

INNOVATIVE

2019 ANNUAL AND SUSTAINABLE PERFORMANCE REPORT

CLIMATE

URBANIZATION

TECHNOLOGIES

PEOPLE

RESOURCES

ARKEMA
INNOVATIVE CHEMISTRY

contents.

Innovate: Why? With whom?

Environmental and societal issues are increasingly pressing, and we – consumers, manufacturers, governments – must all redefine our priorities and lifestyles, as well as our production and governance methods.

INCREASING URBANIZATION is further accentuating the need for these changes.

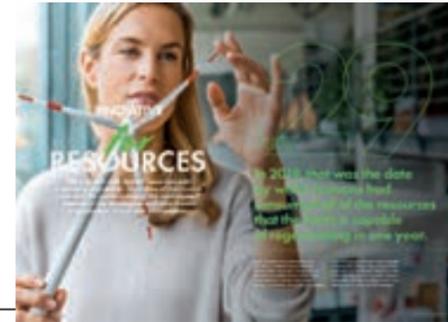
VITAL RESOURCES are being overexploited, from carbon energies to water, and are becoming dangerously scarce.

CLIMATE CHANGE is disrupting the balance of regional relations and requires optimal and urgent solutions. New ways of working and industrial performance now rely on **TECHNOLOGIES** that need to be increasingly reliable and sustainable. In this process of urgent change, nothing can be achieved without **HUMAN PROGRESS**.

INNOVATIVE for, our 2019 annual report reflects our determination to ensure environmental, social and human issues are central to our products and activities. Our promise is to spotlight our materials and solutions that have become part of your daily lives, and to demonstrate their value, technology and sustainability.



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opinion.

We must remain confident in the future

As we complete this annual report, the world is in the midst of the Covid-19 pandemic – an unprecedented health, social and economic crisis. Normal life has vanished during these uncertain times. And yet, once the shock has worn off, life must go on, we must adapt to these extraordinary circumstances and weather the storm with humility. We must also look to the future and stay on track. Like many other groups, Arkema took widespread and immediate action in response to the crisis. We have had the full support of our employees, who have demonstrated incredible professionalism and commitment. Their health and safety is our priority, and we took action so that we could continue our activities to serve our clients and supply essential products to strategic sectors including health, energy, water treatment, and food. In these new conditions, we have been guided by our sense of solidarity and responsibility. At the same time, our entrepreneurial spirit, agility, expertise and, most importantly, our unwavering **confidence** in the future, continue to drive us forward.

We have **confidence** in our ability to withstand this economic recession and the significant decline in global demand expected in 2020. We serve a variety of end markets and operate around the world. We adapt to changing circumstances and short-term needs by adjusting our costs and investments, by strictly controlling our working capital, and thanks to our solid balance sheet and high level of liquidity.

We also have **confidence** in our long-term strategy. Since 2006, we have been implementing major change within our Group to allow us to gradually gain leadership positions in Specialty Materials, through targeted investments, an innovation policy based on major sustainability trends, and active management of our business portfolio. The Specialty Materials businesses are profitable and resilient, and now represent nearly 80% of our revenue. This is set to rise to 100% by 2024!

Lastly, we have **confidence** in our ability to offer concrete solutions to major societal challenges such as growing urbanization, the scarcity of resources, climate change, and technological developments. The crisis we are going through, despite its severity, should not undermine our priorities in ecological and energy transition and the decarbonization of different business sectors. In a context of growing demand for new, sustainable and high-performance materials, Arkema enjoys a unique position in Specialty Materials and solid expertise in innovation. This allows us to offer, in partnership with our clients, solutions that will help to overcome these major challenges. As a responsible and committed manufacturer, Arkema will, without a doubt, be a driving force in changes in society around green growth and the circular economy over the coming decade.

This is at the heart of this **INNOVATIVE for** annual report.

Despite having to manage the current crisis, we are already preparing for the post-crisis phase and for Arkema's future.

THE EDITORIAL TEAM

Close-up.

2019 was a busy year, with acquisitions, industrial investments, partnerships, major trade fairs, innovations and awards. We look back over the highlights of the year, which reflect the constant growth of our dynamic, innovative Group.

▾ January

BOSTIK'S FIX & FLASH IS A WINNER!

Bostik won recognition from French consumers who named Fix & Flash the "2019 Product of the Year" in the "glue and repair" category. This is the first retail glue to use LED light for instant drying on all types of materials!



▾ January

LOOKING AHEAD TO THE NEXT GENERATION OF ELECTRIC BATTERIES

Arkema anticipated the future of battery technologies for the transportation market by acquiring a stake in OXIS Energy, which manufactures lithium-sulfur batteries. Since 2012, Arkema has been supplying OXIS Energy with electrolyte salts from its fluorochemicals activities, as well as carbon nanotubes and value-added polymers to improve the lifetime and energy density of these batteries.

▾ January

SPONSORING THE YOUNGER GENERATION

In France Arkema became a partner of the Sport in the City charity, in particular supporting its "L in the City" program to help young women integrate into society and the workplace. Arkema has been a sponsor of the Théâtre des Champs-Élysées (Paris) since the 2017/2018 season, and is now supporting the program to bring opera to young people by giving 10,000 students from deprived neighborhoods the opportunity to learn about and sing classical music in a fun way.



▾ February

SPORTY POLYMERS!

Arkema took part in ISPO, the biggest trade fair for the sports industry. This was an opportunity to showcase to equipment manufacturers from around the world our high-performance polymer Pebax®, which offers lightness, energy return and sturdiness for footwear soles, as well as our Kynar® fluoropolymer, valued in technical fabrics for its durability and anti-friction properties.



▾ February

POWDER COATINGS BOOM IN INDIA

Arkema opened a first-class polyester resin manufacturing facility in Navi Mumbai, in India. These Reafree® resins are used in low-VOC powder coatings for industrial and architectural applications, which are experiencing strong growth in India and the Gulf region.



▾ February

ARKEMA WORKS TO BOOST 3D PRINTING

Arkema has teamed up with Autodesk and Farsoon to develop an optimized ecosystem combining software, printing equipment and materials. The goal is to accelerate the adoption of laser sintering of Rilsan® polyamide 11 powders, which are high-performance polymers with superior durability and performance for industrial production.



▾ March

A PROMISING FUTURE FOR RECYCLABLE COMPOSITES

Arkema took part in JEC World Paris, the world's largest composites trade fair, showcasing its unique range of thermoplastic materials for the production of recyclable composites destined for wind turbines, construction, transport and sports. With these products, Arkema intends to address the environmental problem of processing end-of-life composites. At the fair, Arkema received first prize in the Construction category for its innovation in glass fiber composite reinforcement for concrete and cables, made using its Elium® thermoplastic resin.



March
PEKK COMES TO THE UNITED STATES

Arkema opened a PEKK production unit at its Mobile site (Alabama, US). This investment will support Arkema's response to the strong demand for carbon fiber-reinforced composites and 3D printing solutions for the aeronautics, oil and gas, electronics, and automotive industries.



April
OUR UV RESINS ARE BEING DEVELOPED IN CHINA

Sartomer has successfully started up the 30% capacity extension of its photocure liquid resin production plant in Nansha, located south of Canton, China. This investment is a response to growing demand in Asia's electronics, 3D printing, and adhesives markets.



March
HEXCEL LAUNCHES OUR PEKK IN FRANCE

Arkema and Hexcel opened a joint R&D laboratory in Les Avenières, in Isère, France, to develop PEKK (Poly-Ether-Ketone-Ketone) thermoplastic prepreg composite tapes for the manufacture of structural parts in future generations of aircraft. These competitive solutions will provide lightweight technologies and faster production cycles for aerospace customers.

May
NEW RILSAN® PLANT IN SINGAPORE

Arkema chose the location of Jurong Island in Singapore to build its new world-scale plant dedicated to the manufacture of the amino 11 monomer and its Rilsan® polyamide 11 resins. With this 50% increase in its global capacities announced in July 2017, the Group is supporting strong demand from its customers in Asia, especially for transportation, with high-performance bio-based solutions.



May
ARKEMA EXPANDS IN SURFACTANTS

Arkema reached another milestone in the development of its surfactants activities with the acquisition of ArrMaz, a US-based leader in specialty surfactants for crop nutrition, mining, and road infrastructure. ArrMaz has sales of \$290 million and offers Arkema excellent complementary technologies and geographic reach. See opposite



May
WORLD CUP: CHEERING ON WOMEN!

As France's official sponsor for the FIFA Women's World Cup 2019™, Arkema successfully kicked off its outreach actions during the tournament. The Caravan'Arkema toured France, and Arkema launched the first official FIFA chat bot, held competitions, dedicated a film to the competition's ambassador, footballer Gaétane Thiney, and pursued other activities to connect with the public.

June
CARBON AND ARKEMA: TWO ARE STRONGER IN 3D

Carbon, the world's leading digital manufacturing company, and Arkema, a pioneer in liquid resins for 3D printing through its subsidiary Sartomer, announced a strategic partnership and Arkema's investment in the start-up. The aim is to deliver highly innovative materials and new technologies for 3D mass production, to disrupt the supply chain model.



June
ARKEMA SUPPORTS THE D1 WOMEN'S FOOTBALL LEAGUE

Arkema continues to promote women's football as well as women's role in the company, and signed a naming contract with the French Football Federation for the Division 1 women's football league for three seasons, now known as the Arkema D1.



Arkema+ArrMaz: A new leader in specialty surfactants



JEAN-FRANÇOIS CHESNEAU, President of surfactants and additives & CEO of ArrMaz

Which markets relate to surfactants?

Surfactants are additives that alter the tension between two surfaces to make things more easily soluble. They are found in many applications. For example, they improve the fluidity of road asphalt during laying. They are used as coating agents for fertilizers, to prevent them from solidifying, and are used in mining to separate the extracted metal parts from their impurities. They are also used in detergents, paints, cosmetics, and oil and gas extraction. ArrMaz's portfolio is particularly focused on fertilizers, mining, and road asphalts.

What does the acquisition of ArrMaz represent for Arkema?

This acquisition makes Arkema one of the world's leaders in surfactants. ArrMaz is extremely complementary to Arkema, geographically, commercially and technologically. ArrMaz's leading position in buoyant markets in North and South America, the Middle East, Asia, and Africa complement Arkema's solid position in Europe. ArrMaz is also a leader on several strong growth niche markets. These include the recovery of lithium ore, increasingly in demand due to the growth of electric vehicles; the fertilizer market, with additives that make them more effective; and the asphalt market, with additives that improve the quality and recyclability of road surfaces. Our shared portfolio allows us to target all market segments in all regions.

Do you have any joint innovation projects?

ArrMaz is known for its formulation expertise. We will build on this almost made-to-measure know-how across our product offering. Together, we will achieve further developments in bio-based and biodegradable surfactants and incorporate these into turnkey solutions for our clients. Arkema already benefits from experience in this field. For example, we have just launched the bio-based nonionic Sensio® surfactant range in the detergent market. Arkema and ArrMaz's respective areas of expertise will boost our capacity for innovation!



June

BOSTIK HAS BIG PLANS!

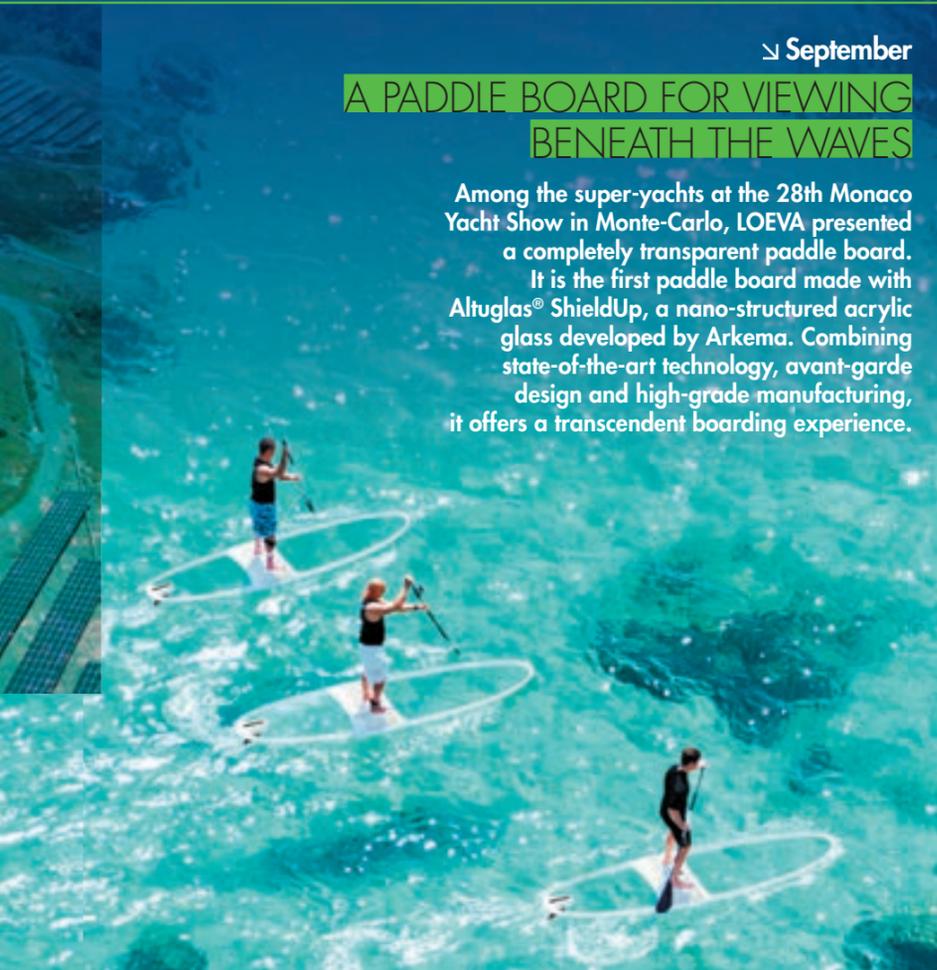
Bostik acquired Prochimir, a French company specializing in high performance thermobonding adhesive films. This acquisition has placed adhesives king Bostik among the world's major players in solvent-free thermobonding films for many fast-growing industrial applications in the automotive, construction, textile and medical markets.



June

OUR SAINT-AUBAN PLANT ENJOYS TIME IN THE SUN

Corsica Sole, an innovator in photovoltaics, and the Arkema plant in Saint-Auban, have opened a solar power plant, the first in France to be fully located within a Seveso-classified industrial site. The initiative involved repurposing a number of the plant's brownfield sites. The energy produced will be used for local consumption to power the operation of the Arkema site.



September

A PADDLE BOARD FOR VIEWING BENEATH THE WAVES

Among the super-yachts at the 28th Monaco Yacht Show in Monte-Carlo, LOEVA presented a completely transparent paddle board. It is the first paddle board made with Altuglas® ShieldUp, a nano-structured acrylic glass developed by Arkema. Combining state-of-the-art technology, avant-garde design and high-grade manufacturing, it offers a transcendent boarding experience.



SARTOMER | LAMBSON
ARKEMA
INNOVATING WITH YOU IN MIND

June

AN ILLUMINATING ACQUISITION

Sartomer acquired Lambson, a UK company specializing in photoinitiators for curing, a technology meeting the demands of cutting-edge markets such as electronics, 3D printing, digital ink, composites and high-performance coatings. These solutions will complement the offering of Sartomer, a global leader in photocure resins, while helping to speed up its development in this fast-growing market.



JULIE HAEVERMANS,
Global Communication
and Marketing Director,
Sartomer

Sartomer acquires Lambson: Poised to revolutionize the UV curing market!

"Sartomer is a world leader in specialty resins for UV curing. This low-VOC technology delivers high-performance coatings based on a liquid formulation that cures instantly under UV light. These varnishes, inks and adhesives fulfill the demands of cutting-edge markets such as electronics, automotive, cosmetics, packaging, and 3D printing for additive-layer manufacturing. For example, our resins are used in smartphone touchscreens to optimize their resistance, light diffusion and image definition.

Sartomer has just made a significant advance in UV curing with the acquisition of Lambson, a UK firm, global leader in the supply of photoinitiators

which initiate polymerization for UV curing. With this acquisition, Sartomer is expanding its product offering, which will foster to drive annual growth of around 5%. Thanks to Lambson's photoinitiator expertise, we gain a comprehensive knowledge of UV curing systems, ensuring we are better placed to respond to the needs of end applications and the challenges faced by our customers. We stand out from our competitors thanks to our tailored solutions with all the necessary ingredients (specialty resins, additives, photoinitiators). We have all the resources we need to disrupt the field of UV curing with our increasingly sustainable approach."



September

ARKEMA SHOWCASES ITS ADHESIVES EXPERTISE

Arkema showcased its new range of pressure-sensitive adhesives at LabelExpo 2019, resulting from its solid expertise in areas such as labels, tapes and protection films, notably used in the packaging, construction and automotive industries. To offer the market the most comprehensive product range including the very latest innovations, the Group decided to pool the expertise of its teams by creating a global network under the name Self-Adhesive Solutions by Arkema. See opposite

Bostik's pressure sensitive hot-melt adhesives

ÉRIC PAROIS,
Global Market Leader – Tape, Label and Medical at Bostik Advanced Packaging

How would you summarize Bostik's range of pressure sensitive hot-melt adhesives?

Bostik is a world leader in this field. Our expertise comes from in-depth knowledge of the value chain, allowing us to offer the labels/packaging market a comprehensive product range that incorporates the latest innovations and reflects concerns such as sustainability.

What new products did you bring out in 2019?

We focused on solutions based on more sustainable, eco-responsible technologies, including solvent-free. These include our linerless labels, which are free from silicone and reduce our waste and carbon footprint. We also developed a labeling concept for recyclable glass bottles. This new hot-melt adhesive for washable labels is particularly attractive to recycling companies.

The label detaches easily, leaving no trace on the glass or residue in the cleaning water. We also offer a new adhesive with no mineral oil for cardboard packaging, which does not interfere with the cardboard recycling chain while complying with the most stringent standards. It is designed using bio-based products for food labeling, to respond to needs for sustainability and consumer safety. Lastly, our silane-modified polymer pressure sensitive adhesive (PSA) is based on moisture curing, which is a disruptive technology. It offers a coating speed three to five times faster than similar traditional solvent-based glues, and a better compromise between adhesion and cohesion.

Are sustainability and recycling considered throughout your product development?

Absolutely. Even outside our direct clients, who are self-adhesive label manufacturers, all brands, particularly those in the food and drink sector, want more cost-effective packaging as well as eco-responsible designs. The same demands are coming from online retailers, which consumes vast quantities of paper-cardboard packaging, and recyclers who are using increasingly stringent processes. These challenges represent incredible opportunities for Bostik.

October

A NEW GIANT REACTOR IN THE UNITED STATES

In order to support the growth of its North American customers in the markets for superabsorbents, paints, adhesives and flocculating agents for water treatment, Arkema brought on stream a new 90,000-ton acrylic acid reactor at its Clear Lake site in Texas.



October

THE ELECTRIC CAR RACE IN CHINA

To support the growth of the lithium-ion battery market for electric vehicles, Arkema is increasing the production capacity for its Kynar® PVDF fluoropolymer at its Changshu plant by approximately 50%.



November

ARKEMA FOCUSES ON COMPOSITE 3D PRINTING

This new technology offers promising prospects in the aeronautics, automotive, energy and construction sectors to meet growing demand for lightweight materials. Arkema, a leader in materials for 3D printing and composites, has teamed up with two up-and-coming start-ups in this field: Continuous Composites for the development of Continuous Fiber 3D Printing (CF3D®) technology with Sartomer's UV-curable resins, and 9T Labs for the 3D printing of Kepstan® PEKK composites.

Born2Bond™

POLIVIO GONCALVES,
Market Manager,
Bostik Engineering Adhesives

Bostik is investing in the rapid-growth market for engineering adhesives with its Born2Bond™ range. What is it?

Born2Bond™ is a range of high-performance adhesives for applications that require extreme-precision instant adhesive solutions. It targets the electronics market with complex assembly needs such as smartphones and on-board automotive electronics, jewelry, luxury packaging, medicine with the assembly of specialist accessories and devices (catheters, ultrasound scanners, etc.), and the maintenance of industrial equipment and vehicles. Together, they represent potential revenues of €7 billion a year, with an estimated annual growth of 9%. We want to be one of the world's top five manufacturers of engineering adhesives.



What demands do you meet?

Precision, speed and user comfort. We use methoxyethyl cyanoacrylate (MECA) technology to formulate our instant adhesives. The resulting patented products are very fast curing, low-odor and low-blooming – essential qualities for high-end products. Our adhesives fulfill extremely high demands such as complex assembly and design, increasingly rapid curing times, less cost to implement, user comfort, and the need to meet strict environmental and health standards.

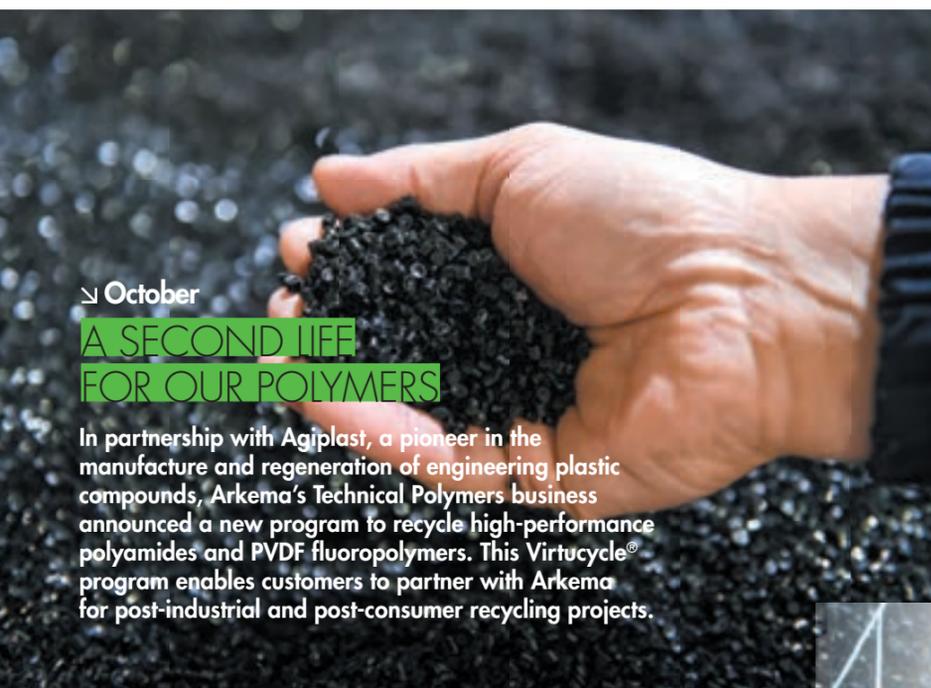
How is Born2Bond™ technology innovative?

