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## About the author



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### Author's Foreword

I thank all those who supported me in building this report, notably Jarbas Enzenberg, Edigio Vertamatti and Carlos Moura from Arteb, Mr. Dutra from FCA, C.V Raman from Maruti and D.Madhusudan Joshi from ICAT.

I also thank DVN CEO Hector Fratty for his advice and support, DVN Chief Editor Daniel Stern for his editing, image selection, and content contributions, and Jeevan Pursala for his help in India.

# 1 - Executive Summary

Developing countries account for a limited share of worldwide automobile production with 19.2 million vehicles produced in 2019 out of 91.8 million worldwide—that is just under 21 per cent. However, these countries contain a major part of the worldwide population, with 4.9 billion people in 2019; that is 64 per cent of the worldwide population (without China, which is not considered a developing country). In 2050, this population proportion will have increased to 71 per cent of the forecast total population of 9.4 billion people. Conversely, during that period, developed countries will see their population stagnate.

In 2019, three vehicles per thousand people were sold in developing countries instead 37 vehicles per thousand people in the most developed countries. Over a twelvefold difference!

This gap represents a large reservoir of future activity for the automotive industry and particularly the lighting industry. We forecast a level of production in these countries in 2050 at more than 60 million vehicles, three times the current level. At that time, China should produce around 50 million vehicles, twice the current level, and the most developed countries should maintain their current level of 50 million vehicles. India should lead the developing world strongly in 2050 with around 25 million vehicles produced.

The automotive and lighting industries in developing countries substantially include the world's leading carmakers and set makers with established subsidiaries in these countries. But there are also quite a few local independents carmakers Maruti, Tata, Mahindra in India, Khodro in Iran, Perodua and Proton in Malaysia; setmakers Varroc, Lumax, and Uno-Minda in India, Arteb in Brazil, Odello-Farba in Turkey, and so on. Often they started as licensees of bigger international companies; now many of them are internationalising their activity by exporting directly or in some cases buying other companies even in developed countries, as did Tata with JLR and Daewoo, Mahindra with Pininfarina, Farba with Odello, and Varroc with the Visteon lighting activities.

About lighting equipment, there are often still some issues about its use, for instance:

- Headlight adjustment neglected, especially in older cars. Even dealerships, despite having a headlight beam tester do not know how to make the adjustment correctly.
- Burned out bulbs frequent especially in older cars / trucks.
- Misuse of headlights very frequent with the fog lights on and even constant use of high beam on highways.
- Aftermarket with lots of bad products, blue lights, low quality headlights
- More recently, the use of some low-cost LED Chinese auxiliary lights along with the low beam by many drivers, just "to look beautiful".

For new cars, lighting products are generally still basic currently with a majority of halogen front lighting, and primitive H4 lights at that. However the technology is not so different from developed countries, just with significant lag to implementation (projector headlamps are still talked-up as a novel advance in India, for example, even if they have halogen bulbs). But LEDs are more and more used and will eventually push glowing filaments into the history books.

For the other advanced lighting technologies—ADB and  $\mu$ LEDs, AEB and other ADAS—they will certainly appear, but not for a long time; at least ten years and possibly closer to twenty in many of these countries. However, road safety in these countries badly lags that of developed countries, with death

rates around four times higher than the best developed countries. Lighting and ADAS functions could strongly help for improvement, even if speed, impaired (drunk, etc) driving, and road infrastructure are the current priorities.

Finally, despite their difficult environment, these countries have also a strong dynamism. They use naturally the most cost-effective solutions, but now, they implement also more and more new technologies as LEDs in their new safer and stylish cars. Their race toward technological progress and prosperity is still sometimes chaotic, but they will certainly be in the next decades the most important reservoir of automotive growth.

## 2 - Introduction

DVN Reports published up to now have covered a wide range of subjects in relation to techniques, lighting actors or countries. But aside from our 2005 DVN Report on lighting in India, we haven't covered the situation in developing countries. This report fills that gap. Developing countries will take a more important place in the global vehicle and lighting ecosystem in the future, so we wanted to imagine and forecast this future to allow DVN readers to better prepare for it.

China currently has a particular place, having evolved from a developing country to a country classified (at least) as a transition country. In many domains, including automotive, China counts as a developed country, so it is not a focus of this report.

The figures provided herein are as much as possible official. We use U.N. population figures, for example, and sales and production figures from OICA. For forecasts, particularly for long-term forecasts for the automotive industry in developing countries, we have found reliable sources that we consider realistic; these have allowed us to formulate DVN forecasts for this 30-year horizon.

