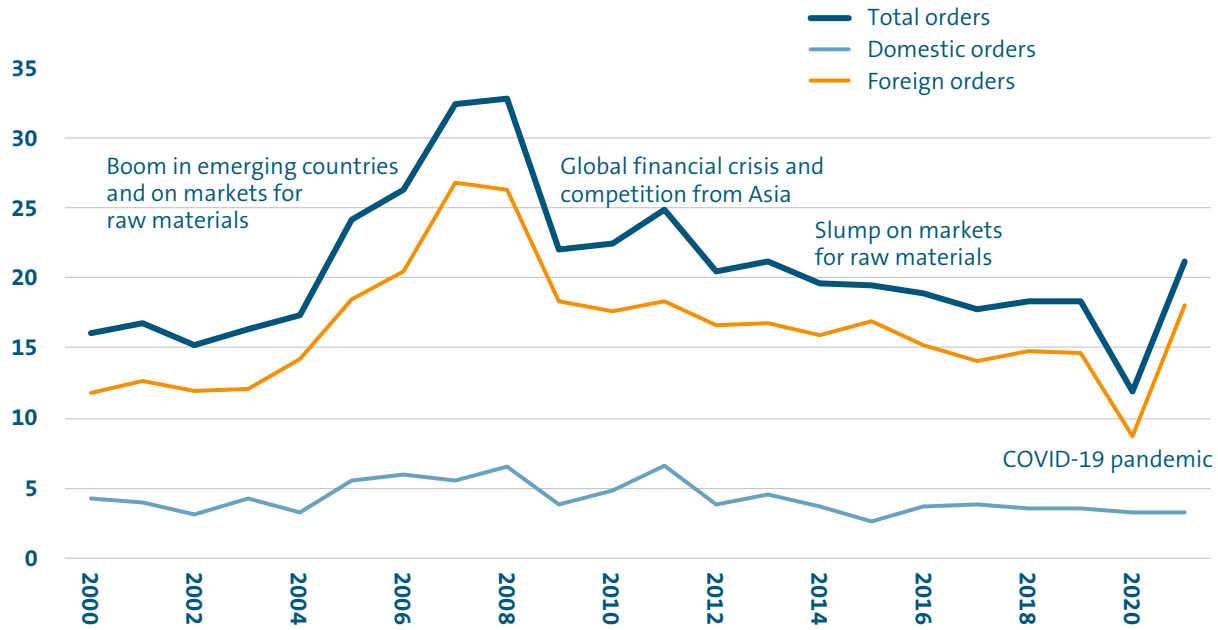
The driving force behind this upswing was foreign business with an export ratio of almost 85 percent. Numerous large orders from emerging countries, e.g. for power plants, paper mills and chemical plants, ensured high capacity utilisation and triggered an increasing demand for skilled labour. At the same time, orders for state-of-the-art industrial plants that enable sustainable production and protect the environment also increased.

Turnover fell by 19 percent to 13.3 billion euro in 2021 (2020: 16.3 billion euro) as result of weak incoming orders from the first year of the pandemic. In view of the long-term nature of the business, this key figure predominantly reflects orders from previous years. As such, turnover in large-scale plant construction is unsuitable as an indicator for assessing the current market development and is not considered in the following.

Figure 4

Order intake in large industrial plant manufacturing 2000 – 2021

billion euro

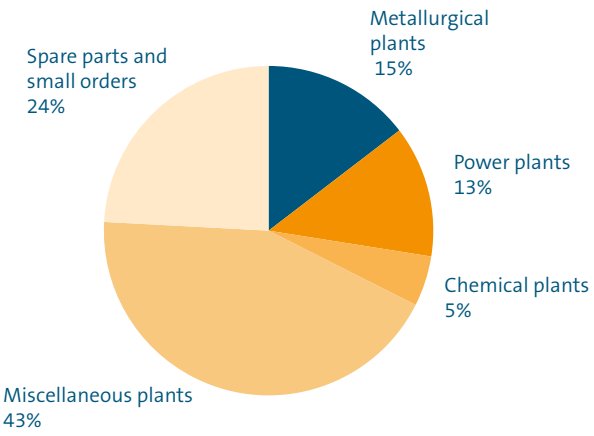


Source: VDMA Large Industrial Plant Manufacturers' Group

Figure 5

Domestic incoming orders by segments 2021

per cent



Source: VDMA Large Industrial Plant Manufacturers' Group

Domestic orders stable at a low level

Domestic orders were unchanged at 3.2 billion euro in 2021. In a long-term view, incoming orders are thus 11 percent below the average of the last decade (2012 to 2021: 3.6 billion euro); compared to the record year 1993 (7.4 billion euro), demand has even dropped by almost 60 percent.

In power plant construction, domestic orders fell to their lowest level in decades during the reporting period. The imminent nuclear phase-out, the foreseeable end of coal-fired power generation and uncertainties about the future of natural gas as an energy source are major reasons for the reluctance to invest in the thermal power generation sector. In addition, significant declines in orders were also recorded in chemical plant construction (- 70 percent) and for electrical equipment (- 15 percent).

In metallurgical plant construction orders reached 470 million euro in 2021 (2020: 128 million euro), the highest value since 2011. The reason for this increase were several large orders, including an order for an annealing and insulating line for electrical steel. The plant is to produce over 200,000 tonnes of electrical steel annually, which is mainly used to manufacture electric motors and generators for electric cars.

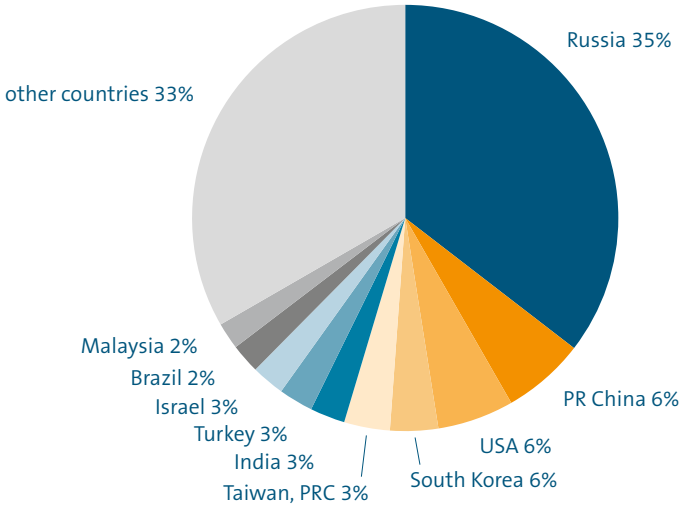
Foreign business soars thanks to major orders

There was a very strong upturn in foreign business in 2021. Incoming orders rose by 108 percent to 18.0 billion euro (2020: 8.6 billion euro). Eastern Europe and the CIS states recorded the highest growth, with orders from the Asia-Pacific region and the Near and Middle East also increasing strongly. The export ratio rose to 85 percent in the reporting period (2020: 73 percent).

Figure 6

Foreign incoming orders by countries

per cent



Source: VDMA Large Industrial Plant Manufacturers' Group

A large part of the foreign orders is due to the large orders worth more than 25 million euro, which are particularly important for the companies' capacity utilisation. In the reporting period there were 125 such projects with a total volume of 13.7 billion euro (2020: 70 major projects worth 5.5 billion euro). Some of these orders are due to projects that were originally planned for 2020 but had to be postponed to the following year due to the pandemic.

In the course of this recovery, the members of AGAB have increased their staff. Currently, the companies employ 50,400 people at their headquarters, which is about 1,800 more than in the previous year (2020: 48,600). The ratio of employees with an engineering degree was 39 percent (2020: 35 percent).

Record orders from Eastern Europe and the CIS

Customers from Eastern Europe and the CIS – these are the Eastern European EU members as well as the countries of the Balkans and the former Soviet Union – placed orders worth 6.9 billion euro in 2021 (2020: 2.3 billion euro). The previous record value from 2008 of 4.3 billion euro was thus exceeded by 60 percent.

Russia is traditionally the core market for large-scale plant construction in the region and was the most important customer country worldwide in the reporting period with bookings of 6.3 billion euro (2020: 1.6 billion euro). 95 percent of this volume came from large-scale projects in the chemical, energy and steel sectors, including mega orders for the construction of a gas processing plant and a plant for liquefied gas. However, following the unprecedented economic sanctions imposed on Russia by the EU, the USA and other countries, the execution of these projects is subject to considerable reservations.

Moderate increase in demand in the industrialized countries

New orders from the industrialised countries – by which this report means the countries of Western Europe and North America as well as Australia, New Zealand, Japan and South Africa – rose by 47 percent to 3.8 billion euro in the reporting period (2020: 2.6 billion euro). Despite this increase, the industrialized countries thus lagged behind both the growth rates in other regions and their average pre-Covid level of 4.5 billion euro.

The most important market in terms of order intake was Western Europe. Here, AGAB members recorded significantly more orders than in the previous year in countries such as France (359 million euro; plus 132 percent), the UK (328 million euro; plus 146 percent) and Italy (311 million euro; plus 136 percent). The largest single order was reported from Greece. There, an AGAB member is building a new combined-cycle gas turbine power plant with an installed electrical capacity of 877 megawatts (for more details see page 33).

In North America, 2021 demand increased by 57 percent to 1.1 billion euro (2020: 702 billion euro). However, the value of these orders is below the last pre-pandemic year (2019: 1.7 billion euro), which was characterised by a boom in the US-market for metallurgical plants and rolling mills.

More major orders from China again

Orders from the Asia-Pacific region – according to the AGAB-definition, these are the countries of China, Hong Kong, North and South Korea, Mongolia, Taiwan and the ASEAN states – rose by 90 percent to 3.6 billion euro in 2021 (2020: 1.9 billion euro).

Demand for large-scale plants in the important market of China increased by 41 percent to 1.1 billion euro (2020: 786 million euro). The People's Republic was thus the second most important foreign market for VDMA large-scale plant engineering last year. Growth was strongly characterised by major projects: while there were only 7 major orders in 2020, their number rose to 17 projects with a total volume of 782 million euro last year. However, there were no contracts worth more than 100 million euro. A trend towards awarding smaller order packages has been apparent in China for some time. After all, the country is striving to provide more added value in China itself and to build up own knowledge in project management.

South Korea is not only a competitor, but also a partner and customer for AGAB members. In the reporting period, demand from South Korea jumped to 647 million euro (2020: 287 million euro), driven primarily by orders for gas-fired power plants. Customers from Malaysia ordered plants worth 361 million euro (2020: 50 million euro), with major orders for the construction of a methanol plant and an air separation unit. In view of the strong local competition, the continued market successes of VDMA's large-scale plant manufacturers in the countries of East and Southeast Asia are particularly noteworthy.

Slight recovery in the Middle East

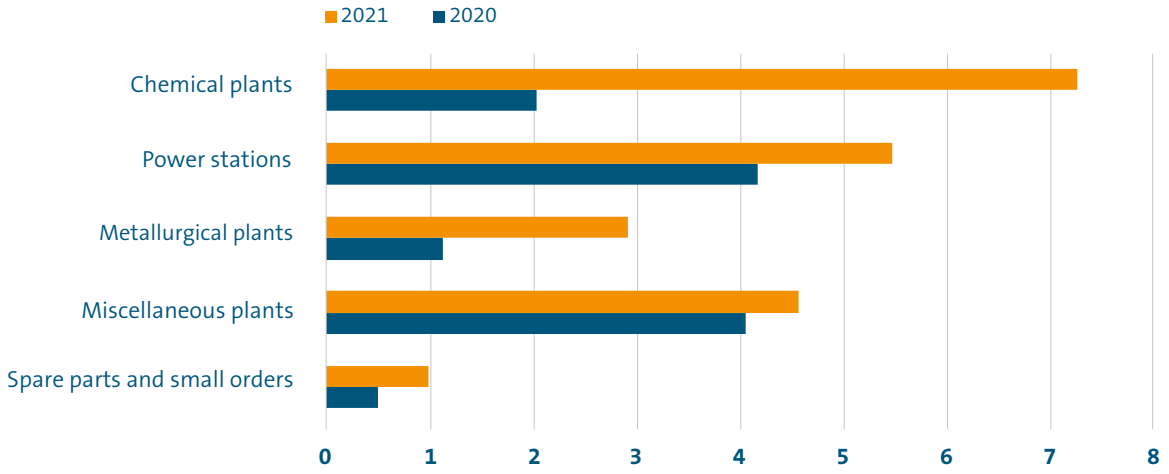
Although demand for large-scale plants in the Middle East increased significantly by 86 percent to 1.2 billion euro in the reporting period, it is still far from the peak values of the noughties with average orders of 3.8 billion euro per year. Strong competition from Asian engineering giants, the unstable political environment and the frequent lack of incentives for investments in sustainable technologies are major reasons for the rather weak order situation. The announcement by some countries in the Middle East to invest in the production and export of hydrogen together with Western partners gives hope. An order placed with an AGAB member to supply an electrolysis plant with a capacity of over two gigawatts for one of the world's largest green hydrogen projects in Saudi Arabia illustrates the economic potential that climate protection projects in the Middle East could have.

The most important customer country in the region in 2021 was Israel, with orders worth 448 million euro (2020: 39 million euro), followed by Iraq with 237 million euro (2020: 99 million euro) and Saudi Arabia with 219 million euro (2020: 225 million euro). The bulk of orders in these countries were for the delivery of gas and steam turbine power stations and chemical plants.

Figure 7

Incoming orders by segments 2020 and 2021

billion euro



Source: VDMA Large Industrial Plant Manufacturers' Group

More orders from emerging markets

This category includes all countries that cannot be assigned to any of the four groups mentioned above. These include Africa (excluding South Africa), South and Central America, South Asia with India, Turkey and Oceania. Orders in this country group doubled in 2021 compared to the previous year to 2.4 billion euro.

The most significant markets in the reporting period were India with orders of 471 million euro (2020: 144 million euro), Turkey with 464 million euro (2020: 104 million euro) and Brazil with 396 million euro (2020: 117 million euro). In all three countries, the focus was on investments in the modernisation of the steel industry and the expansion of the energy supply.

The award of a major turnkey contract for the construction of a gas and steam turbine power plant in the Brazilian state of Rio de Janeiro to a member of AGAB deserves special attention. The plant will run on liquefied gas and is to provide an output of 1.7 gigawatts. Also associated with the contract is the operation and maintenance of the plant using remote monitoring and remote diagnostic technologies.