We are the first firm to offer up to 250% elongation on adhesives that are usually very crystalline. Our MECA-based, low-odor, mono- and duo-component formulas offer much greater user comfort than competitors' products. The Born2Bond™ Academy is available to our clients and distributors around the world to train their technical and sales teams.

October

A SECOND LIFE FOR OUR POLYMERS

In partnership with Agiplast, a pioneer in the manufacture and regeneration of engineering plastic compounds, Arkema's Technical Polymers business announced a new program to recycle high-performance polyamides and PVDF fluoropolymers. This Virtucycle® program enables customers to partner with Arkema for post-industrial and post-consumer recycling projects.



November

A NEW R&D CENTER DEDICATED TO 3D PRINTING

Arkema opened a new Global Center of Excellence for 3D Printing within its Cerdato R&D Center in Serquigny, Normandy, in France. Dedicated to additive manufacturing based on high-performance polymers, and equipped with the latest-generation printers, it will help companies in the region to encourage adoption of these new production methods.



November

MAJOR AMBITIONS ON THE MICRO-BONDING MARKET

Bostik launched Born2Bond™, a range of innovative, high-performance, fast-cure adhesives designed for high-precision micro-bonding (between 500 microns and 2 mm) in a wide variety of applications. Bostik aims to become a leading player in this rapidly expanding market. See opposite

December

BOSTIK CARVES OUT A LEADERSHIP POSITION

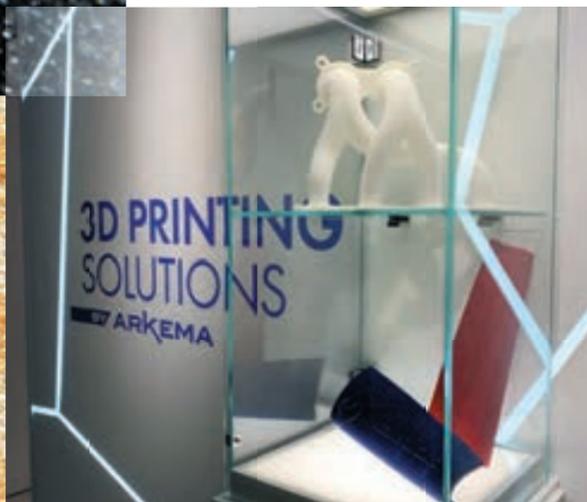
Bostik has acquired Danish company LIP, one of Scandinavia's leaders in construction chemicals with its tile adhesives, waterproofing systems and floor preparation solutions, recognized for the quality of its products by building professionals. This project has allowed Bostik to strengthen its presence in Nordic countries.



October

OUR POWDERS ARE GOING FROM STRENGTH TO STRENGTH

Arkema has started up a new production line at its Mont plant, in France, for its high-performance fine polyamide 12 powders under the name Orgasol®. This has increased the Group's global capacity by over 50% to support strong demand in the coatings, personal care, composites and 3D printing markets.



interview. Results and outlook

Thierry Le Hénaff reviews the Group's strong performance in 2019, and discusses the start of 2020, which has been marked by an unprecedented global crisis. This exceptional situation has highlighted the agility of Arkema's workforce and the Group's financial solidity. Looking beyond the current year, Thierry Le Hénaff has confidence in the next stage of the Group's development, which was presented to investors at the recent Strategic Update, and in Arkema's vision of becoming fully focused on Specialty Materials by 2024.



2020 has been marked by the exceptional context of Covid-19. How have you managed this situation on the ground?

Thierry Le Hénaff – This crisis is truly unprecedented, and we had to act quickly while continuing to adapt to the changing situation. In these troubled times, Arkema's immediate priority has been to put in place the necessary health and safety measures to protect the Group's employees, and also to support governments in order to limit the spread of the virus, paying particular attention to the most vulnerable people.

Internally, we have put in place strict and coherent procedures in line with the requirements in each country. We have stepped up measures to reduce exposure and face-to-face contact, and we have limited site access to essential staff only, with strict safety and disinfection measures in place.

We have also ensured that protective measures and social distancing are being respected, and have moved to remote working wherever possible.

The Executive Committee holds a daily video conference to discuss the running of the Group, define new initiatives, and keep up to date with the situation in this rapidly changing context. We are now busy preparing for the second quarter, which could be more complicated for businesses in terms of demand.

I have been impressed by the commitment and professionalism of our people around the world. The Group's values are essential in this context. Solidarity is one of Arkema's four key values, and we are demonstrating it very clearly in the current situation.

What have the impacts of the crisis been on the ground?

T. L. H. – Thanks to the efforts of Arkema's employees, we have been able to maintain our operations wherever possible around the world and serve our clients in conditions that are often complex. Many of our products are essential to downstream industries and the economies of countries in which we operate.

We have also responded to high demand from our clients for several of our products such as PMMA (acrylic glass) sheets to protect checkout staff in supermarkets, PVDF to make protective masks, and molecular sieves for medical respirators. The number of examples increases every week and makes our expertise particularly relevant.

We are proud to contribute to the fight against Covid-19. We also quickly put in place systems to produce large volumes of alcohol sanitizer gel in France, and to a lesser extent in the United States. This socially responsible effort has been possible thanks to the rapid response and expertise of our teams.

How could this exceptional situation affect the Group's financial health?

T. L. H. – The crisis, which started off being about global health, has rapidly turned into a full economic crisis with a steep decline in demand in many sectors such as automobiles and construction, and with a real lack of visibility.

Fortunately, the Group is solid and prepared for this situation, although we will require a great deal of effort internally during this time. Our sound management in the past, our healthy balance sheet, our technological expertise, our commercial >>>

"ARKEMA REMAINS ON A SOLID FOOTING IN THE CONTEXT OF COVID-19 AND IS AMBITIOUS FOR THE FUTURE."



SOLIDARITY IS ONE OF ARKEMA'S FOUR KEY VALUES, AND WE ARE DEMONSTRATING IT VERY CLEARLY IN THE CURRENT SITUATION.

“WE WANT TO BE FULLY FOCUSED ON SPECIALTY MATERIALS BY 2024. AT THE MOMENT THEY REPRESENT 79% OF OUR ACTIVITY. IN FIVE YEARS THIS WILL BE 100%.”

>>> presence, and our progress in recent years are all strengths that mean we can look ahead with great caution and concern, of course, but also with confidence. Our diversified presence on many end markets gives us greater protection than businesses that depend on one or two segments.

“In the current context, our responsiveness has already been a key element, and will continue to be so.”

In the current context, our responsiveness has already been a key element, and will continue to be so. It is essential that we adapt our inventory, our operational spending, and our investments, intelligently and determinedly and without delay. As part of our responsible approach, we must also start to prepare for life after the crisis and to consider the way we operate, particularly as lockdown eases.

Looking back at 2019, did Arkema perform well again?

T. L. H. – 2019 feels like a long time ago in the circumstances, but it is important to review it. The macroeconomic context was less buoyant in 2019 than in 2018. Our revenue totaled €8.7 billion, largely in line with the previous year, and EBITDA reached €1,457 million, comparable with the record performance of the previous year. Cash generation remained very solid and reached a historical high, with free cash flow of €667 million, a significant rise, and an operating-cash-flow-to-EBITDA ratio of 52%.

This financial performance reflects the Group’s solidity and resilience in an economic environment that was already being affected by a slowdown in certain key end markets. It also confirms the quality of our business portfolio and the soundness of our strategy to move towards specialties. These product lines registered a 13% increase in EBITDA in 2019. They have overtaken the Intermediates businesses, which were down overall, notably due to difficult market conditions in fluorogases.

Our performance also reflects the relevance of our strategy and the efforts made by Arkema’s teams to adapt to the volatility of the macroeconomic environment.

At the beginning of 2020, Arkema defined an ambitious new road map for 2024. What are its main themes?

T. L. H. – Since Arkema was founded, we have always had a clear vision of what we wanted to become: a leader in Specialty Materials. Starting with the spin-off in 2006, we transformed our Group, altering our business portfolio, making our organizational structure more effective and competitive, and focusing our innovation on sustainable development. It altered our business portfolio, made our organizational structure more effective and competitive, and set us on a clear path of innovating for sustainable development.

In April 2020, we presented this new Arkema at a meeting with investors – a pure player in Specialty Materials, worth €10 to €11 billion, with a simplified, resilient portfolio focused on sustainable solutions. It is a clear vision, an ambitious project, and an important source of value for all our stakeholders.

In our new position, we will be better placed to offer solutions to fulfill the strong demand for new materials in mobility, urbanization, and environmental protection, and new technologies such as 3D printing. Our clients need high-tech, lightweight, bio-based, and recyclable materials. We can supply them thanks to our areas of expertise in materials science.

We have structured these areas of expertise, including glues, substitution, and lightening and protecting materials, into three coherent, complementary platforms for growth: Adhesives, Advanced Materials, and Coating Solutions. Together, these three segments make up Specialty Materials, and define the Group’s medium-term profile.

Our vision is also based on a strategic review of our Intermediates segment, where we are considering a number of disposals and partnerships.

“At the beginning of the year, the Group announced an ambitious climate plan for 2030 to help keep the global temperature rise well below 2°C, in line with the Paris Agreement.”

The combination of these three Specialty Materials platforms is unique in the chemicals industry. It allows us to generate significant synergies in innovation, commercial opportunities, and operational efficiency. It also gives us an exceptional capacity to serve our clients in growth markets.

How has corporate social responsibility been made even more central to Arkema’s development?

T. L. H. – By basing our innovation on key sustainability priorities, Arkema is focusing on supplying its clients in the field of lightweight materials, new energies, water, and bio-based products. This policy allows us to contribute to the Sustainable Development Goals defined by the United Nations and to respond to major present and future challenges, including population growth, climate change, and the scarcity of natural resources.

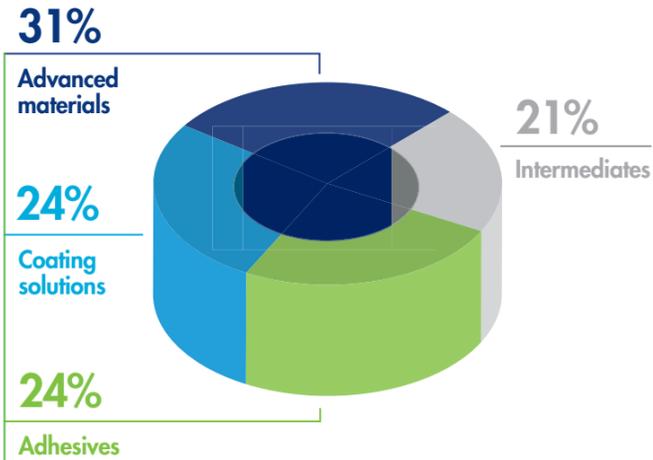
In fact, Arkema has been committed to the principle of responsible manufacturing since it was founded, and prioritizes the health and safety of its employees, environmental performance, the reliability of its industrial facilities, and open communication with our stakeholders.

Thanks to the progress the Group has already made in environmental issues since 2012, we announced at the start of the year our ambitious climate plan for 2030 to help keep the global temperature rise well below 2°C, in line with the Paris Agreement. Arkema has set a target to reduce its absolute greenhouse gas emissions by 38% between 2015 and 2030, and has also defined new environmental objectives for emissions into the air and water, as well as for energy consumption. These commitments, as well as the progress achieved by increasing the proportion of women among its directors, is helping Arkema consolidate its position among businesses that are committed to and perform well in matters of corporate social responsibility. —



profile.

A PORTFOLIO BUILT AROUND FOUR MAJOR BUSINESS SEGMENTS



Specialty materials represent **79%** of our revenue

ARKEMA AT A GLANCE

REVENUE OF **€8.7 billion**

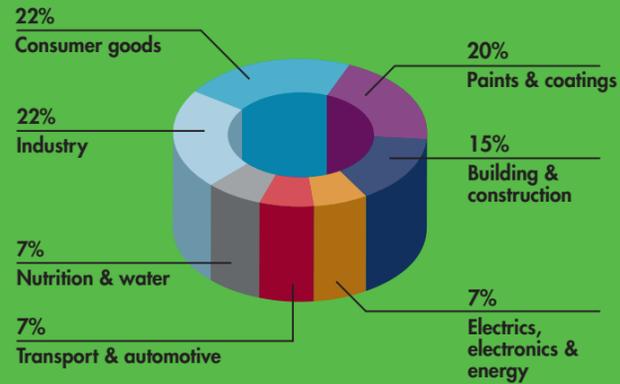
EMPLOYEES **20,500**

PRESENT IN **55 countries**

PRODUCTION SITES **144**

WORLD'S **No. 1 to No. 3**
IN 90% OF OUR BUSINESSES

OUR KEY MARKETS



INNOVATION, A CORE FOCUS OF OUR BUSINESS PURPOSE

2.8% OF REVENUE DEDICATED TO R&D

222 PATENTS FILED IN 2019, 67% OF WHICH CONCERNED SUSTAINABLE DEVELOPMENT

RANKED IN THE **Top 100** GLOBAL INNOVATORS FROM 2012 TO 2018 (RANKED BY CLARIVATE ANALYTICS)

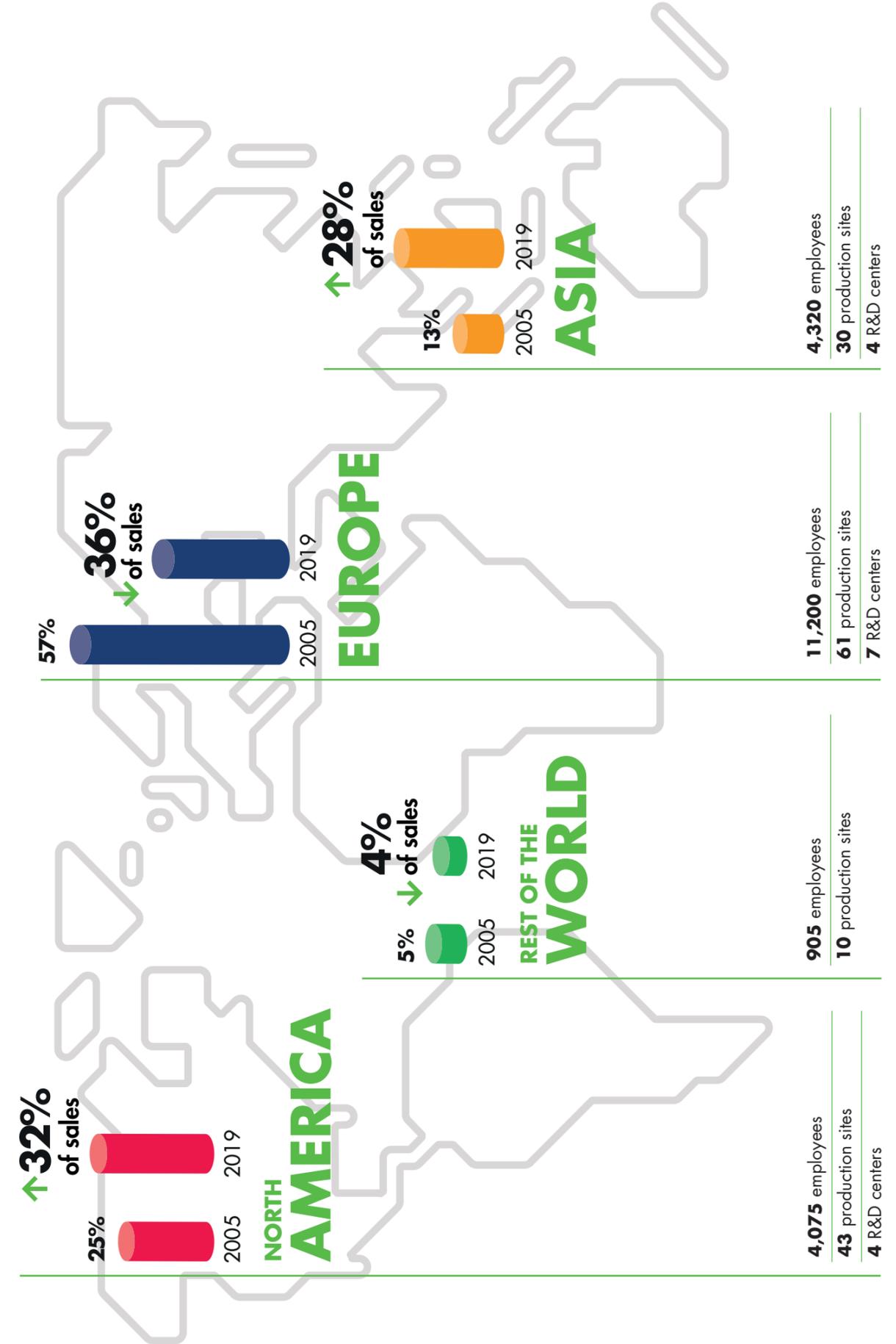
15% OF OUR REVENUE IS GENERATED BY PRODUCTS LESS THAN 5 YEARS OLD

1,600 RESEARCHERS

6 R&D PLATFORMS DEDICATED TO SUSTAINABLE DEVELOPMENT

- Bio-based products
- Electronic solutions
- New energies
- Lightweight materials and design
- Water management
- Home efficiency and insulation

A GLOBAL MANUFACTURER





THE OVERSIGHT BODY

The Board of Directors defines Arkema's strategy and oversees its implementation. Chaired by Thierry Le Hénaff, the Board has 12 other members, including six women.



1 Thierry Le Hénaff,
Chairman & Chief Executive Officer of Arkema

- 2 Yannick Assouad,**
Aeronautical Director
- 3 Isabelle Boccon-Gibod,**
permanent representative of the French equity fund *Fonds Stratégique de Participations* (FSP)
- 4 Marie-Ange Debon,**
Vice-President of MEDEF International
- 5 Ian Hudson,**
retired, also Chairman of the Board of Directors of Carbios
- 6 Alexandre de Juniac,**
Director General and CEO, International Air Transport Association (IATA)
- 7 Victoire de Margerie,**
Executive Chairman, Rondol Industrie

- 8 Laurent Mignon,**
Chairman of the Management Board, BPCE group
- 9 Héléne Moreau-Leroy,**
Project Director, Integration of Zodiac Aerospace, Safran
- 10 Thierry Morin,**
Chairman, Thierry Morin Consulting
- 11 Marc Pandraud,**
Vice Chairman of Investment Banking for Europe, the Middle East and Africa, JP Morgan
- 12 Nathalie Muracciole,**
Director representing employees
- 13 Jean-Marc Bertrand,**
Director representing employee shareholders

8 times IN FISCAL YEAR 2019, THE BOARD OF DIRECTORS MET EIGHT TIMES (COMPARED TO SIX IN 2018).

95% THE ATTENDANCE RATE WAS 95% (VERSUS 97% IN 2018).

To strengthen its expertise, the Board of Directors has two permanent specialized committees.

AUDIT & ACCOUNTS COMMITTEE

Chaired by Marie-Ange Debon and composed of three other directors: Isabelle Boccon-Gibod, Héléne Moreau-Leroy and Ian Hudson. This committee ensures the quality of internal control and the reliability of information provided to shareholders and financial markets.

NOMINATIONS, COMPENSATION & CORPORATE GOVERNANCE COMMITTEE

Chaired by Thierry Morin and composed of two other directors: Alexandre de Juniac and Victoire de Margerie. This committee makes recommendations concerning membership of the Board of Directors, compensation policy for the Chairman and CEO, and corporate governance best practices.

THE DECISION-MAKING BODY

The Executive Committee manages the operational activities of Arkema alongside Thierry Le Hénaff. Each member oversees a business segment or several support functions. In May 2020, three new members from inside Arkema joined the committee, including one woman and one American.

Our top decision-making body, the Executive Committee meets twice a month to examine strategic issues and growth and development plans, including capital expenditure, new capacity and acquisitions.

It also supervises the implementation of the Group's strategy, monitor the business and financial performance of our different activities, and attentively track safety and environmental performance.

To implement Executive Committee decisions, Arkema is organized into four business segments and six business lines, led by Executive Vice Presidents of operations. Our corporate departments report to four Executive Vice Presidents and provide support for all activities and operations.



1 Thierry Le Hénaff,
Chairman & Chief Executive Officer of Arkema

2 Marc Schuller,
Chief Operating Officer, Advanced Materials, Coating Solutions and Intermediates

3 Bernard Boyer,
Executive Vice President, Strategy

4 Vincent Legros,
Executive Vice President, Bostik

5 Luc Benoit-Cattin,
Executive Vice President, Industry and CSR

6 Marie-José Donsion,
Chief Financial Officer

7 Thierry Parmentier,
Executive Vice President, Human Resources and Corporate Communications

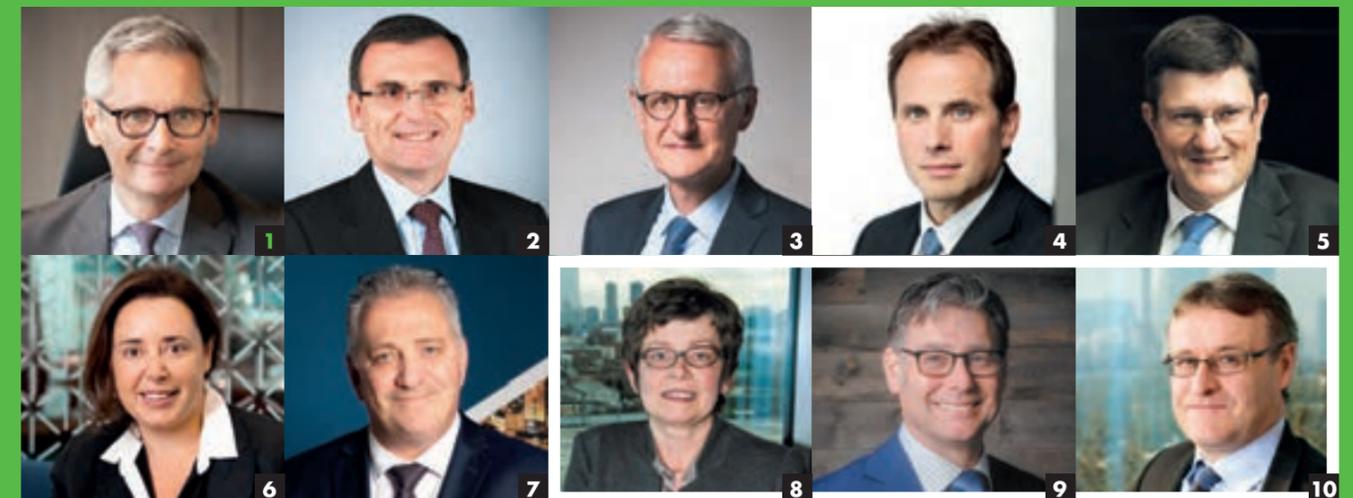
THREE NEW MEMBERS WERE APPOINTED IN MAY

8 Marie-Pierre Chevallier,
Senior Vice President, Performance Additives

9 Richard Jenkins,
Senior Vice President, Coating Solutions

10 Erwoan Pezron,
Senior Vice President, High-Performance Polymers

These three members report to Marc Schuller



ROBUST FINANCIAL AND CSR PERFORMANCE

The Group attaches equal importance to improving its financial, environmental, social and societal performance. It set new targets for most of these at the end of 2019 and beginning of 2020. They drive our success and motivate all our employees.

