PAGEV

TURKISH AUTOMOTIVE PLASTICS MATERIALS
INDUSTRY FOLLOW-UP REPORT
2017

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FOREWORD

The plastics industry is one of the key drivers of the Turkish economy. With over 10 million tons of production, 40 billion dollars in revenue, 5 billion dollars in direct exports and an annual rate of growth that has consistently exceeded 10% over the last decade, the industry is increasingly a major contributor to the economy. The industry has the second highest production capacity in Europe, and sixth in the world. Staying true to our mission of being the "uniting force" of the Turkish plastics industry, we at PAGEV continue to implement projects that will carry our industry forward.

We rely on scientific, proven data showing how plastics constitute an indispensable part of our lives to solve long-standing issues in the industry in a meaningful way, and we realize that having accurate and reliable information is the largest part of the solution. We keep up the research, collect and compile new data, and publish them in reports. We make our reports and position papers containing valuable information available to all plastics industry representatives and stakeholders, and to public institutions.

We developed a set of reports through long and thorough research, which we hope will contribute significantly to our industry. Expert researchers used accurate and reliable data to determine the current position of the Turkish plastics industry, the problems we all face, and what tangible steps we need to take in order to overcome these issues. We believe that the set of reports and position papers we make available to PAGEV members and all stakeholders will help to shape the world of plastics. It delights us further that our work will enable public authorities to access the most current and accurate data regarding the plastics industry.

By offering these reports in English, we hope that our members will be able to share the true potential of the plastics industry in Turkey with their business partners abroad.

It is our pleasure to present you a compendium of current reports and supplemental information, and I would like to take this opportunity to extend my gratitude to everyone who has helped our industry grow into the driving force that it is today.

Yours sincerely,

Yavuz EROĞLU
PAGEV Chairman

CONTENTS

- EXECUTIVE SUMMARY -

Turkey ranks 7th in the EU countries and 17th in the world in passenger cars production, ranks the first among the EU countries and 8th in the world in commercial vehicle production. The production of vehicles in Turkey is following a different course every year in parallel with the economic conjuncture and the crises that have taken place. In the period covering from 2013 to 2017, annual compound annual growth rate (CAGR) of production is 15.3% in passenger cars, 3% in commercial vehicle and 10.4% in total vehicles.

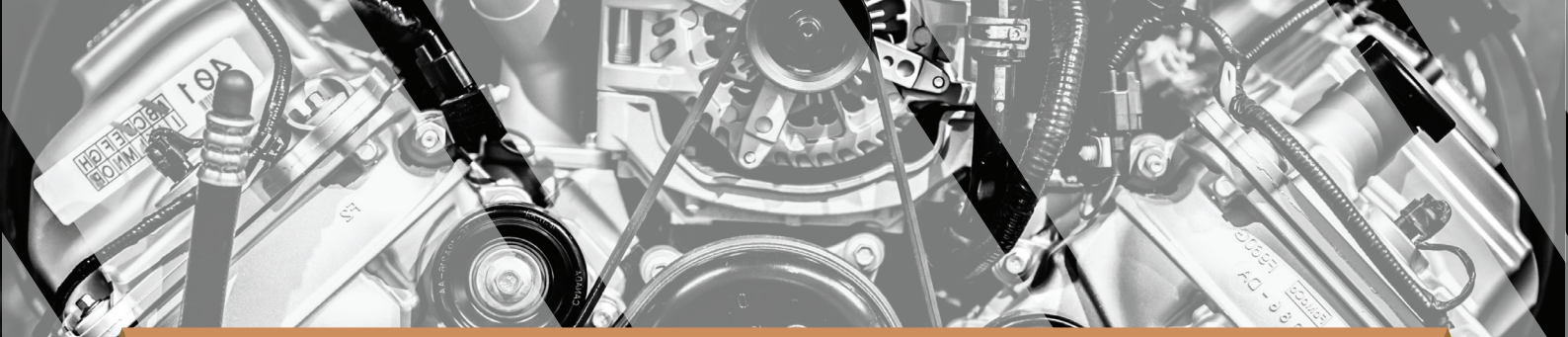
In 2017, a total of 1 million 674 thousand vehicles, including 1 million 121 thousand passenger cars and 553 thousand commercial vehicles have been produced. In comparison with 2016, production increased by 13% in total and 18% passenger cars and 3% in commercial vehicles.

Every day the global automotive industry faces more and more demands from drivers and society. While drivers seek higher performance, superior reliability and safety, more comfort, lower fuel consumption, smarter style and lower prices in the automobiles they want to purchase, social pressures for a more effective environmental protection are on the increase. The only material that meets these contradicting demands optimally and that will shape cars of the future is considered to be plastic.

The percentage of main materials used for the vehicle manufacturing of the entire world between the years 2013-2017 is given in the table below and in 2017, an average of 53.3% of a vehicle's net weight was comprised of steel and 16.9% of metals apart from steel. It is estimated that the share of plastics in a vehicle manufacture which was 9.9% in 2010 to have risen to 12.7% in 2017

Total weight of plastics increased by 53.3% and rubber by 57.7% in 2017 compared with 2013 in Turkish automotive industry requested by the vehicles produced and vehicles in park. As a result of this increase, it is observed that consumption of plastics increased from 328 thousand tons to 503 thousad tons and consumption of rubber increased from 282 thousand tons to 287 thousand tons in the last 5 years.

Plastic usage in the Turkish automotive industry is increasing in parallel with the manufacturing of vehicles apart from the technological developments. Changing according to vehicle production, plastic usage of the Turkish automotive industry comprised over 6% of the total plastic production after 2015 and rose up to 6.8% in 2017.



1. CURRENT SITUATION IN THE TURKISH AUTOMOTIVE INDUSTRY

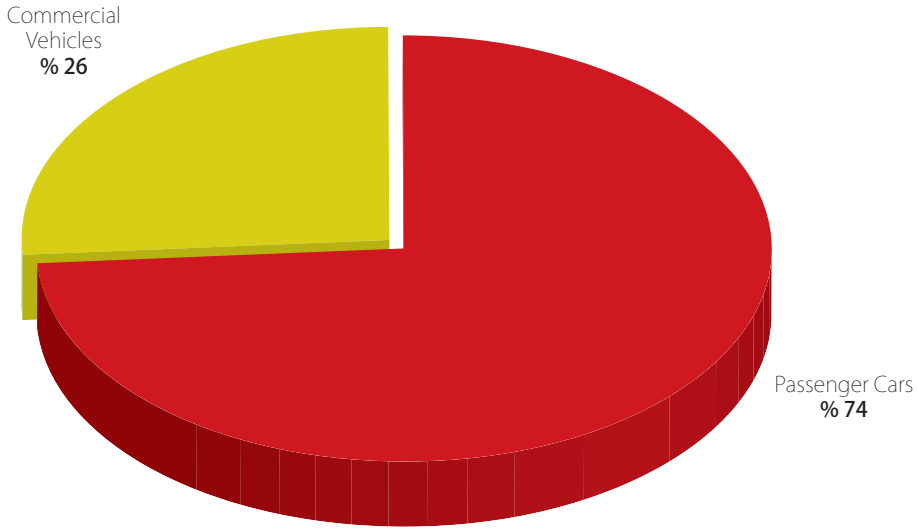
The automotive sector, as it is in the other developed and developing countries, is principally one of the engines, biggest exporter and investor sectors of the Turkish economy. Apart from the added value and employment it provides to the national economy, it is the leading strategic sector of the economy in terms of its impact for advancing the technological development.

Within the Turkish automotive industry, the companies are putting vehicles of different models on the market by domestically manufacturing and importing every year in parallel with the changing preferences of the consumer. As of today, the number of vehicles, commercial vehicles and models that have been put on the market is over 100.

As from the year 2000, the Turkish automative industry selected the manufacturing model based on large scales of vehicle and spare part exports. The structural change which began in the early 2000s and lasted until today within the sector brought upon the international competition conditions in the manufacture of vehicles and sub-industry manufacturing rather than a domestic competition and vehicles and part manufacturing in the automative sector can now be carried out on an international standart.

1.1. PRODUCTION CAPACITY

As of 2017, 13 companies (except farm tructors) are active in the vehicles manufacturing industry and the total production capacity of these companies is at a level to manufacture 1 million 917 thousand,74% of which are passenger cars and 26% are commercial vehicles.



Graphic 1: Production Capacity in Turkish Vehicles Industry
Source: Automotive Manifacturers Association (OSD)

1.2. PRODUCTION

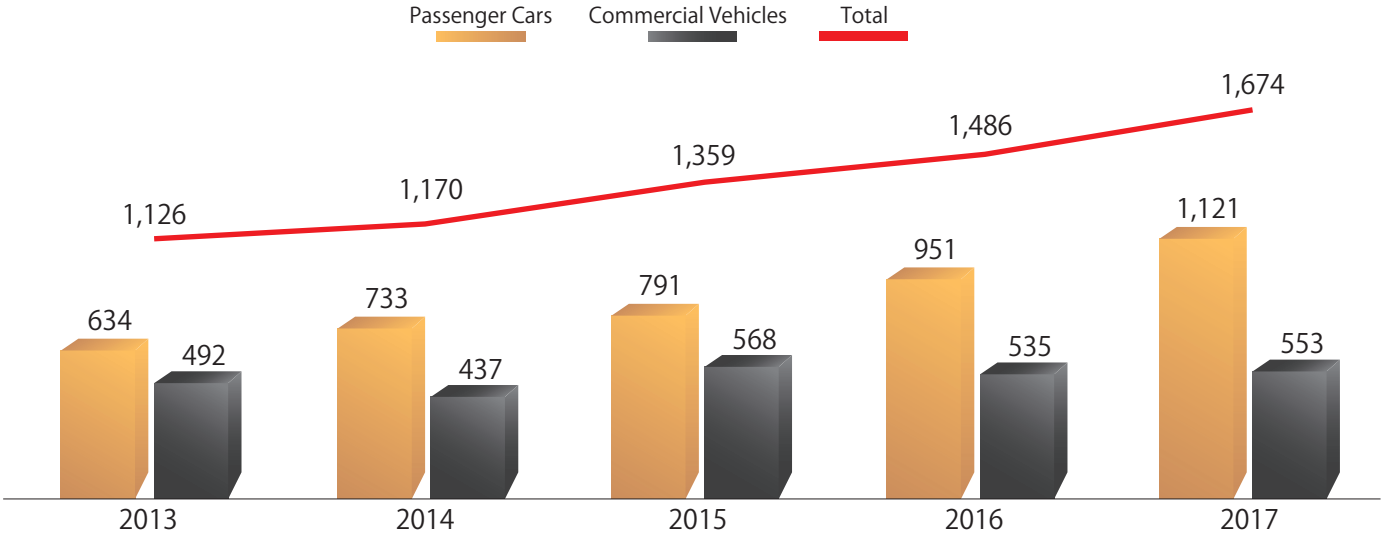
Turkey ranks 7th in the EU countries and 17th in the world in passenger cars production, ranks the first among the EU countries and 8th in the world in commercial vehicle production. The production of vehicles in Turkey is following a different course every year in parallel with the economic conjuncture and the crises that have taken place. In the period covering from 2013 to 2017, annual compound annual growth rate (CAGR) of production is 15.3% in passenger cars, 3% in commercial vehicle and 10.4% in total vehicles.