After providing long-term views for population, wealth and automotive sales and production in developing countries, this report presents details on the current status of some important countries, particularly India and Brazil, with interview of some important actors. We've also got coverage here of Indonesia, Turkey, Thailand, Malaysia, Mexico, Iran, South Africa, and Morocco. Still other countries have also an automotive industry with a long history—Argentina and Colombia, for example—or had such an industry in the past (Nigeria), but developing countries are so numerous that a selection needed to be done, and so those countries will have to wait until a future DVN Report.

# 3 - Developing Countries in the World

## 3.1 What is a Developing Country?

Developing countries have some common characteristics with higher health risks, limited energy access, often widespread poverty, and low education levels. In the domain of transportation, these countries typically have a high number of road traffic accidents, worse outcomes from those accidents because of a lower level of automotive safety technology, a large number of old and poorly-maintained vehicles, poor-quality roads, and generally poor infrastructure.

Conversely, they have for many of them an annual level of growth higher than the world average. Previously, United Nations classified nations in three main categories: developed countries, developing countries and least developed countries:

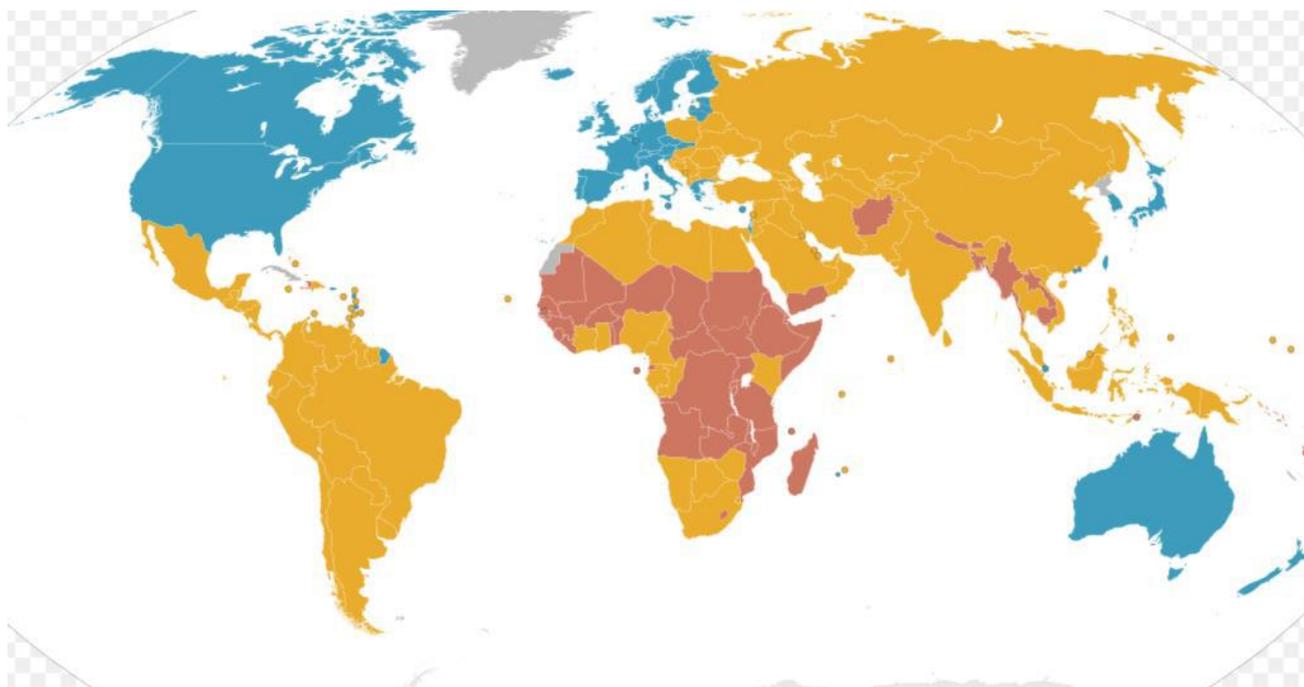


Chart 3.1.1: Developing countries (United Nations)

More recently in the 2019 report, they used only one category for developing countries, avoiding the "least developed country" category. The list of these developing countries is in annex 9.1, the choice being guided by their GDP (Gross Domestic Product) based on PPP (Purchasing Power Parity). This DVN Report focuses on the countries most heavily involved in the automotive industry: India, Indonesia, Thailand, Malaysia, Turkey, and Iran in Asia; Brazil, Mexico, and Argentina in the Americas; and South Africa, Morocco, Egypt, and Ethiopia in Africa.