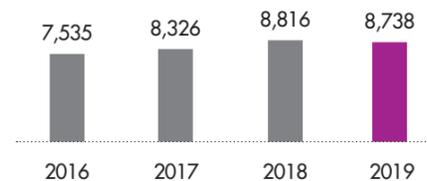
1.

SOLID PERFORMANCE AND NEW TARGETS FOR 2024

In 2019, Arkema achieved a strong financial performance, driven by specialty businesses in a gradually declining economy. The Group generated a record level of cash while maintaining ambitious investment in its future growth.

REVENUE (in € million)

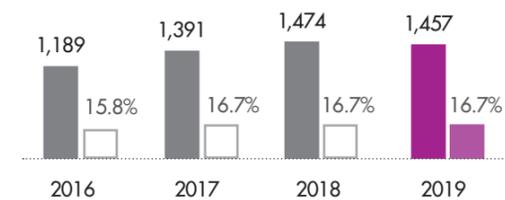
2019 revenue amounted to €8.7 billion, similar to that of 2018, in an uncertain macro-economic context that was less buoyant than the previous year.



➤ **2024 TARGET: Become a pure player in Specialty Materials with revenue between €10 and 11 billion**

EBITDA (in € million) AND EBITDA MARGIN (in %)

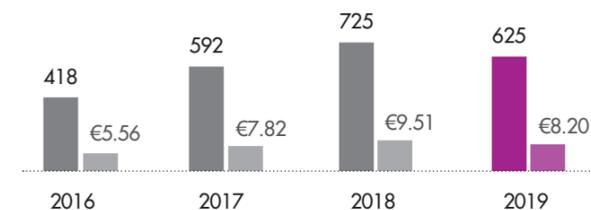
EBITDA amounted to €1,457 million, comparable (-1.2%) to the record level in 2018. The high EBITDA margin of 16.7% remained stable.



➤ **2024 TARGET: EBITDA margin of approximately 17% compared with 15.8% today for Specialty Materials**

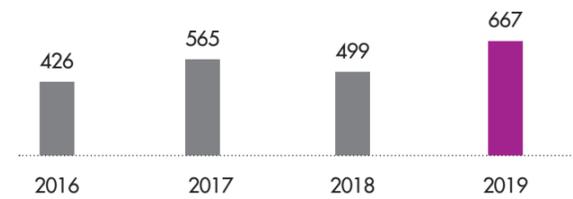
ADJUSTED NET INCOME (in € million) AND ADJUSTED NET INCOME PER SHARE (in €)

Adjusted net income totaled €625 million, or €8.20 per share.

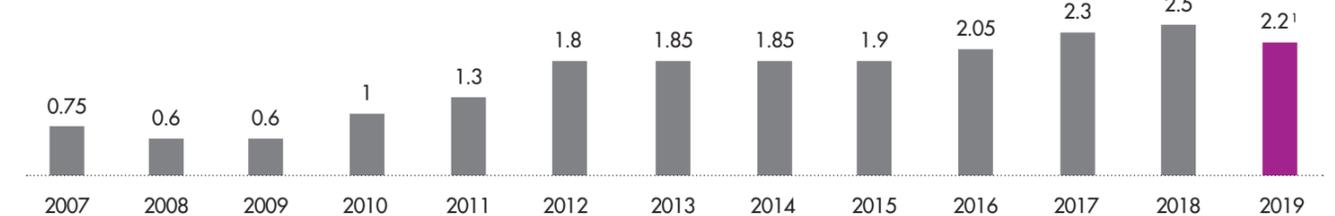


FREE CASH FLOW (in € million)

In 2019, Arkema generated a record free cash flow of €667 million while maintaining an ambitious level of investment in its future growth.



DIVIDENDS UP SINCE 2007 (in € per share)



1. Dividend recommended to the Annual Shareholders' Meeting on May 19, 2020.

In the context of the social and economic crisis due to Covid-19, as well as support for and responsibility towards all stakeholders, the Board of Directors decided to reduce the dividend recommended on February 26, 2020 for financial year 2019 to €2.20 per share, which is 12% less than the previous year and almost 20% less than the amount originally proposed (€2.70). The Board also stated its intention to make up this difference to shareholders in a form to be decided, when normal circumstances and the right conditions resume.

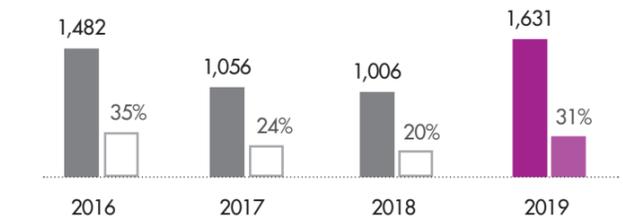
2.

CSR INDICATORS IMPROVING CONSTANTLY AND AMBITIOUS TARGETS FOR 2025 AND 2030

Arkema uses precise indicators and, in some cases, targets, to maintain constant progress through three commitments - to offer innovative solutions to sustainability issues, to act responsibly as a manufacturer and to encourage open dialogue with its internal and external stakeholders. It aims to rank among the best-in-class in the chemicals industry for safety and the environment.

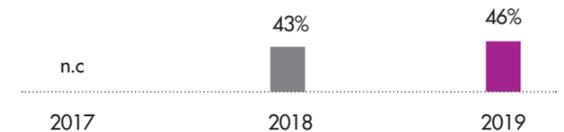
NET DEBT (in € million) AND DEBT-TO-EQUITY RATIO (in %)

At end December 2019, net debt was firmly under control at €1,631 million. It represents a net debt-to-equity ratio of 31%, or 1.1 times 2019 EBITDA.



1. SUSTAINABLE PRODUCTS

Share of revenue that has made a significant contribution to the UN's Sustainable Development Goals¹



1. Based on an evaluation of 44% of the Group's sales to third parties

Number of filed patents relating to sustainability

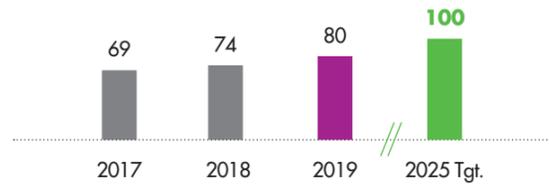


2. RESPONSIBLE MANUFACTURER

AIMS AUDITS (health, safety, environment)

Percentage of AIMS audited sites

Arkema has developed the Arkema Integrated Management System (AIMS), which combines in a single audit all the safety, security, environmental and quality audits we perform. In 2019, 80% of the Group's sites were audited using AIMS.

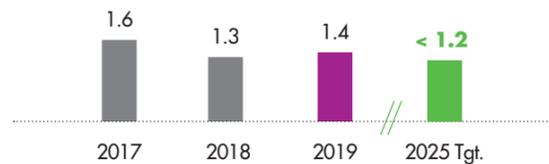


2025 TARGET: To carry out AIMS audits on all sites

SAFETY

Total Recordable Injury Rate (TRIR) per million hours worked

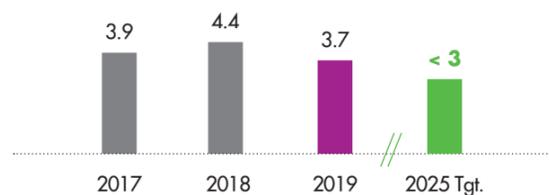
In 2019, Arkema further consolidated its performance with a TRIR of 1.4, almost the same as 2018. This figure takes into account the excellent results for external companies' personnel (TRIR of 1.1 compared with 2.3 in 2018).



2025 TARGET: TRIR < 1.2

Process Safety Events (PSE) rate

In 2017, Arkema adopted a new process safety indicator, Process Safety Events (PSE) per million hours worked. In 2019, the PSE rate improved to 3.7 as a result of targeted actions on sites.



2025 TARGET: PSE rate < 3

ENVIRONMENTAL IMPACT

By 2018, Arkema had achieved three of its four strategic environmental targets for 2025, and decided to revise them with a new, more ambitious target for 2030. The new climate indicator is expressed as an absolute value to ensure consistency with the Paris Agreement. The three other targets – energy, water and air – are based on Environmental Footprint Performance Indicators (EFPIs), which reflect changes in the Group's business scope and plant output.

Climate (greenhouse gas emissions)

In 2019, Arkema reduced its greenhouse gas emissions by 13% compared with 2015.



1. Target in absolute terms compared with 2015 for scope 1 and scope 2 emissions as defined by the Kyoto protocol, plus substances defined by the Montreal protocol, in line with the Paris Agreement

2030 TARGET: Reduce greenhouse gases by 38% compared with 2015

This means a reduction in absolute emissions of more than 1.7 million tons of CO₂ equivalent to under 3 million tons by 2030, whatever the increase in production volumes.

Energy (net energy purchases EFPI)

In 2019, the increase in this indicator was due to the decline in production volumes at some plants.



2030 TARGET: Reduce the net energy purchases EFPI by 20% compared with 2012

"ARKEMA HAS ADOPTED A VOLUNTARY IMPROVEMENT PROCESS FOR CSR WITH THE ULTIMATE AIM OF JOINING THE DOW JONES SUSTAINABILITY INDEX (DJSI)."



Virgine Delcroix, Vice President, Sustainable Development

Water (chemical oxygen demand or COD EFPI)

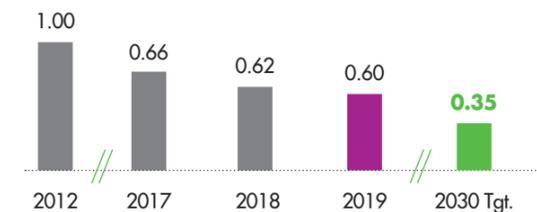
In 2019, we improved our COD due to efforts at wastewater treatment stations, particularly one of our sites in Italy.



2030 TARGET: Reduce the COD emissions EFPI by 60% compared with 2012

Air (volatile organic compounds or VOC EFPI)

In 2019, VOC emissions were reduced thanks to progress in treatment methods at some plants, particularly in France.



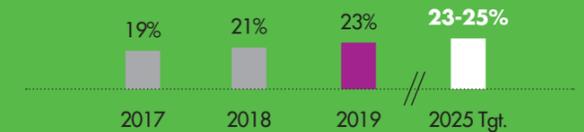
2030 TARGET: Reduce the VOC emissions EFPI by 65% compared with 2012

3. OPEN DIALOGUE

EMPLOYEE DEVELOPMENT AND DIVERSITY

Proportion of women among senior management and directors

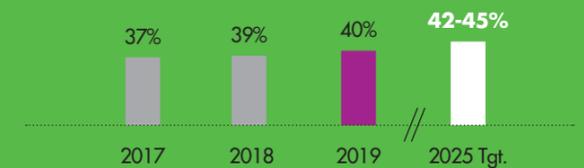
In 2019, we improved this indicator largely through our program put in place in 2016 to support equal opportunities and gender equality.



2025 TARGET: 23-25% female senior management and directors

Proportion of non-French nationals among senior management and directors

In all countries in which Arkema operates, we prioritize local skills and expertise at every level, including senior management and directors.



2025 TARGET: 42-45% non-French nationals among senior management and directors

CIVIC ENGAGEMENT

Proportion of manufacturing sites that have taken part in the Common Ground® program

The number of Common Ground® initiatives has fallen slightly from 1,064 in 2018 to 990 in 2019, although they have reached a greater number of people. These actions are now more focused on local communities and different types of beneficiary profiles. Common groundr is a program characterizing all local actions taken by our sites to promote open dialogue with their different stakeholders.



ON THE ROAD WITH ARKEMA

The automotive market is changing rapidly as it faces challenges in weight reduction, recyclability, electronics and electrification. It is calling on our expertise in polymers, paints, additives and adhesives.

WINDSHIELD

Bostik SMP windshield caulks offer great flexibility, sealing and UV resistance. They contain neither solvents nor isocyanates, and can glue metal, aluminum and glass.

TIRES

Low rolling-resistance tires or “green tires” are growing in popularity. They help to cut fuel consumption by around 30% by reducing the energy required to overcome their inertia. This technology consists in adding a large amount of silica to the rubber of the band in contact with the road. The agent Ekaland™ DPG ensures that the silica is completely miscible in the rubber, preventing degradation of the tire’s quality (heating or dispersion of particles).



ENGINE HOSES AND PARTS

Rilsan® bio-based polyamide (derived from ricin) is tough, chemically resistant and heat-resistant, allowing it to be used to protect metal hoses or even replace them, e.g. fuel lines from tank to engine. It is three to nine times lighter than aluminum and brass, offering real reductions in weight – and production cost. Rilperm® is a unique technology for multilayer hoses that can meet the most extreme requirements by giving hoses such properties as low permeability or a low level of extractable content.

With exceptional chemical resistance to high temperatures, Rilsan® HT polyamide is used to manufacture lay-flat and rigid pipes as a

DASHBOARD

Altuglas® acrylic resin is used for dashboard displays because of its exceptional transparency and scratch resistance.

Third-generation Forane® refrigerant gases (HFCs, or hydrofluorocarbons), which respect the ozone layer and are non-flammable, are used in air-conditioning systems. The next generation – HFOs, or hydrofluoro olefins – are in the development pipeline and will have low global warming potential.

SUNROOF

Altuglas® ShieldUp reinforced acrylic glass, used for manufacturing sunroofs, is ultra-tough, more transparent than glass and twice as light.

ASSEMBLY ADHESIVES

Bostik SAF® methacrylate structural adhesives can be used to assemble parts of the bodywork, as well as glass, plastic and rubber. These products are exceptionally tough; they are used in place of heavier weldings and riveting.

METALLIC PAINTS

Encor®, Synaqua®, Synocure® and Synolac® resins for bodywork paint add shine, scratch resistance and weather resistance. Dianol® anti-corrosion additive improves adhesion properties and makes the paint even more durable and resistant to high temperatures, scratches and gravel impact.

TAIL LIGHTS

Altuglas® acrylic resin allows automakers to produce tail lights in a wide range of reds and oranges that let through 98% of light. This recyclable plastic is also highly scratch-resistant.

SEATS AND CABIN

Adiansol® polyol additives are used in the manufacture of polyurethane foam for seats and steering wheel. They improve rigidity and speed up hardening of the foam.

Encor® finishing resin is used on interior leather trim in the cabin and on seats, for a soft feel and resistance to wet and dry abrasion.

Bostik hot-melt adhesives are used to assemble leather, textiles and fabrics for the dashboard, seats, door panels and roof trim. They improve soundproofing and reduce vibration. Platamid® hot-melt adhesive is a recyclable, bio-based version produced from castor oil.

BODYWORK

Elium® thermoplastic resin is used to make recyclable composites for external panels and semi-structural parts. The resulting thermoformable parts are lighter than those made of metal.

ELECTRIC BATTERY

Kynar® PVDF is used in lithium-ion batteries because of its remarkable electrochemical resistance to the electrolyte, the liquid the ions pass through. It is the substance that makes the active particles adhere to the electrodes, and plays a large role in the batteries’ durability.

replacement for many parts made of steel or rubber, which are two to three times heavier.

Orgalloy® polyamide alloys are used to manufacture the protective layer inside air conditioning pipes, among other things. They offer excellent adherence and exceptional resistance to fluids (refrigerants used in air-conditioning systems, oils, etc.).

Kynar® Flex PVDF is used to manufacture cables that are highly resistant to oil and fuel in the engine.



interview.

CSR strategy

Excellence in Corporate Social Responsibility (CSR) is a major issue for Arkema and its stakeholders. Combined with financial performance, it allows us to define the Group's sustainability model. The Group remains committed to its founding principle of acting in an exemplary manner. It defines its policy to maximize its contribution to the United Nations' 17 Sustainable Development Goals, and adopted ambitious new programs and targets in 2019. We hear from Virginie Delcroix, Vice President, Sustainable Development.



With increasing pressures on resources and energy, a growing population, climate change, and the environmental crisis, we face many challenges on a planetary scale in the next decade. How does a Group like Arkema contribute to the changes that must take place in society?

Virginie Delcroix – Increasingly, our role as a manufacturer is to use our capacity for innovation and value creation to contribute to a more sustainable world. Sustainable development includes social and economic progress for all, particularly to fulfill the essential needs (food, health, mobility, wellbeing) of a growing population, while drastically reducing its impact on the environment and the climate. Business, starting with the big industrial groups, needs to play a major role in energy transition and the adoption of more resource-efficient production methods. This is particularly true in chemicals, which has a direct effect on these problems. With this in mind, we are moving well beyond regulatory requirements and have set our own voluntary targets. This is the purpose of our CSR policy, through three main commitments – to offer sustainable solutions driven by innovation, to be a responsible manufacturer and to cultivate open dialogue and close relations with our stakeholders.

What concrete actions is the Group taking to define and implement its CSR policy?

V. D. – Our CSR policy is not fixed; we are constantly adapting it to the expectations of our stakeholders, with whom we are in regular communication. To this end, at the beginning of 2019, Arkema carried out its second "materiality analysis" following the first one in 2016. This took the form of an online survey in seven countries, as well as individual interviews, to question a wide panel of the Group's internal and external stakeholders – clients, suppliers, partners, investors, employees – on the CSR issues they judge to be most important. This analysis is helping us to focus our actions on priority themes such as climate change, sustainable innovation and safety, and to identify issues of growing importance such as the circular economy and work/life balance for employees.

"BIG BUSINESS HAS AN ESSENTIAL ROLE TO PLAY IN THE TRANSITION OUR SOCIETY MUST ACCOMPLISH."

We have used the findings to shape our CSR policy, set targets and launch programs. On the topic of the circular economy, the Virtucycle® project was defined in 2019 to organize the recycling of our specialty polymers, alongside the MMAtwo project to recycle PMMAs (ed: see p. 44-45). More generally, in 2019 we made significant progress with our Portfolio Sustainability Assessment (ed: see inset opposite). This is a systematic assessment of how our solutions contribute to the UN's Sustainable Development Goals, which Arkema has been working towards for the past four years.

To be a responsible manufacturer, we must choose what we produce but also how we produce it...

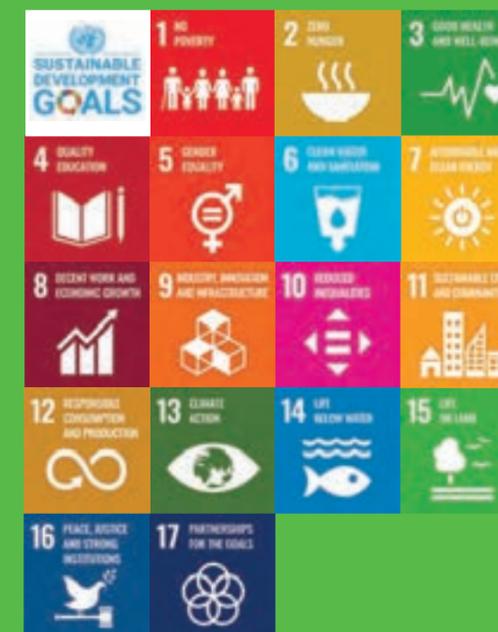
V. D. – Absolutely. The safety of people and procedures is a constant priority and we are permanently reducing our environmental impact. We aim for excellence in the way we conduct our operations, through our choice of manufacturing procedures and a process of constant improvement, and through our energy purchasing and resource management policies. We have made considerable progress in recent years on all these fronts through programs such as Arkenergy, to optimize our energy efficiency, and Optim'O, to ensure we manage our water resources responsibly. By 2018, we had already achieved three of our four strategic environmental targets for 2025. This year, we have therefore set ourselves even more ambitious goals for 2030 (see p.20). Our commitment to respect the Paris Agreement (see p.52) positions Arkema among the most proactive and ambitious chemicals manufacturers for our efforts to limit global warming. —



OUR SOLUTIONS PORTFOLIO IS ANALYSED FOR SUSTAINABLE DEVELOPMENT GOALS

At the end of 2018, Arkema launched its Portfolio Sustainability Assessment, a systematic process to evaluate its solutions portfolio (taking into account a product's different applications and regions) from the perspective of sustainability. "The method we have developed is based on the methodological guide issued by the WBCSD¹ and looks at the whole of the value chain. It is deployed by each of Arkema's activities as well as business expertise teams, R&D and regulations," explains Noël Zilberfarb, Sustainable Products Manager. For each solution, it initially establishes the potential risks, whether these are related to regulatory trends or market demands. "If we identify a risk for a solution, we define the best actions such as alternative development or substitution." If the solution presents no risk, we assess its contributions (positive or negative) to the UN's Sustainable Development Goals. This analysis has a real impact on the policies of our Business lines, which are encouraged to focus on innovation and sales of virtuous solutions. At the end of 2019, 44% of sales had been assessed, and 46% of these featured one or more significant positive contributions to the UN's Sustainable Development Goals, with no significant negative contribution. This approach is being pursued in 2020 to increase the proportion of sales that are assessed, and in the long term to increase our contribution to the Sustainable Development Goals.

1. World Business Council for Sustainable Development (WBCSD). This global organization has more than 200 major corporate members which work together to accelerate transition to a more sustainable world.





INNOVATIVE *for* URBANIZATION

The increase in the global population and rising size of cities will be one of the great humanitarian, environmental and industrial challenges of the 21st century.

63%
of the global population will live in a city by 2050, according to the UN.

In thirty years' time, the population is expected to reach 9.8 billion, over two thirds of whom will live in cities. This increasing urbanization, which will be particularly marked in Africa and Asia, will bring new needs for healthcare, food, water management and construction.

Many of the answers to these challenges can be found in industry's ability to devise and produce the materials and solutions to produce better living conditions for everybody.

RISING TO THE CHALLENGES OF URBANIZATION

We have a growing population that is increasingly urban, with exponentially growing needs for food, long-term housing, access to drinking water and hygiene products. A large part of Arkema's portfolio is aimed at fulfilling these essential needs.

1.

DRINKING WATER

Our Kynar® PVDF is used to make filtration membranes to produce water that is free from dirt and ultrafine particles, including viruses and bacteria.