In 2017, a total of 1 million 674 thousand vehicles, including 1 million 121 thousand passenger cars and 553 thousand commercial vehicles have been produced. In comparison with 2016, production increased by 13% in total and 18% passenger cars and 3% in commercial vehicles.

1. CURRENT SITUATION IN THE TURKISH AUTOMOTIVE INDUSTRY

	2013	2016	2017	CAGR % 2013-2017	% Increase 2017/2016
Passenger Cars	634	951	1,121	15.3	18
Commercial Vehicles	492	535	553	3.0	3
Total	1,126	1,486	1,674	10.4	13

Table 1: Vehicles Production (1000 Units)
Source: Automotive Manifacturers Association (OSD)



Graphic 2: Vehicles Production (1000 Units)
Source: Automotive Manifacturers Association (OSD)

A total of 1 million 363 thousand vehicles were produced in Turkey between 2013 and 2017, with an average of 846 thousand passenger cars and 517 thousand commercial vehicles per year. In this period, 62% of total production and 38% of commercial vehicles were commercial vehicles.

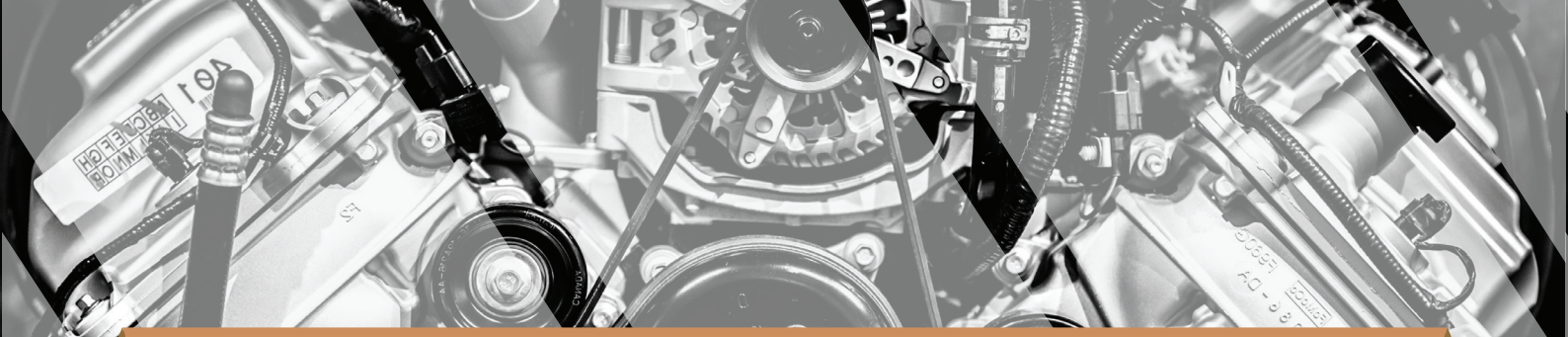
1.3. FOREIGN TRADE

1.3.1. IMPORTS

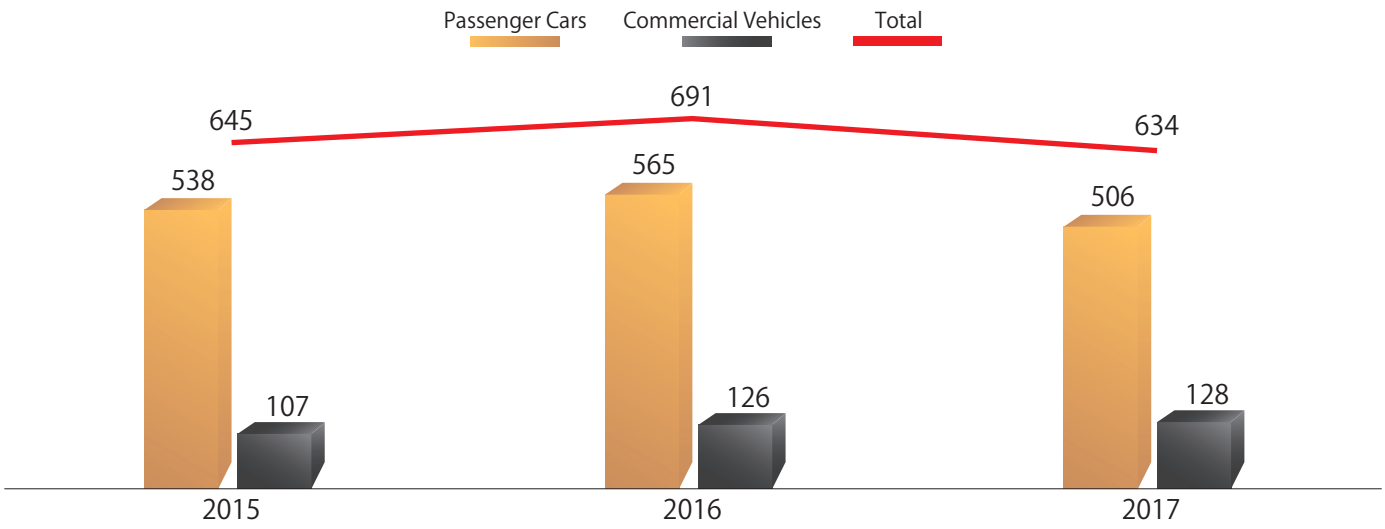
Imports increase in vehicles shows significant changes over the years. After the Customs Union integration in 1996, imports of motor vehicles increased rapidly. Between 2013 and 2017, annual average rate of decrease in imports of passenger cars is 0.6% while 7.9% increase in commercial vehicles and 8.3% increase in total. In 2017, a total of 634 thousand vehicles, 506 thousand of which are passenger cars and 128 thousand are commercial vehicles, were imported. In comparison with 2016, imports decreased by 10% in passenger cars, 8% intotal while inceased 2% in commercial vehicles.

	2013	2016	2017	CAGR % 2013-2017	% Increase 2017/2016
Passenger Cars	518	565	506	-0.6	-10
Commercial Vehicles	106	126	128	4.8	2
Total	624	691	634	0.4	-8

Table 2: Vehicles Imports (1000 Units)
Source: Automotive Manifacturers Association (OSD), TurkStat



1. CURRENT SITUATION IN THE TURKISH AUTOMOTIVE INDUSTRY



Graphic 3: Vehicles Imports (1000 Units)
Source: Automotive Manifacturers Association (OSD), TurkStat

1.3.2. EXPORTS

Important structural changes took place in the automotive sector following the 2000s. Foreign partners of manufacturing companies selected Turkey as their manufacture and exportation center which will meet the demands of global markets for some of the models and Turkey became one of the cornerstones of world manufacture and exportation center for sedan automobiles and commercial vehicles. This change in the manufacturing industry of vehicles positively affected the automotive sub-industry and many automotive sub-industry companies started to become the alternative supplier of global vehicle manufacturers.

As a result of key and sub-industry global manufacturers selecting Turkey as a manufacturing center, great progress was also made within the sector in terms of technology and Turkey came to be regarded as an economic manufacturing and exportation center for many of the brands, models and accessories and spare parts of these models.

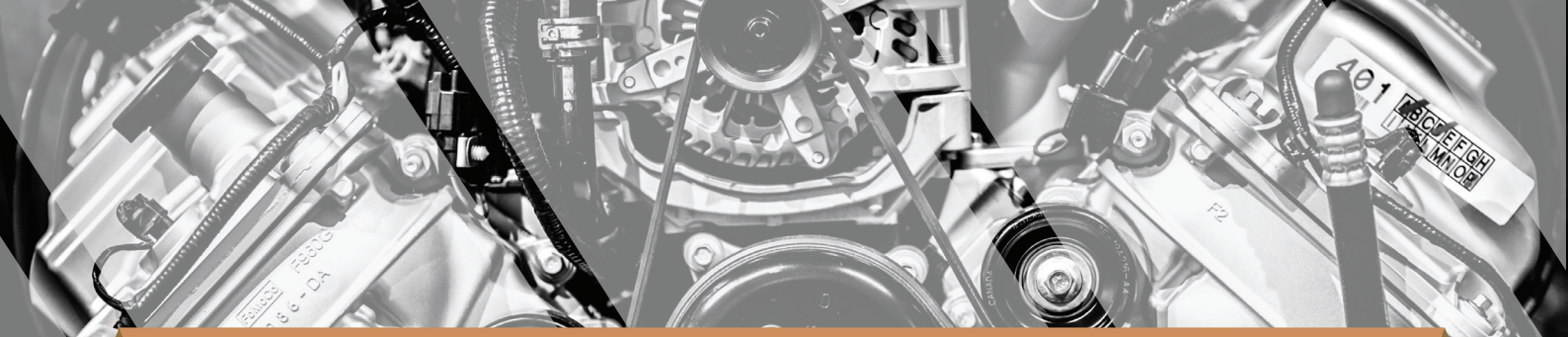
The exports in automotive industry rapidly increased together with the extensive development in the integration process with the EU countries. As a consequence of the new investments made by the automotive sector, close to 60% of its manufacture became exportable.

Keeping in mind that it changed by years, the compound annual growth rate of exports between the years 2013-2017 was 17.49% for passenger cars, 4% for commercial vehicles and 12.4% for the total vehicles.

In 2017, a total of 1 million 323 thousand vehicles, 921 thousand of which are passenger cars and 402 thousand are commercial vehicles, were exported. In comparison with 2016, exports increased by 23% in passenger cars, 1% in commercial vehicles and 16% in total. In 2017, 79% of vehicles produced domesticaly are exported.