## 3.2 Population of Developing Countries

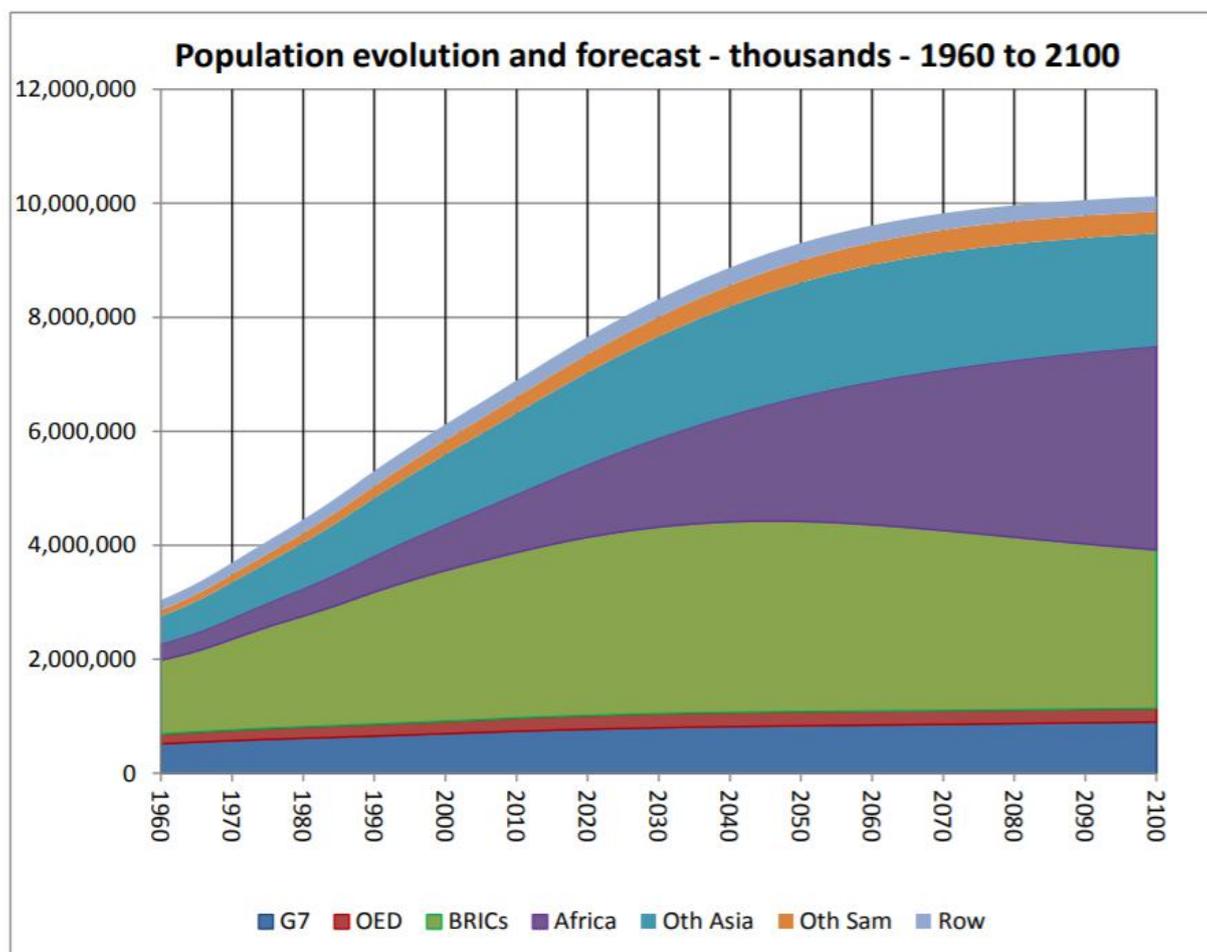
For the next thirty years, developing countries will strongly increase their population by 36 per cent on average, a figure that will include enormous growth in some countries, for instance +96 per cent for Nigeria, +98.9 per cent for Ethiopia, +106.3 per cent for Mozambique, and +144.3 per cent for Malawi. On the other hand, population in developed countries will stagnate or decrease, as for instance Japan at -15 per cent and Germany at -13.8 per cent, and the global population of these developed countries is forecast to decrease by 2.6 per cent on average from 2020 to 2050.