2.

WATER TRANSPORTATION

Our 100% bio-based Rilsan® fine powders provide pipes with long-lasting protection against corrosion.

3.

WASTEWATER TREATMENT

Our Albion® hydrogen peroxide and flocculants made using our acrylic acid contribute to the effective functioning of water treatment plants.

4.

INDUSTRIAL PAINTS

Our acrylic, alkyd and polyester resins are used to produce very hard-wearing paints with low VOCs.



5.

DIAPERS

Our acrylic acid is used to produce superabsorbent polymers for the manufacture of billions of diapers manufactured every year, and fastened with a few grams of Bostik adhesives.

6.

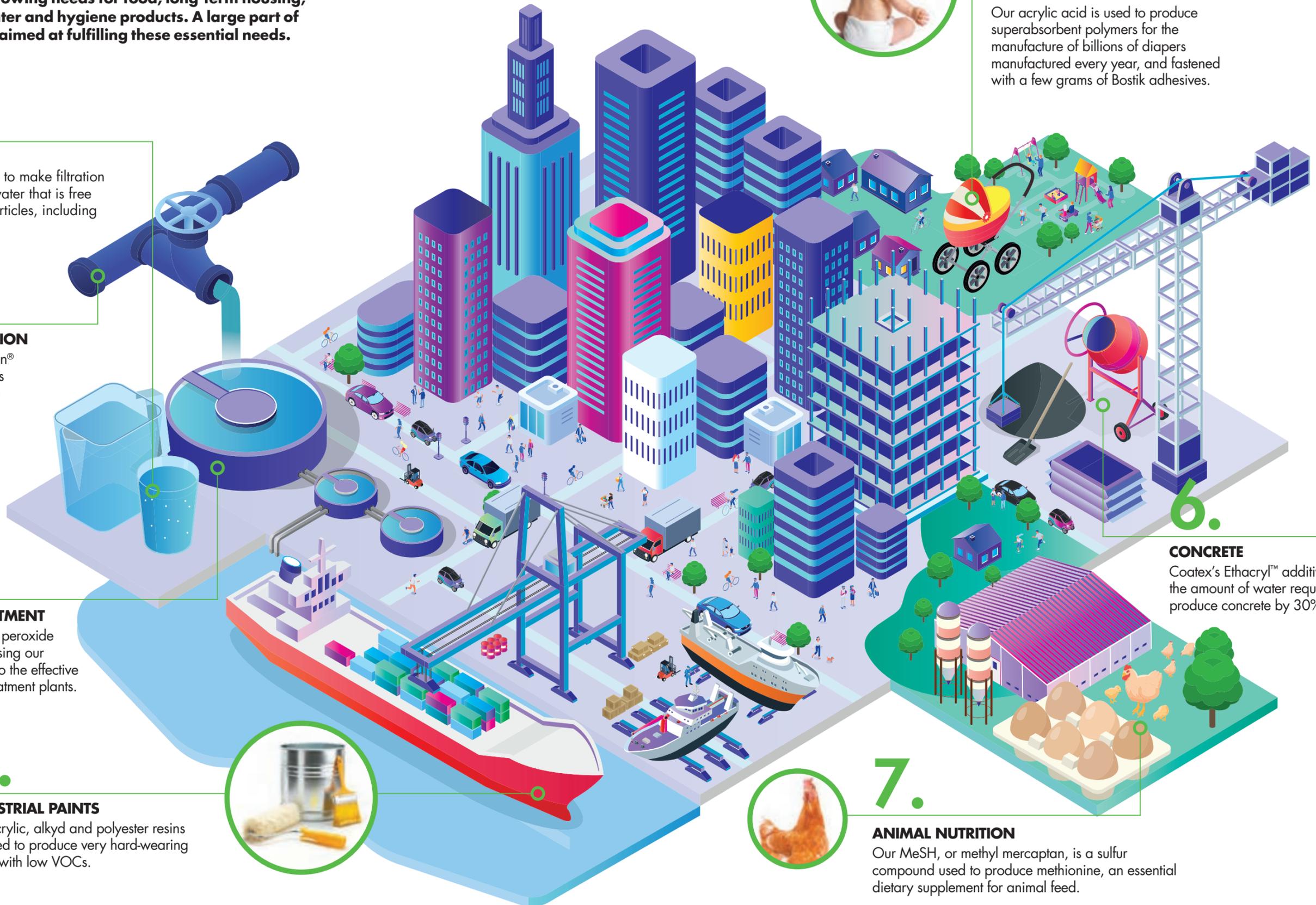
CONCRETE

Coatex's Ethacryl™ additives reduce the amount of water required to produce concrete by 30%.

7.

ANIMAL NUTRITION

Our MeSH, or methyl mercaptan, is a sulfur compound used to produce methionine, an essential dietary supplement for animal feed.





1. ULTRAFILTRATION FOR WATER TREATMENT

**KYNAR® MEMBRANES:
AIDING HUMAN
DEVELOPMENT**

For treating drinking water and wastewater, the ultrafiltration membranes developed by Arkema offer unrivaled performance in addressing a global challenge.

Ensuring everyone has access to high-quality water is one of the major challenges of the 21st century. Now one of the most common solutions for water treatment, ultrafiltration systems involve water flowing through membranes (hollow microporous fibers of 1 to 2 mm in diameter) that retain particles, bacteria and viruses. "These are purely mechanical solutions that require little energy," explains Bernard Schlinquer, Manager, Kynar® Films & New Markets at Arkema. It is a vital market for which the Group is developing special grades of high-performance PVDF. "Membranes made from Kynar® DH 100, the latest to come out of our R&D department, stand out for their long-lasting hydrophilic property," Schlinquer continues. "They retain more than 99% of bacteria and viruses, can filter larger volumes (20% more) with the same energy, and have double the lifespan of more traditional products."

These Kynar® membranes are used in portable kits, developed in partnership with the module manufacturer Polymem, for drinking water solutions in developing countries.

Membrane bioreactors

More widely, drinking water processing plants, which must meet very high standards in terms of filtration, are the ideal application for Kynar PVDF® fibers. The latter are used widely in industry too, particularly for treating wastewater. "We work with many membrane bioreactor manufacturers in China, the United States, and Europe," says Schlinquer. In 2019, the wastewater market represented two-thirds of sales of Kynar® ultrafiltration products.

2. HYDROGEN PEROXIDE AND ACRYLIC MONOMERS

SUPPORTING WATER TREATMENT PLANTS

A major issue in protecting water environments is the treatment of wastewater. Arkema's acrylic monomers, which are used to produce flocculants, contribute to this process, as does hydrogen peroxide for desulfurization applications.

In a water treatment plant, flocculants play two essential roles. "They absorb materials suspended in the water, forming large flocs, which can then be filtered, and they are also used to thicken and dry sediment to make sludge for spreading," explains Bernard Darricau, Director, Acrylic Monomers Europe at Arkema. These agents are based on acrylic monomers, of which Arkema is one of the world's leading suppliers. In addition to state-run water treatment plants in developed countries, these products are essential in the treatment of industrial effluents around the world.

Hydrogen peroxide: Clean and rapid

Hydrogen peroxide is another Arkema product that makes a valuable contribution to certain urban network configurations. "When water remains in the system too long, and in hot weather, bacteria can develop that lead to the formation of hydrogen sulfide (H₂S), which is very damaging to the functioning of treatment plants," explains Philippe Zydowicz, Hydrogen Peroxide Development Director. To protect the plant, materials and staff, one effective option is to inject incoming water with hydrogen peroxide, of which the Group is the world's third biggest producer, under the Albone® brand. "When continuously injected at the levels corresponding with measured concentrations of H₂S, it reacts instantly, generating byproducts of water and non-toxic sulfate," says Julien Leroy, Business Manager, Oxygenated Products. This clean, rapid solution has been implemented by Veolia, for example, in various treatment plants in the south of France.



3. WATER PIPES

A BIO-SOURCED COATING AS AN ALTERNATIVE TO STAINLESS STEEL

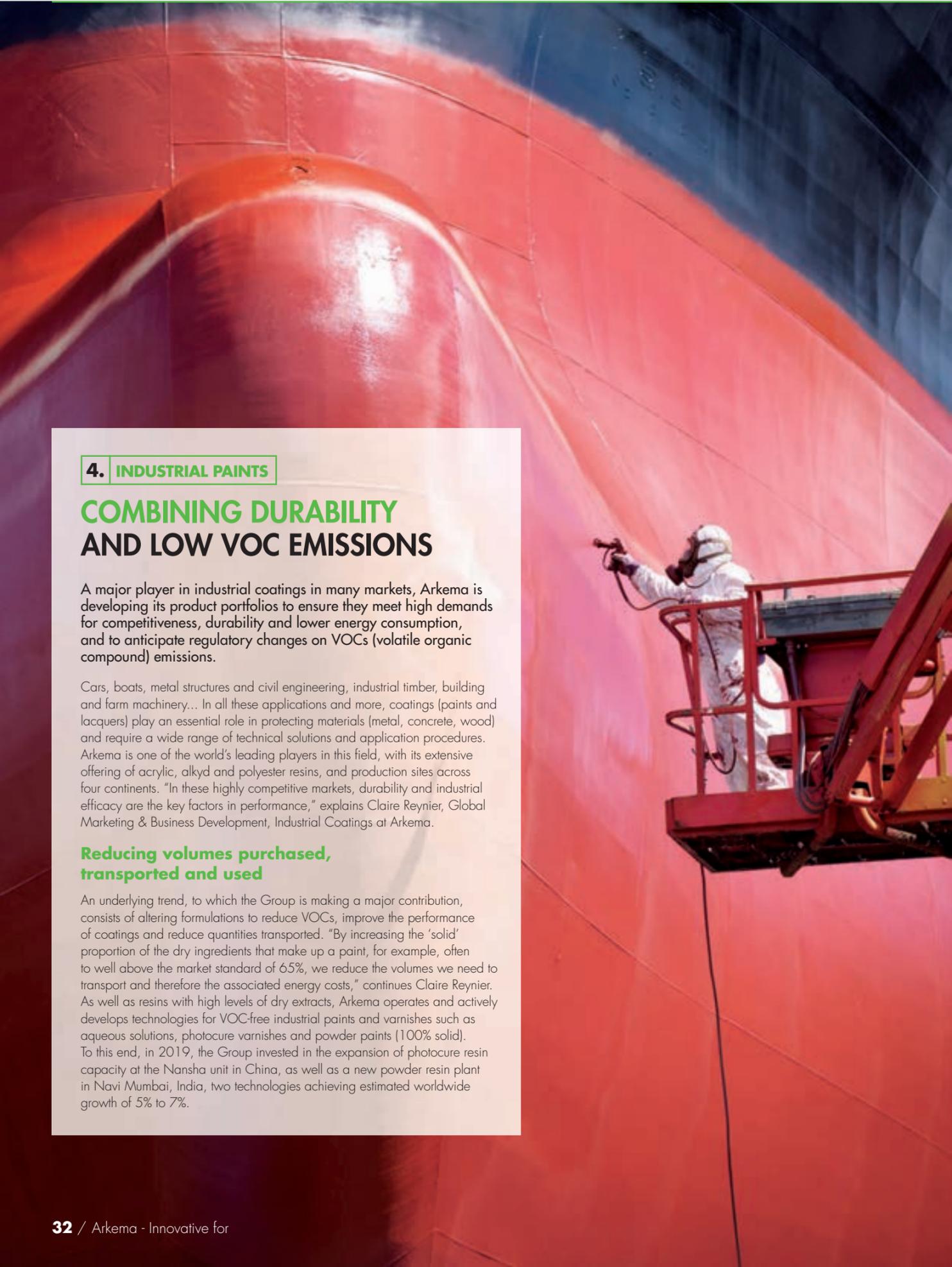
Used to protect carbon steel pipes, Rilsan® polyamide 11 powders offer a competitive, bio-sourced solution for transporting water.

For transporting drinking, waste, industrial and sea water, the trend is toward replacing stainless steel with carbon steel, which contains no chrome and costs less to produce. However, the inside of the pipes need protecting with an anti-corrosion coating. Developed by Arkema over more than 50 years for this purpose on the water market, Rilsan® polyamide 11 fine powders – applied to the hot metal to form a film 500 µm thick – is increasingly a preferred solution. "They combine very good chemical, corrosion and abrasion resistance with the major advantage in today's world of being 100% bio-sourced from ricin oil," explains Jérôme Porte, Global Market Manager for Specialty Powder Industrial Markets at Arkema.

Free from bisphenol-A

More competitive than stainless steel for large diameters (≥ 300 mm), carbon steel pipes coated with Rilsan® powders offer a problem-free lifetime of more than 20 years. These coatings are also widely used for fittings and valves, for which they benefit from greater impact resistance during assembly than epoxy resins. Unlike the latter, Rilsan® powders are also bisphenol-A (BPA) free, which makes them particularly suitable for drinking water as they meet the highest health and safety standards. They are certified for contact with drinking water. "We are very active in this market, especially in Northern Europe, Japan and the Middle East," adds Jérôme Porte. Another major application for Rilsan® fine powders is emerging – sea water transportation, a strong growth market due to the increasing number of drinking water plants springing up in dry regions.





4. INDUSTRIAL PAINTS

COMBINING DURABILITY AND LOW VOC EMISSIONS

A major player in industrial coatings in many markets, Arkema is developing its product portfolios to ensure they meet high demands for competitiveness, durability and lower energy consumption, and to anticipate regulatory changes on VOCs (volatile organic compound) emissions.

Cars, boats, metal structures and civil engineering, industrial timber, building and farm machinery... In all these applications and more, coatings (paints and lacquers) play an essential role in protecting materials (metal, concrete, wood) and require a wide range of technical solutions and application procedures. Arkema is one of the world's leading players in this field, with its extensive offering of acrylic, alkyd and polyester resins, and production sites across four continents. "In these highly competitive markets, durability and industrial efficacy are the key factors in performance," explains Claire Reynier, Global Marketing & Business Development, Industrial Coatings at Arkema.

Reducing volumes purchased, transported and used

An underlying trend, to which the Group is making a major contribution, consists of altering formulations to reduce VOCs, improve the performance of coatings and reduce quantities transported. "By increasing the 'solid' proportion of the dry ingredients that make up a paint, for example, often to well above the market standard of 65%, we reduce the volumes we need to transport and therefore the associated energy costs," continues Claire Reynier. As well as resins with high levels of dry extracts, Arkema operates and actively develops technologies for VOC-free industrial paints and varnishes such as aqueous solutions, photocure varnishes and powder paints (100% solid). To this end, in 2019, the Group invested in the expansion of photocure resin capacity at the Nansha unit in China, as well as a new powder resin plant in Navi Mumbai, India, two technologies achieving estimated worldwide growth of 5% to 7%.



5. SUPERABSORBENTS, ADHESIVE SOLUTIONS

INTELLIGENCE IN DIAPERS!

Distributing products such as infant diapers, adult incontinence pads and sanitary pads to a growing, aging population is a global health challenge. It is also an industrial challenge, to which Arkema is contributing its expertise in two key fields.

What can absorb liquid up to 20 times its weight without leaking, even under pressure? Sodium polyacrylate, the absorbent in diapers. This polymer, with its unique properties, has changed the lives of millions of people, and that is, in part, thanks to Arkema. "In three plants in France, the United States and China, we produce glacial acrylic acid, a key component of superabsorbent polymers which are sold to all leading diaper brands. At Carling, our French acrylic acid site, we also produce these superabsorbent polymers ourselves in a neighboring unit for the Sumitomo Seika group," explains Bernard Darricau, Chairman of Acrylic Monomers Europe at Arkema. This is a premium contribution to a colossal market: in 2018, nearly 170 billion diapers were sold worldwide, in addition to 274 billion sanitary pads, and 48 billion incontinence pads, with strong growth in developed countries owing to the aging population.

Adhesive solutions: doing more with less

The arrival of superabsorbents, which gradually replaced cellulose, made sanitary pads lighter (35g today, compared with 65g in the 1990s). This significant progress was made possible by advances in another field, in which Arkema is a world leader: Adhesive Solutions. "Our hot-melt glues cover all key functions for assembling and securing diapers," explains Christophe Morel, Global Technical Marketing Manager at Bostik. "The enhanced performance of our products has allowed us to reduce to a minimum the quantity of glue required for a diaper (1-1.5g), while speeding up production. A single assembly line can now produce 1,000 to 1,200 diapers per minute." Speed is of the essence with hygiene products!

6. CONCRETE ADMIXTURES

BUILDING WITH LESS WATER

Water is an increasingly precious resource. Arkema's Ethacryl™ additives help save water in the construction industry by reducing the volume needed to make concrete by 30%.

The polycarboxylates produced by firms such as Coatex, a subsidiary of Arkema, are used as concrete admixtures to improve dispersion of cement particles, which makes the concrete flow better. They also deliver considerable water savings. With 1% admixture in the cement, the volume of water needed to prepare a cubic meter of concrete can be reduced by 30% to 40%. "These additives, described as third-generation, are much more effective than their predecessors," says Christophe Salus, Global Business Manager, Building Materials at Coatex. "They really dominate the market in developed countries, and are achieving strong growth – 14% since 2014 – in Asia (Indonesia, Thailand) and the Middle East."

Urban densification

In this highly competitive sector, Arkema's Ethacryl™ range is recognized for its specific qualities. Some grades are formulated to lengthen the flow time of the concrete. This is because it sometimes takes three or four hours to pump it to the top of increasingly high tower blocks. Others are formulated to increase their mechanical properties or their resistance during the first few days after curing. "These properties answer the current needs of urban densification and vertical living," says Christophe Salus. Ethacryl™ additives are also used to produce plasterboard (commonly employed in building in the United States). Here too, they reduce the volume of water required – and therefore the quantity of energy consumed to dry the products.



7. ANIMAL FEED

Methionine: A key to improved use of agricultural resources

A vital amino acid in the assimilation of nutrients by animals, methionine is a powerful efficiency driver for free-range and intensive farming, where it is used as a food supplement. At Kerteh, Malaysia, Arkema's partner CheilJedang is producing methionine with a world-first industrial process that uses a sulfur derivative supplied by Arkema (methyl-mercaptan) and bio-based raw materials. This energy efficient process synthesizes only the most "useful" form – L-methionine.



Just 0.1 to 0.2% of methionine in a chicken's feed is enough to significantly impact its metabolism and growth curve. To reach a given muscle weight will take only half the amount of feed and far less time. And yet, methionine is neither a doping agent nor a wonderdrug: "It is an amino acid that is essential to the synthesis of proteins in both animals and humans, and which is naturally found in limited quantities in various cereals and pulses," says Georges Frémy, a thiochemicals expert at Arkema. "But for the animal to assimilate the amount needed to reach a good metabolism, it would have to be overfed, which is pointless, and that's why we need properly dosed supplementation," he goes on. Methionine supplements have been used in feed for poultry and other livestock for almost 80 years, and are essentially a means for farmers to optimize the resources required for the development of their animals, while promoting the best-quality meat (muscle rather than fat). This efficiency driver is more vital than ever, with the global population standing at 7.7 billion and potentially reaching 9.8 billion by 2050. "Demand for meat is growing fast, especially in Asia, and that's putting a lot of pressure on the use of agricultural land," continues Georges Frémy. "Methionine helps to secure this source of protein at the minimum level required, and that frees up more crops for human consumption."

**A CHALLENGE FOR R&D:
PRODUCING METHIONINE BETTER**

Methionine is widely used today, especially in the farming of poultry, pigs and prawns. But such success naturally comes at a cost: "The traditional industrial processes for chemical synthesis have a high demand for energy and are based on oil resources," points out Georges Frémy. Moreover, they can only produce DL-methionine, which contains equal quantities of the L-form and D-form of the amino acid. "But only L-methionine, the natural form, is useful to animals, because only L-form can be used for protein synthesis" explains the expert. "Their organisms can metabolize the D-form into L, but research shows that the transformation reduces the effectiveness of the supplement compared to natural L-methionine."



The L-methionine produced by CJ is based on an intermediate product made from

100%
bio-based raw materials

such as sugars and glycerol produced from vegetable oils.

Against this backdrop, Arkema and its South Korean partner CheilJedang (CJ) spent several years working on a breakthrough technology. Since 2015, at its site in Kerteh, Malaysia, CJ has been producing L-methionine directly using an unrivaled process.

**A BIO-BASED,
ENERGY EFFICIENT PROCESS**

Like other such sites, Kerteh has a unit producing methyl-mercaptan, a sulfur compound needed for all methionine syntheses, of which Arkema is the world's leading producer. "One of the innovations is in the fermentation process, developed by CJ, which allows an intermediary product to be synthesized from 100% bio-based raw materials such as sugars or glycerin from plant oils," explains Georges Frémy. The final stage consists in a reaction between the mercaptan and the bio-based intermediary and is a bio-catalysis at room temperature in an aqueous medium. The entire process is therefore simpler (with fewer stages) and far less energy intensive than the traditional chemical processes, which rely on reactions at temperatures that are up to forty times higher. The result is bio-based methionine, with a low energy requirement, that is

directly produced as L-methionine, which is perfectly adapted to animals.

« ARKEMA IS, THROUGH THIS MODEL PARTNERSHIP, MAKING A MAJOR CONTRIBUTION TO THE IMPROVED EFFICIENCY OF METHIONINE. »

DOUBLE CAPACITY

The Kerteh site went into service in 2015, and was expanded in 2019. The two partners made a considerable new investment in order to increase their production capacity. The product commercialized by CJ is competitive, high-quality and resource-efficient – a perfect response to market expectations, whether from farmers or distributors. Just as with the other producers of methionine which Arkema supplies with methyl-mercaptan, the Group is, through this model partnership, making a major contribution to the improved efficiency of methionine, which constitutes a precious asset in the face of the major food challenges that await in the decades to come.



INNOVATIVE
for
RESOURCES

On a planet with limited resources and a growing population, the future of the human race and the preservation of the environment depend on the development of new modes of production, travel and consumption.

July 2019

In 2019, that was the date by which humans had consumed all of the resources that the Earth is capable of regenerating in one year.

Earth Overshoot Day, estimated by the U.S. N.G.O. Global Footprint Network, arrives earlier every year. It expresses the unsustainable nature of our current mode of development, and the urgent need to change it completely. Alongside governments,

industrial businesses are the actors capable of leading this change. They must put their innovation and production capacity to work on the development of renewable energies, sustainable mobility, recycling and the more efficient use of water and raw materials.

PRESERVING, OPTIMIZING AND RECYCLING OUR RESOURCES

We make bio-based materials, polymers used to optimize the performance of new energies and electric vehicles, solutions to extend the lifetime of our clients' products, and recycling programs for our materials. Positioned at the start of the supply chain leading to the end user, Arkema makes concrete contributions to the optimization of raw materials and natural resources.