Environment and market trends in large industrial plant manufacturing

Strong recovery of the global economy in the second year of the pandemic

In returning to growth, the global economy had to overcome many obstacles in 2021. New virus variants that restricted freedom of travel, increasing geopolitical tensions and rising prices for energy and raw materials – the list of challenges is long. Nevertheless, growth rates turned out to be high after the historic slump in 2020. In its estimate for 2021, the International Monetary Fund (IMF) expects global economic output to grow by 5.9 percent, the strongest increase in over 40 years. In many countries, the pre-crisis level was reached again faster than initially thought possible. This was also helped by the stimulating effect of an expansive financial policy, which is now, however, weakening or has already come to an end.

Driven by the USA and China, the global economy is expected to remain on an expansion path in 2022. The IMF expects 4.0 percent growth for the United States, 4.8 percent for the People's Republic and even 5.6 percent for the ASEAN group with its heavyweights Indonesia, Thailand and Vietnam. High economic dynamics are also expected in the European Union (IMF forecast: 3.9 percent). However, the war between Russia and Ukraine is now putting this growth optimism to the test. According to OECD estimates, the conflict could cost the global economy more than one percent growth this year and further fuel inflation. In Germany, some economists have almost halved their forecasts: instead of 4 percent, they now expect growth of just over 2 percent.

Bottlenecks in supply chains prevent smooth project execution

The VDMA large-scale plant engineering sector should benefit from rising demand and the transformation process towards decarbonisation. However, the current shortages on procurement markets – for example for electronic components, metals and plastics – as well as the tensions in the global supply chains are leading to delays in the execution of projects. According to a recent VDMA survey, this situation is unlikely to change much by mid-2022. The large-scale plant construction industry is reacting to the bottlenecks by readjusting its supply chain: the companies are specifically turning to new suppliers on procurement markets that have received little attention so far.

China is becoming the most important competitor in large-scale plant construction

The competitive situation in international large-scale plant construction eased slightly last year in the wake of the improved order situation; only some smaller and less internationalized niche suppliers felt increasing market pressure in 2021. According to a VDMA survey conducted in February 2022, China is currently considered the most important international competitor and is now placing more emphasis on the export of renewable energy generation plants: The People's Republic has long been the market leader for photovoltaic systems and is about to export wind turbines on a grand scale soon. When it comes to building new hydro power plants, China is involved in around 70 percent of all global projects.

The reasons for China's growing importance in the international market are the strengthening of its own capabilities in project execution as well as the rapid technological catch-up process of recent years, which is closely related to the current five-year plan as well as the "Made in China 2025" strategy. With these concepts, the People's Republic wants to achieve greater independence from supplies from western countries and at the same time improve its competitiveness in the export of industrial goods. China's state export promotion is another factor that plays a vital role in this context. The industrial policy measures range from offering favourable conditions for project financing to special export subsidies to the politically directed establishment of national champions to achieve economies of scale.

Decarbonisation on a grand scale is only possible with large-scale plant construction

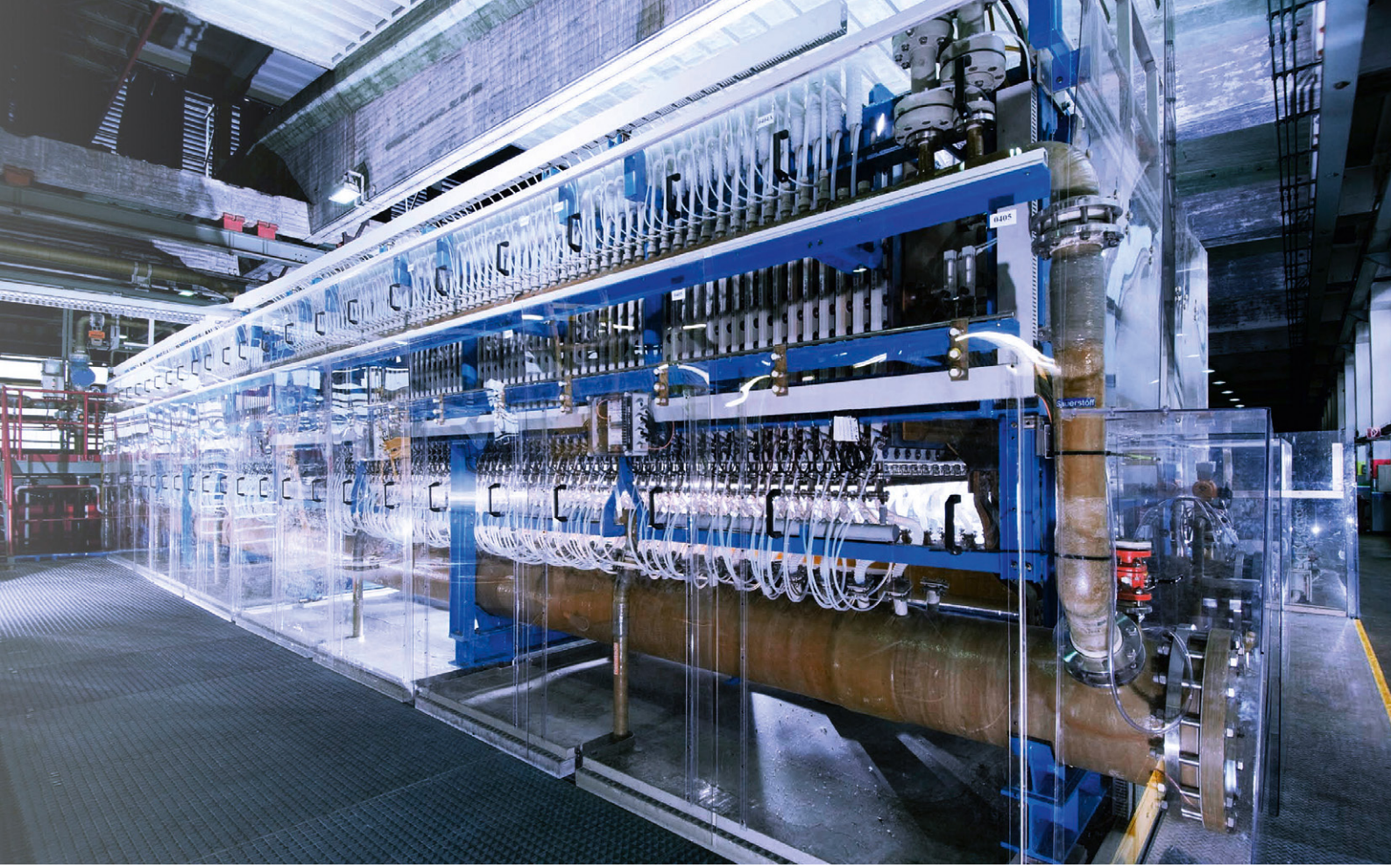
The large-scale plant construction industry is a supplier to many energy- and greenhouse gas-intensive industries, such as the chemical, steel and cement sectors, which together are responsible for more than 20 percent of global greenhouse gas emissions. Due to increasingly strict regulatory requirements, these sectors are obliged to significantly reduce emissions of climate-relevant gases. In Europe, this is taking place against the backdrop of an ambitious climate policy, according to which net greenhouse gas emissions are to be reduced by at least 55 per cent by 2030 compared to 1990. By 2050, the EU even wants to become the first climate-neutral continent in the world, thus realising the European Green Deal.

In the meantime, many economies, including large ones, are following the EU's plans: Japan, South Korea, Canada, the UK and the USA, among others, are planning to be climate neutral by 2050. China and Russia are committed to CO_2 neutrality by 2060.

This offers the technology-driven large-scale plant engineering sector in the VDMA enormous opportunities to bring new plants and technologies to the market and to enable customers to produce in a way that conserves energy and resources. The industry is thus one of the pioneers of the global energy and mobility transformation and makes a substantial contribution to society's goal of sustainability. One thing is clear: without significant contributions from the VDMA's large-scale plant engineering sector, the global climate protection targets cannot be achieved.

Examples of the industry's performance in the field of sustainability are plants for CO_2-free energy generation, such as hydropower, wind and solar plants. Another area in which large-scale plant construction sets standards is the construction of plants for recycling. VDMA large-scale plant engineering is also a global leader in the supply of industrial air purification systems and in the development of technologies for synthetic fuels.

In addition, the companies also supply complete plants for green hydrogen, which is expected to play a major role in the energy industry of the future as a storage facility for electricity and energy carrier as well as a reduction agent in the steel industry. In this context, the ability of large-scale plant construction to scale up technologies from lab-scale to an industrial format comes into play. The companies are thus creating the basis to provide the large quantities of green hydrogen needed on the market in the coming years. Internationally, the industry is already an valuable technology provider, as evidenced by an order placed with an AGAB member to supply an electrolysis plant for one of the world's largest green hydrogen production projects in Saudi Arabia.



Sustainable large-scale plant engineering: about 70 per cent of all chemical products are manufactured using chlorine. A VDMA large-scale plant manufacturer has developed an energy-saving technology that reduces energy consumption and CO_2 emissions in the production of chlorine by up to 25 percent.

Companies set their own sustainability goals

Large-scale plant construction is not only an important partner for its customers in the decarbonisation of production processes. Rather, many VDMA members also set their own ambitious sustainability goals and thus assume responsibility for society as a whole. The milestones formulated by the companies concern both the German and international headquarters that are to become climate-neutral and the entire supply chain. Since the share of suppliers in large-scale plant construction is over 50 per cent on average for all projects, there is considerable potential in procurement and logistics to become more sustainable, for example by purchasing recycled materials or using environmentally friendly means of transport and packaging. In order to define the requirements for suppliers, the large-scale plant construction sector uses tools such as supplier codes and purchasing guidelines, which also take into account social goals such as human rights, inclusion, gender equality and fair working conditions.

Record prices on the commodity markets

The trend towards rising energy and commodity prices has intensified dramatically in the wake of the global economic upswing, pandemic-related supply shortages and Russia's invasion of Ukraine. At the end of the first quarter of 2022, the prices of important industrial metals such as aluminium, copper and nickel reached long-term highs. Prices on the energy markets have virtually exploded: the price of natural gas, for example, has tripled since its low in April 2020, and a barrel of Brent crude oil has increased in price by more than 500 percent compared to summer 2020.

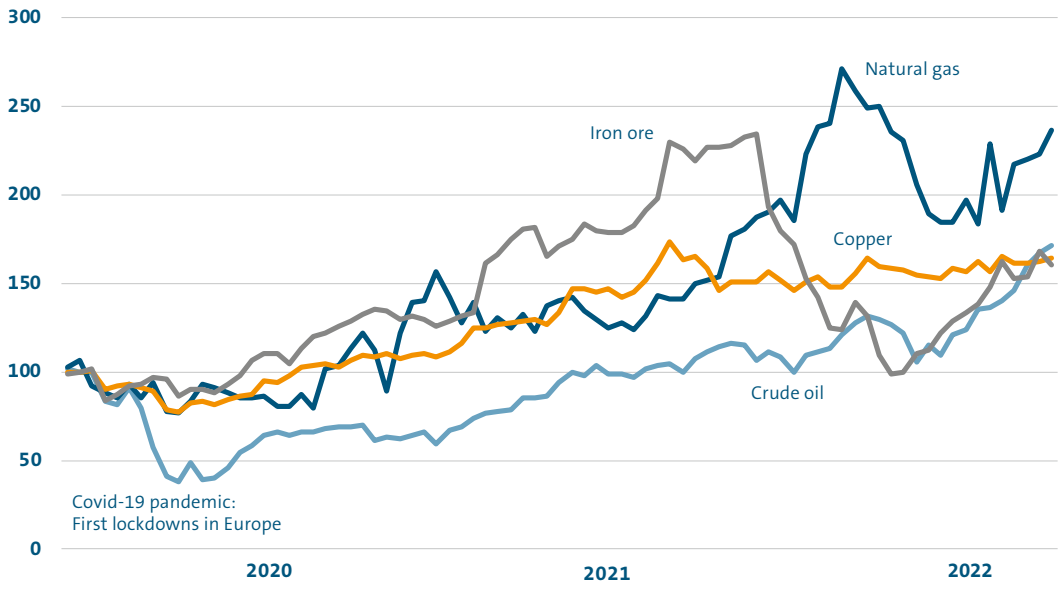
Some commodity analysts are already talking about the beginning of a so-called super cycle. In this context, the COVID-19 pandemic is not seen as a cause, but as a reinforcement of a structural development that has already begun. According to this, digitalisation and particularly the desired decarbonization of the economy are bringing about a technological change, which leads to a structural increase in demand for certain raw materials. A rapid decline in price pressure on the markets for energy, metals and raw materials is therefore not to be expected, even if the Ukraine conflict should de-escalate in the medium term.

Investment conditions in the commodity sector have fundamentally improved due to this price rally and the mood in commodity-related large-scale plant construction has brightened. Nevertheless, in view of high price volatility in recent years, uncertainties remain about the further development of the market, so that large-scale projects have rarely been commissioned so far. In view of the unbroken market dynamics, however, a more optimistic view could quickly take hold among raw material owners, which could prompt them to place additional orders for new systems and plants in raw material extraction and processing.

Figure 8

Price developments of crude oil, natural gas, iron ore and copper

Basis January 2020 = 100



Source: finanzen.net GmbH and own calculations

Increased focus on modernisations services and large-scale projects

Currently, the market for industrial plants is focussing on services and the modernisation of existing plants triggered by the megatrends of digitalisation and decarbonization. This trend, which until recently was limited to Europe and North America, can now be observed worldwide.

At the same time, larger projects are again being commissioned by customers in some regions. In the first year of the pandemic, the number of large-scale projects had fallen to a low for many years. In 2020, the members of the VDMA Large Industrial Plant Manufacturers´ Group were only able to win 11 orders with a volume of more than 125 million euros. In 2021, the number of these projects rose again to 15 orders, roughly the same level as before the pandemic. Among them was a mega-project for the construction of a large-scale process plant in Russia with an order value of several billion euros. Such a volume is exceptional even for large-scale plant engineering and testifies to the customers' confidence in the companies' exceptional planning and technological skills.

