SPECIAL:
Plastics World Market

Polyethylene (PE): Shaping New Trends in Power Generation and Packaging

Resilient through Changing Markets

Since its invention, polyethylene (PE) has created new areas of application, replaced other materials in their traditional functions and continuously shifted its own limits of use. This has made PE the most widely used plastic in the world, with 115 million t consumed annually. Consumption and manufacturing capacities are growing most in North America and China. In Europe, companies are working on specific paths.

PE films with monoaxial and biaxial orientation help to replace multi-material compounds for packaging. © LyondellBasell

The average growth rate of PE over the last five years was 4.6 % per annum worldwide, leading to a consumption of 115 million t in 2021. This increase in consumption also remained unbroken in the pandemic years of 2020 and 2021. On the contrary, with 5.7 % and 5.2 % growth in 2020 and 2021, respectively, PE has increased disproportionately to its own growth average, but more importantly to the general global Gross Domestic Product (GDP). Worldwide, investments of about 10 so-called "world-scale" plants per year are needed to ensure that the supply and demand structure is not permanently impaired.

Of course, there are segment-specific differences in growth. At the same time, it is remarkable that, with a few exceptions, none of the ten application segments defined by the market research company Chemical Market Analytics have recorded negative growth over the same period (**Fig. 1**).

Market researchers assume that the usual growth rates of the recent past of 4 to 5 % on average will continue unchanged. There is a significant difference in the world regions though. While growth in mature markets is only moderate and flattening out, Northeast Asia and especially China are almost solely responsible for the overall global growth (**Fig. 2**).

Two World Regions Are Dominating Growth

If we look at the capacity expansions for the period from 2016 to 2022 and venture a capacity outlook up to 2031, we find something surprising (**Fig. 3**). Capacity growth is keeping pace with consumption growth, but utilization rates remain very high at 85 to 90 %. It is particularly striking that the traditional chemical location of Western Europe has not played a role in terms of capacity expansion in the last decade and this will remain the case for this decade. Also, Eastern Europe is hardly significant in the overall global capacity picture. The Middle East, which functioned as a capacity engine especially in the last decade, is weakening enormously. In contrast, the USA is sticking to its strategy of refining cheap shale gas and thus ethane into polyethylene, not only to cover its own needs but also to increasingly establish itself as a global export region for PE. If we take a closer look at the USA, it has added about 11 million t of PE capacity in the last five years and plans to add another 13 million t by 2026.

13 Million Tons of New Capacity

The situation in China is similarly impressive. It is expected that China will build up an additional 13 million t of PE capacity. The self-sufficiency rate, i.e. the ratio between Chinese production and Chinese demand, was 57 % in 2017. Therefore just under half of Chinese consumption had to be imported. One would think that with the massive capacity increase of 10 million t since 2017 and an additional 13 million t by 2026, China would make itself independent of imports; however, this is not the case. While the expected self-sufficiency rate will improve to up to 62 % in 2026, it still keeps the door open for imports of around 20 million t.

Neither a significant increase in demand nor capacity expansions in Europe, especially Western Europe, are foreseeable. This forecast refers to conventionally produced PE, i.e. PE from polymerization plants and based on fossil raw materials. Similar to the electricity discussion in Europe, the focus is not on growth but on sustainability. In other words, how to enjoy the undisputed usefulness of this material and at the same time avoid or at least reduce undesirable side effects, such as its CO_2 footprint and especially its waste. The answers are either already commercially available or at an advanced stage of development.

Conventional high-density polyethylene (HDPE) of fossil origin has an average cradle-to-gate carbon footprint of 1.84 CO_2 equivalent; i.e. the production of 1 t of HDPE causes the emission of 1.84 t of CO_2, considering the entire value chain starting from crude oil (cradle) until the finished HDPE product leaves the respective industrial site (gate). If crude oil is replaced by plant-based waste or biomass, the CO_2 footprint is reduced by 3.71 CO_2-eq to a negative value of –1.87 CO_2-eq. This means that the plant-based raw materials behind the biomass have absorbed more CO_2 from the atmosphere during their current growth than the entire manufacturing process of PE releases again. Not many refineries are currently designed to convert vegetable waste and biomass into cracker-ready naphtha, but this journey has begun, nonetheless. Close cooperation between Finnish refiner Neste and polyethylene producer LyondellBasell is making it possible to produce PE based on renewable raw materials that match the quality of conventional PE.