1.

DECORATIVE PAINTS

Our Encor® resin for paints is made from 98% bio-based raw materials.



2.

100% BIO-BASED MATERIALS

Produced from castor oil, our Rilsan® polyamides are used to make sports shoe soles, spectacle frames, cases for mobile phones and laptops, and auto engine parts.



3.

ELECTRIC CARS

Our Kynar® fluoride material boosts the performance of batteries.



4.

HYDROGEN CARS

Elium® composites are used to design gas tanks that are more lightweight and recyclable.



9.

RECYCLING

We have two recycling programs for our PMMA (acrylic glass) and value-added polymers.

6.

WIND TURBINES

Our liquid thermoplastic resin Elium® is used to make recyclable turbine blades.



5.

PHOTOVOLTAIC PANELS

Panels are more durable thanks to protective films made with our Kynar® fluoride material.



7.

COATINGS FOR RETURNABLE BOTTLES

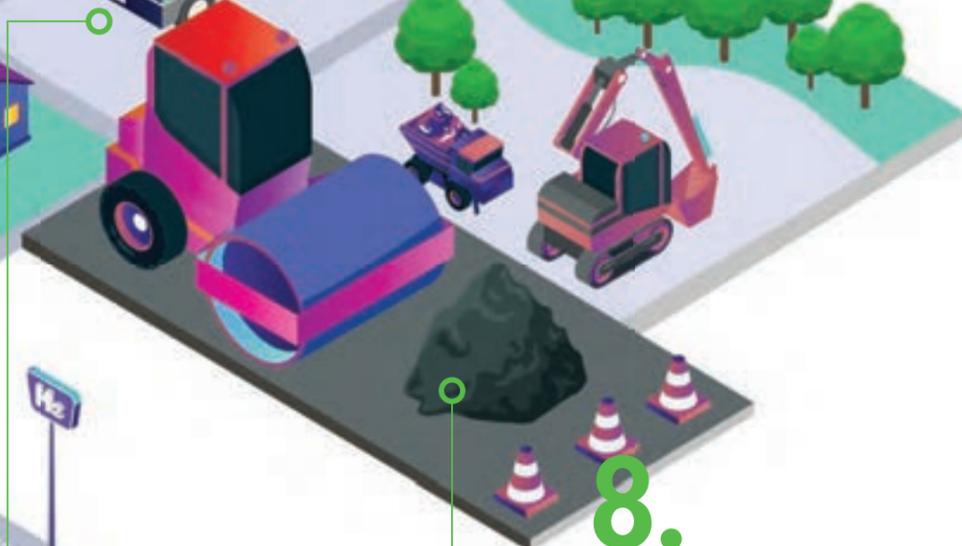
Our Kercoat® and Opticoat® glass coatings lengthen the durability of bottles.



8.

"GREENER" ROADS

Our Cecabase RT® additive lowers the preparation temperature for asphalts.





1. RILSAN® POLYAMIDES 11

SUSTAINABLE GROWTH FOR THE ONLY FULLY BIO-BASED POLYAMIDE

In the automotive industry, water networks and retail electronics; for the manufacture of lay-flat pipes and connectors; sports shoe soles, parts for electronic installations, eyewear frames and even 3D printing... Arkema's many members of the Rilsan® polyamide 11 (PA 11) family, the fruit of over 70 years of unrivalled expertise in the chemistry of ricin, are closer than ever to market expectations in a very large number of applications. "These products combine the high performance of their oil-based equivalents (chemical resistance, heat resistance and mechanical properties) with the advantage, which is more and more essential today for both ourselves and the community, of being produced from castor beans," says Guido Donà, Director, Planning and Strategy, Technical Polymers. To manage growing demand, in 2019, Arkema launched the construction of a production site on an international scale in Singapore – an exceptional investment, which increased its global production capacity for polyamide 11 by 50%.

Reducing CO₂ emissions by 40%

The life cycle analysis reveals that the production of a Rilsan® polyamide 11, which is fully bio-based, generates 40% lower CO₂ emissions than the production of the oil-based polyamide PA12, which has the closest performance profile to PA11. Castor oil, made from a non-edible plant that grows in semi-arid areas of which Arkema is the world's number one buyer, is mostly produced in Gujarat in India, by thousands of small growers engaged in a sustainable program. The Group is supporting them through a pilot scheme named Pragati, which means progress in Hindi, and which aims to improve social, environmental and economic conditions.

2. DECORATIVE PAINTS AND VARNISHES

A 97% BIO-BASED RESIN!

The resins in the Synaqua® range, which are basic components of alkyd-based decorative paints and varnishes, all contain high levels of bio-based materials – 42% to 74% of total carbon, depending on the grade. But the latest addition to the family goes so much further: Synaqua® 4856 contains more than 96% of bio-based materials. "These are essentially co-products from the paper industry, from sustainably managed forests in Europe, which therefore take no land from agriculture," explains Chantal Roidot from Coating Resins at Arkema. This resin was presented at the European Coating Show in Nuremberg (Germany) in 2019, and has already been adopted by one of the world leaders in the paints market. It is designed for indoor use, and also has the laboratory-tested advantage of very low emissions of volatile organic compounds (less than 1g/l). All this without any compromise in the criteria that make the difference, to the eye and to the touch, once the paint has been applied to a beautifully even surface – hardness, water resistance, color intensity and shine.



3. ELECTRIC CARS

KYNAR® PVDF, A BRILLIANT BATTERY BOOSTER

Arkema is a longtime competitor in the global R&D race to improve the performance of lithium-ion batteries, and is playing an active role in the growth of electric vehicles.

Greater range, reduced charge time and lower purchase prices are some of the factors that will gradually leverage electric vehicles and transform the mobility landscape. They mainly relate to the performance of lithium-ion (Li-ion) batteries, the technology that currently dominates the market, to which Arkema is making major contributions thanks to its leading expertise in fluoropolymers. "For the past 15 years, we have been working on a series of special grades of Kynar® PVDF, which play various key roles in batteries," explains Thomas Fine, Global Market Manager, Batteries.

Three continents

Kynar® polymer performs very well as a separator film (between the anode and cathode), helping to reduce the charge time and increase the battery lifetime. It also plays an important role as a binder in electrodes, making batteries more energy efficient. An established partner to battery manufacturers, Arkema posted two-digit growth for these PVDF applications in 2019. It is the only firm in the world to produce them on three continents – Europe, North America, Asia – using the same procedure, an essential factor for all major battery players. The Group also offers other innovative Li-ion battery solutions (carbon nanotubes for cathodes, electrolyte salts), and is investing in R&D for emerging technologies around lithium-sulfur and solid-state batteries.



4. HYDROGEN ENGINES

LIGHTER, LESS COSTLY TANKS

Already employed in taxis and buses in Paris and elsewhere, the hydrogen engine is playing a part in decarbonizing transport for the future. For vehicle manufacturers, the key challenge lies with the hydrogen tanks, which need to withstand internal pressure of 700 bars while offering the best weight per stored volume. "Current systems, obtained by filament winding thermoset epoxy resins, are costly and take a long time to produce," explains Guillaume Clédât, Business and Development Manager, Arkema. Elium® thermoplastic resin combined with carbon fibers could change everything. "The first prototypes, made in 2019 in partnership with major automotive parts manufacturers, show significant industrial gains in terms of reducing the winding time and eliminating the cure time." Arkema's R&D department is also developing a second technology based on carbon tapes impregnated with Rilsan® Matrix resin, which also offers notable productivity gains, as well as improved temperature resistance and new levels of performance in terms of rapid charging.

5. PHOTOVOLTAIC

DURABILITY CAN ALSO BE IMPROVED ON THE BACK OF PANELS

In a rapidly expanding photovoltaic market, Arkema's Kynar® PVDF-based solutions are making a discreet but essential contribution to energy transition.

In 10 years, the cost of photovoltaic (PV) per watt-peak¹ has fallen from €5 to €0.2. With regular 10% growth, solar power will be a key contributor to decarbonizing our future world. An important factor is the longevity of panels, as they are constantly exposed to heat, UV and humidity. The front is protected by glass, while for the back, fluoropolymers are a popular choice among manufacturers. Arkema is a major player in this highly competitive sector, thanks to its high-performance Kynar® PVDF. "The multilayered structure of our white films extends the lifecycle of backsheets to more than 25 or 30 years," says Bernard Schlinquer, PVDF expert at Arkema.

Transparent film for bifacial solar modules

Alongside this mature market, Arkema is investing in emerging sectors. "A major trend is the arrival of bifacial solar modules, which can produce 10% more electricity in ground-mounted arrays," explains Bernard Schlinquer. "For the back, we are developing a transparent Kynar® grade with greater UV resistance; the first pilot tests were approved in 2019." The Group's R&D department is also working on dedicated coatings with flexible PV films, and is partnering with large research laboratories on "thin crystalline layer" technologies using perovskite, a crystalline mineral that could, in future, offer an alternative to silicon in photovoltaic cells.

1. The peak power of a photovoltaic panel refers to the maximum output it can deliver into the electricity network in clearly standardized conditions.

6. WIND POWER

RECYCLABLE BLADES WILL SOON BE ON THE MARKET

With several thousand wind turbines produced every year around the world, that makes more than 550,000 tons of composites used in the blades. These composites are manufactured using a thermoset resin that is very hard to recycle, so what happens to the wind turbines at the end of the product lifetime? In this rapid-growth market (15-20%), Arkema is a game-changer with its Elium® liquid resin for manufacturing large wind turbine blades. "It is a thermoplastic material," explains Guillaume Clédot, Elium® Development Manager. "The composite parts made with it can be ground, then depolymerized, and their resin can be reused with exactly the same qualities." Its properties of lightness, mechanical resistance and durability, coupled with short cure times at room temperature, are generating major gains in productivity. Manufacturers are getting on board, and the first recyclable wind farms will go into service in the mid-2020s. "We are forming partnerships with several major players in the sector, to check production processes and optimize the recycling procedure," says Guillaume Clédot. The first blade design in Elium® resin was certified in 2019 by DNV GL (the standardization body for wind power), and the first depolymerization of actual-size blades is scheduled for 2020. This material certainly has the wind in its sails!



8. ROAD MIXES

25% OF ENERGY SAVINGS THANKS TO CECABASE RT® ADDITIVE

Produced and applied at a lower temperature, and allowing increased incorporation of recycled aggregates, warm mixes are on the rise, driven by Arkema among others, and leading us down the road of low consumption...

Just 150g of Cecabase RT® surfactant additive mixed into the asphalt makes all the difference between one ton of hot-mix asphalt and one ton of warm-mix asphalt. To make hot-mix asphalt requires a temperature of 160°C, while warm-mix asphalt is produced at 120°C. "This gap means a 25% reduction in production site fuel consumption and easier conditions for the workers applying the asphalt to the roadway," says Eric Jorda, an expert working for Arkema. The Group has been a leader in additives for road mixes for many years and strengthened its position in this market with the 2019 acquisition of ArrMaz, leader in specialty surfactants based in the U.S., a country in which warm mixes are seeing strong growth.

Up to 40% of recycling in warm mixes

In large urban centers like Mexico City, warm mixes have enjoyed long popularity, and this success is now reaching many other countries, especially in northern Europe and the United States, where additional cost for the additive is becoming less of a barrier in the face of public demand for improved resource use. They also have another advantage – by improving "fluidity" of the asphalt mix, Cecabase RT® additive promotes recycling of aggregate from breaking up old roadway, which helps to save natural resources such as granulate and, most particularly, asphalt. "The use of Cecabase RT® additive significantly increases the share of recycled road aggregate, which can reach 30-40% in the warm mix, compared to just 20% in the hot mix, without any need for different machinery," concludes Eric Jorda. This is a substantial advantage at a time when national regulations (especially in Europe and the United States) are increasingly banning disposal of end-of-life road aggregate in landfills.



7. BOTTLED BEER

RECYCLED AND RETURNABLE, THERE'S A FUTURE FOR GLASS

Glass bottles have become the mass-market containers that come closest to a circular economy. Arkema is extending their lives, and focusing on one market in particular that weighs heavily on a global scale: returnable beer bottles.

1,960 million hectoliters: the amount of beer consumed worldwide every year... 42% of which is sold in returnable glass bottles. "Deposits are mainly taking off in the southern hemisphere, especially Latin America and Asia, where this is how most beer is sold," says Isabelle Birken, Business Manager Glass Coatings. "They are falling out of use in northern countries, where producers gamble, successfully, on collection and recycling." In all cases, returnable beer bottles are still the container whose production generates the lowest carbon emissions, ahead of aluminum and PET (polyethylene terephthalate) so we need to look after them, especially since the global supply of sand is falling. And this is what Arkema's Glass Coatings activity is for – the range of Certincoat® coatings is the most popular in the world for improving the solidity of new bottles.

Up to 50 cycles of use

As for returnable bottles, two complementary ranges offer a considerable extension to their life cycle. The Kercoat® covering delays the appearance of fissures and scratches; used after every wash, it can extend the use of a bottle to 50 cycles, compared to 20 traditionally. And Opticoat® emulsion reduces the appearance of fissures and marks, which makes the containers more attractive. "The two solutions can be used either separately or together, depending on the individual bottler's strategy," says Isabelle Birken. Like the Petropolis group, number three in the Brazilian market, which opted in 2019 to apply the Opticoat® solution to its Premium range, showing that it is possible to improve the user experience by making bottles look almost new, even as part of a sustainable development drive, by preventing the disposal of scratched bottles.

THE EXTRA YOU GET WITH CECABASE RT® ! ↙

Cecabase RT® is made using 50% bio-based raw materials (without any impact on food production).



9. PMMA, POLYAMIDES, PVDF

Arkema takes up the challenge of the circular economy

Industrializing the recycling of polymers is an objective that is now crucial in preserving resources, which will require determined mobilization of the entire value chain, from organizing the collection of materials, to finalizing industrial processes and creating economic models. Arkema is fully invested in this work through its two major programs: MMAtwo, for the collection and depolymerization of PMMA¹ (acrylic glass), and Virtucycle®, which is dedicated to the recycling of polyamides and PVDF fluoropolymers.



Fully 300,000 tons of PMMA (or acrylic glass) are produced in Europe every year, but just 10% of this is currently collected and recycled, either mechanically through the grinding of industrial scraps, or by depolymerization. There is plenty of room for improvement. "PMMA can be regenerated as its original monomer and reintroduced into the manufacturing process to make new resins, with its properties unchanged, whereas recycling it mechanically tends to degrade its properties," explains Jean-Luc Dubois, Catalysis, Processes, Renewables and Recycling Scientific Director at Arkema. In order to exploit this property, the Group has signed up to the EU program MMAtwo, launched at the end of 2018 for four years, and provided with a budget of €8.9 million. The consortium has 13 partners from the entire PMMA value chain, working towards concrete ambitions. "We think we can increase recycling by collecting more production scraps from factories and collecting PMMA objects at their end of life," continues Jean-Luc Dubois, who chairs MMAtwo's Executive Board.

BUILDING THE COLLECTION NETWORK

PMMA depolymerization, which consists of returning to the monomer, MAM, is a process that chemists are familiar with, and Arkema itself has used it in the past. Its energy equation is good, since a large part of the energy required to produce a sheet of PMMA is used to produce the initial monomer. Turning the polymer back into its monomer uses 70% less energy and creates 70% fewer greenhouse gas emissions than producing the monomer. For the consortium, the goal is to validate the industrial viability of the process and demonstrate its competitiveness in the European market. Ultimately the project is intended to lead to construction of a recycling plant in the Netherlands, to be operated by the project's partner company Heathland. With this in mind, MMAtwo's other major activity is setting up a network to collect PMMA, including scraps from producers, and in the form of end-of-life objects, which are the major potential source. "We are working with the environmental body Ecologic, which specializes in collecting WEEE² and is also a member of MMAtwo, to organize collection flows for the most useful objects – large pieces such as neon signs, computer screens, and automotive tail lights," says Jean-Luc Dubois. The PMMA contained in end-of-life products may, however, contain chemical additives of unknown natures and in unknown quantities. Therefore, an important part of MMAtwo's role is to ensure these additives are eliminated during depolymerization and to establish their impact on the quality of monomer produced.

1. Polymethyl methacrylate
2. Waste Electrical and Electronic Equipment



"OUR STRATEGY IS TO PRODUCE POLYMERS THAT ARE AT LEAST 30% RECYCLED."

POLYAMIDES AND PVDF: CLOSED CIRCUIT OR OPEN CIRCUIT?

Alongside its involvement in MMAtwo, Arkema launched another ambitious program in October 2019, dedicated to PVDF and the high-performance polyamides it produces for customers. "This program is called Virtucycle®, and it aims to develop circuits for the collection and regeneration of our products, in partnership with Agiplast, the world leader in the regeneration of this kind of polymer," explains Guido Donà, Director, Planning and Strategy, High-Performance Polymers. In the short term, the most accessible driver is located in the Group's customers' production sites, i.e. transformers who make parts out of our materials, including pipe extruders, molders and manufacturers of 3D printed parts. Scraps and shavings can represent up to 20% of volume consumed, depending on the technology and type of part. Arkema and Agiplast approach their manufacturer customers on a case-by-case basis, to jointly build virtuous cycles, either closed circuits (the recovered scraps are ground and purified before being directly reinjected into the production of the plant), or open circuits (Arkema provides the customer with grades of recycled polymers, that may come from other markets or applications). The regeneration processes developed by the two partners are based, in this case, on mechanical recycling, and stages of physical separation. "This is perfect for our polymers, which have the capacity to recover their original properties, minimizing CO₂ compared to any other recovery technology. Our strategy is to produce polymers that are at least 30% recycled, which provides excellent quality for industrial applications," continues Guido Donà. "This allows us to offer a performance guarantee at the same time as higher volume under a recycled label, which responds to a genuine market expectation and a solid contribution to sustainable development in the polymer industry."

ECO-DESIGN: MOVING TOWARDS FINISHED PRODUCTS THAT HAVE BEEN DESIGNED FOR RECYCLING

Within the context of Virtucycle®, Arkema is already working with some major brands on projects for the recovery of end-of-life products, which involves the creation and optimization of cost-effective collection networks. What is really critical in developing this model is the design process for finished products. Currently, products often have several materials of different kinds either glued or molded together, and fulfilling different functions (in a sports shoe or multilayer car pipe, for example) and this makes them very hard to recycle. The same applies to the additives and quantities used. "We are lobbying for a simplification of design processes, with the use of materials in the same family, for example – solutions that are perfectly achievable using our polymers," insists Guido Donà. "This is a message we are actively selling to major sportswear and automotive brands that understand this necessity." This cultural change is vital if we want to move manufactured products towards a circular economy.



Turning the polymer back into its monomer uses **70%** less energy and creates 70% fewer greenhouse gas emissions than producing the monomer.



INNOVATIVE
for
CLIMATE

To contain climate change and prepare human society to adapt, we have to change things today. Tomorrow may be too late!

+2°C

The Paris Agreement, that 195 U.N. member countries signed up to in 2015, aims to hold the increase¹ in global temperature well below 2°C up to 2100.

Achieving this goal would limit the impact of climate change to acceptable levels for the biosphere and human society. This would, however, require the immediate mobilization of all political, economic and industrial

actors. We all need to increase our efforts to achieve a lower carbon energy mix, slash the emission of greenhouse gases caused by human activities and implement energy-efficient solutions.

¹. compared to pre-industrial levels.

SLOWING CLIMATE CHANGE

With its ambitious climate plan, Arkema is committed to reducing its carbon footprint significantly over the next ten years, including through the use of renewable electricity in its plants. We are also developing solutions for our clients to lower transportation weight and improve building insulation. The aim of these measures is to drastically reduce the consumption of CO₂-emitting fossil fuels.

1.

REPLACING METAL

Planes and cars are lighter thanks to our Kepstan®, Rilsan® and Elium® thermoplastic materials, and are therefore more fuel efficient.

2.

REPLACING GLASS

50% lighter than glass, our PMMA, Altuglas® ShieldUp PMMA can be used in automotive windshields and sunroofs.

3.

ADHESIVES AND CAUKS

Bostik insulation products meet the highest environmental standards, for eco-friendly construction solutions.

4.

HOME INSULATION

Our Forane® blowing agent for insulating foam has a global warming potential (GWP) of almost zero.

5.

CLIMATE PLAN

Arkema has committed to reducing its greenhouse gases by 38% by 2030 compared with 2015.

6.

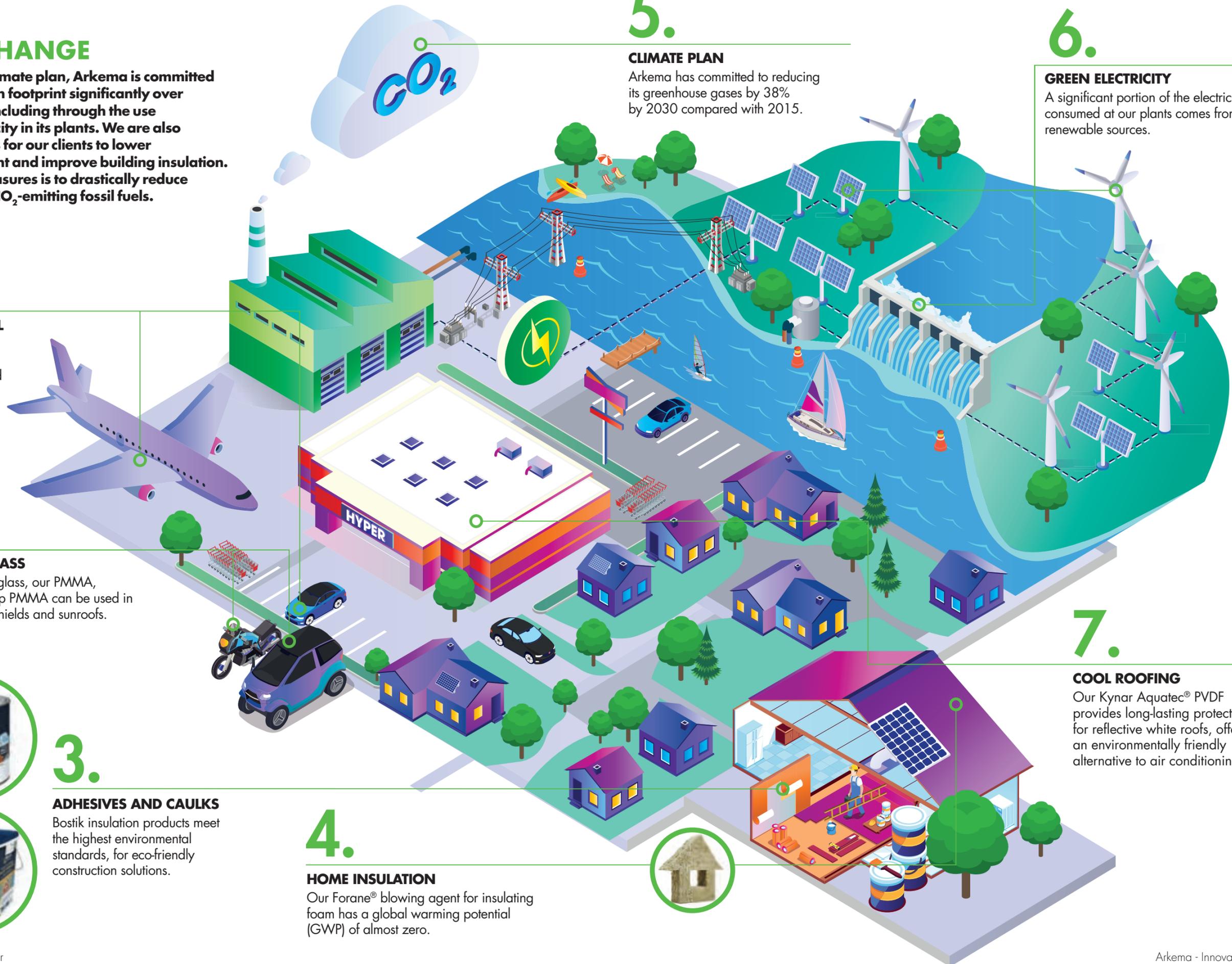
GREEN ELECTRICITY

A significant portion of the electricity consumed at our plants comes from renewable sources.