The members of AGAB expect demand for large-scale projects to remain at a high level in the coming years. The main reason for this optimism is increasing customer enquiries for large-scale solutions for the decarbonization of industrial processes, for example in steel manufacturing, hydrogen production, power generation and carbon capture and storage. Some of these enquiries and feasibility studies could become reality as early as 2022. After all, the current political mood in Berlin and Brussels is in favour for investments in sustainable projects.

Low operating costs become an award criterion

Customers have always been in demand for high quality, short execution times and low investment costs (CAPEX), which can be successfully enforced depending on the market situation. Although the balance of power in the current market environment has shifted slightly in favor for large-scale plant construction, the above-mentioned customer demands remain essentially unchanged.

What is new is that clients are giving greater weight to the operating costs (OPEX), incorporating considerations of risk and sustainability. This is particularly noticeable in markets with demanding environmental and climate protection requirements and high energy costs, such as in Europe, North America and Japan. The large-scale plant manufacturers organised in the VDMA are benefiting from this trend, given their experience in building particularly resource-efficient plants. Outside the industrialised countries, this trend is still weak due to a lack of investment incentives. In the future, however, it can be assumed that low life-cycle costs could also become an important criterion for awarding contracts in emerging countries due to increasingly stringent climate protection regulations worldwide.

Innovative technologies improve efficiency in project execution

The approach to execute plant construction projects has changed fundamentally since March 2020. The restrictions associated with the pandemic, such as the closure of construction sites, strict quarantine rules or costantly changing travel regulations, have led to significant challenges in the execution of projects and the direct personal contact that typically accompanies them. In response to these difficult conditions, virtual formats and the use of innovative technologies have proven effective: Remote maintenance, remote commissioning, virtual audits, virtual customer tours, and the use of robots, drones and 3D-goggles on construction sites are now common in large-scale plant construction. Many companies expect these new approaches to remain or even become more important after the pandemic. After all, clients have learned that they can save costs and shorten project duration to a considerable extent.

Advisory competence of large-scale plant construction in sales becomes more important

In the course of the transformation to more sustainability and the accompanying changes in the project environment (e.g. new legislation and financing options), the ability of large-scale plant construction to advise customers as early as the sales phase is gaining importance across all sectors. The focus here is on understanding the needs of the customers very well and jointly developing viable concepts for their very complex, capital intensive and long-term projects. To fully meet these requirements, it is necessary for sales staff to have comprehensive competencies, such as the willingness to listen and to think along from the customer's perspective and to learn continuously.

It is also important to have a high level of intercultural sensitivity and the ability to develop financing concepts. Against this background, careful staff selection and continuous training of sales experts are fundamental building blocks for consulting success.

The trend towards decarbonisation seems to be irreversible and will drive the fundamental technological change in the entire large-scale plant construction sector. The topic of consulting expertise should therefore continue to gain importance in the foreseeable future. This is good news for the members of AGAB. Building on their own strengths in continued training, engineering as well as in research and development, it should be possible for the companies to stand out from the international competition with customised consulting services in sales.

An important lever for reducing costs and increasing productivity in large-scale plant construction is the modularisation and prefabrication of complete plants and technology modules.

Large-scale plant construction increases its productivity in many ways

To compete in a challenging market environment and to meet customer expectations, large-scale plant construction relies on a broad bundle of measures to improve productivity. For example, the companies are continuously strengthening their competences in project, quality and risk management, in engineering, in global procurement and in contract and claims management, while also relying on the diverse possibilities of digitalisation. In addition, the companies are also making use of technical innovations, for example on construction sites, where drones and robots are taking on a variety of tasks, some of which are risky, thus effectively relieving and protecting the bottleneck resource of construction site personnel.

Another important lever for reducing costs and increasing productivity, now established throughout the industry, is the modularisation and prefabrication of complete plants and technology modules in the company's own workshops or at qualified suppliers. Although there are limits to these efforts due to the individuality of the business, large-scale plant construction has achieved significant success in the past and will continue to exploit potential in the future. According to a study by the VDMA, savings of up to 15 percent in engineering costs and project durations can be realised through consistent modularisation. Depending on the scope of the project, this can mean a reduction in execution times by several months - while at the same time significantly increasing the reliability of the schedules. Furthermore, by applying intelligent modularization-concepts, large-scale plant construction has managed to significantly reduce the number of construction site accidents as well as quality costs.

Driving research and development forward together with partners

In order to expand the leading position of VDMA large-scale plant engineering in the technology competition, especially against the background of the growing demands for sustainable and climate-neutral solutions, the industry is increasingly working together with universities, associations, engineering companies and start-ups. Many successful projects have already been launched within this ecosystem. Examples include the cooperation of a power plant manufacturer with a automotive company to build a pilot plant for the production of synthetic fuels, several strategic partnerships with customers from various industries for the production of green hydrogen, and a joint venture in the field of battery recycling.

The VDMA's large-scale plant engineering sector also invests considerable internal funds in the development of resource-saving processes, and employs around 5 percent of its staff in research and development (R&D). The current focus of R&D activities, which often take place in close cooperation with customers, is in the areas of carbon-free energy generation, energy storage, and the decarbonisation of industrial value-added processes, for example in the production of steel, cement, and chemicals.

Demographic change calls for creative approaches in personnel acquisition

In the course of demographic change, the recruitment and long-term retention of skilled workers is becoming a task that will determine the future viability of entire industries in almost all sectors of the economy. This statement is especially true for large-scale plant construction, which is more dependent than other industries on the experience and know-how of its employees. While in the past it was already difficult to find personnel for longer construction site and service assignments, in view of well-filled order books companies are now desperately looking for qualified specialists in other areas as well, especially in procurement, engineering and project management. To be successful in recruiting the urgently needed skilled personnel, various strategies are used. In addition to classic approaches such as in-house training, visiting job fairs, using head-hunters and cooperating with universities, some companies also use alternative approaches very successfully. Addressing career changers or university dropouts have already proven successful in practice.

The clear commitment of large-scale plant construction to sustainability, diversity and social responsibility helps in the search for personnel and improves the chances of long-term employee retention. As a pioneer of environmental protection and climate neutrality, the large-scale plant construction industry is well placed to be perceived as an attractive employer in the "war for talents", as the industry satisfies the need, especially of the younger generation, for purpose in their own work.

Knowledge management comes into focus in demographic change

Knowledge is a complex resource that contributes significantly to a company's success. The topic of knowledge management has therefore accompanied large-scale plant construction for decades. Against the background of an aging society, knowledge management is now gaining new topicality. Many companies are therefore intensively engaged in strengthening their methodological competence and use digital tools in the preparation of information to ensure knowledge transfer between individual employees, project teams and entire departments. On the one hand, this reduces knowledge losses due to the increasingly observed retirement of experienced employees who, in addition to their manpower, also take their personal know-how with them. On the other hand, the higher the share of customised products in total production, the more difficult the transfer of knowledge becomes. In industrial plant construction this aspect is particularly important because all projects are taylor-made or even prototypes. Abstraction and documentation of the specific experience gained there are much more difficult than in series production. The implementation of management concepts that help to reduce complexity and to use the resource knowledge in a success-oriented way are therefore of outstanding importance.

Large-scale plant construction relies on sustainable political framework conditions

Despite a variety of challenges in the market, 2021 was a successful year for large-scale plant construction. On the one hand, the industry benefited from the more favourable macroeconomic conditions and the rising demand for investments. On the other hand, it paid off that the members of the VDMA Large Industrial Plant Manufacturers' Group used the first year of the pandemic to digitalise their workflows, to develop new business models and to expand the range of products for climate protection. As a result, the companies have become much more competitive internationally and in this respect are emerging stronger from the Covid-crisis.

In addition to its own efforts, however, the large-scale plant construction industry is also dependent on support from politicians, especially when it comes to establishing a level playing field on international markets. The information on pages 22 to 28 shed light on the economic policy environment of the industry and provide detailed information on important fields of action in foreign trade and tax policy.

Positions of the VDMA Large Industrial Plant Manufacturers' Group on foreign trade policy

Due to the pandemic, the members had to report the sharpest drop in orders in 2020 since statistical surveys began in 1969. In 2021, however, the outlook had brightened considerably and the order intake recorded by the companies in the reporting year picked up faster than originally expected. The driver, with an export ratio of almost 85 percent, was foreign business - but this development will not continue due to the outbreak of the Ukraine war.

Disruption through the Ukraine war

The war in Ukraine is a painful eye-opener for Germany and Europe, because Russian aggression also targets the Western social and economic system. That is why the tough sanctions against the Putin regime are the right response. However, the German government must also ask itself how it intends to support the economic system and businesses in an increasingly aggressive world in the future. At the time of going to press with this management report, it is already possible to say with regard to the project business of large industrial plant manufacturing that there will be no new business with Russia and Belarus in the foreseeable future, concerning Ukraine it will depend on the course of the war.

Foreign trade promotion in upheaval

Against the backdrop of this disruption, the entire field of foreign trade promotion is even more challenged to find quick and good answers to solve energy policy issues, climate issues and the goal of an international level playing field.

In the reporting year 2021, export credit guarantees from the German government again provided significant support for the export of German industrial plants and equipment for infrastructure. For decades they have played a central role in the market development and order protection strategy of the capital goods industry in the case of risks that are hardly insurable by the private sector. The same applies to the European members of the VDMA Working Group, who rely on export promotion in Austria, France, Finland or Italy.

One of the main reasons for the upheaval in foreign trade promotion is the fact that Europe is now giving climate protection a high priority across all policy areas. At the beginning of 2022, the entire world and its economic systems are still facing the major challenge of achieving the goals set in the Paris Climate Agreement, in particular to limit global warming. At the political level, there are numerous initiatives under the catchword "sustainable finance", such as the package of measures of the European Green Deal together with the accompanying taxonomy, which will significantly change the framework conditions for companies in industry and the financial sector.

Adjusting screws for a climate strategy in the area of Export credit guarantees

Thus, the search for new eligibility criteria has also begun in the area of export credit guarantees. In the highly regarded "Export Finance for Future" (E3F) initiative[1] Germany and other European countries have joined forces to develop

1 For example, the report on the pages of the French Ministry of Finance https://www.tresor.economie.gouv.fr/Articles/2021/04/14/seven-countries-launch-international-coalition-export-finance-for-future-e3f-to-align-export-finance-with-climate-objectives.

guidelines for the export promotion of sustainable technologies. In principle, there are three levels of design for export credit guarantees: national promotion policy, EU guidelines and the international OECD Consensus.

At the national level, however, the EU members in particular are subject to narrow limits in terms of the instruments they can use, since the rules of the OECD Consensus, in conjunction with those of EU state aid law, define all the important parameters of a credit offer. National leeway exists at most in the formulation of eligibility, for example with regard to the minimum values of national deliveries, or in the direct provision of financial resources. The EU is currently considering specific facilitation to support large projects through a European export credit facility as part of the Green Deal - but decisions on this are not expected until 2023 at the earliest.

OECD consensus: urgent need for action

For years now, the VDMA has been pointing out with concern that the rapid pace of change in the global economy – whether geopolitically in competition with Asia, most recently due to the pandemic and now due to the enormous financing requirements for the climate transformation – is being countered by a development of the regulations for export and project financing that is clearly too slow[2] .

In the following, therefore, three points will illustrate the need for action for a fundamental reform of the OECD consensus, which is more urgent than ever. For the OECD level in particular is the one with the greatest impact in moving closer to a level playing field in foreign trade promotion in the competition between OECD members, but especially with non-OECD members. The ECAs of Canada, France, Germany, Italy, Japan, the United Kingdom and the USA agree that the modernisation of the OECD Consensus is crucial for effectively ensuring a level playing field in international trade[3]

Seize opportunities – risk appetite required

The export credit guarantees have been confronted with a shift in the funding weights for several years now. In the past, the central task was to provide a balanced state risk guarantee and to concentrate financing on economically viable projects. Now, the focus is increasingly on projects with new technologies, often supplemented by digital services, while at the same time the project risk is regularly higher. This increased complexity requires new, holistic answers. It is important to combine all financing options, private investments, development funds and the services of ECAs in order to realise foreign projects with such a multidimensional risk profile.

2 Cf. the detailed outline of the complex situation in the last report: "Pandemic and climate change - large-scale plant engineering accelerates transformations" (VDMA 2021, p. 26).

3 Cf. https://www.agaportal.de/news/beitraege/g7eca-20211215,

However, projects in pursuit of the United Nations Sustainable Development Goals, which are highly relevant for developing countries, can hardly be realised without a fundamental modernisation of the consensus for companies from OECD countries. Thus, it is precisely public infrastructure (water, transport/mobility, energy, education, health) and public clients that depend on state-supported export credits and European cutting-edge technology. The pandemic has also shown how important it is to education and training that needs to be built up locally and sustainable local industrial production production by competent local companies.

The VDMA therefore welcomes the first adjustments to the OECD Consensus, which it has long called for and which were implemented in 2021, particularly with regard to the requirements of developing countries. For example, for certain transactions, the possibility was temporarily opened to increase the cover limit for financial credits to 95 percent (and thus to reduce the required down payment from 15 percent to 5 percent). This is intended to relieve the strain on the national budgets of important target markets caused by the pandemic and, in particular, to enable further investments in infrastructure projects or crisis prevention measures. Another important step, long demanded by the European export industry[4], was the OECD decision to increase the permissible co-financing of local costs. This measure also eases the burden on local project financing and strengthens local procurement and employment. In view of the special competitive situation of European large industrial plant manufacturing, this decision was one of the necessary, overdue milestones on the way to a fundamental reform, since up to now it has been the competition from China that has scored particularly well in this respect.

4 Cf. for example the detailed presentation of the background and arguments in the joint paper of BIAC, EBF and ICC: https://biac.org/wp-content/uploads/2019/11/Final-version-Joint-business-position-on-Future-of-OECD-Arrangement5.pdf

Reliant on process reliability for project initiation

Large-scale projects also require specific technological know-how and are highly challenging in terms of organisation and execution. This is why the VDMA has repeatedly highlighted the special features of large-scale international projects in recent studies. This involved the future importance of digital business models and, above all, the specific role of EPC providers in the project[5].