	2013	2016	2017	CAGR % 2013-2017	% Increase 2017/2016
Passenger Cars	485	746	921	17.4	23
Commercial Vehicles	344	397	402	4.0	1
Total	829	1,143	1,323	12.4	16

Table 3: Vehicles Exports (1000 Units)
Source: Automotive Manifacturers Association (OSD), TurkStat



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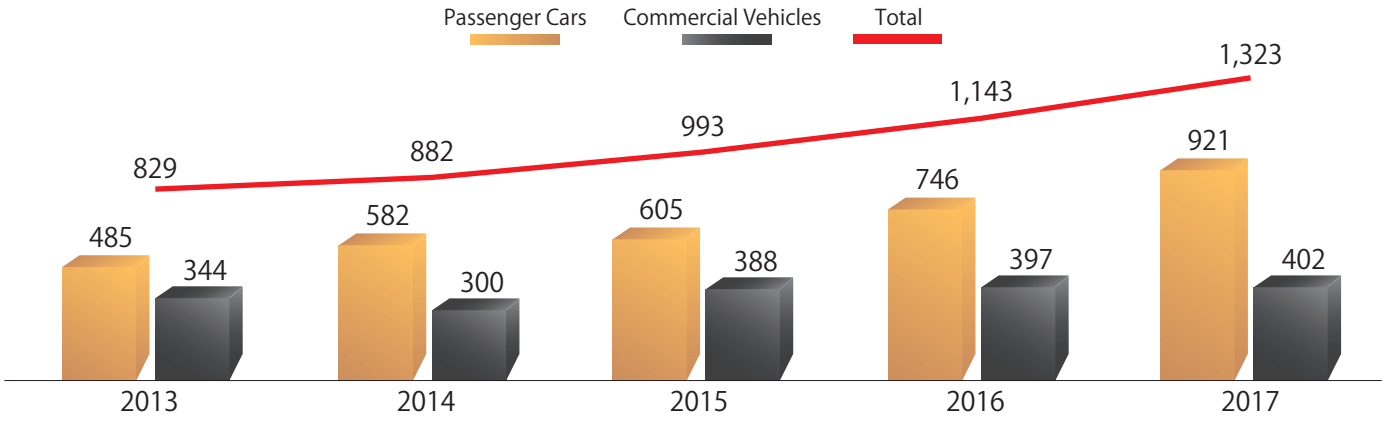


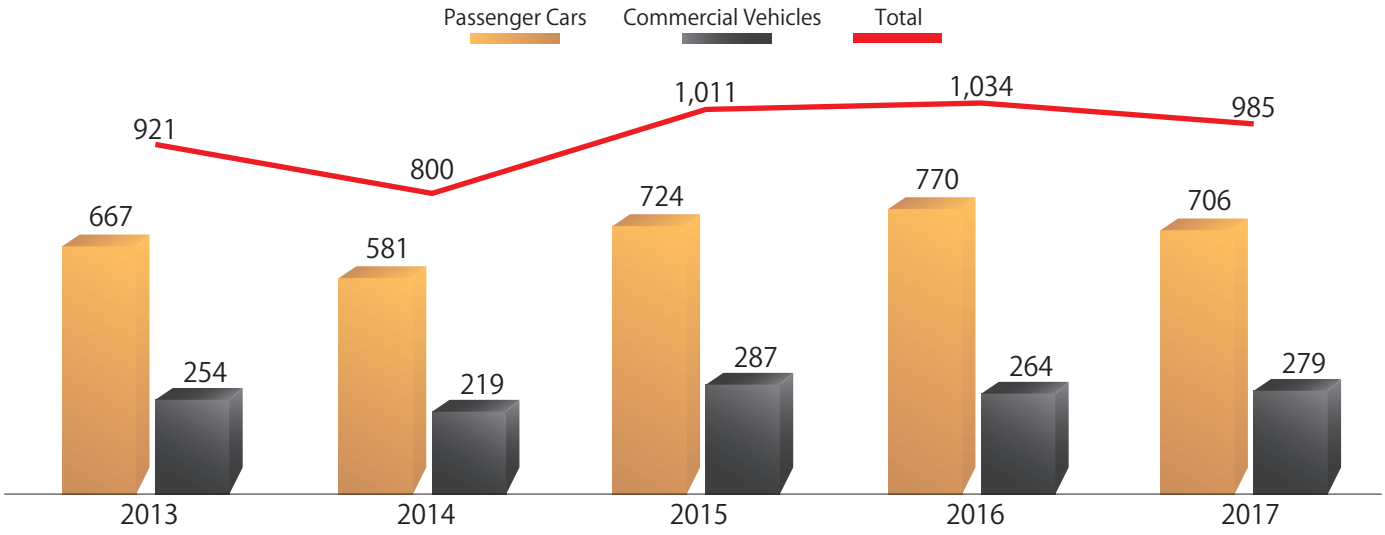
Graphic 4: Vehicles Exports (1000 Units)
Source: Automotive Manifacturers Association (OSD),TurkStat

1.4. DOMESTIC SALES

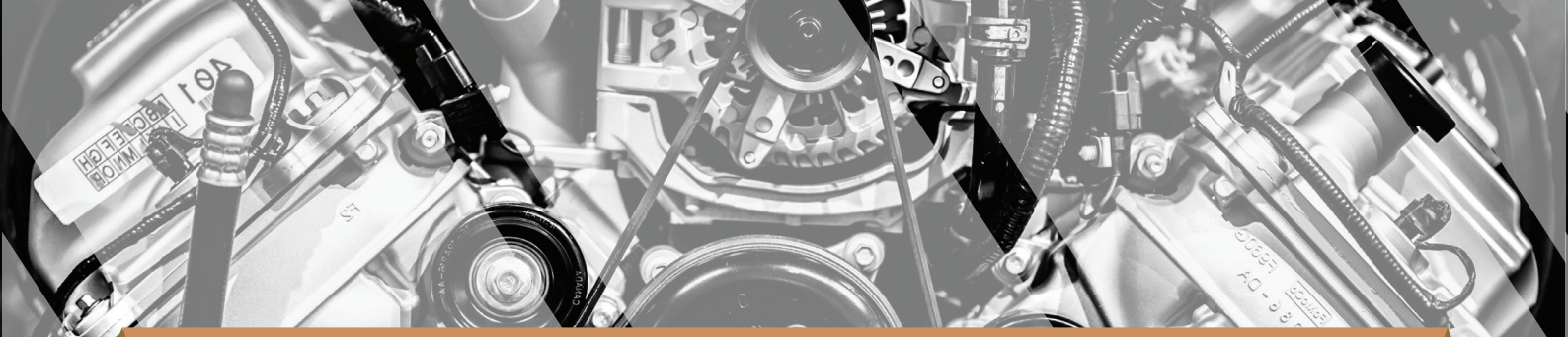
The domestic market demand for vehicles progressed in a different manner in parallel with the economic conjuncture by years. However, it is observed that a 1.4% compound annual growth rate (CAGR) occurred in passenger cars, 2.4% in commercial vehicles and 1.7% in total between the years 2013-2017. In 2017 domestic sales realized as 706 thousand in passenger cars, 279 thousand in commercial vehicles and 985 thousand in total, decreasing by 8% in passenger cars 5% in total whereas 6% increase in commercial vehicles.

	2013	2016	2017	CAGR % 2013-2017	% Artış 2017/2016
Passenger Cars	667	770	706	1.4	-8
Commercial Vehicles	254	264	279	2.4	6
Total	921	1,034	985	1.7	-5

Table 4: Domestic Consumption For Vehicles (1000 Units)
Source: Automotive Manifacturers Association (OSD), TurkStat



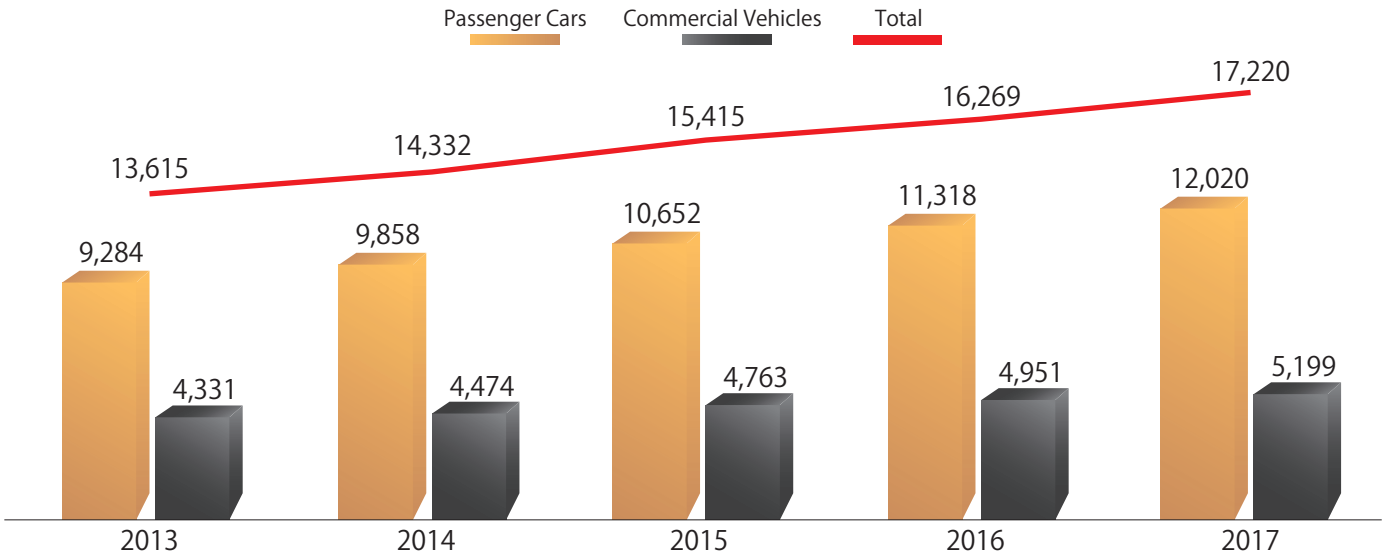
Graphic 5: Domestic Consumption for Vehicles (1000 Units)
Source: Automotive Manifacturers Association (OSD), TurkStat



1. CURRENT SITUATION IN THE TURKISH AUTOMOTIVE INDUSTRY

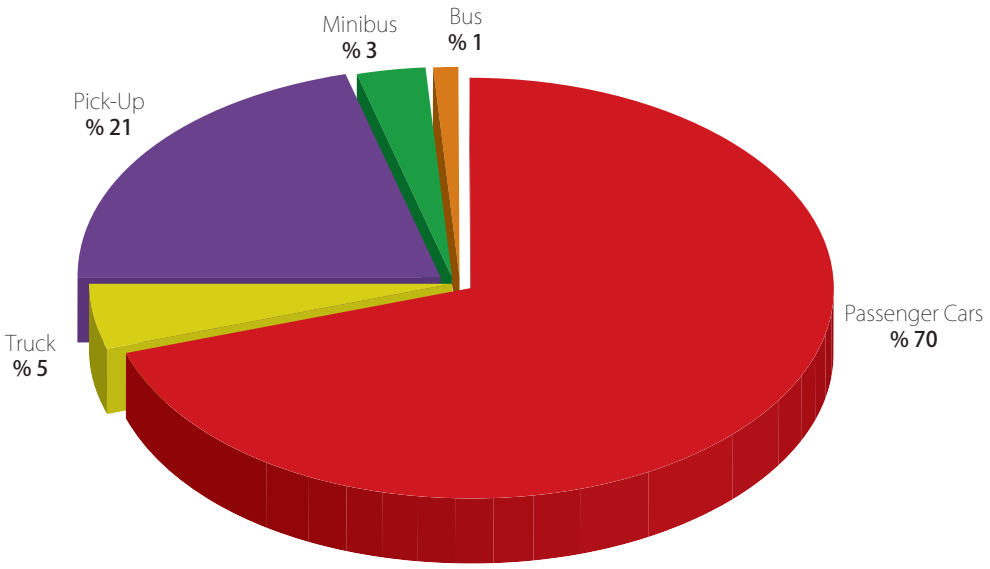
1.5. VEHICLE PARK

Parallel to the increase in domestic sales, the car park is also rapidly increasing. The increase in the number of parks positively affects the sales of all materials, including plastics used in the automotive industry, and therefore the production. The compound annual growth rate (CAGR) of the park between 2013 and 2017 was 6.7% in passenger cars, 4.7% in commercial vehicles and 6% in total vehicles. As of the end of 2017, there are a total of 17.2 million vehicles in the park, including 12 million cars and 5.2 million commercial vehicles.