7.

COOL ROOFING

Our Kynar Aquatec® PVDF provides long-lasting protection for reflective white roofs, offering an environmentally friendly alternative to air conditioning.





1. AERONAUTICS, AUTOMOTIVE

LEADING THE RACE TO MAKE VEHICLES LIGHTER

Lighter vehicles mean a smaller carbon footprint – the Holy Grail for aircraft manufacturers and automakers. The quest for lightness is pushing boundaries further with Arkema’s ultra-high-performance materials.

Arkema’s Kepstan® PEKK, combined with high-performance carbon fibers, is a perfect choice for the aeronautics industry – 40% lighter than aluminum and offering exceptional mechanical and thermal resistance (up to 260°C). “PEKK composite tapes, developed through our partnership with Hexcel, have a growing number of applications in the manufacture of structural parts (longitudinal struts and circular frames), as well as in the “skin” of devices, for which they offer the benefit of shorter production cycles than thermoset composites,” explains Philippe Bussi, General Manager, Kepstan®. Furthermore, PEKK is ideal for 3D printing, as its lighter weight means it can be used for very complex shapes, such as air distributors.

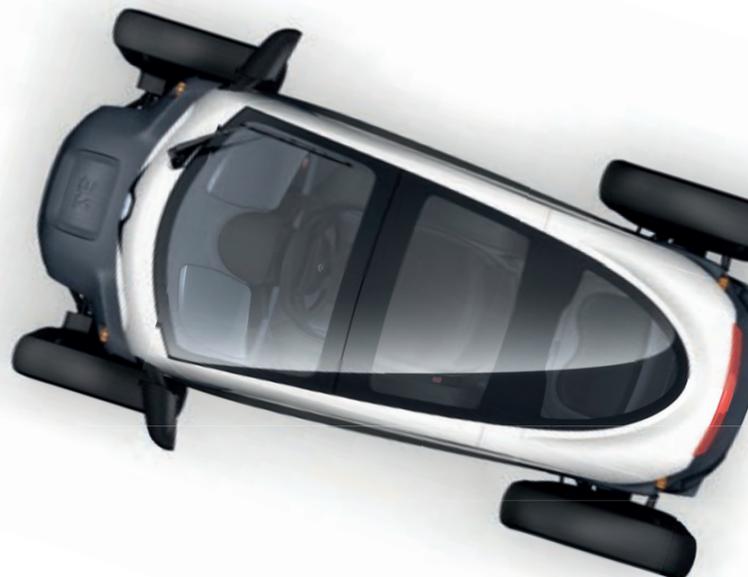
Battery packs and cooling circuits

Also in aircraft, Elium® thermoplastic resin offers a competitive solution for various interior parts (bucket seats, cup holders, etc.) But its most significant application in terms of weight reduction is battery protection packs for electric and hybrid cars, for which Arkema is forging partnerships with Renault, PSA, and Faurecia. “Elium® fiberglass composites, which are 10-15% lighter than steel, have the advantage of being recyclable, unlike thermoset composites, and are suitable for the fastest production processes in the automotive industry,” says Guillaume Clédât, Business and Development Manager, Elium®. Lastly, Rilsan® HT polyamide 11 is 70% bio-based and boasts exceptional temperature resistance (135°C in continuous use). It is increasingly popular with automotive suppliers as an alternative to metal in fluid transport applications close to the engine, in cooling circuits.

2. REPLACING GLASS

ALTUGLAS® SHIELDUP ACRYLIC GLASS: TWICE AS LIGHT AS GLASS

PMMA, or Altuglas® ShieldUp acrylic glass offers significant advantages over glass. It is 50% lighter with five times greater impact resistance; it is clearer, offers better insulation and it is highly resistant to detergents. There is only one catch... It is less scratch-resistant than glass, and therefore less resistant to wiper blades. Launched in 2015, the range has extended the common applications of PMMA and has enjoyed growing success on the market for motorcycle windshields, with a high-end positioning. “It is perfectly suited to thermoforming complex or very curved parts, which are difficult to achieve with glass,” explains Marilyne Hurtado, Market & Technical Manager, Altuglas® ShieldUp. This elegant material is also well suited to car sunroofs and is used for this purpose on the Renault Twizy, as well as for its wind deflectors.



3. ADHESIVES AND CAULKS

SOLVENT-FREE AND PHTHALATE-FREE FOR SUSTAINABLE CONSTRUCTION

With its multipurpose Premium Aware range, launched in 2019 in Benelux, Bostik has set a new environmental standard for construction and insulation products. Its adhesives, caulks and polyurethane foam are solvent-free (the A990 Premium Acrylic caulk is also phthalate-free), and they meet the highest certification standards in terms of greenhouse gas emissions and volatile organic compounds (EC1PLUS, A+ and/or M1 classification). “In the last few years, there has been a major demand from the construction industry for more environmentally friendly products,” says Rodrigo Lacerda, Senior VP – Global Head of Construction and Consumer Business, Bostik. “This unrivaled range, the latest to come out of our R&D, reflects our determination to support these changes while maintaining the high level of quality and performance that have made Bostik so successful.” The adhesive specialist has also announced that it will update its acrylic caulks catalog at the end of 2020, making all its formulations phthalate-free.



4. FOAM BLOWING AGENTS

BUILDING INSULATION... WITHOUT THE GREENHOUSE GASES!

With Forane® FBA 1233zd blowing agent, which is well ahead of environmental regulations, Arkema has achieved a disruptive innovation in blowing agents for polyurethane foams.

Polyurethane insulation foam, in the form of blocks or rigid panels, is widely used in construction and refrigeration appliances, but the expansion agents it contains, based on hydrofluorocarbons (HFCs), have a very high global warming potential (GWP) – often more than 1,000 times its CO₂ equivalent. But not for much longer; from 2023, European regulations will prohibit blowing agents with a GWP of over 150. Arkema has not only anticipated this new regulation, it has gone much further. Its Forane® FBA 1233zd, launched in 2018, has a GWP of just one CO₂ equivalent, “while offering better insulation, i.e. a reduction in energy consumption of up to 15% compared with today’s foam solutions,” says Mélanie Jourdain, Business Director, Fluorogases Europe.

Expanding markets

This latest-generation product is the result of R&D efforts that began more than ten years ago. “Derived from hydrofluoro olefins (HFOs), which should replace HFC-type products in a variety of applications, it required major research and development efforts, which means that we are now way ahead in this growth market,” Mélanie Jourdain continued. The Group also sells HFO-based solutions for the refrigerant gas market. Forane® 449A(XP40) is used in refrigerated retail display units, another area in which regulations are changing rapidly.



5. CLIMATE PLAN

REDUCING GREENHOUSE GAS EMISSIONS BY 38% BETWEEN 2015 AND 2030

In the face of a climate emergency, it is essential to reduce greenhouse gas emissions. In accordance with the Paris Agreement, the Group has set itself even more ambitious environmental targets and has adopted a voluntary new climate plan.

Arkema fully subscribes to the target defined by the Paris Agreement, to keep a global temperature rise “well below 2°C” above pre-industrial levels by 2100. To respond to this essential requirement, we must act immediately and determinedly. The Group has therefore committed to a new climate plan, with the key objective of reducing its absolute greenhouse gas emissions by 38% by 2030, compared with its 2015 level – whatever the growth in its business activities. “This objective was determined using the science-based target methodology and corresponds to the contribution Arkema must make to global efforts to keep global warming below 2°C,” explains Sophie Huguier, Head of Sustainable Development. “It is based on a detailed study of the Group’s projected growth, as well as development plans for manufacturing procedures, the reduction of energy consumption, and opportunities to buy electricity from increasingly low-carbon sources.” In absolute values, it represents a reduction of 1.7 million tons of CO₂ equivalent, to reach a level below 3 million tons by 2030. Arkema’s target takes into account all greenhouse gas emissions from its industrial activities, meaning direct emissions from production (known as “scope 1” and those due to substances that deplete the ozone layer - ODS), as well as indirect emissions from energy purchasing (“scope 2”).

Taking action on every front



Greenhouse gas emissions Scopes 1 + 2 + ODS (millions of tons of CO₂ equivalent)

Arkema has been working to reduce its carbon footprint for many years, by continuously improving its production procedures and implementing a determined policy of optimizing energy efficiency. “For example, the introduction of systems to treat emissions, and the adoption in 2013 of the Arkenergy program to reduce our energy consumption, are among the actions put in place,” continues Sophie Huguier. “We have already reduced our absolute emissions by 37% between 2012 and 2019. With this new target, we are further reinforcing our efforts on climate change.” We will achieve these climate plan targets by continuously improving and innovating manufacturing processes, by pursuing efforts underway in energy sourcing, and by prioritizing carbon issues in all our investment decisions (acquisitions, unit expansions, etc.). Each of Arkema’s business lines must contribute to this change. Carbon neutral projects – which could benefit from offsetting mechanisms for incompressible emissions – are also being considered on a case-by-case basis for some of the Group’s plants and product ranges.



6. GREEN ELECTRICITY

RENEWABLE ENERGY ARKEMA PURCHASES... AND PRODUCES!

As a contributor to the transition to new energies, the Group is taking action on every front to decarbonize energy purchasing and support green electricity producers.

On July 3, 2019, Corsica Sole, a photovoltaic electricity producer, commissioned a 10 MWp solar energy plant covering about 25 acres on Arkema’s production site in Saint-Aubain in the south of France. This solar plant represented an investment of €13 million and will produce 19 GWh of energy each year, mainly to be consumed by the factory. “This flagship project demonstrates the feasibility of green electricity on industrial sites, where it does not compete with farmland,” explains Loïc de Bergh, Head of Energy at Arkema, which has announced several other similar projects in France.

Purchasing contracts in the pipeline

As well as on-site production projects, the Group is working on various fronts to support green energy producers and offer its clients assurances required by their own CSR policies. For example, Arkema has obtained strong commitments from Apple. Energy purchase certificates allow it to state that all electricity consumed in manufacturing Apple branded products in China, France and the US comes from renewable sources. The Group is also working on green power purchase agreements with producers – “especially in the US, and later in China, where the electricity mix is dominated by fossil fuels,” Loïc de Bergh continues. For a manufacturer like Arkema, these types of contracts are possible due to the improving performance of technologies, including solar energy, for which the MWh price is a quarter of the cost from a decade ago.

7. COOL ROOFING

Twenty-first century cities will have white rooftops

Repainting roofs reflective white significantly lowers the temperature inside buildings during heatwaves. This is known as the “cool roofing” principle, a cost-saving and environmentally friendly alternative to air-conditioning that is rapidly being adopted around the world. Arkema has contributed a value-added layer to this solution with Kynar Aquatec® acrylic PVDF latex, which enhances the performance and durability of white roofs.



Black absorbs thermal radiation and white reflects it. In these times of record high temperatures, this well-known phenomenon is attracting growing attention. A major innovation is spreading across rooftops from the United States to Europe and Asia and contributing to energy efficiency around the world: cool roofing. This involves painting roofs with a reflective white paint that keeps buildings cool while the temperature soars outside, and reduces the need for air-conditioning and its associated greenhouse gas emissions. New York City is pioneering this solution and already has more than 850,000 sqm of painted white roofs, following a municipal campaign launched in 2010. Meanwhile, in Europe, over the past five years an increasing number of public buildings and large retail spaces are turning white on top. The trend is being encouraged by local authorities, including the City of Paris, which has identified cool roofing in its Climate Energy Plan as a way of combating urban heat islands.

UP TO 30% ENERGY SAVINGS

In France, Cool Roof is one of the companies driving uptake of this solution. Founded in 2015, the Brittany-based startup took on its first contract the same year, to cover 7,000 sqm of a Leclerc shopping mall. Data collected on site has recorded a 15% reduction in the building's energy consumption, representing nearly four metric tons of CO₂ equivalent per year, and annual energy savings of €20,000 for the retailer. Some fifty clients have followed suit, from the 2G terminal of Paris-Roissy Charles de Gaulle Airport to the Paris Fire Brigade's center in Villeneuve-Saint-Georges. In 2018, the Géant Casino store in Valence-Sud acquired the largest reflective roof in France, covering 18,000 sqm. The hypermarket recorded temperature reductions of up to 36°C on the roof after treatment. “Depending on the building, the reduced need for air-conditioning can represent 30% of the energy cost,” explains Antoine Horellou, Chairman and CEO of Cool Roof France. “And for non-air-conditioned spaces, we improve interior comfort.”

“ARKEMA IS WORKING ACTIVELY TO PROMOTE THE BENEFITS OF COOL ROOFING.”

KYNAR AQUATEC®, BOOSTING PERFORMANCE AND DURABILITY

To obtain these results, a quality coating is essential. Cool Roof – like Aximum, another supplier of reflective paints – drew on Arkema's expertise to develop their solution. The white, highly reflective, water-based paint is protected with a UV- and mold-resistant finish based on Kynar Aquatec® PVDF. This acrylic, waterproof emulsion significantly improves the performance of white roofs by increasing reflectivity of the sun's rays to 95%, compared with 70% for a traditional paint. Furthermore, it ensures an unrivaled lifespan. “Infrared and ultraviolet light from the sun eventually break down basic white paint. This

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means the roof needs repainting frequently, which quickly becomes expensive,” says Bertrand Dinelli, an Arkema cool roofing expert. The Kynar Aquatec® topcoat prevents soiling. “It's like the difference between regular cloth and waxed canvas. The rain naturally washes away deposits and grime that would otherwise blacken the roof and reduce its reflective qualities.” Cool Roof France promises its formula will last at least 20 years.

MILLIONS OF SQUARE METERS IN PROSPECT

Developed by Arkema in the United States, Kynar Aquatec® emulsion boasts the exceptional properties of Kynar 500® PVDF resins, which have been protecting the metal structures of many buildings for 50 years – including the Louvre pyramid. “Our engineers wanted to develop an acrylic PVDF latex that transferred these properties to a paint that could be applied not to metal in the factory, but directly to the building on-site using traditional tools,” explains Agnès Beaugendre, Product Development Manager. Their efforts paid off. The topcoat based on Kynar Aquatec® latex can be applied with a sprayer or brush to all types of materials. Cool Roof quotes maximum costs of €20 per sqm, including surface preparation, undercoat and topcoat. There are many buildings suitable for application. In France alone, flat commercial roofs cover around 5 million sqm, and many are aging and poorly insulated. “Arkema is working actively to promote the benefits of cool roofing, which has taken off around the world in recent years. This is just the start, with new sustainable building standards and requirements to reduce the carbon footprint of existing buildings. Our teams are working hard to present the proven benefits of Kynar Aquatec® in terms of energy savings. It clearly outperforms traditional acrylic coatings in terms of total solar reflectance (TSR), dirt-resistance and longevity,” says Paul Lavallee, Global Market Manager, Kynar® Coatings. In construction, the future looks white, especially with a coat of Kynar Aquatec® emulsion!

AN ONLINE ENERGY-SAVING CALCULATOR!

In the United States, our researchers have developed an app – Kynar-aquatec-calculator – that instantly calculates the annual energy savings generated by a white roof surfaced with Kynar Aquatec® resin over three years, based on sunlight levels in each state and the surface area of the roof. Results are shown in kW, dollars and CO₂ emission reductions. On large surface areas, savings generated by the reduction in air-conditioning required can quickly add up!



63%
more energy-efficient

White, so-called cool roof coatings made with Kynar Aquatec® PVDF resins are up to 63% more energy-efficient over time than those made with acrylic resins.

INNOVATIVE *for* TECHNOLOGIES

Recent technological developments are leading to new consumer behaviors, new business activities, and more agile production methods. The latest industrial revolution is digital and is well and truly under way.

That was the number of smart objects in 2019, for a population of 7.7 billion. This figure is projected to rise to 38.6 billion by 2025 and to 50 billion by 2030¹.

Alongside these dizzying numbers, artificial intelligence, powerful big data and increasingly reliable robotics are leading society into a new, all-digital era, which is having a profound effect on the way we live and on production structures.

The digital economy is the new driver of world growth. It was worth \$13,500 billion in 2019, accounting for 15.5% of the world's GDP, and should rise to 25% in less than a decade.

SUPPORTING THE TECHNOLOGICAL REVOLUTION

Digital offers limitless power in this Industry 4.0 era. Digital resources let us manufacture faster and with enhanced security. They can anticipate potential breakdowns, simulate a factory's operation and management before it is built, and even virtually develop new materials. Our portfolio of solutions fulfill manufacturers' need to adopt 3D printing technologies and the exponential demands of the electronics market.

1.

ARTIFICIAL INTELLIGENCE (AI) IMPROVES QUALITY

With AI, our cameras learn to recognize manufacturing defects on our products.

2.

PREDICTIVE MAINTENANCE

Extremely reliable tools anticipate the probability of failures in our manufacturing facilities.

3.

LETTING THE DATA TALK

Analytical tools interpret millions of pieces of information generated by our production units in just a few clicks.

4.

SMART CLOTHING

Smart work clothes mean our operators can work more safely at more ergonomic workstations.

5.

VIRTUAL REALITY

Using 4D simulators, our operators can experience virtual plants to improve the design of a production facility before it is built.

6.

SIMULATING PRODUCTION OPERATIONS

We can train our operators by simulating the operation of a plant before it even exists.

7.

MODELING FUTURE MOLECULES

Our software can virtually design molecules and materials, letting us anticipate their properties.

8.

SAFETY IN GAMING MODE

We train our operators on safe working methods using virtual reality systems.

9.

TECH FOR INDUSTRY 4.0

All these digital manufacturing tools are brought together in an incubator showroom to encourage their adoption throughout the Group.

10.

RETAIL ELECTRONICS

Our polymers and resins improve the performance and longevity of smartphones and tablets.

11.

FUTURE ELECTRONICS

Our electroactive polymers will be used to design smart objects with incredible properties, such as articulated gloves for medicine, flexible screens and smart labels.

12. and 13.

3D PRINTING AND COMPOSITES

Our wide range of materials and resins for 3D printing, along with our targeted partnerships, help manufacturers adopt the revolutionary production method of 3D composite printing.

DIGITAL MANUFACTURING: WELCOME TO A NEW DIMENSION

Digital transformation is a powerful means of leveraging performance and industrial processes. Arkema is working on a wide variety of projects in this field, with its resolutely innovative and collaborative approach. Welcome to Industry 4.0.



INDUSTRY 4.0: TAKING OFF NOW!

Our plants are going digital and interacting intelligently with operators. Arkema is developing new tools that are ideally suited to their needs, ready for immediate adoption and delivering instant benefits.

"Digital is first and foremost about collaboration," asserts Frédéric Gauvard. For Arkema's Director of Digital Transformation, everything starts with users' needs. "The success of a new digital project depends on our ability to get everyone on board and identify exactly where things can be improved." This collaborative approach is at the heart of the transformation process. It is about understanding needs and implementing the necessary changes, but it is also about opening people's eyes to the scope of opportunities. "It is about striking the right balance between dream and reality. You need a great vision while remaining pragmatic."

Digital proof of concept

"Proof of concept," or POC, involves testing a digital concept with its direct users. "You can offer a technology and say how great it is. But does it fulfill a real need? With the help of operational staff, we identify these concepts and consider how they can be applied in the field. The next step is to create prototypes that let us check what the solution offers in practical terms and then, if there are benefits, we can launch actual industrial production. The benefit of this approach is that it encourages the adoption of innovative solutions through a participatory design model," says Laurent Baseilhac, Director of Processes with responsibility for Digital Manufacturing.

Digital - an accelerator to meet different production needs

One example is the Bostik site in Roosendaal in the Netherlands. "Operators on the ground told us about the problems they encounter. We asked them to think about possible improvements," explains Pierre Grolier, Industrial Director at Bostik. "For example, they mentioned challenges with loading raw materials into reactors, so we found a way to adapt the appropriate digital tool. Now the operation happens automatically using a barcode scanning system. The operator no longer has to enter the quantities and batch numbers on the process sheet. It saves them time. It is also a safety measure, as they can be sure of following the correct sequence of loading the materials into the correct reactor. So the system offers gains in terms of respecting the manufacturing orders, product quality, and productivity."

IN BRIEF...



1. ARTIFICIAL INTELLIGENCE PROMOTES QUALITY

How can we automatically detect non-quality in finished products? By combining optics and deep learning. Bostik has rolled out this solution on its manufacturing lines for hot-melt adhesives in the Netherlands. Artificial intelligence is paired with a camera system that learns to recognize faults (bubbles, black specks, non-compliant packaging). With the automation of quality control, operators are freed up to devote themselves to other more valuable tasks, which improves workstation ergonomics.



2. MAINTENANCE: BEST TO BE PREPARED

Digital allows us to optimize supervision programs that guarantee the integrity of our industrial facilities. This is the purpose of Risk Based Inspection, a predictive maintenance system deployed on several sites in France, the Netherlands, India and Italy. It offers significant gains in terms of the availability and reliability of facilities by detecting the risk of part failure and wear. Feedback from process technology engineers and maintenance engineers in the plants is used to improve the system.



"Incorporating digital into our processes enables us to save time, optimize our resources, and enhance our production activities. There is a prerequisite – we need to get employees on board well in advance of designing a new tool."