	2020		2050		Evolution 2020-2050
	Population	%/World	Population	%/World	
Developing countries	4890.2	64.0%	6648.7	70.7%	36.0%
Developed countries	1356.2	17.7%	1321.4	14.0%	-2.6%
China	1397.0	18.3%	1438.0	15.3%	2.9%
Total	7643.4	100.0%	9408.1	100.0%	23.1%

Chart 3.2.1 with population in million

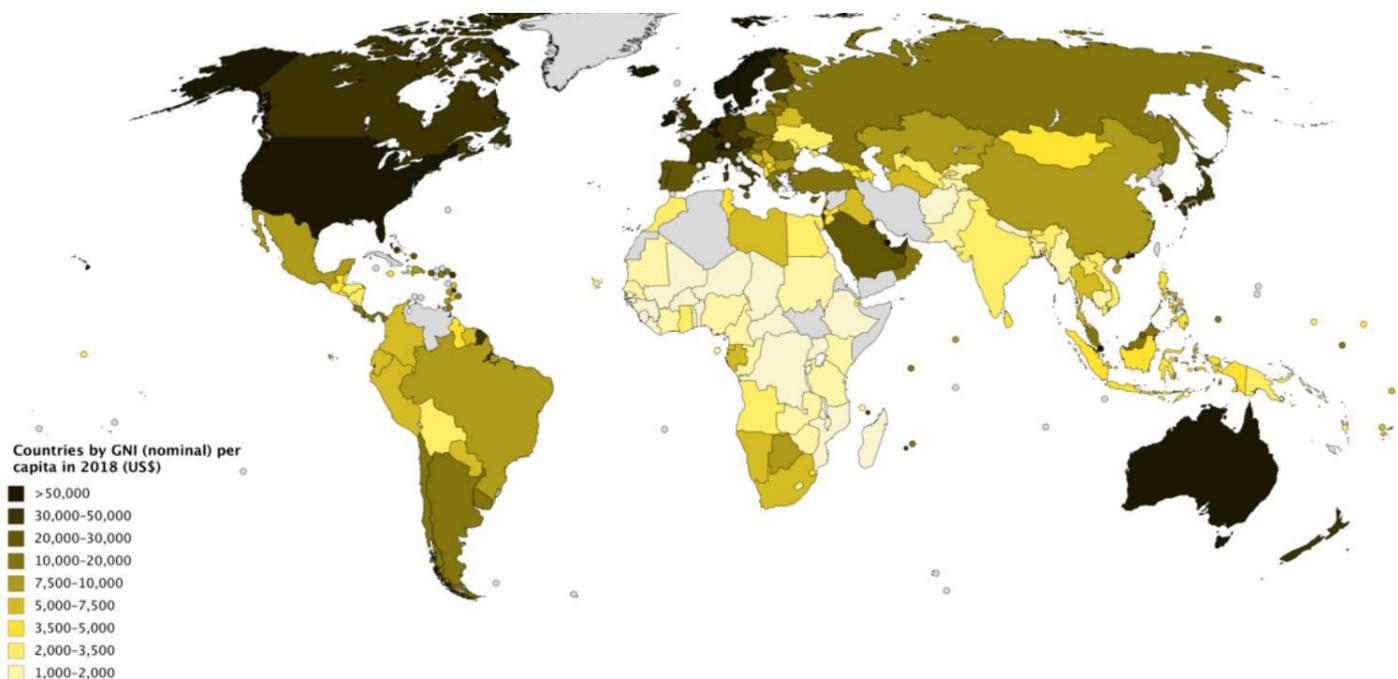
Find details about population evolution per country in Annex 9.2

Chart 3.2.2 Long term Population evolution (from Sutherland-Campbell):



### 3.3 Productivity and Income in Developing Countries

Considering the potential automotive market, the important point is not only the level of population, but also those people's wealth. There is currently a huge gap between the GNI (Gross National Income) per capita in 2020 of the most developed countries—an average of \$62,327—and the least developing countries with an average of \$4,820 (according to PRB).



*Chart 3.3.1: GNI per capita, per country*

This gap is naturally even much higher considering one of the highest, the USA with their GNI per capita in 2019 at \$65,000 compared to one of the lowest in Burundi with only \$280, so a ratio of more than 200:1, though it must be pointed out that the U.S. figure is driven up by a relatively small number of extremely wealthy individuals.

A positive point is that on average, these developing countries have a relatively high annual growth, higher than is seen in developed countries.

For developing countries, the GDP (Gross Domestic Product) evolved on average by +4.6 per cent per year from 2010 to 2019; in developed countries, that figure is just +1.87 per cent.

In the future, this evolution seems set to continue, and so the forecast developed countries' GNI per capita in 2050 will likely land at around \$13,500, comparable to the current China figure of \$10,500, enough to support a large automotive market. Find details about this forecast in Annex 9.3 of this report.

## 4- Vehicle Production in Developing Countries

### 4.1 History of Vehicle Production, Comparison With Developed Countries and China

The worldwide production of passenger and commercial vehicles increased by +62 per cent in the last twenty years, but the production in developed countries that counted for 87 per cent of the total in 1999 decreased slightly during this time to 51 per cent in 2019. Europe and Japan maintained their production, Korea increased by +42 per cent, but in North America, production in the USA and Canada decreased on strengthening Mexican imports.