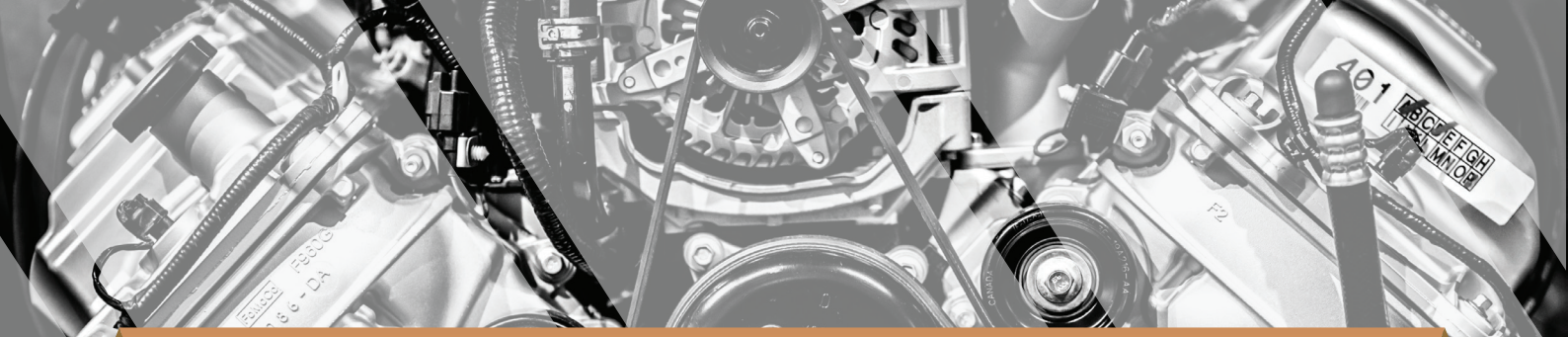


Graphic 6: Developments in Vehiclec Park (1000 Units)
Source: Automotive Manifacturers Association (OSD), TurkStat

As of 2017, 70% of the total vehicles park is made up of passenger cars, 21% of pickups, 5% of trucks, 3% of minibuses and 1% of buses.



Graphic 7: Share of Vehicles In Total Park
Source: Automotive Manifacturers Association (OSD), TurkStat



1. CURRENT SITUATION IN THE TURKISH AUTOMOTIVE INDUSTRY

1.6. SUPPLY AND DEMAND

In the Turkish vehicles industry, the compound growth rate between 2013 and 2017 was 10.4% in production, 0.4% in imports, 12.4% in exports and 1.7% in domestic sales. In 2017, 79% of production was exported and 64% of domestic sales are covered by imports. In the last 5 years covering 2013-2017, 76% of the manufactured vehicles were exported while 67% of the domestic demand was met with imports.

This shows that a production model based on exports is selected in the vehicles industry. The increase in production is realized through export rather than domestic sales, the production in the sector carries the risk of external dependency and the share of imports in domestic sales is also very high.

	2013	2016	2017	CAGR % 2013-2017	% Increase 2017/2016
Production	1,126	1,486	1,674	10.4	13
Imports	624	691	634	0.4	-8
Exports	829	1,143	1,323	12.4	16
Domestic Sales	921	1,034	985	1.7	-5
Exports/Production (%)	74	77	79		
Imports/Domestic Sales (%)	68	67	64		

Table 5: Supply and Demand Balance in Vehicles Industry (1000 Units)
Source: Automotive Manifacturers Association (OSD), TurkStat

1.7. FUTURE ESTIMATES

Although the size of the domestic market is important for the country's industry as well as the success in the export markets, it is seen that the domestic market does not grow to the expected extent. With the investments made by the automotive sector, it has increased its capacity to the level of producing 1.5 million vehicles. Especially with new incentives, both production capacity and very important projects have started. However, the tax increases that affect the demand structure of the market in the negative direction are regarded as a negative development that narrows the domestic demand for the sector.

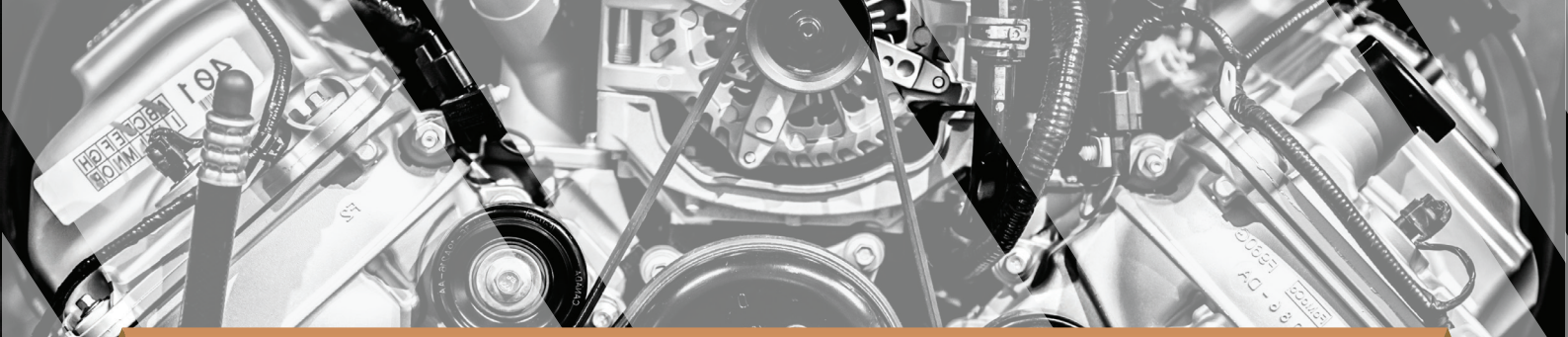
Looking at the 2023 targets, Turkey's target of 4 million requires an increase in production by 2 times. It is expected that the market, which is under pressure and depressed in the conjuncture we are in, will affect 2023 targets in the long run in the negative direction.

Turkey's domestic market, limited to high taxes, is not attractive for new capacity investments. The investments of the global industry, which has an overcapacity problem, are directed towards the BRIC countries, which have a higher demand potential. In this case, a balanced tax system that will expand the demand in the domestic market with the provisions promoting the automotive industry in the State Aid Legislation in Investment is of strategic importance.

Despite the adverse conditions in the world economy, the automotive industry is in the mid-range with the support of the competitive supply chain; continue to work with determination to achieve their strategic goals of being ranked among the top 10 in the world in total production, and the top 3 in the EU.

Implementing policies that will open up the automotive sector will allow for higher growth targets in the sector. It is assumed that vehicle production will continue to increase in 2017-2020 period, 5% for passenger cars and 3% for commercial vehicles.

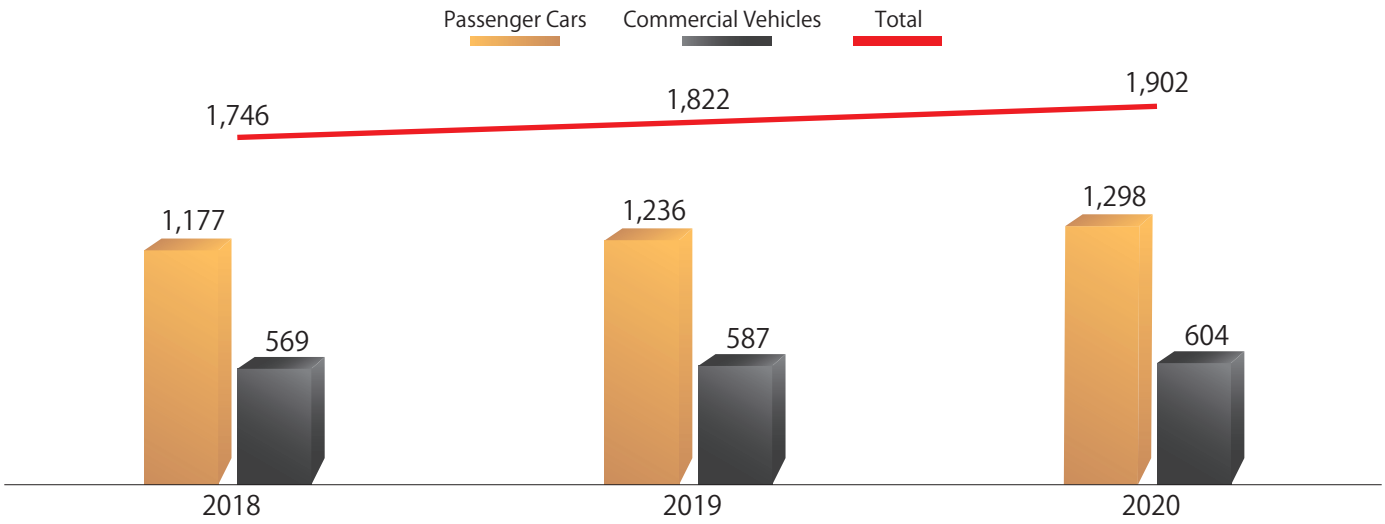
Although, the application of the policies that will open up the automotive industry will enable the higher growth targets in the sector to be realized, in order to see the risks in the estimations of automotive plastic products production, the production of vehicles in 2018-2020 period it is estimated that production will increase 5% in passanger cars, 3% in commercial vehicles. According to this acceptance, it is estimated that the production will reach 1 million 298 thousand in automobile, 604 thousand in commercial vehicle production and 1 million 902thousand in total.