Frédéric Gauvard, Director of Digital Transformation at Arkema

3. LETTING THE DATA TALK

Data processing and analysis are at the heart of digital transformation. Philippe Kemikian, Project Manager for Digital Manufacturing, sums it up: "We want to allow production staff to utilize the data generated by industrial equipment. New digital solutions are letting us process and analyze it without the need for specific programming skills. We expect it to have a significant impact on the way we run our facilities and monitor the equipment."



4. ASSESSING RISK EXPOSURE FACTORS THROUGH SMART CLOTHING

Elite sportsmen and women are already familiar with smart clothing to monitor their vital signs such as pulse rate, and now it is being used in our plants too. These intelligent clothes can communicate information about the body to objectively measure the difficulty of performing a task, using data on posture. Arkema's plant in Serquigny (France) has implemented this method successfully. The aim is to promote safe movements to prevent injuries, adapt workstation ergonomics, and make it easier to return to work after sick leave.



5.
**IMMERSIVE SIMULATION
 TOOLS TO HELP BUILD
 AND IMPROVE OUR PLANTS**



Implemented in 2015 to design the thiochemicals unit in Kerteh, Malaysia, and used again for a new high-performance production line for molecular sieve beads at the Honfleur site in France, facilities modeling is now used during the design of all Arkema's production units.

This was the case for the new production line for Orgasol® powders in Mont, as well as for the Carling-Saint-Avoid platform, at the Jarrie plant in France, for the extension of the Kerteh 2 plant in Malaysia, and for the set-up of the future production site for high-performance bio-based Rilsan® polyamides in Singapore. The idea is to model the future production facilities, which are designed entirely in 3D digital form. The result is a significant timesaving in design and construction, fewer design errors, lower costs, greater efficiency at the start of production, better anticipation of maintenance work, improved training for operators, and so on.

Immersive and collaborative

"We win in every respect," notes Laurent Baseilhac. "Particularly because 3D workshop modeling has the unique ability to bring into play everyone involved in the engineering and production in real time. "For example," says Cetia's Digital Director, "by immersing operators in their future working environment, we can take into account improvements relating to the use of equipment at a very early stage, and they are always happy with the workshop that is built in line with their requirements. In this way, they are helping to make the future facility safer, more ergonomic and more efficient for everyone. They can also use this 3D model later as an immersive training tool to create operational scenarios and check what they have learned."

IN BRIEF...



6.
**IS THERE A PILOT
 IN THE BUILDING?**

Digital modeling has many applications for Arkema's production operations. For example, it can be used as a simulator for production facilities, like those used by pilots during flight training. "We can model what happens on the whole chemical platform even before it is built, to train people who will be operating it. This is what we did at Lacq (France) and Kerteh (Malaysia), and it is what we are putting in place for the new platform in Singapore," explains Laurent Baseilhac.

7.
**MODELING
 FUTURE MOLECULES**

The incredible power of digital calculation allows us to design and manufacture molecules that will be used to make our future materials, faster and more efficiently. Thanks to the latest generation of molecular modeling tools, we are now able to predict the properties and behaviors of new molecules even before producing them!



8.
**HEALTH AND
 SAFETY GAMING**

Health and safety training in the form of a video game... this is the project that took place at Arkema's Mont plant (France), where around 100 employees donned 3D headsets to test this new training method. "The idea is to ask how best to go about a specific task while ensuring safety for yourself and the facilities," says Pierre Montagnon, Health & Safety Director, Europe. "We put everyone into a virtual world that is just like the real one, but without the risk. The act of taking part helps people remember the training. Neuroscience has taught us that our brain can retain 80% of a message in a participatory virtual/augmented reality setting compared with 10% in a traditional setting, such as a Powerpoint presentation with passive participants."



9.
**INDUSTRY 4.0:
 WELCOME TO A NEW ERA**

A new high-tech center has been created in Pierre-Bénite, France, as a result of the collaborative efforts of the Cetia teams, to provide an incubator for Arkema's digital manufacturing projects. "This new center will be called Agora. It will have a space for operating and demonstrating new digital technologies (remote assistance, virtual reality, analytics, etc.) and a space dedicated to stimulating creativity and collaborative approaches focused on practices," explains Laurent Baseilhac. Arkema will be the first chemicals company in Europe to have a 3D immersive wall display powered by LED technology. Other collaborative and immersive centers should follow, in Asia and the United States.

**DIGITAL
 CHAMPIONS
 NETWORK**

A Digital Champions Network has been put in place in collaboration with the Arkema HR department. Led by Philippe Kemikian, it brings together manufacturing managers who have all been specially trained in the "digital mindset" to pave the way for digital transformation. This is the jewel in the crown of Arkema's digital ecosystem. Through its members, the network reinforces the effects of the transformation process. It is a brilliant way of encouraging fresh approaches!



10. RETAIL ELECTRONICS

OUR MATERIALS ENHANCE THE PERFORMANCE OF SMARTPHONES AND TABLETS

Our R&D department is constantly developing new materials to optimize the durability and operation of mobile devices.

Sartomer resins for brighter screens!

We need optimal light diffusion from a screen to provide the clearest, most colorful image possible. The acrylate resins from Sartomer play a significant role in this. They are used to manufacture high-tech adhesives for the different layers that make up touch screens on smartphones and tablets, and offer key benefits including durability, complete transparency and protection against yellowing. They can also be found in protective varnishes on the shells of these devices thanks to their scratch- and abrasion-resistant qualities. What makes these resins special is that they harden instantly under UV-LED light, with no solvent emissions. Sartomer is constantly adapting its offering to the needs of this rapidly expanding market, in which products are replaced every two or three years.



Lightness and longevity with technical polymers

In the smartphone segment, leading phone brands have already opted for Rilsan® Clear polyamide. It is one of the few materials to combine chemical and impact resistance with thinness, lightness, a soft feel and a glossy finish. Lighter than polycarbonate and aluminum, which are commonly used, manufacturers have adopted Rilsan® Clear to design particularly robust, shaped shells and frames.

Another field of excellence for Arkema is lithium-ion batteries. When such batteries are subjected to temperature variations and repeated charge/discharge cycles, they lose adhesion between the active particles and the electrodes, causing reduced battery capacity and even failure. To solve this problem, battery manufacturers use Kynar® PVDF to bind active particles to electrodes. Its adhesive properties and exceptional resistance to electrolyte corrosion help to extend battery capacity and lifetime. It is also used as a separator coating between the two electrodes, which improves battery longevity. Thanks to Arkema's essential products, mobiles enjoy longer lives!

STAGGERING FIGURES ↙

In 2019, while sales of smartphones fell slightly, around 1.4 billion phones were on the market. Sales of tablets, with 144 million units, rose by 14.3% compared with 2018.



11. FUTURE ELECTRONICS

SENSATIONAL POLYMERS!

The smart device revolution is upon us with the emergence of a new generation of organic, flexible, printed, lightweight, ultra-thin electronics. Arkema is contributing to this through its subsidiary Piezotech, which specializes in the production of high-performance electroactive polymers derived from PVDF. Their properties open up opportunities for a wide range of applications in the electronics, robotics, aeronautics, medical and automotive industries.

These unique polymers undergo deformation under the action of an electric field and, conversely, generate an electric current under mechanical pressure. They will be incorporated into a host of interactive, smart and everyday objects, in powder, thin film or ink form. "Our polymers will be part of wearable technology initiatives providing new sensory properties," predicts Fabrice Domingues Dos Santos. For example, our researchers are working on haptic applications, in which these polymers make surfaces vibrate when you touch them. A control panel, a watch strap, or an intelligent glove in virtual or augmented reality could give the user tactile information via vibration. Paper covered in our materials could be used as a loudspeaker. These capabilities are revolutionizing the way that information is communicated via smart products.



Printed electroactive inks as sensors

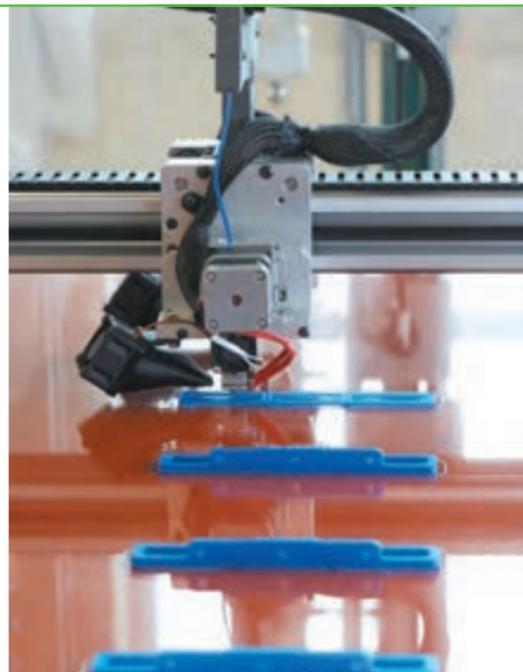
Another market for these polymers is for new generations of thin sensors, which can now be printed onto flexible surfaces such as fabric, paper, and flexible plastics. These polymers can make objects intelligent, and sense heat, vibrations and changes in shape. For example, a textile can feature countless sensors and transmit biomedical data about the wearer. "Many applications – smart labels, flexible screens, ultra-thin sensors – will develop on a large scale in the robotics, aeronautics, medicine and automotive industries in the next decade," continues Piezotech President Fabrice Domingues Dos Santos. These polymers still hold many surprises in store!



12. 3D PRINTING

Arkema is democratizing 3D printing for mass manufacturing

Industry's switch from traditional manufacturing to 3D printing opens unprecedented possibilities for the design of complex parts and productivity gains. This is a technological breakthrough in which Arkema is playing a leading role.



With long-standing expertise in the main technologies of additive manufacturing, Arkema is the only chemicals producer in the world with a complete portfolio of materials for 3D printing – polyamides, PEKK, specialty UV curable resins – that are suitable for the principal printing techniques. In filament, liquid or powder form, these materials have applications in all sectors: consumer goods (sports articles, eyewear), dentistry (dental models, mouth guards), electronics, and the automotive and aerospace sectors. Rilsan®, the bio-based polyamide 11, is the reference for series production due to its unequal mechanical properties. Arkema is the leading global manufacturer of the "ultimate polymer" PEKK Kepstan®, which is light, rigid and incomparably resilient. Kepstan® material is especially well suited to the manufacturing of additives for small and medium series of complex parts, traditionally made of metal for most demanding applications. Sartomer's N3xtDimension® liquid photocure resins allow an exceptional level of property customization in order to meet the precise needs of end applications. As mechanical qualities are improving all the time, these resins can take 3D from the prototyping stage to series manufacture.

20%

Arkema's market share as a supplier of materials used in additive manufacturing.

"MOVING FASTER TO SET UP NEW PARTNERSHIPS IN ADDITIVE MANUFACTURING AND BRING INNOVATIVE NEW SOLUTIONS TO THE INDUSTRY."

In order to help industry master 3D printing manufacturing processes more quickly, Arkema is forming multi-actor partnerships with machinery manufacturers and end-users. Some ecosystems are encouraging this democratization, such as the collaboration with Autodesk, a supplier of professional software solutions, and Farsoon, a company specialized in the laser sintering of polymer and metal powders. This co-development in complementary fields, combining software, printing machinery and advanced materials, fosters innovation and accelerates the adoption of additive manufacturing in industry, by offering end-customers the ability to quickly create hundreds of print-ready designs. "Our goal," summarizes Sumeet Jain, Senior Director 3D Printing Worldwide at Arkema "is to position ourselves very early on at the heart of the technological options that are going to emerge."



Another key partnership is the collaboration between Sartomer and, since its creation in 2013, the start-up Carbon, in which Arkema has acquired a shareholding. This business in Silicon Valley, the world center for digital technologies, is aiming to take 3D printing into the age of mass production. Combining their innovation capacity in terms of technology and materials science, the two players want to push back the frontiers of 3D printing by revolutionizing the logistical and manufacturing model, and producing reliable and competitive parts for mass markets such as sports or consumer goods. "This kind of strategic partnership is going beyond the basic customer-supplier relationship. We co-develop tomorrow's solutions that will revolutionize traditional manufacturing models and open the field to new designs and new performance in all business sectors," explains Julie Haevermans, Global Communications and Marketing Director at Sartomer.

13. COMPOSITE MATERIALS

3D PRINTING OF COMPOSITES: ARKEMA IS WRITING THE FUTURE

Sartomer, working in strategic co-development agreement with the American based start-up Continuous Composites, is extending the use of its high-performance resins to the 3D manufacturing of composite materials. This disruptive innovation heralds a major step forward in weight reduction.

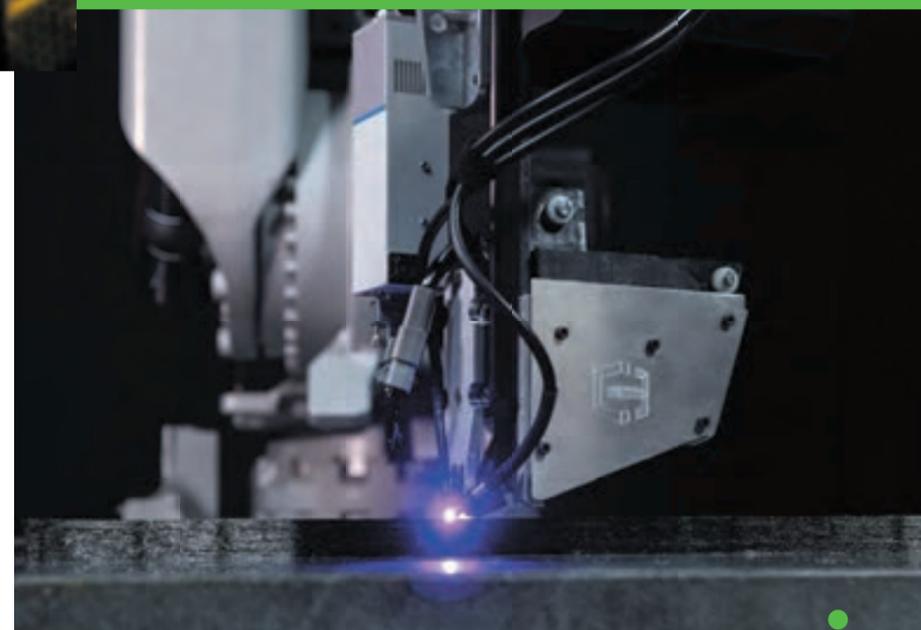
Taking the manufacturing of parts in composite materials to the next level is the challenge that Arkema has taken up with 3D printing, in a strategic agreement signed with the Idaho-based start-up Continuous Composites.

Increasing demand for lighter materials

Continuous Composites' patented Continuous Fiber 3D Printing (CF3D®) technology involves the instant hardening of N3xtDimension® photocure resin deposited through a nozzle attached to the end of a computer-piloted robot arm. This resin impregnates a continuous fiber in carbon or Kevlar®, for example. The part can be printed without support, enabling the 3D printing of complex and unique geometries with neither mold nor autoclave, which will help to drastically reduce leadtimes, cost and waste; and also open up limitless design possibilities compared to traditional composite manufacturing processes. This technology will speed up the development of bespoke composites in sectors with very demanding specifications, such as aerospace, the automotive sector, industry and construction. The goal is to meet the growing demand for lightweight materials, which help to reduce energy requirements and CO₂ emissions.

A disruptive process at the crossroads between 3D printing and composites

Arkema has been supporting the US start-up since its beginnings in 2013, as it implements a manufacturing process for 3D parts that is completely disruptive. "Continuous Composites chose us for our agility – our ability to adapt our resin formulations to the needs of all kinds of applications. This is a genuine co-development relationship," points out Sumeet Jain, Senior Director, 3D Printing Worldwide at Arkema. "We are very proud to position our materials on this technology that is really disrupting the traditional manufacture of composites."





INNOVATIVE
for
PEOPLE

HR professionals are seeing a paradigm shift. Workers don't just want a "good salary" or a "rewarding career" but also a company where they "feel good". A company with a strong ethos and philanthropic principles that fulfills their need for a purpose.

65%

of workers say they are attached to their company

... according to the latest research by recruitment consultancy Hays. But 76% say they would leave their job immediately if they received a more interesting offer. Faced with this ambivalence, companies have to rise to the challenge of retaining their employees, and are increasingly focusing on the quality of life at work, with well-being

training, the design of more comfortable offices and the organization of events to bring people together.

Another trend is that applicants are looking for companies that have a strong community ethos and invest in environmental and humanitarian issues.

"ARKEMA NEEDS TO BE ONE OF THE MOST ATTRACTIVE COMPANIES."

interview. HR Policy

Thierry Parmentier, Executive Vice President, Human Resources and Corporate Communications, joined Arkema in June 2019. He wants to raise the Group's ambitions in diversity, equality and opportunities for career changes and international careers. He feels the Group benefits from strong attributes to retain and attract talent.

Has it been a challenge to manage the Group's employees during the Covid-19 crisis?

Thierry Parmentier – Of course, this pandemic has been a difficult time for all businesses, us included. We have all had to deal with a new situation. Our employees have adapted very well around the world, working from home or continuing to work in our plants, with very strict health and safety conditions. I would like to thank all the Group's teams who have worked so hard to put in place plans to enable us to continue operating, ensure our sites are safe and fulfill strategic production. They have been professional, dedicated and efficient throughout. I know that we will come out of this period different, stronger, even closer, and ready to bounce back!

You joined Arkema in June 2019. What is your main observation as head of Human Resources?

T. P. – What Arkema has achieved since it was founded is exceptional. In barely 15 years, its directors have shown their extraordinary ability to structure and develop a Group of more than 20,000 people, considered one of the global leaders in its field today. Everywhere, you sense pride in belonging to Arkema. Since my appointment, I have visited some 30 Group sites around the world, and have seen strong commitment. Arkema has a low staff turnover rate, less than 5%, which shows how well it retains its employees. The 2019 survey found that most of them feel good with the Group. The response and satisfaction rates were remarkable, well above what is often seen with these questionnaires. Other indicators confirm these results. For example, we are among the top 20 in the 500 large companies that are best rated by their employees (see p.73)! This is a good sign of employee satisfaction.

How are you approaching your new role?

T. P. – I feel I have both inherited the legacy of an exceptional performance and have a responsibility to help the Group continue to adapt to the key issues of the future. Arkema is moving towards €10 billion in revenue, and has leading positions (ranked between first and third) in all its markets. This is a powerful argument for people who are attracted to good businesses, but it is not enough. In terms of human resources, we will soon be facing a different demographic distribution. The big age categories of the baby boomers will soon be gone. At the same time, there will be much less talent on the market. We will have to fight globally to find the best resources in all business lines. Arkema needs to be one of the most attractive companies.

"Arkema has a low staff turnover rate, less than 5%, which shows how well the Group retains its employees."

How can we ensure it remains attractive?

T. P. – We must continue to develop our talent. This is crucial to ensure that those with the best qualities and motivation reach the top. The recent appointment of three of our directors¹ to the Executive Committee is a good sign. This is the first time since 2011 that managers have been promoted internally to the Executive Committee. I am a big fan of meritocracy, but it is not enough to promote our own talent. We must also be able to offer jobs and career paths, opportunities to work abroad, and a working environment that attracts people from outside the Group.

Is it essential to have quality of life in the workplace?

T. P. – It is fundamental. A company that is not in step with this will not be desirable. If we want to attract the new generations in this global battle for skills and talent, we must meet their needs. This is what we are doing proactively (see p.76 and 77).

Can digital help with this?

T. P. – Digital is an essential tool. It gives us global control of human resources in real time, allows us to standardize the most efficient HR management processes, gives us a better knowledge of our international teams and their needs, and so on. More specifically, in terms of development, we want to offer our employees greater opportunities for online learning, which is the best alternative to traditional residential training. Digital is also a means of instantly sharing information and collaborating. We are in the process of setting up a professional internal social network, like LinkedIn, which will cover all our employees around the world.

All the same, is the chemicals industry attractive enough?

T. P. – It is up to us to explain what our business activities involve, to emphasize that the chemicals industry is a sector with strong economic growth, which is also helping to overcome the big environmental challenges. Furthermore, Arkema is active in specialty chemicals and advanced materials, where there is constant innovation to find the most sustainable solutions for the planet. We can be proud of this.

>>>

1. Marie-Pierre Chevallier, Richard Jenkins and Erwoan Pezron

"I FEEL A REAL ENGAGEMENT BETWEEN THE GROUP AND ITS EMPLOYEES."

>>> **What is the role of Arkema's values of simplicity, solidarity, responsibility and performance in talent management?**

T. P. – One of our strengths is the way these values are linked. They are the best foundations to build for the future. I feel a real engagement between the Group, as an organization, and its employees, and I have particularly felt this in the way we have managed the current crisis. I really focus on the quality of talent in the Group. We succeed by taking on people in all types of activities, in different parts of the Group's structure and of the world. We must apply talent management to everyone, based on our values. In other words, we must give everyone



the opportunity to progress in all business lines, sites and countries, without necessarily needing a vertical promotion system everywhere, but by offering opportunities for career changes through training and skill sharing. Someone could move from human resources to sales, or from an operational role to a support job. We should encourage this functional agility, risk taking and geographic mobility. We should facilitate inter-departmental, inter-business unit, inter-country mobility, to break up silos and go beyond our comfort zones. Someone who has worked in different areas, lived in different places, and is familiar with different types of products has more opportunities. We are a Group of more than 20,000 people of more than 100 nationalities, including 13,000 people who work for us outside France in some 50 countries. This is a great strength. Our career management policy must reflect the demographics of our workforce.

By promoting diversity?

T. P. – A company that gets it wrong through a lack of diversity sends out a negative message. But while diversity is important, it is not enough. We must be inclusive. We must bring people into our Group not because they are different, but because they are capable. In today's talent war, we will not be attractive if we do not think about all these aspects: internationalism, diversity, inclusion, mobility. We must send out powerful messages to the market, internally, and to our partners. —

TALENT

WELCOME!

Arkema focuses on talent diversity. The Group is becoming more attractive by supporting career development and promoting all types of roles.

Attracting a diversity of talents is essential to Arkema's success. "In addition to ensuring our workforce is regularly infused with fresh talent, we make sure we support the development of our future experts and leaders who will help us continue to build the Group of tomorrow," says Dominique Massoni, Vice President, Human Resources and Internal Communication Development. Arkema is tackling this by recruiting 1,600 talented individuals around the world every year! These newcomers come from different origins and backgrounds, from those starting out in their careers to others with more experience and expertise. Arkema offers them a choice of more than 200 roles in production, procedures, R&D, logistics, finance, marketing and human resources.

"YOUR FUTURE BELONGS TO YOU. WE HELP YOU EXPLORE IT."