Conversely, Chinese production climbed from 1.8 million to 25.7 million with a share evolving from 3.2 per cent to 28 per cent over the same timeframe. Developing countries other than China saw strong evolution even if it wasn't quite so explosive as China's, increasing their production from 5.4 million to 19.2 million, so multiplying the production by a factor 3.6.

	Vehicles in millions	1999	2004	2009	2014	2019
Developed Countries	Europe	20.0	19.4	15.8	19.1	19.9
	USA-Canada	16.1	14.7	7.2	14.1	12.8
	Japan	9.9	10.5	7.9	9.8	9.7
	Korea	2.8	3.5	3.5	4.5	4.0
	Others	0.6	1.1	1.0	1.2	0.6
	Total Developed	49.4	49.2	35.4	48.6	46.9
	China	1.8	5.2	13.8	23.7	25.7
Developing Countries	Vehicles in millions	1999	2004	2009	2014	2019
	Asia	2.1	5.3	7.4	10.2	11.1
	South America +Mexico	2.9	3.9	4.7	6.6	7.0
	Africa	0.3	0.5	0.4	0.7	1.1
	Total Developing Countries	5.4	9.6	12.5	17.5	19.2
	Total World	56.6	64.1	61.7	89.9	91.8

Chart 4.1.1: Vehicle production by country

Vehicles in millions	India	Turkey	Indonesia	Thailand	Brazil	South Africa	Mexico
1999	0.8	0.3	0.1	0.3	1.4	0.3	1.5
2004	1.5	0.8	0.4	0.9	2.3	0.5	1.6
2009	2.6	0.9	0.5	1.0	3.2	0.4	1.6
2014	3.8	1.2	1.3	1.9	3.1	0.6	3.4
2019	4.5	1.5	1.3	2.0	2.9	0.6	4.0