Against this background, the industry is also counting on the fundamental modernisation of the regulatory framework: the necessary measures named by the industry include an increase in the maximum credit periods with orientation to the product life cycle, the flexibilisation of the repayment profiles and a shift in the "*starting point of credit*" for projects with a long construction period and varying cash flows. A revision of the fee system is also imperative.[6] Finally, new contract models such as "*equipment as a service*" or software-based transactions have long been established in the practice of international plant manufacturing, but can still hardly be reflected in the export credit guarantee system under the current circumstances.

Climate-neutral transformation: level playing field crucial

The big open question of all initiatives for sustainable export financing is the design of incentives for projects that serve the climate-neutral transformation in particular, but also the achievement of the Sustainable Development Goals mentioned above. In this context, it will be crucial to see whether and how the industrialised countries and their national export credit

5 Cf. Digital business models in plant engineering and construction in an international comparison (VDMA, 2019); EPC-Fähigkeit der deutschen Unternehmen im Bereich der Bauwirtschaft und des Maschinen- und Anlagenbaus (BMWi, 2017).

6 Cf. in detail the latest statement by Business at OECD from November 2021: https://biac.org/wp-content/uploads/2021/11/2021_11_Business-at-OECD-Export-Credits-Modernizing-OECD-Consensus-1.pdf

agencies can agree on a common understanding of criteria and incentive instruments at the OECD level.

However, if rules are only agreed between individual states, whether at the European or international level, in which significant other exporting countries do not participate, there will also be no level playing field in climate issues and the OECD consensus would continue to lose significance in this respect. This would not only put German and European exporters at a disadvantage, but would also contribute less to the necessary climate protection efforts.

Therefore, minimum standards must be jointly defined in the OECD consensus and concrete targeted incentives must be provided. It is also important that the reform is not limited to the topics of environment and sustainability, but that the regulatory framework as a whole is modernised from the ground up. In particular, stronger integration with development aid components should be considered in order to be able to address the global challenges, which are interrelated in many ways, in a holistic manner.

Nevertheless, even if the OECD level will be the decisive field of action due to its effectiveness, if Germany in the EU and the EU in the OECD want to take a pioneering role in climate policy with regard to the promotion of foreign trade, plant manufacturing cannot wait for progress on the regulation of a level playing field for export credit guarantees in the European or OECD framework alone. Rather, it is necessary to apply the existing leeway of the OECD consensus, especially at the national level, in order to win contracts for foreign projects.

This is because VDMA plant manufacturing can play a key role in the global market for large-scale projects, and not only in the energy market of the future. Its members are also in demand for complex, state-of-the-art plants for key industries undergoing radical change, such as the chemical and steel industries, in order to ensure the success of sustainable and digitalised production, including a well thought-out circular economy and the recycling of raw materials.

VDMA plant manufacturing therefore supports the German government and the EU in their efforts to fundamentally reform the consensus and offers its practical expertise - also to ensure that the national Hermes instrument does not lose its manageability and predictability with regard to cover requirements and decisions, but can continue to play a supporting role.

Positions of the Large Industrial Plant Manufacturers‘ Group on tax policy

The regulations on the international taxation of foreign activities in the world’s markets have been of ever-increasing importance for years, especially with the intensification of globalisation. The companies in the VDMA Large Industrial Plant Manufacturers’ Group are particularly affected by this due to their high average export ratio (most recently just under 85 percent in 2021) and the associated longer-term assembly and construction activities typical of the project business. They will have to pay considerable taxes, especially due to the increasing double taxation of the pro rata profit at assembly and plant construction sites.

Unfortunately, practice shows that withholding taxes tend to trigger double taxation. This is particularly true for the taxation of technical services. In the double taxation agreements already concluded, Germany allows foreign states to levy withholding taxes on income, while Germany itself does not credit the withholding taxes on this income, but only on the profit from it. The result is considerable additional tax burdens for German large-scale plant manufacturers due to the inadequacies of the German procedure for crediting these withholding taxes in the country of operation against the taxes paid in Germany.

Germany: Risk of double taxation increases due to withholding taxes!

The new government coalition has taken up precisely this issue in its government programme under the heading “Combating tax evasion and tax structuring”. The following was agreed in the coalition agreement: “Income flowing out of Germany is to be taxed appropriately. Both non-taxation and double taxation are to be avoided.
To this end, we will expand withholding taxation, in particular by adapting the double taxation agreements (DTAs), and supplement the interest barrier with an interest rate barrier in order to avoid undesirable taxation.” For the large-scale plant engineering sector organised in the VDMA the question arises as to how this passage is to be interpreted. Theoretically, the introduction of withholding taxes should and can avoid double non-taxation.

The VDMA Large Industrial Plant Manufacturers’ Group calls on the Federal Government to eliminate the discrepancy between tax payments and tax credit!

Germany: Do not reduce the assembly permanent establishment period!

Construction and assembly permanent establishments are special in international tax law in that they do not depend on the existence of a fixed place of business in the respective country. The only thing that matters is how long a company that carries out a construction or assembly activity in another country actually operates there. The period of twelve months proposed by the OECD in the model agreement is in any case a decisive factor for the competitiveness of companies in the VDMA large-scale plant manufacturing sector and therefore requires their special attention in the discussion on the future of German DTA policy. Why?

While most of the foreign operating sites of large-scale plant manufacturing regularly last six to 18 months, there are very many projects in medium-sized plant construction with a run from six to 12 months. A reduction of the assembly site period, for example in the course of the adjustment of the double taxation agreements by the new coalition mentioned at the beginning, would not only trigger a massive shift of German tax revenue to the countries of operation, but would also mean an enormous increase in organisational costs for the companies concerned and massively increase the pressure to relocate entrepreneurial activities to the target countries.

The VDMA Large Industrial Plant Manufacturers' Group therefore calls on the German government to adhere to the twelve-month period for assembly operations.

Europe:
Compliance with double taxation agreements

Due to increasing government budget deficits, many countries tend to tax foreign economic activities more heavily at home. They are moving towards levying taxes in deviation from existing DTA regulations. Time and again, companies in the VDMA large-scale plant engineering sector have to defend themselves, for example, against unlawful taxation of supply profits. The differing views and taxation concepts lead not only to financial burdens, but also to far-reaching practical difficulties in taxation in the state where the activity takes place. The entire project cycle is affected, starting with the offer price calculation, through profit allocation to tax collection.

The VDMA Large Industrial Plant Manufacturers' Group therefore calls on the national governments of its members to lobby even more strongly abroad for strict compliance with double taxation agreements.

OECD: Reform of international corporate taxation

In recent years, numerous topics have been discussed at both the German and international level in connection with the taxation of internationally positioned companies. have been discussed. In order to find a solution to the tax challenges posed by the digitalised economy, the OECD launched the so-called two-pillar project on behalf of the G20. In the meantime, 137 countries (as of 4 November 2021) have agreed on a fair distribution of taxation rights and a global effective minimum taxation with a uniform tax rate of 15 percent. The implementation timetable provides for both pillars to enter into force as early as 2023.

The European Commission had already presented a proposal for a directive on a global minimum tax in Europe at the end of December 2021, with which an effective minimum taxation of corporate profits in the EU member states. Even if this new taxation system is to affect only large multinational companies with a consolidated turnover of 750 million euro in a first step, it must be warned against a hasty implementation. Above all, it is urgently necessary to further simplify the regulations and limit the scope of application. The goal must be a practical implementation of the proposals by both companies and tax administrations. Double taxation and tax conflicts between states can only be avoided if the global minimum taxation is designed in a uniform manner worldwide.

The VDMA Large Industrial Plant Manufacturers' Group is therefore calling on the OECD and the European Commission to again drastically simplify their proposals in order to limit the high additional burden on financial administration and business.

Business outlook and sector reports

Quantitative forecasts of order intake in large-scale plant construction are often not reliable in view of the heterogeneity of the industry and a project business characterised by few, irregularly awarded large or even mega orders. Assessing the prospects of the industry, which supplies plants for about 20 different industrial sectors, is therefore sensibly done in qualitative terms or in the form of trend statements.

Despite crises: Large-scale plant construction remains confident

The VDMA Large Industrial Plant Manufacturers' Group (AGAB) recovered more quickly from the setback of the first year of the COVID-19 pandemic in 2021 than originally anticipated. At 21.2 billion euro, new orders rose well above pre-Covid levels (2019: 18.3 billion euro). Numerous large orders as well as an increasing demand for technologies for the decarbonisation of industrial production processes contributed strongly to these market successes. Most AGAB members are confident that this trend will continue in the current year. According to a VDMA survey conducted in January 2022, almost all companies surveyed expect constant or even rising sales and are also predominantly optimistic with regard to incoming orders.

However, the global political turning point caused by Russia's invasion of Ukraine and the possible effects of the unprecedented sanction measures on the global economy could mean that these assessments prove to be too optimistic. After all, Russia is currently the most important market for VDMA large-scale plant construction and imports from the region, for example for energy and raw materials, are difficult to replace in the short term.

Other risk factors in the market are the continuing material bottlenecks, the brittle logistics chains and the COVID-19 pandemic, which continues to cause delays in project execution, especially on construction sites. Furthermore, the new EU taxonomy could put European plant manufacturers at a competitive disadvantage. In particular, the EU's demand that the construction of new gas-fired power plants that can be converted to hydrogen has to be linked to the replacement of coal-fired power plants is viewed critically by the plant construction industry.

Market opportunities through sustainability and services

Despite these challenges, the general confidence in large-scale plant construction is still intact. This is mainly due to the fact that in the current market environment, solutions for more sustainability are particularly in demand. The members of the VDMA Large Industrial Plant Manufacturers' Group provide their customers with technologies for CO_2-reduced steel and cement production based on hydrogen, carbon-free power generation or the production of synthetic fuels, thus demonstrating their expertise in the field of climate protection.

Furthermore, operators of large plants are increasingly requesting services along the entire value chain to increase the performance and availability of machines, systems and complete plants. Such services contribute to stabilising sales in the volatile business with large-scale plants. Many AGAB members have recognised this and are consistently expanding their service business. In 2021, the companies generated more than a quarter of their revenues from the sale of services for the first time: The ratio rose on average in the industry to the new high of 30 percent. By the middle of the decade, a share of 35 percent is even being targeted.

Industry strengthens its competitiveness

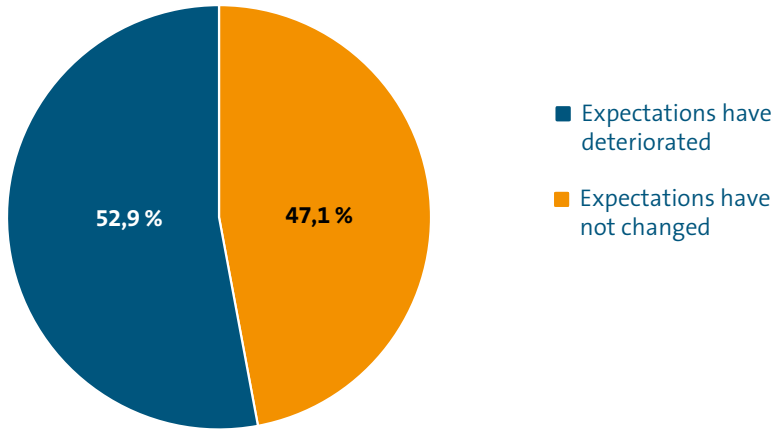
As a result of the current geopolitical tensions, the market environment in large-scale plant construction is characterised by extreme uncertainties and is very volatile. The AGAB members must therefore remain flexible in order to be able to react agilely to market fluctuations. Co-operations with plant manufacturers, customers, service providers and universities create the necessary room for manoeuvre. In addition, the companies use digital tools and innovative technologies in project management to become more productive.

The technological knowledge of VDMA large-scale plant manufacturers, their broad methodological expertise and the internationality of the industry are good prerequisites for holding one's own against the competition. However, the prospects can vary greatly depending on the segment under consideration. For a specific analysis, it is therefore advisable to read the following industry reports, which reflect the assessments of the members of the Large Industrial Plant Manufacturers' Group.

Figure 9

How does the Ukraine war affect the expectations for your company's order intake until the end of 2023?

per cent



Source: VDMA Large Industrial Plant Manufacturers' Group

Thermal power plants

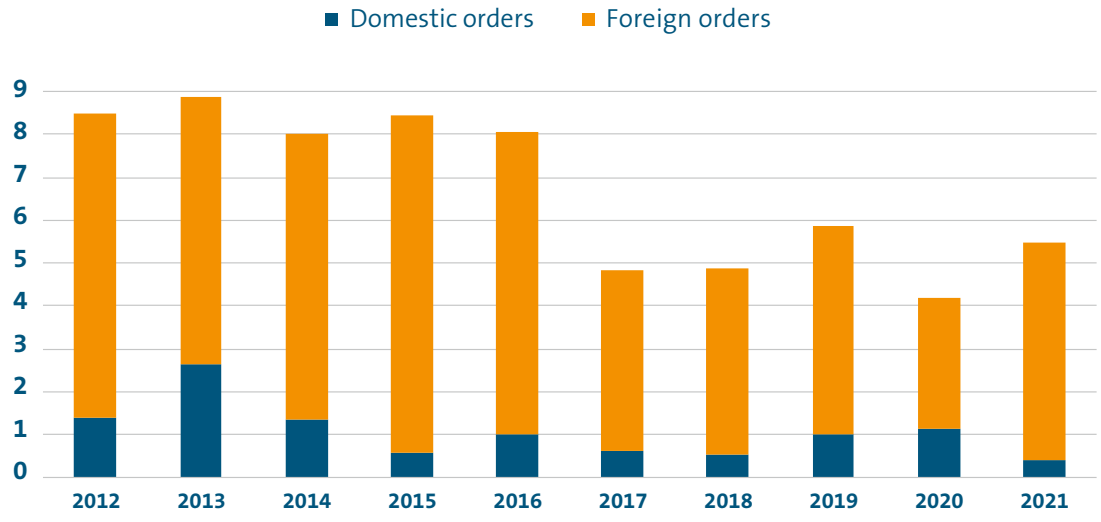
Current market environment in power plant construction

The thermal power plant market is in the middle of a paradigm shift. The driving force behind the transformation is decarbonization and the reduction of net emissions to zero – a goal set by the Paris Climate Agreement of 2015 and reaffirmed at COP26 2021 in Glasgow. The power plant sector organised in the VDMA has been able to hold its own in this challenging environment. Orders received in 2021 rose by 31 percent to 5.5 billion euro and are thus roughly at the level of the years 2017 to 2019. This growth was triggered by a strong increase in demand for thermal power plants from abroad. In parallel, orders in Germany fell to their lowest level in decades. The nuclear phase-out, the foreseeable end of coal-fired power generation and uncertainties about the future of natural gas as a fuel for power plants are key reasons for the reluctance to invest in thermal power generation in Germany. It remains to be seen how the current geopolitical upheavals will affect the demand for thermal power plants in Germany. The only certainty is that the issue of a reliable energy supply has mightily returned to the public consciousness and – according to some politicians – should be weighted even higher than climate protection, at least in the short run.