The choice of roles is particularly adaptable as the Group is creating connections between different areas of activity. "Your future belongs to you. We help you explore it." Sums up a talent manager who is keen to provide applicants with the information and resources they need to develop their skills. To this end, Arkema is making good use of the best digital channels to promote its career opportunities in real time. The Group also offers different forms of support around the world. For example, the Careers Institute is an internal platform, launched in 2019, which provides access to training programs geared to our different careers, like the "Sales Academy" and "Supply Chain Academy". Importantly, this platform anticipates how employees will evolve with the digital transformation (see p.56 to 63). Also created in 2019, the Leadership Institute, in partnership with the French schools INSEAD and HEC and Cornell University in the United States, provides courses for tomorrow's leaders and directors at an international level. Arkema also offers the Managing in Diversity program, which encourages managers to consider bias in perception and selection, and to widen their selection and increase the diversity of applicants' backgrounds through dialogue. "You don't get locked into a career track at Arkema. Many opportunities are open to employees who are prepared to take on challenges," asserts Dominique Massoni. "Arkema also represents a certain attitude. Everyone has their place here, even at the start of their career. This is often mentioned by junior staff who join us. They say they quickly gain their independence and enjoy a fulfilling experience. They emphasize the culture of sharing skills, which is consistent with the values of responsibility and solidarity that we foster."

40%

The proportion of non-French nationals among Arkema's senior management worldwide in 2019. Our aim is to achieve 42-45% by 2025 through diversity recruitment and internal promotion. An international mentoring scheme was conceived in 2019 and launched in 2020 to identify talents around the world and coach them internally.



I'M HAPPY AT ARKEMA!

"Would I advise someone to join Arkema?" French employees were asked this question as part of an internal survey carried out in Europe in 2019. Most people said yes. The Net Promoter Score (NPS), which indicates the proportion of employees prepared to recommend the Group, stands at 20. This is an excellent result compared to similar surveys carried out in other companies. The media and social networks confirm this positive mood. For example, in Capital Magazine's annual ranking of the 500 best employers in France, Arkema is among the top 20 and is in first place in the "chemicals and energy" industries. This feedback was also confirmed by the 2019 Happy Trainees survey, an annual report, eagerly anticipated by hundreds of thousands of would-be interns, which identifies the "most intern- and trainee-friendly companies." Last year, Arkema enjoyed a recommendation rate of 94%!

STARTING OUT AT ARKEMA

In France, the United States and China, Arkema welcomes hundreds of interns, student trainees, PhD students, and international volunteers from all educational backgrounds and sectors. For example, the Group offers doctoral researchers a chance to work on their thesis in various fields such as polymer chemistry, chemical engineering, and humanities, through partnerships with higher education.

ARKEMA BETS ON FEMALE TALENT

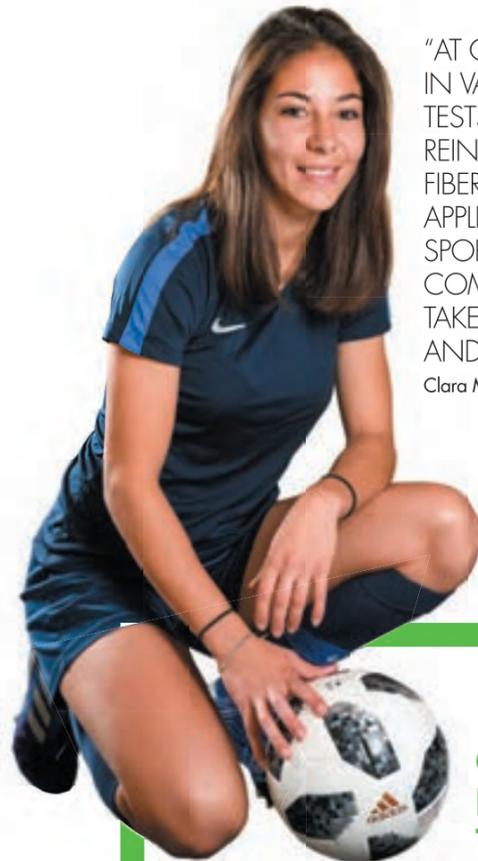
The Group is making a determined effort to strengthen its policy to support the recruitment and promotion of women.

Arkema ensures women benefit from the same career opportunities as their male colleagues. This is a key principle that forms part of the Group's non-discrimination policy. It also focuses on equal pay, equal access to employment, support for professional development and consideration of parenting in career management.



EQUAL PAY AND EQUAL ACCESS TO EMPLOYMENT

Arkema's policy of professional equality between men and women is gradually bearing fruit. The figures are transparent: 25.3% of the Group's workforce are women. This rises to 34% among middle managers, which represents a promising talent pool to help achieve the Group's target for 25% of women at senior management level by 2025. To counter the risk of a glass ceiling and support the advancement of our female employees, Arkema has created a mentoring program for them. Volunteer mentors – male or female senior executives – are trained to coach and assist their mentees in developing their careers.



"AT CERDATO, I TOOK PART IN VARIOUS MECHANICAL TESTS ON A GRADE OF PA11 REINFORCED WITH CARBON FIBERS FOR A SPORTS APPLICATION. R&D AND SPORT HAVE SOMETHING IN COMMON IN THAT BOTH TAKE A LOT OF EFFORT AND PERSEVERANCE."

Clara Mateo

CLARA KEEPS HER EYE ON THE BALL

Clara Mateo is a top-level soccer player who plays in the championships with Paris FC and is at the point of completing her engineering studies in materials at the Polytech Paris-Saclay. She could not find a more ideal training ground than Arkema's R&D center (Cerdato) in Normandy (France). As part of her studies, Clara spent several months there and was "delighted to benefit from Arkema's technological advances in the field of materials for improving sporting performance. Most women soccer players have Pebax® in the soles of their shoes," explains the 23-year-old athlete, who is happy to be able to combine her elite sports practice with her higher education and laboratory training in cutting-edge research. "For me, it's the perfect balance," says Clara, who is "very aware of Arkema's efforts to promote the status and role of women in industry." A finalist on the French team in the U20 World Cup, who was previously invited to play in the French A team group, Clara is naturally pleased to see women excel in her sport. "Women's soccer is getting increasing media coverage. The number of licensed players has rocketed. We've gone from 50,000 ten years ago to 200,000 this year! It is a very good thing that a group like Arkema has signed a partnership with Women's Division 1, following on from the 2019 World Cup (see opposite). Whether it's on the soccer field, in R&D centers or in the plants, the Group is sending out the strong message that women are there to demonstrate and develop their talent to the full!"

WOMEN IN SOCCER

Sports sponsorship is a good way for Arkema to build brand awareness. And by supporting a women's soccer team, the Group is sending an additional message, promoting the role of women, both on the soccer field and in the workplace.

In 2018, Arkema became the first national partner of the 2019 FIFA Women's World Cup France™. It was a great success! During the month of the competition (June 7 to July 7), our image was on show to a billion TV viewers in 180 countries. In France alone, TF1, which held the television rights for the event, recorded its three biggest audiences in 2019 during match broadcasts.

FROM THE 2019 WOMEN'S WORLD CUP TO THE ARKEMA D1

Following this international sponsorship deal, the Group has partnered with women's first division soccer in France, now known as the Arkema D1. By supporting the 12 clubs involved in the French championship over three seasons, Arkema is helping to promote the competition and the professionalization of the sport to the highest level. "It was important for Arkema to build on the legacy of the World Cup," explains Gilles Galinier, Director of External Communications. "This new partnership allows us to associate the Group and the brand with women's soccer over the longer term. The ongoing venture with the D1 championship means we benefit from greater visibility and can reinforce Arkema's commitment to the sport."

SPONSORSHIP REFLECTED AT A LOCAL LEVEL

Women's soccer is popular in many countries where Arkema has an industrial or commercial presence and major recruitment needs. This is the case in the United States, where the girls' national team holds the record for World Cup victories (1991, 1999, 2015 and 2019), as well as in Asia and Europe. This encouraged us to implement grass-roots communications campaigns and mobilize plenty of Arkema supporters. During the World Cup, our sites in France benefited from their proximity to the cities hosting the matches, such as Le Havre, Grenoble, Lyons and Paris. The same is true for the Arkema D1 championship, with clubs playing in cities like Marseille, Bordeaux, Lyon, and Metz as well as the Paris area. Our plants also get involved with local clubs, like our Jarrie site in France, which has partnered with the Grenoble club, and Arkema Inc. in the United States, which is supporting a women's team based in New York.



SUPPORTING WOMEN'S SOCCER TO ATTRACT MORE APPLICANTS

This sponsorship sends a strong message about women's status and role in industry. "The careers we offer are absolutely not exclusive to men," Gilles Galinier continues. "We are working to ensure that our industry, which is still perceived as male-dominated, like soccer, fully recognizes the role of female talent in all disciplines. The decision to support women's soccer is particularly meaningful given that we share the same values of simplicity, proximity, and humility."



"THIS NAMING CONTRACT IS A FIRST FOR THE WOMEN'S D1 CHAMPIONSHIP AND IS EXCELLENT NEWS FOR THE GROWTH OF WOMEN'S SOCCER."

Noël Le Graët, President of the French Football Federation

A GROUP WHERE PEOPLE FEEL GOOD!

Arkema is continually investing in Quality of Life at Work (QLW) – an essential factor in employees' wellbeing and performance, which helps to retain existing talent and attract new people.



HIGH SCORES FOR ARKEMA

Arkema is among the top 20 companies based on employee ratings. Capital magazine questioned 20,000 French employees in some 2,100 companies with a workforce of more than 500: "On a scale of 0 to 10, would you recommend your employer to someone you know or to a member of your family?" For the third year running, Arkema was one of the top-rated companies, with an average score of 7.79/10. Our group ranked 20th overall and came first among businesses in the Oil and Chemicals sector.

PATERNITY LEAVE

We want to promote parental equality. Arkema demonstrates the importance it places on parenting by offering two weeks' paternity leave on full pay after a baby's birth.



THE CAMPUS EFFECT

QLW is a priority for Arkema. Last fall, it opened its new Campus, which was immediately popular with employees. Laid out over 400 square meters at the Group's headquarters in Colombes, it offers a variety of spaces including a brainstorming room to encourage creative thinking, a calm area to recharge one's batteries, a modular auditorium that can be adapted to different types of events, and a coworking space with a more relaxed, informal atmosphere, complete with coffee area, library and games room. The whole campus is full of intuitive digital devices and tools. "The idea was to design a new type of space to encourage employee well-being, multidisciplinary collaboration and creativity," explains Corinne Haran, QLW manager at Arkema's headquarters. "At meetings, people are interacting in a more straightforward, friendly way. It's a virtuous circle. Improving the working environment has a clear impact on human relations, including QLW."

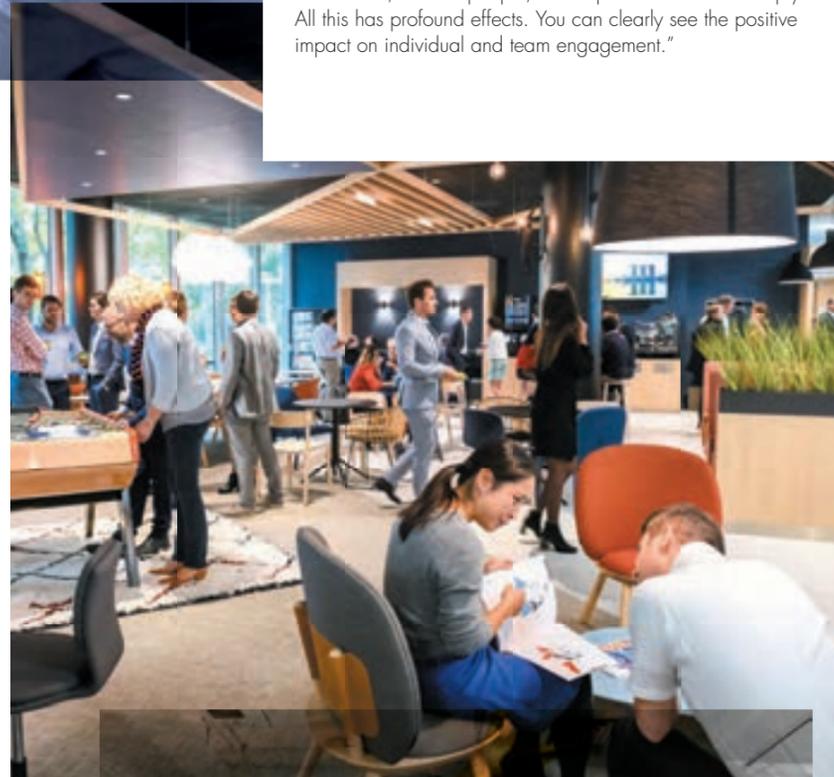
The Campus illustrates an underlying philosophy at Arkema which is to encourage interdisciplinary projects between teams, support digital transformation, and of course improve well-being at work. The Bostik headquarters' move to Colombes was another pilot project. Employees were involved in the project to secure their support. The project was about more than just designing open plan offices; it also involved new approaches such as going paperless. Different ideas are being considered to ensure employees' wellbeing, including sound-absorbing finishes, ergonomic furniture for a pleasant and light-filled environment, and a quiet zone on every floor for employees who need to withdraw from the open-plan spaces from time to time. In China, Arkema's headquarters in Shanghai is based on the same concept. The Social Club is an example of action being taken to encourage well-being at work.

Various leisure and sporting activities are available to anyone here, regardless of seniority. Initiatives like these reinforce the sense of belonging, and this is reflected in the decrease in employee turnover registered in 2019.

WORKSHOPS

It is an unusual sight... fifty Arkema employees taking part in a meditation session in a comfortable auditorium! This collective relaxation is quite unusual in the workplace, but is no gimmick. On the contrary, it reflects a growing interest in QLW. "Our efforts to improve QLW are a response to the need to find resources to deal more effectively with the constraints and complexity of tasks. We are working on everything that nourishes people and provides a positive balance to stress," says Corinne Haran, Head of QLW at Arkema's headquarters. Mindfulness workshops are held regularly alongside talks on a range of issues including self-confidence, creativity and emotional intelligence – soft skills that can help improve our behavioral expertise.

"In the workplace, people also want to have their horizons broadened, to meet people, and experience a shared enjoyment. All this has profound effects. You can clearly see the positive impact on individual and team engagement."



TACKLING QLW FROM EVERY ANGLE

QLW is not exclusive to the central departments. It is also finding its way into life at production sites, through themed weeks, with plenty of local initiatives. When Isabelle Simonetto, a neuroscientist who studies applied research in industry, gave a talk at the Colombes headquarters on the way our brain works to avoid professional and personal risk, she extended the initiative to all sites (production, research, commercial).

On this subject, Arkema is implementing an active psychosocial risk prevention policy in the widest sense. A pioneer in workplace well-being, the Group has created a central stress monitoring unit tasked with spotting high-risk situations. It has put in place awareness-raising programs, led mainly by occupational physicians, focusing on health and well-being at work. In addition, our yearly "Netiquette Week" reviews tips for achieving online-offline balance. We also pay special attention to ergonomics at workstations on all of the Group's sites, either at the design stage or by adapting existing spaces. Best practices are shared among a network of officers. As Pauline Saint Macary, Head of Employee Relations France, puts it: "We must tackle QLW from every angle – the design of the working environment, ergonomics, working conditions, remote working, consideration of disabilities and so on. It is a global approach that we work on collectively, under the Health and Work agreement signed with all employee representatives, drawing on the expertise and suggestions of our employees."



"We want to rank among the best companies to work for. This is about wellbeing and performance for our employees. It is also about demand from younger generations who are avoiding companies

that don't tackle these issues. We are often asked about it during the recruitment process. What are you doing about QLW and CSR? The same goes for remote working, which gives employees greater flexibility. Our QLW policy is a means of becoming more attractive."

Corinne Haran,
Head of QLW at the Arkema headquarters



GETTING INVOLVED OUTSIDE THE FACTORIES

Arkema has a number of sponsorship and philanthropic initiatives, and prioritizes social projects relating to education, the inclusion of young people, humanitarian issues and sustainability. Below are a few examples.



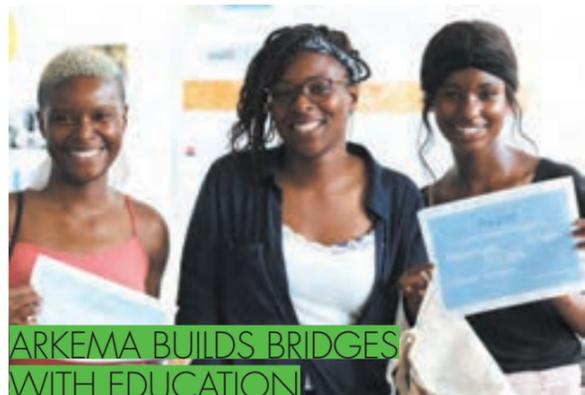
THE CGÉNIAL FOUNDATION IS GREAT!

Since the launch of the Arkema/CGénial Foundation partnership in 2016, collaboration has continued to grow. Numerous initiatives took place in 2019, benefiting more than 800 young people. Many of our sites in France responded to the invitation to support projects inviting "teachers into the workplace", and engineers and "technicians into the classrooms". The former involves high-school teachers visiting our establishments. For the latter, our engineers and technicians volunteer to go into schools to talk about our products and career opportunities. This exciting initiative helps to strengthen our links with education and attracts students to our industry.



"Students like these visits because they relate to real life. We want to get them interested by talking about jobs we offer that are well paid and rewarding, and might interest them when they're a bit older."

Hourida Manessier, Manager, Recruitment and HR Projects



ARKEMA BUILDS BRIDGES WITH EDUCATION

Set up in 2016 to mark the Group's tenth anniversary, the Arkema Fund for Education supports initiatives suggested by employees around the world who volunteer in educational and humanitarian projects. Around 40 projects have been supported since the fund was established. One example is Proxité, a nonprofit that helps to create links between young people from underprivileged areas and the world of work through educational projects. Arkema's donation helps to fund scholarships for teenagers who live near our headquarters in Colombes. Mentors help the young people with their schoolwork by introducing them to their own professional environment.



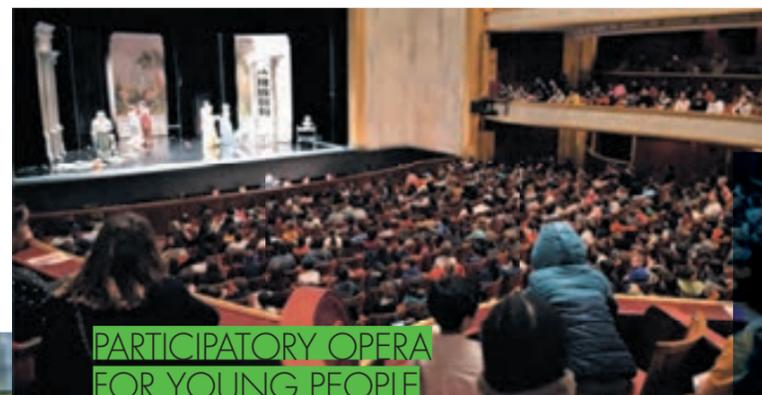
SPORT IN THE CITY AND GIRLS IN THE WORKPLACE

In 2019, Arkema launched a partnership with Sport dans la Ville "Sport in the City", the main nonprofit working on inclusion through sport in France. It supports disadvantaged communities and helps to build soccer pitches and basketball courts next to residential buildings. Above all, it helps young people with schooling and career options through sporting and activity programs. Out of the 6,500 young people supported so far, a thousand girls have benefited from the special "L dans la Ville" project, which gives girls access to the professional world through internships and visits to companies, ensuring they have the same chances of success as boys.



SCIENCE TEACHER: CHEMISTRY FOR PROFESSIONALS

In the United States, the Arkema Inc. Foundation helps fund local social, cultural and educational organizations to improve the quality of life in the communities in which it operates. The foundation focuses on supporting science education at all levels, and initiated the Science Teacher Program, which has benefited hundreds of teachers across the country. The teachers are provided with science teaching kits and collaborate directly with Arkema's engineers and researchers. The idea is to provide them with learning resources to make their teaching more effective and engaging in the science subjects, including chemistry, for thousands of primary and secondary pupils. In 2019, 15 American sites took part in the program, which benefited 41 local schools.



PARTICIPATORY OPERA FOR YOUNG PEOPLE

It is a wonderful thing to watch a performance of Carmen. To take part is incredible! That is exactly what is offered to young people by the Théâtre des Champs-Élysées in Paris (France). Children of all abilities sing along to excerpts from the opera from their seats in the audience. The entire auditorium takes part! This is a wonderful example of the partnership put in place between this prestigious classical music venue and Arkema, as the sponsor. Every year, the theater invites thousands of school children from Paris and the suburbs. In 2019, it staged ten participatory opera performances, preceded by workshops. This project allows Arkema to help children discover classical music and opera in a fun, educational way.



EVERYONE HAS THE RIGHT TO DRINKING WATER!

For three years, Arkema supported the nonprofit Sail for Water, which gave 100,000 people in 22 countries access to drinking water by distributing 1,000 water filters. Sail for water has now handed the reins over to other nonprofits including the No-Thirst Initiative, which has distributed 300 filtration kits to remote regions of Nepal, and Soleil d'Or, which supplied emergency filters to the Bahamas following the devastation caused by Hurricane Dorian. These ultrafiltration cartridges, which Arkema developed jointly with Polymem, a specialist in membrane filtration for water treatment, feature membranes made using our Kynar® PVDF material, and they eliminate 99.9999% of bacteria and viruses.



CLOSE LINKS WITH HIGHER EDUCATION

Our Group maintains close relations with the best training institutions for all its areas of expertise. In France, Arkema takes part in events organized by general and chemistry engineering schools, and sponsors École Polytechnique, ENSIACET and ESPCI ParisTech. The Group also provides financial support to the ENSIC Foundation. Since the funding scheme started, around 100 engineering students in financial difficulty have benefited from a bursary. Every year in the United States, the Developing Engineer Program has led to Arkema recruiting several future engineers who studied in the country's best universities.



ARKEMA'S VOLUNTEERS MEET YOUNG PEOPLE IN CHINA

In China, our employees regularly go into schools and colleges near the plants to meet students as part of a social responsibility project called Arkema ChemArt Green Innovation Class. The aim is to advance the teaching of science subjects, promote careers in chemistry, and raise awareness of environmental issues among the younger generations. On June 5, 2019, for World Environment Day, several employees volunteered to go into Zhangjiagang Lvfang school for the children of migrant workers, in Jiangsu province. They taught the concepts and practices of the circular economy, before taking part in a short game of soccer!



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TACKLING TOMORROW'S CHALLENGES TODAY

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