Chart 4.1.2 Production of main developing countries, 1999-2019

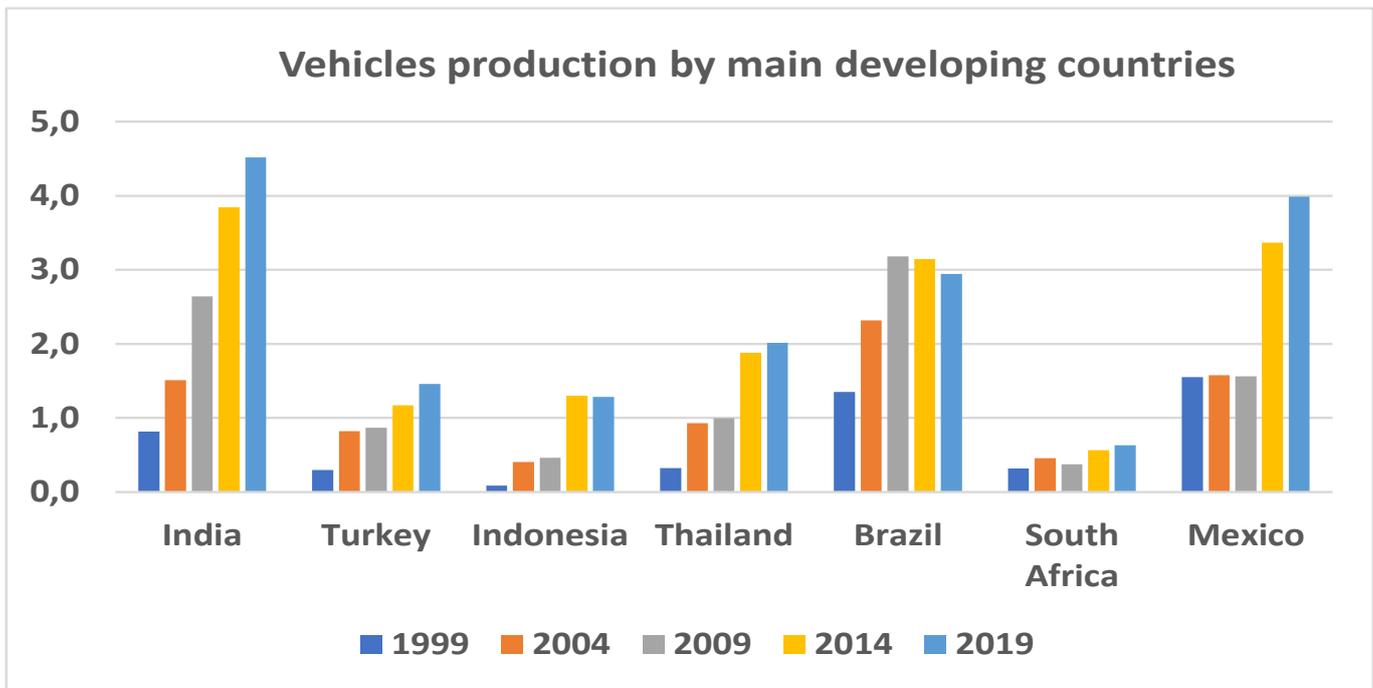


Chart 4.1.2 Comparative production of main developing countries, 1999-2019

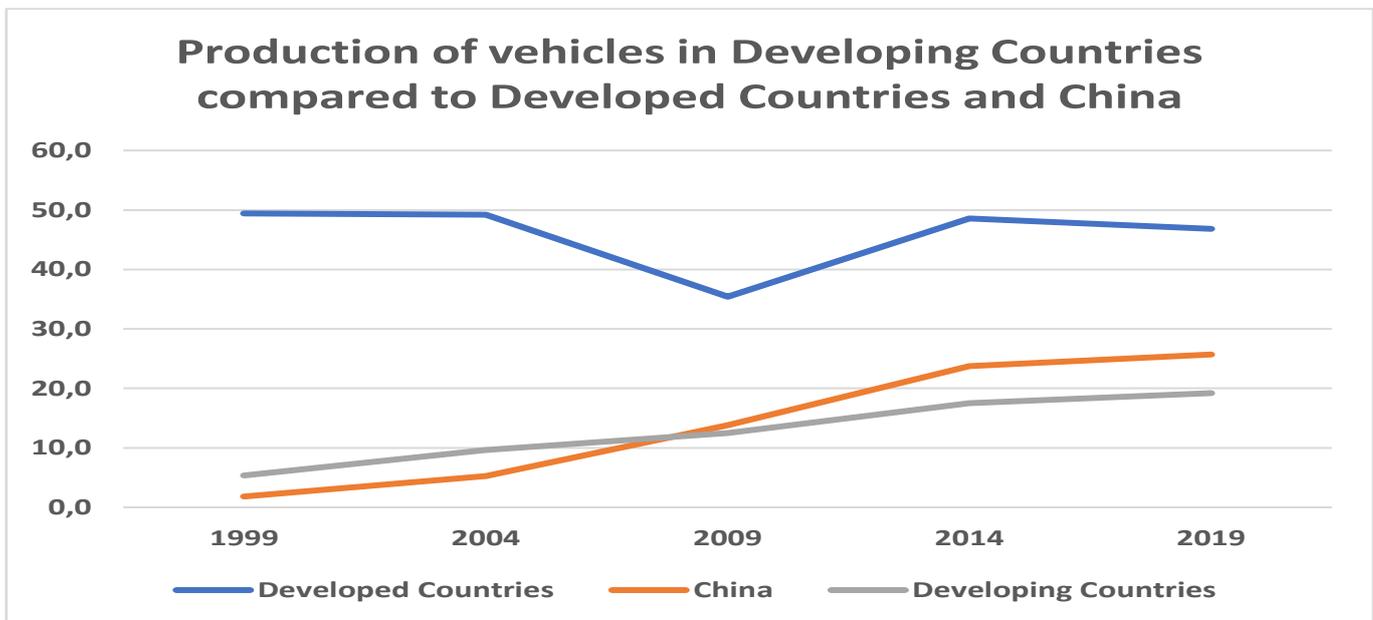


Chart 4.1.3 Production of developing countries vs. developed countries, 1999-2019

These seven developing countries—India, Turkey, Indonesia, Thailand, Brazil, South Africa, and Mexico—represented in 2019 the major part, with 87.5 per cent of the total production of developing countries.

Two main modes of development can be observed:

The model of Mexico and Turkey with dominant exports:

- In Mexico, in 2019, production was 4M and sales 1.4M, so 2/3 of production were exported; mostly to USA and Canada.
- In Turkey in 2019, production was 1.5M and sales only 0.5M, so 2/3 of production were exported; mostly to Europe.

- Morocco can also be added to this category with a production in 2019 of 0.4M vehicles, with 0.16M for its internal market, so also roughly 2/3 exported.