Figure 10

Incoming orders for thermal power plants 2012 – 2021

billion euro



Source: VDMA Large Industrial Plant Manufacturers' Group

In the conversion process of the energy system to predominantly decentralised and climate-neutral electricity generation, thermal power plants continue to play an important role as a bridging technology.

Coal phase-out and expansion of renewables are drivers of decarbonization

At its core, the decarbonization of energy generation involves the phase-out of coal-fired power generation, i.e. the decommissioning of existing coal-fired power plants and the drastic reduction of new construction projects. The share of coal power in global electricity generation has already passed its likely peak in 2019 and should continue to decline in the coming years; after all, numerous countries have decided to phase out coal power soon, such as France (2022), the Netherlands (2029), Canada (2030) and Germany (between 2030 and 2038). In total, around 200 gigawatts (GW) of electric capacity are expected to be put out of service in the coming years. This value could become even greater if China should stop financing new projects abroad.

At the same time, global energy demand is rising continuously. Last year, the increase – also due to the pandemic-related low base of 2020 – was a remarkable 6 percent. Reasons for this development include the increase in electromobility, the digitalization of many areas of life and the electrification of energy-intensive industries such as cement, steel and chemicals. Thanks to the rapid expansion of renewable energies, the rising demand can currently still be well met.

In 2020, renewable energies already contributed 30 percent to electricity generation worldwide. According to the currently available commitments of national governments, this share is to increase to about 45 percent by 2030. However, if electricity generation is to be completely CO_2-neutral by 2050, the share of renewable energies will have to increase by another 15 percent to 60 percent by 2030, according to the World Energy Outlook 2021.

In the transformation process of the energy system to predominantly decentralised and climate-neutral electricity generation by 2050, thermal power plants such as nuclear and gas-fired power plants continue to play an important role as a bridging technology. They compensate for fluctuations in the grid frequency and thus ensure the stability of the electricity grids. Renewable energies, which are highly dependent on weather conditions, cannot perform this task alone.

Switch from coal to gas opens up opportunities for plant construction

Gas-fired power plants are important stabilizers in an energy system that is increasingly dependent on the volatile input of wind and solar energy. They are capable of handling base loads and can thus replace coal-fired power plants. Finally, gas-fired power plants contribute to significantly reduce emissions that are harmful to the climate: A state-of-the-art combined cycle power plant reduces CO_2 emissions by up to 70 percent compared to a coal-fired power plant of the same capacity. Currently, gas-fired power plants account for 24 percent of global electricity generation.

A good example of the performance of such plants is the new Komotini combined-cycle gas turbine (CCGT) power plant with an installed electrical capacity of 877 megawatts (MW), which is currently being built in north-eastern Greece by a member of the Large Industrial Plant Manufacturers' Group. The construction of this plant is of strategic importance for Greece, as it will help to meet the country's growing demand for electricity resulting from the gradual withdrawal from the use of coal in power generation. The commissioning of the modern gas-fired power plant will also contribute to climate protection, as CO_2 emissions will be reduced by up to 3.7 million tonnes per year compared to a coal-fired power plant.

Carbon capture and storage (CCS) technologies are considered another option for reducing CO_2 emissions from fossil power generation. In Germany, CCS is de facto not possible, as the federal states are legally allowed to exclude CO_2 storage on their territory. The federal states that are eligible for storage have already made use of this opt-out clause. However, other countries, such as China, the Netherlands, the UK and the USA, are already successfully using CCS technology and are thus following a technically efficient path to greenhouse gas neutrality.

For coal-fired power plants that are currently facing closure, a fuel switch to gas can be considered. This makes it possible to continue using existing plants, buildings and infrastructure and avoid the creation of industrial wasteland. However, not all coal-fired power plants can be converted to run on natural gas. Depending on the fuel, the boiler geometry and the age of the plant, the technical possibilities and the costs of conversion vary greatly. In particular, the industrial power plants that are widespread in Germany provide a good basis for a fuel switch. Large coal-fired power units, on the other hand, are generally not convertible. Experts estimate that up to 25 percent of the coal-fired power plants installed worldwide can be converted to operation with gas.

H2-readiness of gas-fired power plants is moving into the focus of the market

Hydrogen can play a central role in the decarbonization of energy systems. Particularly natural gas-fired combined cycle power plants that are currently being built or projected could be partly or even completely powered by hydrogen in the future. According to the manufacturers, new gas turbines should be able to burn pure hydrogen by 2030.

Energy suppliers considering the purchase of such a power plant expect a commitment on the suitability of the power plant to use hydrogen as a fuel. The gas turbine manufacturers in the European VDMA EUTurbines working group and the European engine plant manufacturers in the sister association EUGINE have therefore agreed on a uniform "H2-ready" definition for new gas-fired power plants. The definition covers both operation with pure hydrogen and the use of mixtures of natural gas and hydrogen. Three categories provide information on the necessary conversion costs from natural gas to hydrogen operation, with the maximum conversion costs being 20 percent of the costs for a comparable new power plant.

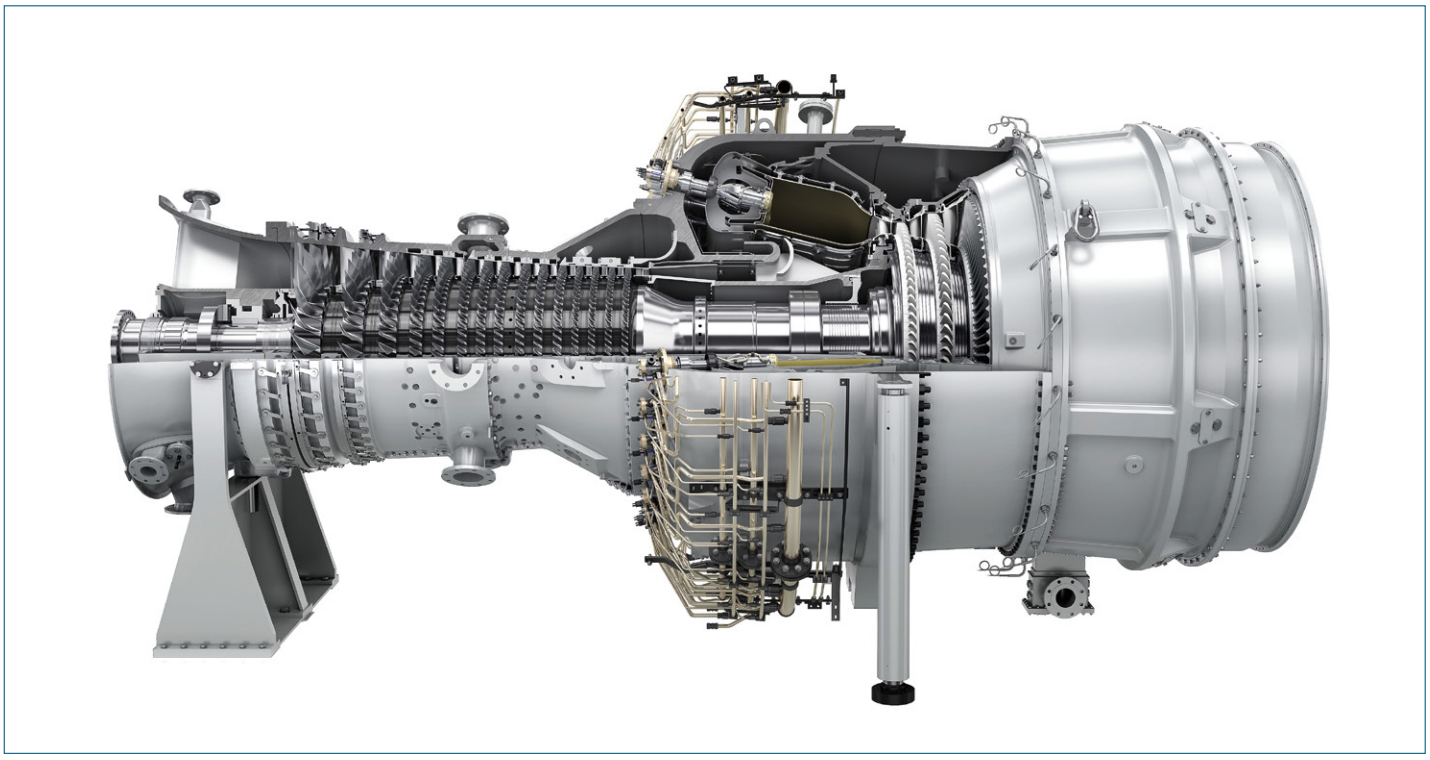
To provide the quantities of hydrogen needed in the future, numerous political initiatives have been launched worldwide in recent years. In the European Union, the EU hydrogen strategy defines the short-term goal of installing electrolysers with a total capacity of 6 GW; by 2030, an electrolysis capacity of 40 GW should be available. If these plants are powered by renewable energies, they can produce so-called green hydrogen, which helps to completely avoid greenhouse gas emissions.

Compared to the expansion targets for renewable energies, the planned expansion path for electrolysis capacities by 2030 appears to be less ambitious. However, it must be taken into account that there is hardly any experience in the production of green hydrogen on an industrial scale yet, even though large-scale plant engineering has already made progress in scaling up existing technologies and is working on further breakthroughs. In addition, a functional infrastructure for the distribution and storage of hydrogen is still lacking. To make progress on the path to a sustainable hydrogen economy, important steps still need to be taken. Government agencies could help to create a favourable framework for private investors by de-bureaucratising licensing procedures, gradually increasing CO_2 prices and creating financial incentives.

Hybrid power plants pave the way to a net-zero economy

A hybrid power plant is a power plant in which different energy generation and conversion processes are coupled together. It can be used for electricity generation, fuel production and/or heat generation. For this purpose, several energy conversion plants are connected to storage facilities and energy consumers and are optimally regulated among each other. The energy conversion plants include both fossil-based and regenerative plants. The energy consumers are usually heating grids, petrol stations, gas grids and supply grids. Since hybrid power plants often combine several energy sources, fluctuations of one energy source can be balanced out and the usable energy can be generated according to demand.

A current example of a hybrid power plant is the Leipzig South CHP (combined heat and power) plant, which is being built by a VDMA member company. The new plant will contribute to the decarbonisation of the energy supply in two ways: on the one hand, Stadtwerke Leipzig is making itself independent of the use of coal with this investment. On the other hand, operation with 30 to 50 percent green hydrogen is planned just a few years after the commissioning of the plant at the end of 2022. In the long term, the aim is to operate the plant in a completely climate-neutral manner with green hydrogen, which can be produced from wind or solar energy by means of electrolysis.



The gas turbines used in the Leipzig South CHP plant are to be fired with natural gas from the end of 2022 and gradually converted to burn ever larger proportions of hydrogen. In the long term, operation with 100 percent green hydrogen is planned.

Hybrid power plants will play an important role in the power plant market of the future and can make significant contributions to achieving sustainability goals in the energy sector. Furthermore, the conversion of renewable energy into green hydrogen by means of electrolysis can provide an energy carrier that helps to gradually decarbonize sectors with a high CO_2 footprint, such as agriculture, transport and industry.

As technology providers and specialists in the implementation of large-scale projects, VDMA large industrial plant manufacturers are pacemakers in this development, thus contributing to global sustainability goals. Despite the many challenges in the current market environment, the companies look optimistically to the future and remain reliable partners for their customers for sustainable solutions in a rapidly changing market environment.

Chemical plants

Order intake in the VDMA chemical plant engineering sector – this report understands this to mean plants for the production of organic and inorganic chemicals, including air separation plants and plants for the production of industrial gases – reached a record level of 7.3 billion euro in 2021 (2020: 2.1 billion euro). Orders from abroad amounted to 7.1 billion euro (2020: 1.9 billion euro), in Germany orders of 159 million euro were booked – as in 2020. This development is essentially based on individual large orders as well as pandemic-related catch-up effects.

The economic recovery has led to strong demand for chemicals across industries in 2021, with capital expenditure in the chemical industry growing more or less in line with production. Most of the investment growth last year took place in Asia. This trend is likely to continue: Market observers assume that in 2030 about two-thirds of the global turnover of the chemical industry will be generated in Asia.

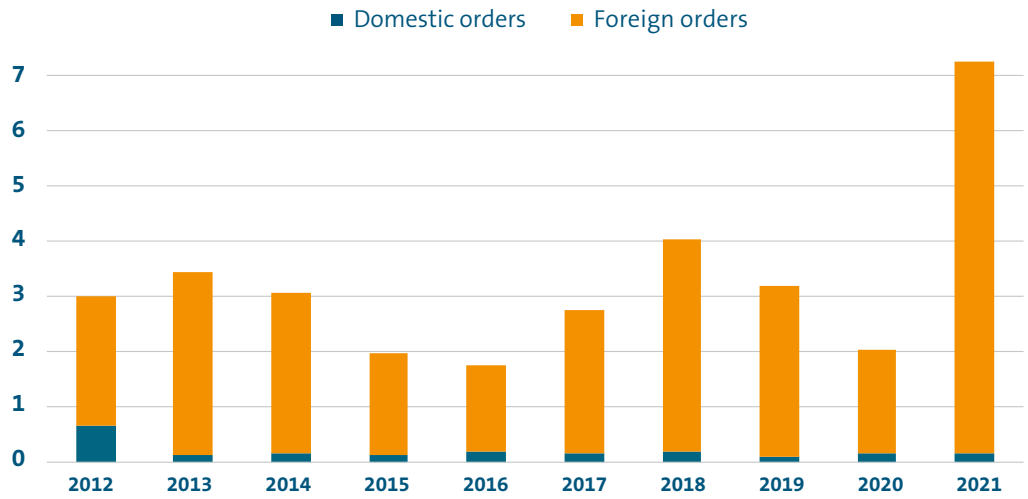
China is the world's number one in the chemical market

With a share of 40 percent of global sales, China is already by far the most important producer of chemicals and will probably be able to further expand this dominant market position by 2030. In the first 10 months of 2021, China's chemicals sector generated a profit of more than 100 billion US dollars, more than double that of the same

Figure 11

Incoming order for chemicl plants 2012 – 2021

billion euro



* = organic and inorganic chmical plants, air separation units, gas processing plants

Source: VDMA Large Industrial Plant Manufacturers' Group

period in 2020 and providing a solid base for future investment. Current forecasts predict that this positive market trend will continue in 2022. A particular challenge for the Chinese chemical industry is the reduction of carbon emissions in its own plants. The industry has already been able to make progress in this regard in recent years; after all, the People's Republic is one of the world's largest investors in renewable energy sources.