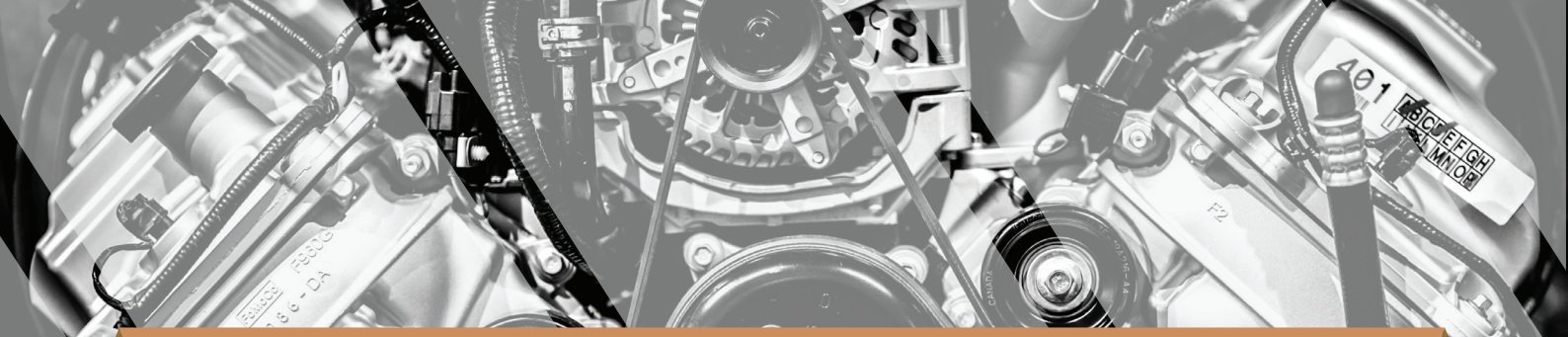
1. CURRENT SITUATION IN THE TURKISH AUTOMOTIVE INDUSTRY

	2018	2019	2020
Passenger Cars	1,177	1,236	1,298
Commercial Vehicles	569	587	604
Total	1,746	1,822	1,902

Table 6: Vehicled Production Estimates (1000 Units)



Graphic 8: Vehicled Production Estimates (1000 Units)



2. PLASTICS USEAGE IN AUTOMOTIVE INDUSTRY

According to EuPC, PlasticsEurope and American Chemistry Council, the automotive industry is facing increasingly new demands. The drivers want to have in their cars;

- Higher performance,
- Greater reliability and security,
- Higher comfort,
- More fuel economy,
- Better style,
- Social pressures are increasing in favor of more protection of the environment while seeking lower prices.

These requests are actually potentially opposite. However, the only material that meets these demands that are contradictory to each other optimally and that will shape the cars of the future is considered plastic. The superior features of plastics that optimize anticipated and contradictory demands on vehicles are;

- It is lighter and stronger.
- Reliable and high security.
- Plastic parts ensure that the balance between safety and lightness is maintained. Without plastic, today's cars will be at least 200 pounds heavier, and as a result, fuel consumption is expected to increase.
- Provides high performance in the vehicle and reduces the cost of production and use of the vehicle.
- Thanks to its versatile and flexible usage, it enables technological innovation and design freedom.
- Complies with higher comfort demands.
- The automotive industry easily meets engineering demands like sophisticated, aesthetic, safety, comfort, fuel efficiency.
- Can adapt to reduce electronic performance cost.
- Positive effects on the environment due to recycling being an easy material.

3. PLASTICS INTERMEDIATE USAGE IN AUTOMOTIVE AREA

It can be seen that the plastics are dominant in the passenger compartment of any car. This is where plastics are more traditionally settled. However, it is also used in control panels, interior trim and upholstery, in plastics lighting, buffer systems, fuel storage and supply systems, ducts, fenders, exterior body panels and increasingly in other parts of the engine compartment or under the bonnet.

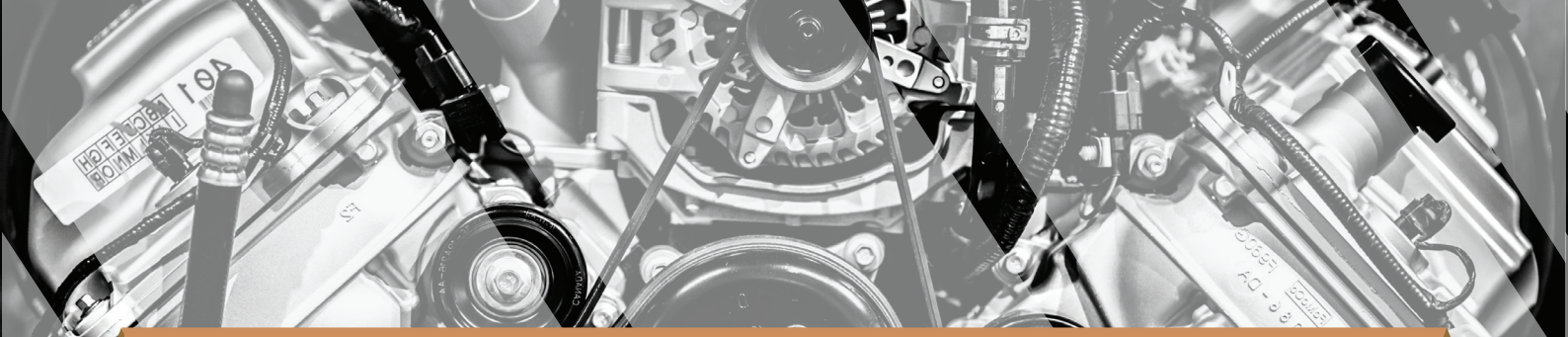
In recent years, plastics have really occupied the under-the-hill region and large molds have been commonly used for air manifolds. They are not only about half the weight of the metal counterparts, but they also help engineers to be more productive by optimally arranging the air flow into the engine, and they also play an important role in reducing noise levels. These glass-reinforced nylon molded parts are extremely sophisticated and show that an era in which plastics are really used as engineering materials.

The use of plastics in the engine compartment is not finished yet. Plastic and automobile engineers are now able to optimize their systems, provide integration of injection and blow molded parts, and provide different properties from "soft" to "hard", but they can be molded in the same or in sequence to achieve a better product without intensive work on the assembly line Plastics and elastomers are in close cooperation to restrain.

Plastics also contribute significantly to the structural character of the vehicles. The intensive development of thermoplastics has opened the way for the production of single body panels by injection molding and the production of electrically conductive glazes for electrostatic painting in order that the paint furnaces used by the automotive industry can withstand the high temperatures.

Structural components such as integrated front modules are also developed from plastic and especially from metal and plastic combinations. This latest development demonstrates the way forward in the future by combining materials to achieve the best performance of each.

Another important development area is fuel systems. This is also the focus of livelihood to save fuel and reduce emissions to the lowest level. It has a longer life cycle than ten years, and is made from fully plastic fuel deposits by blow molding of ultra-high molecular weight high density polyethylene. They are much sharper than single piece metal warehouses with no joints and, at the same time, they provide better design freedom in placing warehouses in difficult places as they can be molded in a good.



3. PLASTICS INTERMEDIATE USAGE IN AUTOMOTIVE AREA

It is estimated that 90% of the new cars produced are plastic warehouses. Development of fuel tanks represents an important indication of the potential of plastics. Initially, the inner surface of the deposits is being processed to reduce the permeability of polyethylene, and is now manufactured by multilayered depressurized molding, which includes a high-barrier polymer layer and connecting layers to connect it to the inner and outer layers, in order to meet more stringent emission requirements, especially in the USA.

A sixth layer is often added in order to reuse the wastes generated during manufacturing. Multi-layer extrusion technology is increasingly used in the manufacture of plastic fuel tubes in order to reduce the permeability to near zero and, where appropriate, to provide electrical conductivity. The next stage will be the integration of the total fuel system to be designed as a complex unit.

Thermosetting reinforced resins have an important role to play. Although there is almost fifty years of experience in the use of glass fiber reinforced resins in body manufacturing, this has been limited to the nature of the material required for low-volume manufacture (with sports cars and special production). Recently, however, major steps have been taken to develop processes for molding fiber-reinforced polyesters and polyurethanes at practical serial manufacturing levels, and the volume of external body panels and buffer systems made from these hardening materials is increasing.

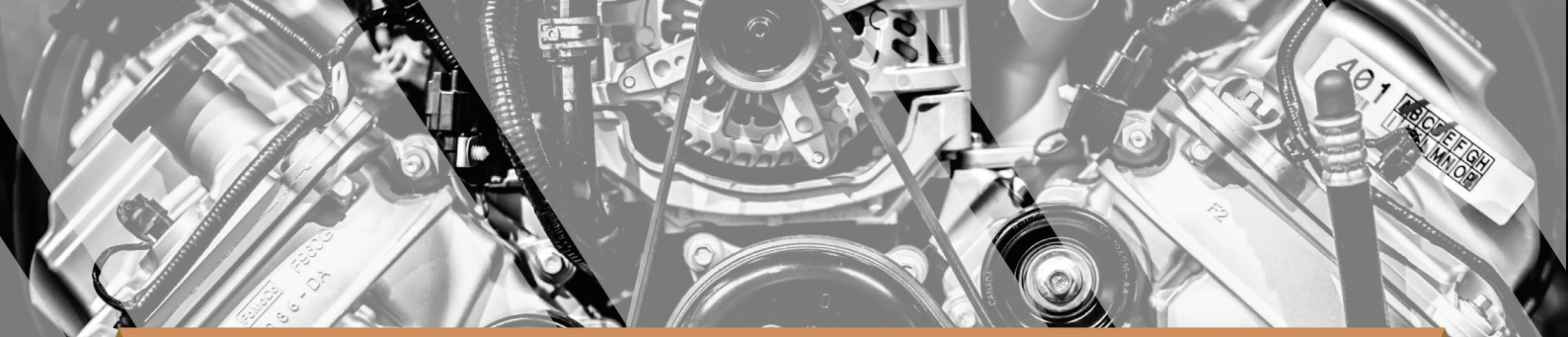
Computer-aided design and manufacturing systems ensure that a project is "concurrently designed" by all participants. Driver and passenger "cockpit" modules, complex doors, air control systems and fuel systems are now being developed by giant corporations.

The versatility of the plastics and the advances in plastic technology make it possible to use shapes and shapes in the advanced level without sacrificing the safety, comfort or stability of a car. For this reason plastics are becoming very attractive materials for designers. The strength and durability of these materials also extend the average life span of a car by more than 12 years, providing better protection against corrosion.

Thanks to their strength and impact resistance properties, plastics provide basic safety features for bumpers, from shock-absorbing to airbags, side impact protection and seat belts. The plastics that take up the windows and the headlight glass provide 250 times more power than the glass.

Plastics have begun to replace conventional materials in flap bodies, and some companies are now beginning to lead the development of polyetherimide flap nets, which are 40 percent lighter than aluminum equivalents and cost 40 percent less.