In the case of plastic waste generated after its initial use, the aim is to offer an alternative to conventional disposal and preserve the value of plastic as a material, keeping it in circulation for as long as possible. The value creation chain is complex and not easy to organize. It starts with collecting the waste and not simply disposing of it. Once this has been done, the waste mixture must be separated largely according to »

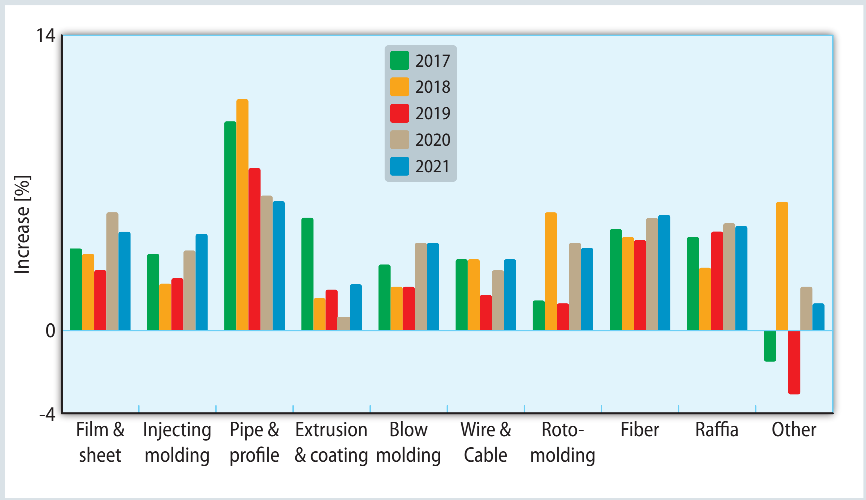

Fig. 1. Development of worldwide growth of PE consumption in different processing and application areas: also in the crisis years 2019 and 2020, consumption increased in practically all areas.
Source: Chemical Market Analytics by Opis, a Dow Jones company; graphic: © Hanser

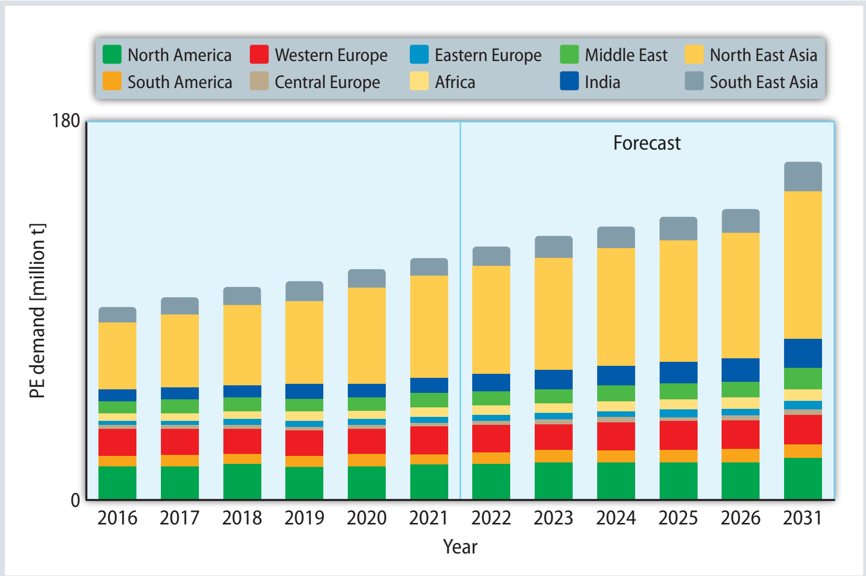

Fig. 2. Worldwide PE demand according to regions: market growth in Asia is strong, and expected to increase even more by 2031. Source: Chemical Market Analytics by Opis, a Dow Jones company; graphic: © Hanser