Then there's the model of India, Indonesia, Thailand, Brazil, and South Africa with a production mainly oriented to their internal market:

- India is producing 4.5M vehicles for a market of 3.8M
- Indonesia is producing 1.3M for a market of 1.1M
- Thailand is producing 2M vehicles for a market of 1M
- Brazil is producing 2.9M vehicles for an internal market of 2.8M
- South Africa is producing 0.6M for a market of more than 0.5M

## 4.2 Vehicle Sales and Production Predictions to 2050

Following the past trends and with the hypothesis detailed in Annex 9.5, developing countries could be in the future the first market for automotive as seen in this chart:

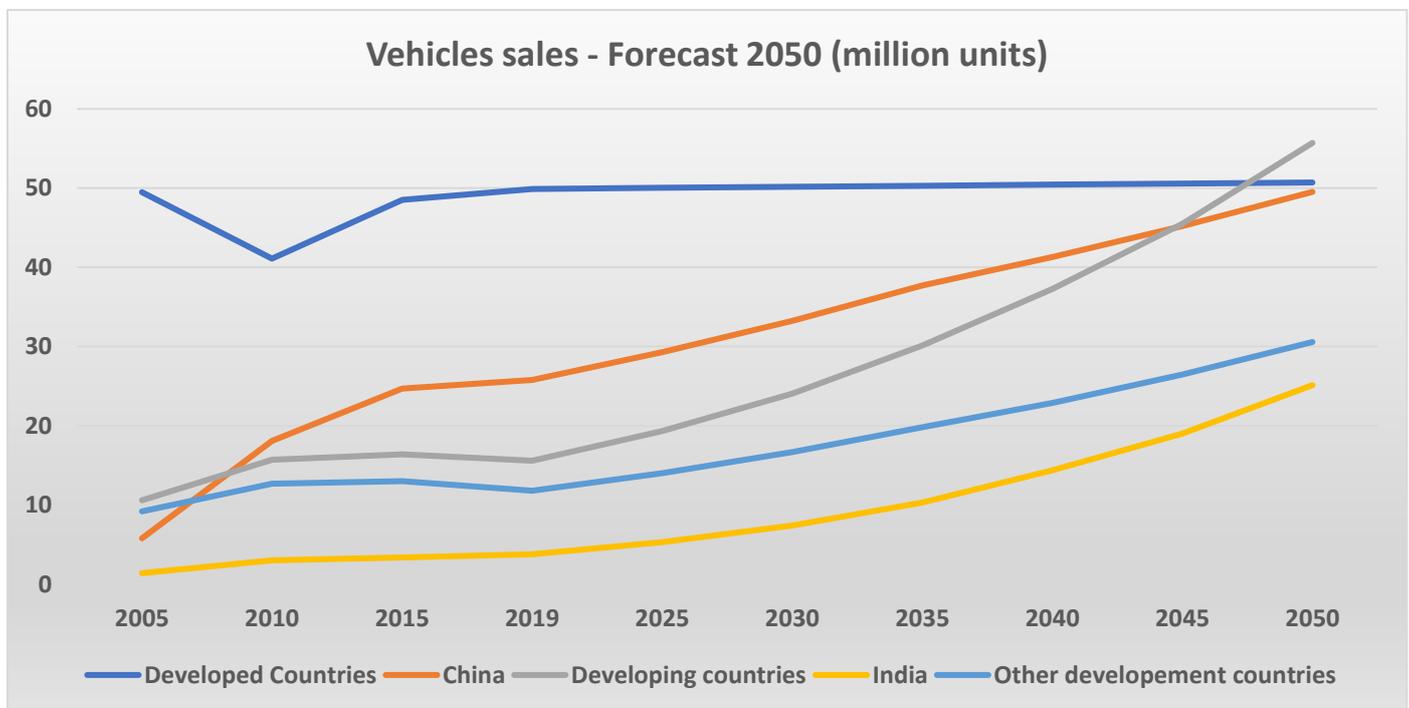


Chart 4.2.2: Vehicle sales forecast to 2020

Naturally, these figures do not include the year 2020 that will be severely impacted by the Covid pandemic.

This forecast shows the growing importance of developing countries, where more than a third of vehicles will be sold in 2050. As some of these developing countries are currently exporting countries and will certainly remain with large exports, their production in 2050 will be even higher, exceeding 60M vehicles.

Another factor which could increase the sales of new vehicles in these developing countries is the fact that roughly 4 million used vehicles are currently sold every year from developed countries into developing countries, half of them in Africa. But there is now a U.N. effort to better control these exports of used-up, worn-out old vehicles that often are unsafe high polluters. As these efforts gain traction,

there will be a complementary need for more new vehicles in developing countries.