Vehicle manufacturers can reduce vehicle assembly times and costs by using plastics. In the past, bumpers, fenders and control panels made from conventional materials that require the manufacture of many parts and the assembly of these parts can now be formed into one piece. Technological innovations mean that in modern vehicles an increasing number of lighter, thinner but stronger plastic parts are used.



4. ENVIRONMENTAL EFFECTS OF USING PLASTICS IN THE AUTOMOTIVE SECTOR

The use of plastics in vehicle design that use less to do more work (minimizing resource use) helps to minimize the environmental impact and save resources. The real challenge for both the automotive industry and the plastics suppliers is to work together to develop new equipment that not only fulfills cost/performance requirements but also facilitates easier disassembly and recycling.

Today, the tools are at the beginning of the list of recyclable durable goods. More than 75 percent of the weight of an average car is reprocessed, which is more than any other product. Legislation can have a positive impact on promoting even higher levels of reprocessing. However, over-emphasizing reprocessing reduces optimal environmental recovery by not fully exploiting all existing recovery paths.

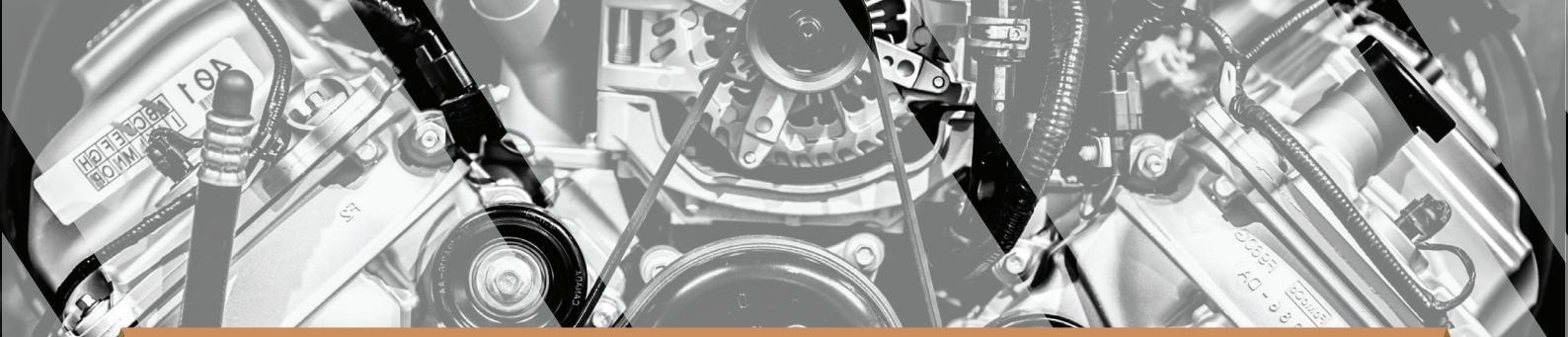
In addition, the proposed reprocessing objectives and the deadlines for responding to these challenges need to be carefully considered. New automobiles are being designed with more detailed information about potential recycling techniques, with increasing recycling in mind.

The collection and disassembly of complex sub-equipment of a car is certainly not difficult, though it is difficult. At the same time, it has also been shown that plastics only provide more effective ways of recovery than mechanical recycling of materials. Techniques are being developed that allow the separation of mixed plastics into new plastics that can be chemically separated to be reformulated.

Despite their widespread use, the natural resources required to manufacture automotive plastics represent only 0.3 percent of global petroleum consumption. At the same time, a significant weight saving is achieved with the use of plastic. In a modern automobile, about 100 kg of plastic takes 200 to 300 kg of traditional material. When all other factors are equal, this reduces the fuel consumption of an average car by 750 liters at a lifetime of 150,000 kilometers. The calculations show that oil consumption in Western Europe is reduced by 12 million tonnes per year and consequently CO_2 by 30 million tonnes per year.

In addition to selecting plastics for their automotive design and performance benefits, manufacturers are increasingly opting for these materials because of their environmental benefits and sustainable development. Thus resources can be used for future generations without restricting economic, social and environmental options.

As plastics find more solutions to automotive design and security problems and create new technological opportunities, their presence in the automotive waste stream is growing. The plastics industry understands the need to improve the recovery of automotive plastic parts in order to make the best use of such a valuable source. The aim of the business is to get the best combination of recycling options to maximize the environmental benefit for the community at the lowest cost.



5. EXPECTATIONS IN DEVELOPMENTS IN THE USAGE OF PLASTICS IN AUTOMOTIVE INDUSTRY

Looking to the future, plastics will begin to play an increasingly indispensable role in the manufacture and use of fuel cells. This is a new development designed to produce the power to run electric cars. The versatility and flexibility of the plastics will support the trend of manufacturing many different automobiles on the same chassis and core set in the automotive industry and thus reducing the retail price during the research and evelopment period.

With lightweight plastics, going 50 kilometers with one liter of fuel will soon be possible and today commercialization of electric cars that require just 40 kW instead of the 120 kW needed by a traditional size car may only be possible in a few years. As we move towards the next century, hybrid motors that supply energy to a car from a variety of sources, such as fuel, plastic-based solar panels, and cellular and fuel-cells that produce catalytically from hydrogen to electricity, will be installed, further reducing CO_2 emissions.

The new plastics are constantly adapted to meet the needs of future electronic cars. Plastics in automotive applications will continue to be found in the desire to make better, safer and cleaner automobiles. The plastics industry will continue to cooperate closely with the automotive industry to meet this challenge by developing technologies and products that will make transportation dreams come true.

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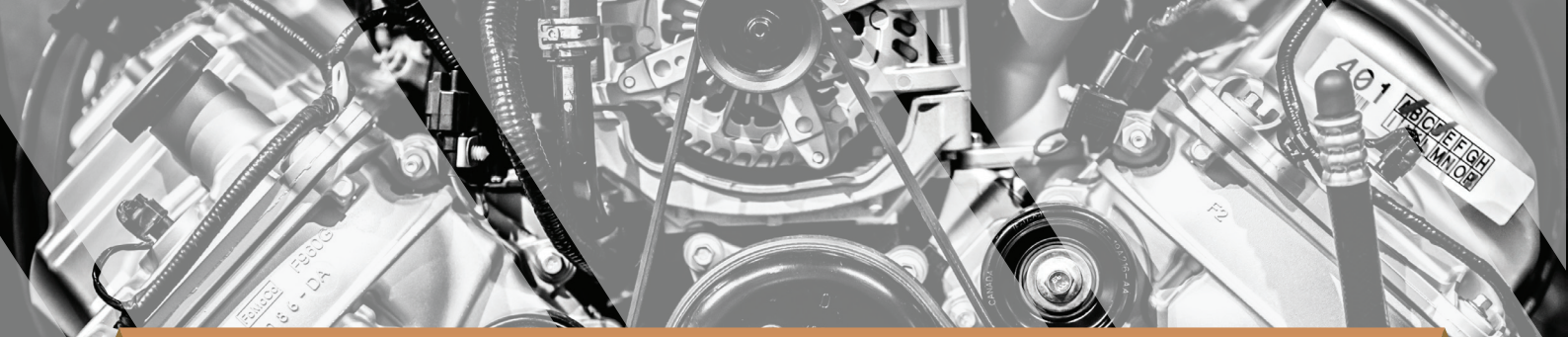
The new plastics are constantly adapted to meet the needs of future electronic cars. Plastics in automotive applications will continue to be found in the desire to make better, safer and cleaner automobiles. The plastics industry will continue to cooperate closely with the automotive industry to meet this challenge by developing technologies and products that will make transportation dreams come true.

Automotive supplier companies in Turkey should also follow the plastic usage trend in automobiles to maintain their future position. It will be possible to produce products for the vehicles of our future to be manufactured in our country, but to follow the technology closely and even to produce technology in these matters.



6. MAIN MATERIALS USED IN THE AUTOMOTIVE INDUSTRY

The percentage of main materials used for the vehicle manufacturing of the entire world between the years 2013-2017 is given in the table below and in 2017, an average of 53.3% of a vehicle's net weight was comprised of steel and 16.9% of metals apart from steel. It is estimated that the share of plastics in a vehicle manufacture which was 9.9% in 2010 to have risen to 12.7% in 2017.

Main Materials	2013	2017	CAGR (%) 2012-2017
Plain steel	36.9	35.3	-1.1
High and Medium Powered Steel	14.2	15.3	1.9
Stainless Steel	1.8	1.8	0.0
Other Steels	0.7	0.6	-3.1
Total Steel	53.6	53.0	-0.3
Iron Casting	4.0	2.8	-8.4
Aluminium	8.8	9.3	1.5
Magnesium	0.3	0.3	0.0
Copper and Brass	1.5	1.4	-2.3
Lead	1.4	1.7	5.7
Zinc Casting	0.2	0.2	0.0
Powder Metal	1.0	1.0	0.0
Other Metals	0.1	0.1	0.0
Metals Apart from Steel	17.3	16.9	-0.6
Total Metals	70.9	69.9	-0.4
Plastics	11.0	12.7	3.6
Rubber	6.1	7.2	4.2
Coating	0.9	1.0	3.2
Textile	1.3	1.4	1.0
Fluids and lubricants	5.2	5.2	0.0
Glass	2.3	2.2	-1.5
Other	2.3	2.4	1.1
TOTAL	100	100	-

Table 7: Consumption of Main Materials Used in the Turkish Automotive Sector (1000 Tons)
Source: American Chemistry Council, TPA Plast Global Engineering

6. MAIN MATERIALS USED IN THE AUTOMOTIVE INDUSTRY

While the share of steel and other materials apart from steel within the total weight of a vehicle decreased by 0.6% and 0.4% respectively between the years 2013-2017, the share of plastics increased 1.7% share of rubber 1.1% and total share of plastics and rubber by 2.8%.

	2013	2017	Diffirence (%)
Steel	53.6	53.0	-0.6
Metals Apart From Steel	17.3	16.9	-0.4
Plastics	11.0	12.7	1.7
Rubber	6.1	7.2	1.1
Plastics + Rubber Total	17.1	19.8	2.7

Table 8: Change in the Rates of Main Materials Used in Vehicle Production (%)

It is observed that by taking average usage rate of materials in vehicles and total net weights of the manufactured vehicles as a basis, the main materials used in vehicle assembly and spare part renovations in Turkey between the years 2013-2017 improved in the manner shown in the table provided below.