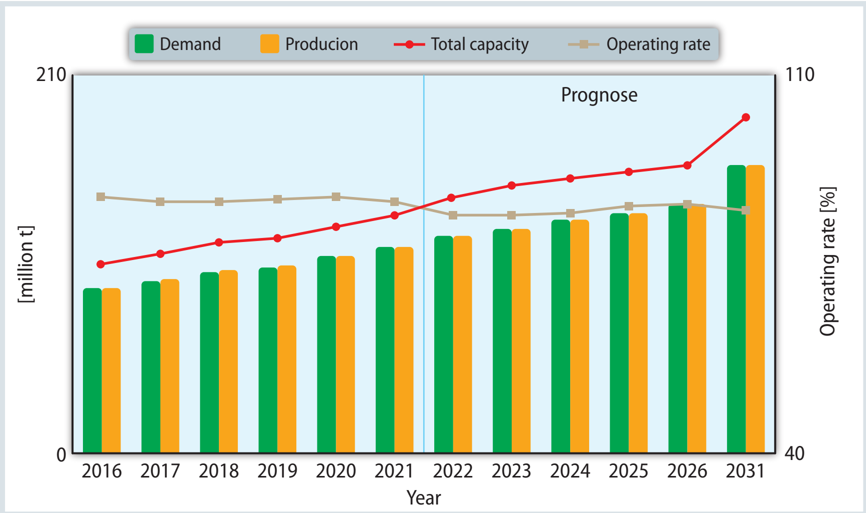

Fig. 3. PE capacities as well as demand will presumably grow uniformly.
Source: Chemical Market Analytics by Opis, a Dow Jones company; graphic: © Hanser

type. The shredded, largely unmixed PE is then cleaned, melted down, extruded for granulation, and used again as regranulate for consumer goods that are not subject to more stringent regulations, such as food approvals or medical applications.

There is a big interest in the valorization of single use plastics and packaging. The switch to such a circular value chain is expected to significantly reduce plastic packaging waste. A notable example of how this can be done is the cooperation between the waste management company Veolia and the Polyolefin manufacturer LyondellBasell. Together, the two companies operate the joint venture QCP (Quality Circular Products), which involves the production interface between the collection and processing of plastic waste and the marketing and sale of this unconventional product category.

High Usage of Recyclates through Improved Sorting and Cleaning

The same strict specifications regarding product safety are applied to recyclates as to comparable virgin materials. This requires constantly improving sorting and cleaning processes, which will ensure that the addressable market for mechanical recyclates will increase significantly in the coming years. One example of this is the use of such materials in cosmetics packaging. Here, the industry consortium Cospatox, which brings together companies along this value chain, is working on the creation of scientifically sound criteria and processes that will allow the safe use of recyclates. Optimized sorting and cleaning processes also allow the use of raw material streams that would not be accessible to mechanical recycling with previous technologies. In addition, the industry is looking for solutions that simplify recycling. Examples include the replacement of composite films made from a range of plastics with mono-material solutions or a new generation of tube packaging in which the tube body, shoulder and cap are made from PE and can therefore be recycled without further separation.

A logical next step would be the use of PE post-consumer recyclate in food applications. However, it will be crucial for value chain collaboration to be in » place to overcome the challenges inherent in using PCR materials in highly regulated applications.

Chemical Recycling – the Next Step towards a Closed-Loop Economy

PE products produced by mechanical recycling have their limits, either because of their quality compared to conventional polyethylene, or because of regulations that do not allow the use of mechanically recycled products for certain applications. This is where chemical recycling comes into play. Chemical recycling is characterized by the fact that polymer chains are converted back into hydrocarbon molecules via a pyrolysis process and sometimes by using suitable catalysts, which in turn can be used in crackers as a naphtha substitute. This achieves many objectives simultaneously. The use of virgin crude oil is reduced and at the same time plastic waste is reduced without loss of the quality level and approval status of the polyethylene finished products produced. Drop-in products manufactured in this way can also be used for articles that have to meet very high hygiene requirements.