However, further measures are needed if the government is to make rapid progress in shifting to a more sustainable growth model. As technology providers, VDMA's large industrial plant manufacturers are sought-after partners here, for example in the supply of plants for the production of green hydrogen or technologies for the resource-efficient production of basic chemicals.

Developments in other market regions

In many emerging markets in Latin America, Eastern Europe and Asia, the chemical industry is expected to grow faster than in the industrialised countries in the coming years. India is one of the largest growth markets due to its large population: last year, the production of chemical products there increased by 4.8 percent compared to 2020. The current market size is around 175 billion US dollars. By 2025, the demand for chemicals is expected to grow by an average of 9 percent annually, so that the Indian chemical industry will then already contribute 300 billion US dollars to the gross domestic product.

In the wake of these market shifts, Europe will have to make efforts to defend its position as the second-largest location of the global chemical industry and as a centre of innovation. For the large-scale plant construction industry, opportunities in Europe will arise primarily in the course of modernisation and expansion projects at existing sites as well as by offering services that help to improve the availability of plants and reduce their carbon footprint.

Productivity driver digitalisation

During the pandemic, digitalisation has continued to gain importance in the chemical industry and chemical plant engineering. It has contributed to the establishment of new, virtual forms of cooperation and fundamentally changed workflows. Examples of this are the growing possibilities of predictive maintenance and virtual commissioning of chemical production plants, which can reduce costs, optimise maintenance cycles and reduce the risk of industrial accidents.

Chemical industry is committed to sustainability

Alongside the steel and cement industries, the chemical sector is one of the major industrial emitters of CO_2. In 2020, carbon dioxide emissions from the chemical industry amounted to around 920 million tonnes, 2.3 percent less than in 2019. The main reason for this decrease was the slowdown in economic activity in the wake of the COVID-19 pandemic.

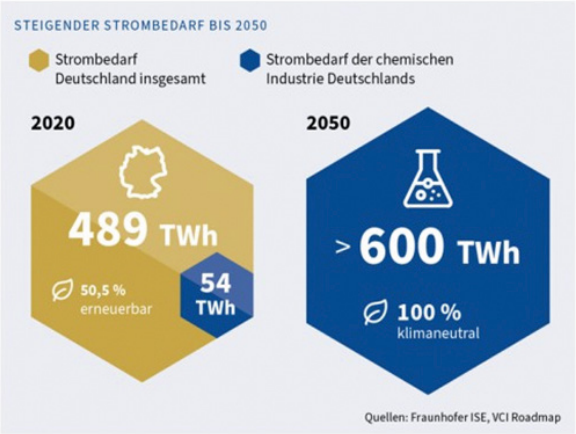


Figure 12

The rules issued by the EU Commission to avoid greenhouse gases require the European chemical industry to make considerable efforts to achieve the targets of a 55 percent reduction in emissions by 2030 and complete climate neutrality by 2050, which are anchored in the European Green Deal. It is expected that the massive investments to be made will increase production costs in the short term and thus dampen the industry's growth. However, the innovative strength of the chemical industry in Europe and its product portfolio, which is geared to the current and future requirements of the economy and society, for example in the areas of energy, food and transport, ensure that the industry remains fit for the future and capable of growth.

About 40 percent of the chemical industry's long-term emission targets can be achieved by investing in efficiency improvements of conventional plants, the use of biological or waste-based raw materials and the recycling of materials. In order to achieve the remaining 60 percent in emission reductions, climate-neutral technologies and innovative plants must be used to a much greater extent than before. After all, industrial plants have a lifespan of up to 70 years; this means that investments in purely conventional plants are already no longer compatible with the long-term goal of climate neutrality.

Green hydrogen is seen as the key to decarbonising the chemical industry, as it enables the climate-neutral production of the nine most important chemical building blocks (ammonia, benzene, chlorine, ethylene, urea, methanol, propylene, toluene and xylenes), which still account for more than half of the chemical industry's CO_2 emissions.

To be able to provide green hydrogen on the scale required, enormous amounts of renewable electricity are needed. The chemical industry is therefore calling on politicians to speed up approval procedures for a more rapid expansion of renewable energies. Figure 12 illustrates how great the need for action is with regard to this expansion in the coming decades.

High energy costs are the Achilles' heel of the chemical industry

The growth in orders in the chemical industry seen last year is accompanied by concerns about rising energy and raw material prices and bottlenecks in global supply chains. For example, the price of oil has doubled over the course of 2021, the price of coal has increased fivefold and the cost of natural gas has even risen in key regions of the world, such as Asia and Europe, to as much as ten times the price in 2020. In the wake of the Russian invasion of Ukraine, the upward price trend has accelerated even further. German chemical companies therefore expect continued burdens from raw material and energy price inflation, as a recent survey by the German Chemical Industry Association shows.

Producers do not expect an improvement in supply problems until summer 2022 at the earliest. They do not expect any easing of the high gas and electricity prices for the whole year. The assessments have great significance for the entire manufacturing industry, because chemicals and plastics are purchased as intermediate products by almost all sectors.

Energy costs and energy availability thus remain the Achilles' heel of the European chemical industry. In order to maintain the international competitiveness of the industry, efficiency increases through innovations are therefore imperative. In this context, VDMA industrial plant manufacturers are strategic partners of the chemical industry, providing its customers with resource- saving processes and tailor-made plants for sustainable industrial production on a large scale.

Hydrogen – the petroleum of tomorrow?

Hydrogen is considered the petroleum of tomorrow. It can play an important role in the substitution of fossil fuels and help to meet both national and international decarbonisation targets. This ambition is reflected in a number of government programmes that formulate concrete expansion targets at the industry level. One example of this is Germany's National Hydrogen Strategy with the three hydrogen lead projects H2GIGA (series production of electrolysers), H2MARE (hydrogen production on the high seas) and TRANSHYDE (development of an infrastructure for hydrogen transport). The strategy's expansion target is a production capacity of 5 gigawatts of electrolysis capacity for green hydrogen, which is to be built up by 2030.

Worldwide demand for green hydrogen is expected to reach 9,000 terawatts by 2050. A recent analysis of the 56 largest economies shows that more than 20 countries, which account for almost half of global economic output, have already adopted a national hydrogen strategy and that other countries will follow with similar plans in the coming years. In addition, more than 30 countries support national and international hydrogen projects. These projects are currently concentrated mainly in North America and Europe, with a focus on the United Kingdom.

The Bécancour plant in Canada, the world's largest proton exchange membrane electrolysis plant with a capacity of 20 megawatts, was commissioned in January 2021.

Other countries are investing in blue hydrogen production, the generation of which is coupled with a CO_2 capture and storage process. The carbon dioxide produced during hydrogen production is thus not released into the atmosphere and the production of hydrogen can be considered CO_2-neutral in balance sheet terms. Besides Japan, South Korea is currently the leader in this market segment, not least due to massive state subsidies. The hydrogen vision announced in October 2021 now postulates a target of 3.9 million tonnes of domestic demand for hydrogen in 2030, twice as much as in a roadmap from the beginning of 2019. If one adds up the currently planned projects, the investment volume in South Korea by 2030 amounts to 9 billion US dollars for blue hydrogen alone. In addition, there are plans to build plants for the production of liquid hydrogen and also green hydrogen.

Members of the VDMA Large Industrial Plant Manufacturers' Group are involved in a number of these projects as cooperation partners and technology providers. If the expansion of the hydrogen economy proceeds as planned, a maximum self-sufficiency level of 60 percent with hydrogen is possible in South Korea. In order to cover the remaining demand, there are – as in Germany – numerous projects to import hydrogen. In these projects, South Korean engineering companies, together with foreign partners, are to build plants for the production of blue and green ammonia, green methanol and green hydrogen, and at the same time develop strategies for transporting hydrogen from abroad. The planned plants are to be built in climatically favourable regions such as Southeast Asia, the Middle East and Australia.

VDMA large industrial plant manufacturers supply technology for decarbonisation

VDMA large industrial plant manufacturers are becoming increasingly important as partners in shaping the energy transition in the chemical industry. The companies' portfolio includes efficient processes and innovative, sustainable plants, and combines these solutions with the ability to scale technologies from laboratory scale to an industrial format. The offerings include, for example, water electrolysis plants, hydrogen liquefaction plants and processes for the capture, utilisation and sequestration of carbon dioxide (CCUS).

With the help of these technologies, the chemical industry is to be decarbonised step by step. Last year, a large number of projects for the construction of hydrogen production plants were announced. According to estimates, the investment projects planned so far will lead to a build-up of global electrolysis capacities in the order of 17 GW by 2026. In the EU, the focus is on projects for the production of green hydrogen. Similar developments are emerging in Australia, the Middle East and South America, which could become important hubs for exports, but also for the production of green hydrogen. In the course of this market ramp-up, observers expect that the price for a kilogramme of green hydrogen could drop from currently about 10 US dollars to about 1 US dollar in 2030.

With substantial subsidies available in Europe and North America, the topic of CCUS is also gaining further importance. One of the lighthouse projects in Europe is the establishment of the world's largest cross-border value chain for the capture and storage of carbon dioxide. The project is being developed jointly by two European chemical companies at their site in Antwerp. By avoiding 14.2 million tonnes of CO_2 in the first ten years of operation, the project is expected to make a significant contribution to the EU's goal of becoming climate neutral by 2050.

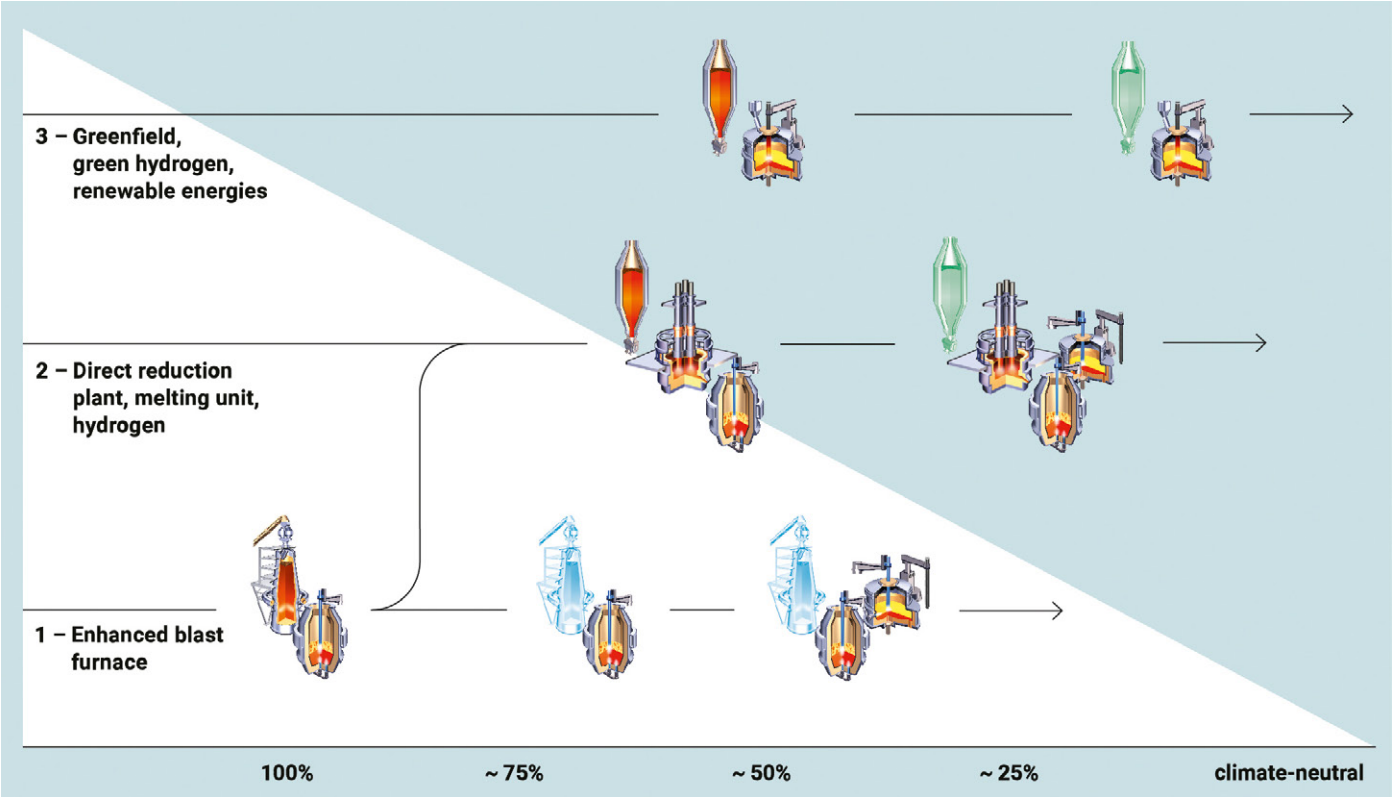
Metallurgical plants and rolling mills

On the way to a sustainable metals industry

The framework conditions set by politicians to curb climate change, such as the introduction of CO_2 prices, emissions trading or the setting of specific CO_2 reduction targets, are forcing manufacturers of steel, aluminium, copper and other non-ferrous metals to undergo a fundamental transformation.

Today, these industries cause about 10 percent of global CO_2 emissions, so decarbonization, i.e. the shift from fossil fuel-based production to climate-neutral processes, is a historic transformation for the entire metals industry.