	2013	2017	% Increase
Plain steel	1,100	1,351	22.9
High and Medium Powered Steel	423	598	41.4
Stainless Steel	54	69	28.6
Other Steels	21	23	9.9
Total Steel	1,597	2,026	26.9
Iron Casting	1.19	99	-17.3
Aluminium	262	364	38.6
Magnesium	9	11	28.6
Copper and Brass	45	51	14.7
Lead	42	71	69.5
Zinc Casting	6	8	28.6
Powder Metal	30	38	28.6
Other Metals	3	4	28.6
Metals Apart from Steel	516	646	25.2
Total Metals	2,113	2,672	26.4
Plastics	328	503	53.3
Rubber	182	287	57.7
Coating	27	40	50.4
Textile	39	52	35.2
Fluids and lubricants	155	199	28.6
Glass	69	82	19.1
Other	69	93	36.1
TOTAL	2,980	3,928	31.8

Table 9: Consumption of Main Materials Used in the Turkish Automotive Industry (1000 Ton)

6. MAIN MATERIALS USED IN THE AUTOMOTIVE INDUSTRY

Total weight of plastics increased by 53.3% and rubber by 57.7% in 2017 compared with 2013 in Turkish automotive industry requested by the vehicles produced and vehicles in park. As a result of this increase, it is observed that consumption of plastics increased from 328 thousand tons to 503 thousad tons and consumption of rubber increased from 282 thousand tons to 287 thousand tons in the last 5 years.

7. MAIN PLASTIC PARTS USED IN THE AUTOMOTATIVE SECTOR

The average percentage distribution of total plastic usage in vehicle production is based on the following table.

The parts that are most consumed on the basis of amount of plastics in the vehicles are the interior lining and seats.

Plastics Parts	% Share
Interior Trim	9.5
Seat	12.4
Bumper	6.7
Under-Hood	5.7
Others	5.7
Floor	8.6
Front Console	19.0
Electricity	6.7
Fuel Systems	3.8
Chassis	4.8
Illumination	7.6
External Components	1.0
Liquid Tanks	8.6
TOTAL PLASTIC MATERIAL	100.0

Table 10: Share of Plastic Part Weight Per Vehicle in Automotive Industry
Source: American Chemistry Council, TPA Plast Global Engineering

7. MAIN PLASTIC PARTS USED IN THE AUTOMOTATIVE SECTOR

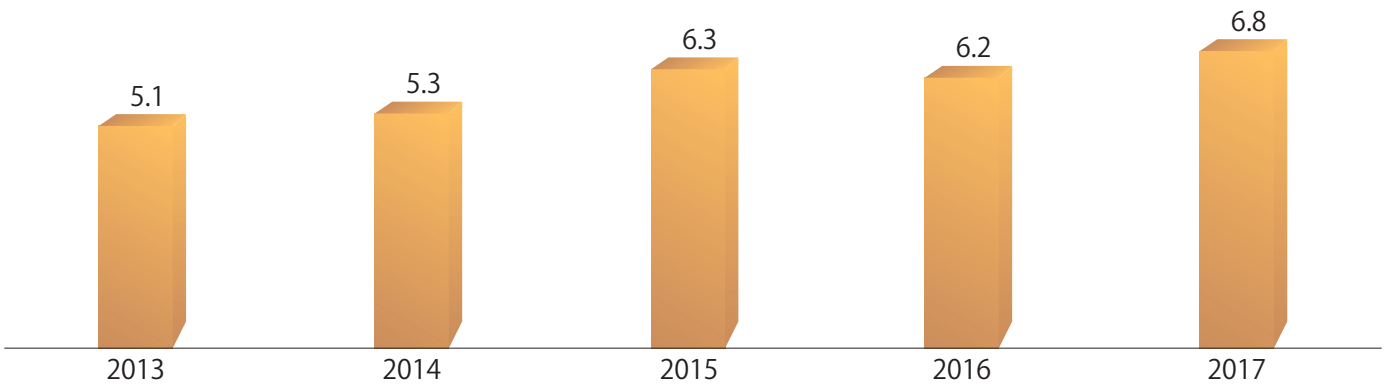
Based on the average usage of parts in vehicle production, the following table shows the development of the plastic parts produced in the Turkish automotive industry between 2013 and 2017 based on quantity.

	2013	2017	Difference 2013-2017
Interior Trim	31	48	17
Seat	41	62	22
Bumper	22	34	12
Under-Hood	19	29	10
Others	19	29	10
Floor	28	43	15
Front Console	62	96	33
Electricity	22	34	12
Fuel Systems	12	19	7
Chassis	16	24	8
Illumination	25	38	13
External Components	3	5	2
Liquid Tanks	28	43	15
TOTAL PLASTIC MATERIAL	328	503	174

Table 11: Plastic Part Production Used in the Turkish Automotive Sector (1000 Ton)

8. SHARE OF PLASTICS USED IN AUTOMOTIVE SECTOR WITHIN THE TOTAL PLASTIC CONSUMPTION

Plastic usage in the Turkish automotive industry is increasing in parallel with the manufacturing of vehicles apart from the technological developments. Changing according to vehicle production, plastic usage of the Turkish automotive industry comprised over 6% of the total plastic production after 2015 and rose up to 6.8% in 2017.



Graphic 9: Share of Plastic Consumption of Automotive Industry in Total Plastic Consumption (%)

9. MAIN PLASTIC RAW MATERIALS USED IN THE AUTOMOTIVE SECTOR

Plastic consumption, which is ever-increasing in vehicle production, also diversifies the plastic raw materials used in the manufacturing of plastic parts. Although more than 10 different plastic raw materials are used in the automotive sector more than 50% of the raw materials consumed are comprised of PP, PUR and PA.

The use of computers to control the motor performance of vehicles creates new areas of application for plastics where metal parts are of no use. While vehicles are gradually becoming more of "electronic" machines and cease to be mechanic, the need for vehicle components which provide temperature and chemical resistance apart from electronic protection is also increasing.

As a consequence of the aforementioned, the demand for thermoplastics is increasing. For example, new engineering plastics such as polybutylterephthalate, aliphatic polyethon and liquid crystal polymers in advanced applications are more increasingly used in extremely challenging applications including connectors and electricity part housings.

Parts	Main Plastics Raw Materials Used
Interior Trim	PP, ABS, PET, POM, PVC
Seat	PP, ABS, PA, PC, PE
Bumper	PUR, PP, PVC, ABS, PA
Under-Hood	PP, ABS, PC
Others	PA, PP, PBT
Floor	PVC, PUR, PP, PE
Front Console	PE, POM, PA, PP
Electricity	PP, PE, PBT, PA, PVC
Fuel Systems	PP, PPE, UP
Chassis	PP, PC, ABS, PMMA, UP
Illumination	ABS, PA, PBE, ASA, PP
External Components	PP, PE, PA

Table 12: Major Types of Plastic Raw Materials Used in The Production of Plastic Parts of Vehicles

9. MAIN PLASTIC RAW MATERIALS USED IN THE AUTOMOTIVE SECTOR

Plastic Raw Material	% Consumption	2017	% Consumption
PP (Polypropylene)	23.3	Other Engineering Plastics	12.0
PUR (Polyurethane)	17.0	Polyacetal	1.9
PA (Nylon – Polyamide)	12.3	PPE	3.8
ABS (Acrylonitrile – Butadiene – Styrene)	7.9	Thermoplastic Polyester	5.7
PVC (Polyvinyl Chloride)	7.0	Other Engineering Plastics	0.6
PE (Polyethylene)	4.4	Other Resins	9.5
PC (Polycarbonate)	4.7	Acrylics	1.5
PBT (Polyvinlyl Butrayl)	2.0	Phenolics	3.1
		Unsaturated Polyester	3.8
		Others	1.1
		Total Plastic Usage	100

Table 13: Plastic Raw Material Rate Used in Automotive Plastic Part Production (%)
Source: American Chemistry Council, TPA Plast Global Engineering

The total consumption amount of plastic raw materials used for automotive plastic part production between the years 2013-2017, in Turkey were calculated in the table provided below by taking the plastic raw material rates used in automotive plastic part production and automotive plastic total consumption as basis.

	2013	2017	Differance 2017-2013
PP	73	112	39
Poliüretan	51	78	27
Naylon	41	63	22
ABS	24	37	13
Polyvinyl Chloride	27	41	14
PE	16	25	9
Polycarbonate	17	26	9
Polyvinlyl Butrayl	6	10	3
Diğer Mühendislik Plastikleri	43.6	66.9	23
Polyacetal	7	11	4
PPE	13	20	7
Thermoplastik Polyester	21	32	11
Diğer Müh. Plastikleri	3	5	2
Diğer Reçineler	29	44	15
Acrylics	4	7	2
Phenolics	11	17	6
Doymamış Polyester	10	16	5
Diğerleri	3	5	2
Toplam Plastik Kullanımı	328	503	175

Table 14: Average Plastic Raw Material Consumption per Vehicle in the Turkish Automotive Sector (kg)

10. MATERIALS CONSUMPTION ESTIMATION IN TURKISH AUTOMOTIVE INDUSTRY

Based on the average material usage rate in vehicles and the estimation of vehicle production and net net weights, the percentage of total consumption of major materials to be used in vehicle production in Turkey between 2018 and 2020 is estimated as follows.

Main Materials	2018	2019	2020
Plain steel	34.9	34.5	34.1
High and Medium Powered Steel	15.6	15.9	16.2
Stainless Steel	1.8	1.8	1.8
Other Steels	0.6	0.6	0.6
Total Steel	52.9	52.8	52.7
Iron Casting	2.6	2.4	2.2
Aluminium	9.5	9.6	9.8
Magnesium	0.3	0.3	0.3
Copper and Brass	1.3	1.3	1.3
Lead	1.8	2.0	2.1
Zinc Casting	.2	0.2	0.2
Powder Metal	1.0	1.0	1.0
Other Metals	0.1	0.1	0.1
Metals Apart from Steel	16.8	16.8	16.9
Total Metals	69.7	69.6	69.5
Plastics	13.1	13.6	14.1
Rubber	7.5	7.8	8.1
Coating	1.1	1.1	1.1
Textile	1.4	1.4	1.4
Fluids and lubricants	5.2	5.2	5.2
Glass	2.1	2.1	2.1
Other	2.4	2.5	2.5
TOTAL	100	100	100