Europe has played and continues to play a pioneering role in the development of new process technologies for the production of PE. At the same time, Europe's engineering spirit is going into application development with this raw material. It can be assumed that Europe will also remain true to its pioneering role in the field of sustainability and set new standards that are successfully met with the help of process technologies developed in Europe. Analogous to conventional PE polymerization processes, it can be assumed that European de-polymerization processes will not only make their necessary contribution to addressing the issue of plastic waste within Europe but could also be marketed or licensed outside Europe.

Fig. 4. Trenchless pipe laying is less energy and work intensive than conventional methods. It is also suitable for installing high-voltage power cables, e.g. during the change in energy distribution to decentralized supplies. © Gerodur MPM Kunststoffverarbeitung

Pioneer Europe

Europe sets quality standards in many application areas that are rapidly spreading internationally. At the same time, the European Union sets regulatory frameworks that lead the way and continually tests them. Environmental and chemical regulations are often the toughest in the world and are becoming increasingly more stringent. There are both risks and opportunities in this approach. Risks in that regulatory conditions make the development and marketing of products more difficult; opportunities in that new products and applications are created through development work, which can also open up new business areas. The following are examples of current significant developments that will have an impact on and change the PE business area from a regulatory perspective.

In the field of PE pipe systems, materials with particularly high stress crack resistance, the so-called PE 100 RC types, were included in the European standard for gas pipe materials for the first time; a corresponding extension of the standard for drinking water materials and a transfer to the ISO standards is expected soon. This confirms the trend towards more robust materials that are designed in particular for the requirements of unconventional installation (**Fig. 4**). These methods, for example trenchless pipe laying, are often superior to conventional methods when it comes to the energy and efforts invested in the laying of pipes, demonstrating a clear sustainability gain to which these innovative PE materials contribute.

Trenchless Laying for the Energy Turnaround

PE-based pipe systems also play an important role in the field of alternative energy supply. Within the framework of the energy

Fig. 5. Instead of fuel tanks, PE is used e.g. for parts of the batteries of electric vehicles.

© Adobe Stock; NVB Stocker

transition, at least 80 % of electricity supply is to come from renewable energies by 2050. In order to ensure a stable and secure power supply in the future, the power grids must be adapted to meet the changed generation structure. Because of more decentralized power generation, underground high-voltage distribution networks are necessary. High-performance direct current lines (up to 525 kV), which are laid as underground cables, play a decisive role here. The high-voltage cables used place special demands on the insulation materials, and in addition to special compounds, synthetic materials based on cross-linked PE (XLPE) are getting established in this application.

The cables also require cable protection pipes that can withstand temperatures around 70 °C for a long service term. To facilitate the replacement, the underground cables are often laid with the help of cable protection pipes made of HDPE. The use of such pipes also allows the cables to be easily replaced at the end of their service life without having to carry out earthworks again.

Suitable for Hydrogen

Another high profile topic in connection with the energy transition is the use of hydrogen, both in industrial applications and as a possible substitute in household energy supply. Investigations into the use of PE pipes in hydrogen supply have shown that PE is chemically inert to hydrogen and is therefore in principle also suitable for hydrogen transport. Further studies on this topic are in progress, e.g. to evaluate the permeation properties of PE.

The electrification of the power train of automobiles will continue to progress, and hybrid-electric vehicles are also included in this terminology. It is generally assumed by industry experts that between 2030 and 2035, the share of electric vehicles will predominate the market. In the case of PE, the elimination of carbon containers is offset by the use of battery separator films. PE is therefore not going out of fashion in spite of different technologies and thus required life cycles in the automobile (**Fig. 5**).