At the same time, the steel, aluminium and copper industries offer themselves as ideal markets for the climate-neutral transformation of the economy for several reasons. Compared to other sectors, the necessary technical solutions are well developed and can be implemented in the short term. The metal industries also have great leverage for emission reductions. For example, the use of one tonne of climate-neutral (green) hydrogen in steel production saves around 26 tonnes of CO_2 compared to the classic blast furnace route. Last but not least, metals are predestined for a circular economy due to their longevity and suitability for recycling.



Schematic representation of three ways to transform steel production: optimisation of the blast furnace route, integration of a direct reduction plant in existing integrated steel plants and construction of new plants based on green hydrogen.

Metallurgical machinery and plant engineering plays a key role in the transformation of the metal industries. All the necessary processes, technologies and plants are developed and realised by or in cooperation with plant manufacturers. Thanks to its innovative strength, large-scale plant construction is a central enabler for the implementation of strategies and measures to achieve the global climate targets. For metallurgical plant engineering, this transformation therefore also represents an opportunity for long-term growth.

Decarbonization of the steel industry

In the steel industry, the decarbonization of pig iron production is the most important single measure on the path to climate neutrality, as this is where more than 80 percent of greenhouse gases occur in the entire production process. In the medium and long term, the path to climate neutrality for most markets involves replacing the classic carbon-based route from blast furnaces. Alternatively, the pre-reduced iron ore pellets can also be melted in a reduction furnace and then refined in a converter-based steelmaking process.

In the context of direct reduction, green hydrogen can be integrated comparatively easily into the steel production process. This technology has already been used for decades on the basis of natural gas (Midrex® technology) and involves reducing iron ores in the form of pellets in a shaft furnace using natural gas instead of coke. Before the natural gas enters the reactor, it is split into carbon monoxide and hydrogen, so that the reduction gas already consists largely of hydrogen. By continuously enriching the reduction gases with green hydrogen, it could even be completely decarbonised.

All well-known steel manufacturers have developed decarbonization strategies for their infrastructure and are pursuing these projects with great vigour. The prerequisite for climate-neutral steel, however, is the availability of green electricity or hydrogen generated from it in sufficient quantities and at competitive prices. The task of politics will be to establish a reliable regulatory, financial and infrastructural framework and thus create good conditions for this historic transformation. As long as green hydrogen is not available in sufficient quantities, direct reduction plants can also be operated with natural gas for a transitional period. This alone can save more than 50 percent CO_2 compared to the blast furnace route.

Due to the extraordinarily high investments in new technologies and plants, the gradual conversion of existing plants and infrastructure is also necessary for a rapid reduction of greenhouse gas emissions. For example, some of the carbon-containing solid fuels can be replaced by injecting synthesis gases into the blast furnace. The CO_2 savings potential here is up to 30 percent. The conversion of the existing plants and infrastructures requires an intensive reassessment of the energy balances and the reorganisation of the energy flows in the integrated metallurgical plants and is not possible without the expertise of large-scale plant engineering.

Circular economy

The term circular economy refers to a sustainable economic model that aims to avoid waste and uses resources in a very economical way. It involves reusing, sharing, repairing, refurbishing and recycling materials and products to create a closed-loop system and reduce the consumption of resources and minimise the generation of waste, pollution and carbon emissions.

Metals are particularly suited to a circular economy as they are extremely durable and can theoretically be recycled an infinite number of times without making any compromises to their quality. Recycling indirectly avoids emissions in the extraction, processing and transport of ores and in primary metal production, while at the same time improving the availability of rare elements, especially in regions poor in raw materials.

In practice, losses in the form of energy, exergy or dissipation naturally occur in the product life cycle. These quantifiable losses are the benchmark for the technological and economic limits of the circular economy. The goal of plant engineering must be to push recycling rates to the thermodynamic and technological limits.

In the steel industry, globally established recycling systems already exist and the production capacity of the energetically much more efficient secondary route with electric arc furnaces is limited solely by the availability of scrap. Comparable systems also exist for copper and other non-ferrous metals.

However, products in this area are often extremely complex and consist of many elements, materials and minerals that are interconnected to create the functionality of the product. For example, a smartphone combines many hundreds of metals, alloys, materials, plastics and glass into a functional mix in a very small space. For metallurgical plant engineering, the challenge is to develop technologically and economically efficient processes to bring the metals back to a level of purity required for the manufacture of new high-tech products.

Within the framework of direct reduction, regeneratively produced green hydrogen can be integrated comparatively easily into the steel manufacturing process.

In the first step of battery recycling, the so-called black mass, which contains the materials for battery production, is obtained by shredding old batteries. In the hydrometallurgical part, lithium, nickel and cobalt are extracted. The highly pure materials can then be used again in cathode or battery cell production.

This opens up new business areas for large-scale plant engineering, such as plants for recycling batteries of electric vehicles. Many car manufacturers, but also steel producers or waste management companies are working on building up appropriate recycling capacities in order to return the raw materials contained in the lithium-ion batteries to the cycle.

Digitalisation

Digitalisation also offers potential for reducing energy consumption in the steel, aluminium and copper industries in the order of 5 to 10 percent in the short term. As energy-intensive industries, they attribute a significant portion of their total costs to diverse energy sources and resources whose use is often not adequately controlled and forecasted.

The biggest levers of digital energy management lie in the areas of energy efficiency, planning and management. In the area of energy efficiency, energy and resource flows can be monitored and predicted, and adapted to current production plans by means of dynamic target adjustment and appropriate contextualisation. In the area of energy planning, cash flows can be simulated and optimised on the basis of current resource flows and contract constellations. Furthermore, in energy management, intelligent, software-based solutions can be used to transparently display the current CO_2-footprint, identify leaks or malfunctions in the distribution network and detect deviations between energy demand and consumption.

Pulp and paper plants

Challenging framework conditions in the paper industry

The market environment in the global paper industry was characterised by a variety of challenges last year. Increased raw material prices, bottlenecks in the procurement of materials, disrupted supply chains as well as lockdowns and other pandemic-related restrictions placed high demands on the flexibility of companies. Despite these obstacles, paper production worldwide rose slightly again in 2021 and almost reached pre-crisis levels.

COVID-19 pandemic accelerates change in paper demand

As in previous years, the strongest production growth in 2021 was again in the board and packaging paper segment. Booming internet trade, which received an additional boost from regional lockdowns, was a key driver for this. The production of hygiene and speciality papers also increased slightly, whereas global demand for graphic papers stagnated at the low level of 2020 as a result of the ever-increasing digitalisation of many areas of life.

The paper plant in Beihai shown here, which was built in the record time of 18 months, can produce over one million tons of paper per year.

These fundamental trends are expected to change little in 2022. Market observers expect production increases in all market segments, with the exception of graphic papers. Due to the overall higher production volumes, a growing demand for spare and wear parts is to be expected. A stronger service business can also be predicted, whereby the still existing travel restrictions and contact limitations represent a particular challenge in international business. One solution is the use of remote maintenance, which makes it possible to offer services independent of time and place.

Global and regional market trends

The market for machinery and equipment for paper production recovered faster than many experts expected at the beginning of the pandemic. Global investment activity picked up significantly in 2021 compared to the previous year. Particularly noteworthy is the very high demand for board and packaging paper machines compared to 2020. High investments were also made in the area of equipment for the production of speciality papers and nonwovens. Despite the global challenges, new plants were also successfully commissioned. The general market trends described above apply in principle to all regions of the world, whereby the following regional developments can be observed:

In Asia, production volumes recovered slightly in 2021 in the areas of speciality paper and graphic paper, but they do not reach the values from the years before the pandemic. On the other hand, the production of board, packaging and hygiene paper exceeded the pre-crisis level, in some cases significantly. As a result, demand for board and packaging paper machines also increased, especially in China. In the graphic paper as well as speciality and hygiene paper segments, the willingness to invest stabilised at a lower level in relation to the previous year.

South America was the only region where production of all paper grades increased last year. However, investment activity remained at a low level and was mainly limited to the tissue paper segment. In North America, paper production – with the exception of the graphic paper segment – was also on a growth path compared to pre-crisis levels. Packaging paper producers expanded their capacities, and to a lesser extent, orders were also placed for new lines to produce hygiene paper.

In Europe, the Middle East and Africa, similar developments as in North America were observed in terms of production: Increased volumes in the areas of speciality paper, board and packaging papers as well as hygiene paper contrasted with lower production volumes of graphic papers. At the same time, the willingness of paper manufacturers to invest recovered in 2021 and reached pre-crisis levels again.

Paper industry focuses on sustainability – with industrial plant manufacturing as the driving force

The global paper industry is facing the major challenge of making its own production processes even more resource-efficient than they already are. This necessity results on the one hand from political and legal requirements, such as the Green Deal adopted by the EU, which stipulates that greenhouse gas emissions in the Union are to be reduced by 55 percent by 2030 in relation to the year 1990. On the other hand, increasing cost pressure and changing social preferences that attach more importance to the issue of sustainability also play an important role. In order to achieve these goals, many companies in the paper sector rely on close cooperation with the paper and pulp plant engineering sector organised in the VDMA, which provides innovative solutions for sustainable and efficient paper production.

New processes reduce water use and improve fibre yield in paper production

In order to achieve global climate goals, the paper industry uses disruptive approaches in addition to the further development of existing technologies. Reducing the use of fresh water is one of the major challenges in the operation of plants in the pulp and paper industry. A strong lever here is the gradual closing of water loops in the production process. In the most modern paper production processes, the water used is purified with the help of anaerobic treatment techniques and completely reintroduced into the production process. In this way freshwater consumption per kilogramme of paper produced can be reduced to 1.5 litres. Due to the anaerobic process, a large amount of biogas is produced at the same time. This can be used as primary energy and reduces both energy costs and CO_2 emissions. In total, the closed water cycle reduces CO_2 emissions by up to 10 percent.

The recycling of recovered paper is another starting point for improving the sustainability of the material. After all, paper products made from recovered paper require significantly fewer resources than paper products based on virgin fibre. Great progress has already been made in this area over the past decades: Paper recycling rates in Europe are at 74 percent (2020), and globally a value of 50.2 percent was reached in 2018 - with an upward trend. In this context, cross-industry initiatives such as the 4evergreen alliance are also working towards sustainability goals, promoting the spread of sustainable and recyclable fibre-based packaging. VDMA plant engineering companies have made a significant contribution to these successes by developing innovative technologies that allow paper fibres to be recovered from wastepaper in even higher quality with lower energy consumption.

With this test coater, small batches of barrier papers can be produced for market tests and various line concepts can be tested. This increases planning reliability for customers for future projects.

Digitalisation with increasing relevance – also in the paper industry

The virtual control and implementation of industrial processes and services has become increasingly important across all industries in recent years. Paper manufacturers are also using the enormous potential of digitalisation. They are supported by the plant engineering industry by offering innovative services with which plants can be monitored remotely and maintenance work and troubleshooting can be carried out automatically and proactively. An illustrative example of this is a technology based on artificial intelligence and big data analysis that automatically detects critical process conditions in paper production, initiates countermeasures and thus prevents web breaks and production downtimes.

Another innovative solution brought to the market by a member of VDMA's plant engineering industry relies on the use of artificial neural networks, which learn with the help of expert knowledge to analyse recovered paper even before stock preparation and assign it to the respective trade classes. The early provision of this information enables efficient process control, which reduces fibre losses and facilitates to produce at lowers costs.

These examples illustrate that sustainability and digitalisation go hand in hand in the paper industry, ensuring the future viability of paper as a key material. In this context, plant engineering plays the role of a driving force, supplying the industry with innovative technologies in order to produce paper both in a cost-effectively and a resource-conserving manner.

Hydropower plants

The influence of the Covid-19 pandemic on the energy market

Due to the Covid-19 pandemic and the associated decline in economic activity, global electricity consumption fell significantly in 2020. In 2021, there was growth again, which is expected to continue in the medium term due to the increasing electrification of almost all areas of life and many industrial processes.

A good half of this growth came from renewable sources. According to estimates by the International Energy Agency (IEA), their share of global electricity production is currently close to 30 percent, with as much as 70 percent of all global investments in the expansion of electricity generation flowing into “green” projects.

In hydropower, the market volume can fluctuate significantly from year to year due to the high level of investment in individual hydropower projects. In 2021, global awards increased slightly from the very low level of the previous year but remained well below pre-crisis levels in the face of pandemic-related household deficits and difficulties in private project financing. The pandemic also made it difficult to complete projects and carry out service and construction site activities.

Asia continues to lead in the expansion of hydropower

Asia took a leading role in the expansion of hydropower worldwide towards the end of 2020. Plants with a total capacity of 16 gigawatts (GW) were commissioned. East Asia and the Pacific region accounted for about 14.4 GW of this, and South and Central Asia for about 1.6 GW. After the expansion of hydropower in the important market of China had recently stalled due to delayed energy market reforms, the market volume rose again to 13.8 GW in 2020. The International Hydropower Association (IHA) expects that by 2030 around 40 percent of the global expansion will take place in China alone – followed by India as the second most important market.

Hydropower prevents Europe from blackouts

Largely unnoticed by the population, the European power grid was put to the test in January 2021 and only narrowly escaped a widespread blackout. After several power plants in South Eastern Europe suddenly suffered outages, there was an abrupt drop in frequency in the European power grid. Only through the joint efforts of all electricity grid operators, with the connection of hydroelectric power plants in Austria and the targeted disconnection of consumers in France and Italy, it was possible to stabilise the system again and thus prevent a blackout. This event underlines the enormous importance of hydropower – especially pumped storage technology – as a stabiliser in a European energy system dependent on volatile wind and solar power supply.

With over 3 GW of new capacity added, Europe was the second most important market for hydropower equipment suppliers in 2021. Demand was mainly focused on the expansion and modernisation of existing facilities, primarily pumped storage power plants. Worth mentioning in this context is the expansion of the Austrian Kühtai power plant complex in Tyrol. With the construction of a second pumped storage power plant at this location, renewable energy can be generated flexibly and electricity from other energy sources can be stored temporarily. The expansion project thus makes an important contribution to the European energy transition.

It remains to be seen whether the significant acceleration and simplification of approval procedures for renewable energy projects promised by the new German government will also lead to a renaissance of hydropower in Germany. Plans for the construction of new pumped storage power plants already existed in the past. However, the implementation of these projects often failed due to strict regulations, a lack of permits, local resistance from the population and, last but not least, a lack of support from politicians, who did not support such projects to the necessary extent.