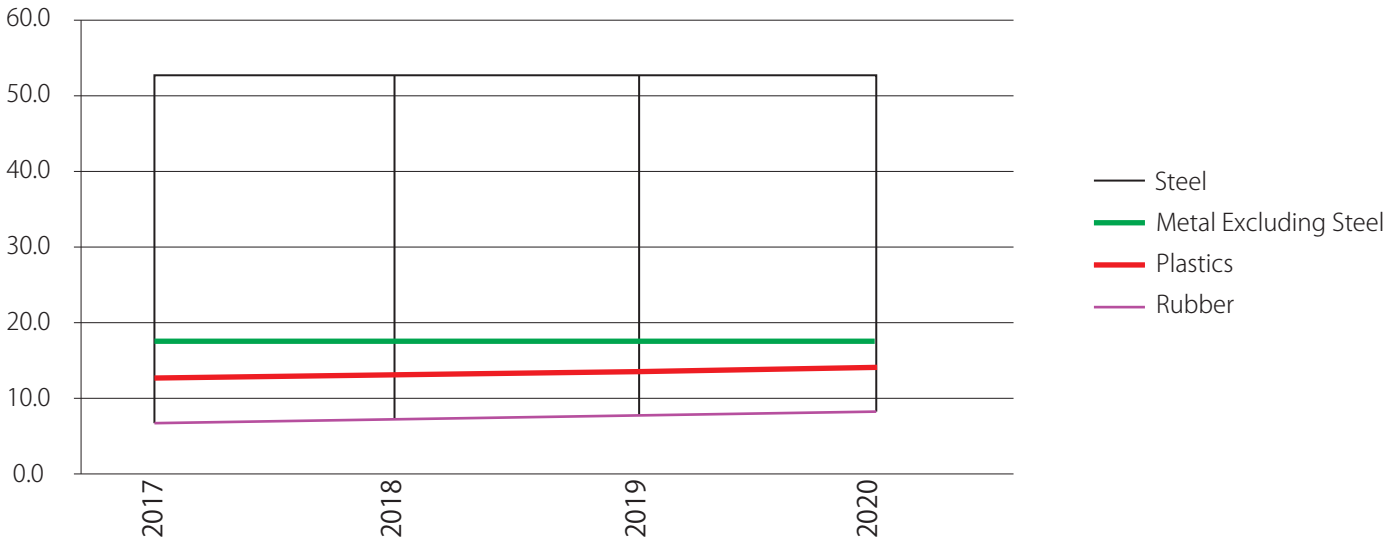
Table 15: Turkish Automotive IndustryPlastic Parts Consumption Rate Estimation (%)

The share of steel within the total material consumption will decrease by 0.2%, metals apart from steel by 0.0% and all materials by 0.2% in 2020 for the Turkish automotive sector when compared to 2017. On the other hand, the share of plastic will increase by 3.5% and of rubber by 4.1%. The share of plastic and rubber within the total material consumption is expected to increase by 3.8%.

10. MATERIALS CONSUMPTION ESTIMATION IN TURKISH AUTOMOTIVE INDUSTRY

	2017	2018	2019	2020	% Differance 2020-2017
Steel	53.0	52.9	52.8	52.7	-0.2
Metals Apart From Steel	16.9	16.8	16.8	16.9	0.0
Plastics	12.7	13.1	13.6	14.1	3.5
Rubber	7.2	7.5	7.8	8.1	4.1
Plastics + Rubber Total	19.8	20.6	21.4	22.2	3.8

Table 16: Changes in the Rates of Materials Used in Vehicles Production (%)



Graphic 10: Changes in the Rates of Materials Used in Vehicle Production

According to the calculations provided above the consumption amount of main materials within theautomotive sector is estimated as to be in the table provided below.

These estimates show that the automotive plastics amount which was 503 thousand tones in 2017, will increase by 16.7% and go up to 587 thousand tons and the rubber on the other hand, will increase by 18%.

	2017	2018	2019	2020	% Fark (2020-2017)
Steels	2,026	2,067	2,128	2,195	8.3
Metals Apart from Steel	646	658	680	703	9.0
Total Metals	2,672	2,725	2,808	2,899	8.5
Plastics	503	513	548	587	16.7
Rubber	287	292	314	338	18.0
Other Materials	467	476	493	512	9.6
TOTAL	3,928	4,006	4,164	4,335	10.4

Table17: Consumption Estimate of Main Materials In the Automotive Sector (1000 Ton)

10. MATERIALS CONSUMPTION ESTIMATION IN TURKISH AUTOMOTIVE INDUSTRY

The amount of plastic parts consumption between the years 2017 – 2020 within the Turkish automotive industry was estimated to be as shown in the table below by taking the average % usage of parts in vehicle production.

	2017	2018	2019	2020	Difference (2020-2016)
Interior Trim	48	48	52	56	8
Seat	62	62	68	73	10
Bumper	34	34	37	39	6
Under-Hood	29	29	31	33	5
Others	29	29	31	33	5
Floor	43	43	47	50	7
Front Console	96	96	104	111	16
Electricity	34	34	37	39	6
Fuel Systems	19	19	21	22	3
Chassis	24	24	26	28	4
Illumination	38	38	42	45	6
External Components	5	5	5	6	1
Liquid Tanks	43	43	47	50	7
TOTAL PLASTIC MATERIAL	503	503	548	587	84

Table 18: Consumption Estimate of Main Materials In the Automotive Sector (1000 Ton)

10. MATERIALS CONSUMPTION ESTIMATION IN TURKISH AUTOMOTIVE INDUSTRY

The consumption of plastic raw materials which will be used for the automotive parts production between the years 2017-2020 in Turkey is estimated to be as shown in the table provided below by taking the rates of plastic raw materials used in the automotive plastic parts production and total consumption estimate of automotive plastics.

	2017	2018	2019	2020	Difference (2020-2017)
Polypropylene	112	114	122	131	19
Polyurethane	78	80	85	92	13
Nylon	63	65	69	74	11
Acrylonitrile – Butadiene – Styrene	37	37	40	43	6
Polyvinyl Chloride	41	42	45	48	7
Polyethylene	25	25	27	29	4
Polycarbonate	26	26	28	30	4
Polyvinlyl Butrayl	10	10	10	11	2
Other Engineering Plastics	66.9	68.2	72.9	78.0	11
Polyacetal	11	11	12	12	2
PPE	20	20	21	23	3
Thermoplastic Polyester	32	32	35	37	5
Other Engineering Plastics	5	5	5	6	1
Other Resins	44	45	48	52	7
Acrylics	7	7	7	8	1
Phenolics	17	17	19	20	3
Unsaturated Polyester	16	16	17	18	3
Others	5	5	5	6	1
Total Plastic Raw Material	503	513	548	587	84

Table 19: Plastic Raw Material Consumption Estimate of the Turkish Automotive Sector (1000 Ton)

It is estimated that in 2020 the Turkish automotive industry will consume at least 587 thousand tons of plastic raw materials and the consumption of plastic raw materials will increase by 16.7% compared to 2017 and that the share of automotive plastics in total plastic consumption will increase to 7.5% in 2020.

The demand for plastics within the global automotive sector is ever-increasing with each passing day. This is due to the fact that while drivers seek higher performance, safety, more comfort, lower fuel consumption, smarter style and lower prices in the automobiles they want to purchase, the society, on the other hand, demands lower pollution levels. The ever-increasing demands of the drivers and society has increased the competition within the automotive sector and forced vehicle manufacturers to continuously invent innovations. As for these innovations, they obliged the selection of plastics as an alternative material.

The manufacture of products and raw materials with higher added values and that are innovatory is dependant on the increase of production of plastic oriented towards the automotive sector which is dependant on the vehicle production. However, due to the inability to reach the target production level in vehicle production, Turkey remained under developed western societies, which is 10% of total plastic consumption, compared to the share of automotive plastics in total plastic consumption.

11. PAGEV PROJECTS

As the "uniting force" of the plastics industry, PAGEV develops various projects to address the above issues. The two leading initiatives are the "PAGEV Plastics Center of Excellence" and "International Regional Plastic Production Hub".

11.1. PAGEV PLASTICS CENTER OF EXCELLENCE

Plastics are used in every aspect of life and are quick to replace other materials due to their outstanding properties. Plastics are gaining currency in all sectors and are set to become the indispensable material of the 21st century. Although the Turkish plastics industry is young, it is quick to grow, and is already the 2nd largest in Europe and 6th largest in the world. Striving to become a leader in Europe, the Turkish plastics industry aims to achieve certification on more products and improve added value. As the "uniting force" of the plastics ndustry, PAGEV leads the industry to achieving this target with the "PAGEV Plastics Center of Excellence". The planned mission of the PAGEV Plastics Center of Excellence will include the following activities:

- Research and Development
- Testing and Laboratory Services
- Certification
- Training
- Competent Consultancy

The Center of Excellence will provide testing and laboratory services, eliminating the current high costs, customs procedures and long waiting times associated with sending samples abroad for testing.

PAGEV Plastics CoE will develop platforms needed for sharing information and knowhow across the industry, and in-depth training curricula will be offered to the industry's benefit. The CoE will work on the latest technologies while cooperating with industrial companies, universities, research institutions, professional associations and nongovernmental organizations with an ultimate purpose of making the Turkish plastics industry a global leader.

Supported by the Ministry of Industry and Technology, the PAGEV Plastics Center of Excellence will help to train industrial skills and talent that will provide the foundation of national projects, providing a boost to the plastics industry in particular, and the Turkish economy in general. The PAGEV Plastics Center of Excellence will be a product of strategic partnership which will encourage scientific research with traceable objectives and a high potential for commercialization in order to accelerate the growth of the plastics industry.

The CoE is under construction next to the PAGEV Vocational and Technical High School in Küçükçekmece, Istanbul, and when complete, it will have over 30,000 square meters of space. The PAGEV Plastics Center of Excellence will make Turkey the hub of plastic production in the world and develop innovative projects.

The Center will also act as a controlling body for export products, which will ensure that plastic products made in Turkey will enjoy better trust and reputation in global markets. Another benefit of the Center will be tests performed on imported plastics before they are admitted through customs, which will prevent non-standard products of poor quality from entering the market.

The Center will be a more cost-effective and faster provider of certification, accelerate the development of the industry through R&D efforts, improve the competitive strength of Turkish companies, and focus on the development of product and manufacturing technologies.

The Center will follow developments in the global plastics industry to create innovative ideas, and offer consultancy services from determining appropriate input materials to designing process optimization to improve the competitive ability of the industry.

11.2. INTERNATIONAL REGIONAL PLASTIC PRODUCTION HUB

Although the Turkish plastics industry is the 2nd largest in Europe and 6th largest in the world with a production capacity of nearly 9 million tons, over 85% of the raw materials it requires is still imported. One key advantage of the Turkish plastics industry is its location between Middle Eastern countries which produce petroleum and other plastic raw materials, and Europe, which is the main consumer of plastic goods. To turn geographical location into an advantage, PAGEV plans to build a plastic production hub of international presence in the Southeast Anatolia region of Turkey, where the plastic raw material production potential of Middle Eastern countries will serve the product manufacturing skill and knowledge available in Turkey. Built on a win-win approach, the hub will enable raw material producers to access a large and reliable market, while the Turkish plastics industry will benefit from inexpensive and reliable raw material supply, growing even more, and taking advantage of lower costs to compete in global markets.

CONNECTING POWER OF PLASTICS INDUSTRY

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