Packaging – Tethered Caps and Mono-Materials

The Single-Use Plastics Regulation (EU) 2019/904 will require the tethering of movable components to the packaging base for a number of plastic articles beginning in 2024. This is valid, for example, for bottle caps, so called tethered caps (**Fig. 6**). The reduction of plastic waste envisaged thus requires optimized material distribution to maintain product properties without additional material consumption. LyondellBasell product portfolio provides robust materials for new cap designs. Through optimized strength and stiffness, a variety of "tether" geometries can be realized, which leave nothing to be desired in the area of conflict between design requirements, packaging integrity and user-friendliness.

Flexible multi-material packaging is currently widely used in the packaging industry. It is made of many different types of plastic, which makes recycling difficult. From the point of view of the intended circular economy, multi-material sol- »

utions must be replaced by mono-material structures. This change requires a redesign of the packaging. To improve recyclability, the laminated PET film in the outer layer is to be replaced by a stretched PE film. Accordingly, the bag will then also be recognized as PE during IR sorting. To achieve this, orientation of the PE film is necessary, which can be achieved by using a monoaxial or a biaxial orientation process. Both technologies produce PE film with excellent mechanical and optical properties, comparable to the properties of multi-material packaging.

Due to the trend towards mono-material packaging solutions, so-called aluminum barriers are being replaced by plastic laminate barriers. With special PE materials, the requirements for high strength and toughness can be balanced and the laminate can be reduced in its dimensions, so that the amount of plastic waste is reduced. These new barrier solutions can be used primarily in product applications such as cosmetics, body care, oral care or food packaging.

Polyethylene – a Material for the Future

While the market in North America and China is driven by increasing demand and capacity expansion, alternative raw materials and regulations are opening up new areas of application in Europe. It remains exciting to see how the availability of renewable raw materials and recyclates, as well as the refinement of new production technologies, to make products easier to recycle and introduce back into the value chain, will continue in the coming decades. The pandemic years have shown that polyethylene is and will remain a crisis-proof material which is resilient in changing market conditions. ■

Fig. 6. Sealing covers firmly attached to the product, so-called tethered caps, will be compulsory, e.g. for bottles, from 2024 onwards. This requires an adaptation of design and materials to prevent excessive waste of material. © United Caps

Info

Text

Dr.-Ing. Ugur Akgün is Head of Application Development & Technical Service, Polyethylene Europe, at LyondellBasell.
Michael Berger is Director PE Specialties, Polyethylene Europe, at LyondellBasell.
Dr. Patrik Schneider is Associate Director R&D, Polyethylene Product Development and Circular Design EU, LyondellBasell.

References & Digital Version

You can find the list of references and a PDF file of the article at ***www.kunststoffe-international.com/archive***

German Version

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Moretto at the K 2022

New Granulator for Recycling

Technology, sustainability and connectivity will characterize the new Moretto products, which will be exhibited at the K fair in October as the new dosing and feeding solutions for micro molding and small production plants. They are also available for use in cleanrooms. Thanks to their compactness they can be installed as stand-alone solutions or on the IMM.

Recycling in focus: Moretto will present the new granulators of the GMK series which ensure uniform and constant granulation minimizing the dust formation. © Moretto

Among the solutions dedicated to recycling, Moretto will present the new granulators of the GMK series, which ensure uniform, constant granulation while minimizing dust formation. Their small size allows them to be placed next to the processing machine, thus optimizing production space. The implementation of more compact solutions permits increased production rates while reducing energy consumption and noise pollution. The innovations also include the DVM8 volumetric doser, which ensures perfect microdosing.

This is a brief preview of what will be exhibited at the Moretto booth.

Moretto operates in a very complicated business, both for the high level of innovation that characterizes the sector and for the well-known critical issues related to the massive use of plastic products. In spite of this the company has been able to identify a winning strategy, developing solutions with a high technological content that contribute to the progress and optimization of processes in a sustainable way and respect the environment. This has contributed to achieving a prominent position in the sector that is recognized all over the world.

K 2022: Hall 11, booth H56/H66
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