Pumped storage perspective and modernisations in North America

DInvestments in new hydropower plants in North America were again rather low in 2020, with an addition of 530 MW. Nevertheless, the USA and Canada have a very large installed base and many power plant operators are focusing on modernising their plants in the current market environment, which is characterised by an ambitious climate policy. In addition, the huge infrastructure package worth 1.2 trillion US dollars passed by the Congress in December 2021 could have a positive impact on the construction of new hydropower plants.

A current project example is the modernisation of the Robert Moses hydropower plant located in New York State, currently one of the largest hydropower projects in the USA. A member of the Large Industrial Plant Manufacturers' Group was awarded the contract for planning, delivery and installation of important electro-mechanical components. Furthermore, pumped storage technology continues to gain attention in the US, with the US Hydropower Association recently stating that there has been a significant increase in planned pumped storage projects in the US over the past decade. At the end of 2019, 67 pumped storage projects were in various stages of development, representing 52.5 GW of new capacity – an increase of 22 percent comared to 2018.

The Robert Moses hydropower plant, located on the Niagara River in New York State, is being modernized by a member company of VDMA.

South America: Market volume shrinks as expected

In 2019, South America was the second most important market for hydropower plant suppliers worldwide in terms of commissioning, behind Asia. In 2020, the continent fell significantly behind with a capacity expansion of only 476 MW. This development is not surprising, after all, because there was no major commissioning in South America as there was in 2019, for example, when the large-scale Belo Monte power plant with 5 GW was connected to the grid. Nevertheless, Brazil remains the largest regional market in terms of new capacity additions, followed by Chile and Argentina. Given the age of many plants, it can be assumed that a major modernisation wave is also imminent in Latin America.

Potential in Africa still untapped

In Africa, hydropower remains the most important renewable energy source. According to IEA estimates, the share of hydropower generation in Sub-Saharan Africa will triple by 2040. Individual countries such as the Democratic Republic of Congo or Ethiopia already cover more than 75 percent of their energy needs with hydropower. However, the start of many new projects is delayed due to ongoing political and economic difficulties. Above all, the financial situation of many emerging countries, which has become more difficult due to the COVID-19 pandemic, is having a dampening effect on the development and concrete implementation of large infrastructure projects in Africa. At the same time, uncertainties in project financing are also leading to the postponement of projects by private investors.

Good growth prospects for hydropower

Almost all serious experts assume that global electricity consumption will continue to rise in the medium and long term, with the strongest growth likely to occur in developing and emerging countries. At the same time, the transformation of the energy sector is being driven forward and requires massive investments in new and in the modernisation of existing plants. While there is a strong expansion of wind and solar energy, the need for pumped storage power plants, in particular, is growing to ensure grid stability and security of supply.

In the short term, the award volume in the market for hydropower plants can fluctuate considerably, as it depends heavily on individual large orders. In the long term, however, the prospects for plant suppliers are very positive against the backdrop of the global energy transformation. While in Europe and North America the expansion and modernisation of existing plants is the focus of customers, there is potential for new engineering projcets especially in Africa, Asia and South America. However, if these market opportunities are to become concrete projects, reliable political, economic and financial framework conditions must first be created.

What private-sector engagement can lead to in this context is demonstrated by some members of the Large Industrial Plant Manufacturers' Group who, in close cooperation with financial institutions and insurers, create the conditions in Africa that enable African customers to stretch the repayment periods of loans over a realistic time frame. In addition, the companies promote know how transfer to Africa by working with clients to jointly repair and maintain existing infrastructure and train future skilled workers locally to operate plants.

All figures in million euro

Statistical annex

Figure 13

Incoming orders in large industrial plant manufacturing 2012 – 2021

	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Total incoming orders	20,511	21,195	19,643	19,503	18,880	17,784	18,326	18,303	11,903	21,200
Three-year-average	22,616	22,213	20,450	20,114	19,342	18,722	18,330	18,138	16,177	17,135
Domestic orders	3,0901	4,502	3,733	2,620	3,653	3,750	3,487	3,555	3,249	3,221
Foreign orders	16,610	16,692	15,910	16,883	15,227	14,034	14,839	14,748	8,654	17,979
Export share	81.0	78.8	81.0	86.6	80.7	78.9	81.0	80.6	72.7	84.8

Figure 14

Foreign incoming orders by group of countries 2012 – 2021

	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Eastern Europe and CIS	2,380	2,060	4,062	2,157	1,774	1,794	4,265	2,365	2,342	6,942
Industrialized states	3,325	4,951	4,335	4,243	4,149	4,465	4,134	5,066	2,588	3,798
Asia-Pacific region	4,890	3,552	3,729	2,008	2,180	3,491	2,185	3,733	1,889	3,602
Middle East	1,814	2,165	1,791	2,383	1,765	1,383	2,088	1,379	633	1,208
Rest of the world	4,201	3,964	1,993	6,092	5,359	2,901	2,168	2,205	1,202	2,429
Total foreign orders	16,610	16,692	15,910	6,883	15,227	14,034	14,839	14,748	8,654	17,979

All figures in million euro

Figure 15

Turnover by group of countries 2012 – 2021

	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Total turnover	22,603	20,828	20,336	20,538	22,807	21,242	18,651	16,255	16,282	13,273
Domestic turnover	4,892	4,394	4,517	6,057	4,540	2,684	3,024	3,125	3,211	2,685
Foreign turnover	17,711	16,434	15,819	14,481	18,267	18,558	15,627	13,130	13,071	10,588
thereof										
Industrialized States	4,322	4,342	3,958	4,868	4,759	5,407	4,620	4,349	4,184	3,928
Asia-Pacific region	3,789	4,013	3,771	3,178	3,263	3,352	3,246	3,039	2,748	2,370
Eastern Europe and CIS	1,675	1,957	2,020	1,483	1,761	2,485	1,139	1,197	2,833	1,359
Middle East	2,957	3,046	1,943	2,090	2,426	1,868	1,658	1,686	1,523	1,055
Rest of the world	4,968	3,076	4,127	2,862	6,058	5,446	4,963	2,859	1,783	1,876

Figure 16

Domestic incoming orders by segments 2012 – 2021

Segment	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Metallurgical plants	301	191	189	170	137	257	192	281	128	470
Power stations	1,403	2,645	1,351	598	987	622	546	1,002	1,124	416
Chemical plants	177	37	65	66	102	84	114	83	121	36

All figures in million euro

Figure 17

Foreign incoming orders by segments 2012 – 2021

Segment	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Power stations	7,068	6,218	6,679	7,847	7,063	4,224	4,325	4,876	3,050	5,062
Metallurgical plants	2,404	2,551	2,159	1,461	1,287	1,988	2,041	2,203	999	2,450
Chemical plants	2,332	3,336	2,888	1,852	1,554	2,540	3,857	3,084	1,882	1,105
Cement plants	401	529	198	306	494	224	156	116	29	136

Figure 18

Quarterly incoming orders in large industrial plant manufacturing 2021

Quarter	Domestic orders	Foreign orders	Total orders	Export share
1	861	2,793	3,654	76.4
2	1,094	2,361	3,455	68.3
3	721	9,005	9,726	92.5
4	545	3,820	4,365	87.5
Total	3,221	17,979	21,200	84.8

All figures in million euro

Figure 19

Incoming orders by countries

Country	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2012 - 2021
1. Russia	895	884	2,376	1,193	983	1,086	2,351	1,384	1,604	6,298	19,054
2. PR China	1,629	1,774	1,000	823	840	1,401	1,243	1,346	786	1,112	11,937
3. USA	810	1,888	1,548	1,317	1,008	1,031	914	1,529	617	1,030	11,694
4. Egypt	253	144	51	2,575	3,232	159	213	605	77	244	7,554
5. India	945	1,163	386	693	385	470	390	290	144	471	5,328
6. South Korea	1,386	198	904	352	233	132	192	411	287	647	4,675
7. Saudi Arabia	395	1,004	916	511	549	132	333	129	225	219	4,508
8. UAE	452	146	311	719	309	330	620	335	169	110	3,502
9. Turkey	698	400	252	554	206	282	269	196	104	464	3,426
10. Great Britain	176	133	245	227	268	665	604	306	133	328	3,087
11. Poland	738	208	875	325	119	151	56	206	60	120	2,829
12. Malaysia	423	463	987	137	135	82	58	86	50	361	2,776
13. Brazil	591	361	152	362	65	68	220	411	117	396	2,743
14. Iraq	323	352	122	135	12	108	234	595	99	237	2,217
15. Taiwan, R.O.C.	174	141	58	124	181	149	132	211	353	618	2,141
16. Sweden	243	167	214	170	243	161	182	425	166	145	2,116
17. France	186	83	246	201	124	177	94	333	155	359	1,967
18. Netherlands	193	190	194	244	301	173	207	141	131	164	1,937
19. Canada	325	347	268	174	61	173	222	197	85	74	1,927
20. Hungary	20	64	69	158	35	42	1,081	48	258	138	1,911
21. Austria	120	118	122	196	128	385	233	157	115	325	1,900
22. Italy	158	196	170	133	152	157	153	199	132	311	1,762
23. Singapore	215	46	31	36	33	63	38	966	52	39	1,518
24. Thailand	61	232	244	116	114	322	82	91	152	95	1,507
25. Spain	67	120	124	151	259	224	105	138	107	116	1,410

Glossary

CAPEX
Capital Expenditures: CAPEX is the term used to describe the one-off expenses incurred at the time of acquisition for longer-term assets such as buildings, infrastructure or machinery. In the past, these costs were often in the focus of investment decisions.

CCU/CCS
Carbon capture and utilization (CCU) refers to the capture of carbon dioxide (CO_2), primarily from combustion exhaust gases, and its subsequent use in further chemical processes. The term is closely related to carbon capture and storage (CCS), in which the captured carbon dioxide is stored without a container. In contrast to CCS, the primary goal of CCU is not to remove CO_2 from the atmosphere, but to provide chemical raw materials. Thermal power plants with CCU technology therefore initially supply CO_2 as a raw material for other applications, which is temporarily captured but released again when used for energy. Thus, although the CCU process per se has no climate protection effect, it can play an important role in a circular economy. If the CO_2 used is permanently protected from release, this can be a building block for climate protection.

Double taxation agreement
An agreement to avoid double taxation is an agreement under international law between two states. It governs the extent to which a state is entitled to a right of taxation for the revenues earned in one of the two contractual states or for the assets located in one of the two contractual states. The aim of a double taxation agreement is to prevent natural persons or legal entities that realize revenues in both states from being taxed in both states.

ECA
Export Credit Agency (ECA) is the international term for government export credit insurance in the OECD, which promotes export projects in emerging and developing countries – either through pure credit insurance, or also through direct financing, refinancing and interest rate subsidies. In Germany, Euler Hermes is responsible for the implementation.

EPC
Engineering, Procurement, Construction: In large industrial plant manufacturing, contracts are frequently awarded as EPC packages. It means that the contract to be awarded comprises engineering, procurement and construction of a plant. The plant constructor generally carries out an EPC contract as a general contractor or as head of a consortium.

General contractor
Where the plant manufacturer acts as general contractor for a project, which is routinely the case for turnkey plants, he is responsible to the client for all deliveries and services arising from the contract received. The plant manufacturer thus takes the place of the client in coordinating the interfaces between the respective individual trades.

HSE
Health, Safety, Environment: HSE management involves the planning, implementation, monitoring and optimizing of business processes relating to health protection, occupational safety and environmental management. Due to the increasing volume of legislation and extensive customer requirements, these issues have become considerably more important in large industrial plant manufacturing in recent years.

Mega project
The VDMA defines megaprojects as very complex, technically demanding and economically relevant projects with order volumes of at least 500 million euro. Megaprojects are also characterized by a large number of participants and project durations of several years. On the other hand, the VDMA speaks of a major or large-scale project for ventures worth at least 25 million euro.

OECD Consensus
The OECD Consensus is a "gentlemen's agreement" of the OECD members EU, USA, Canada, Norway, Switzerland, Japan, Korea, Australia, New Zealand, Chile, Iceland, Israel, Mexico and Turkey to grant officially supported export credits only within defined limits. This is intended to largely prevent distortions of competition in the relationship between exporters as well as financing competition at the expense of state budgets. Since this is not a legal act of the OECD, other countries outside the OECD could also join the consensus. However, efforts to include China in particular have failed so far.

OPEX
Operational Expenditures: OPEX refers to the current expenses necessary for the operation of a plant. These include, for example, the costs of raw materials, consumables, personnel and energy. In the current market environment for large-scale plant construction, operating costs are becoming increasingly important from the customer's point of view.

Withholding tax
In large-scale plant construction projects, withholding taxes in the broader sense are all taxes levied by the target country of the project directly on the income by the plant constructor as part of its limited tax liability. Withholding taxes in the narrower sense are all taxes withheld from income without assessment through tax deduction. In most countries, these taxes are levied on dividends, interest and royalties. Under double taxation agreements (DTAs), withholding tax rates are usually reduced.

Hydrogen (green, grey, blue)
Green hydrogen is produced by the electrolysis of water, using only electricity from renewable sources. Regardless of the electrolysis technology chosen, this production of hydrogen is CO_2-free, as 100 percent of the electricity used comes from renewable sources. Grey hydrogen is produced from fossil fuels. As a rule, natural gas is converted into hydrogen and carbon dioxide under heat during production (steam reforming). If the CO_2 is then released unused into the atmosphere, this increases the global greenhouse effect. Blue hydrogen is grey hydrogen whose CO_2 is captured and stored during production (CCS). In this way, the CO_2 generated during hydrogen production is not released into the atmosphere and hydrogen production can be considered climate neutral.

Imprint

Imprint

The overview of business developments and all statistical figures are based on surveys performed by the VDMA Large Industrial Plant Manufacturers' Group. The Status Report serves as a reference point and provides an overview on the economic situation and political concerns of the large industrial plant manufacturing industry.
The report does not claim to be complete. Furthermore, the particular features of the different sectors and products of the large industrial plant manufacturers, as well as their different applications, are to be considered. Therefore, a variety of other assessments on the issues raised in the Status Report are possible.

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Status
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