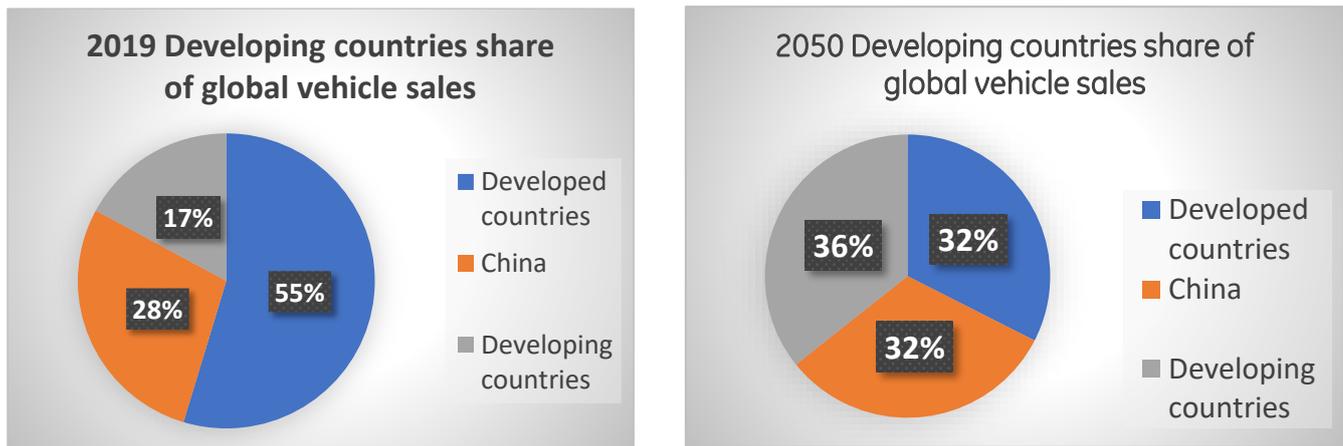


Chart 4.2.3: Developing countries' share of global vehicle sales, 2019 vs. 2050

### Worldwide vehicle sales forecast

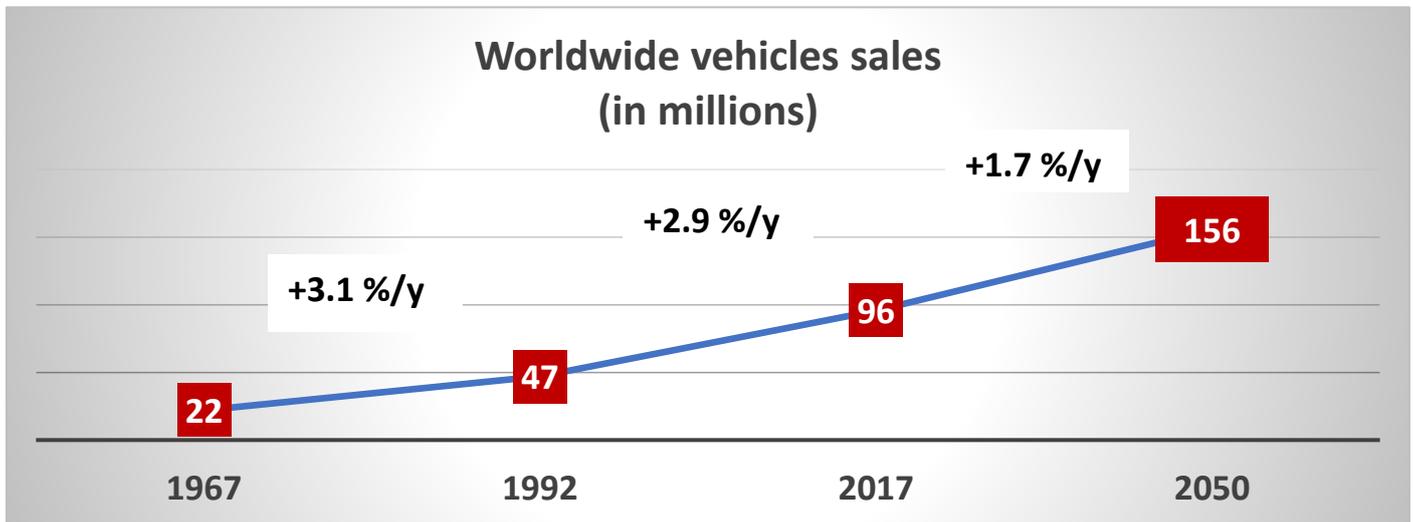


Chart 4.2.4: (25 years between each time mark except 2017-2050)

	2019				2050			
	Population in million	Vehicles sales in millions	Sales per thousands people	Market Share in %	Population in million	Vehicles sales in millions	Sales per thousands people	Market Share in %
Developed countries	1356	49.9	36.8	54.7%	1321	50.7	38.4	32.5%
China	1397	25.8	18.5	28.3%	1438	49.5	34.4	31.8%
Developing countries	6287	15.6	2.5	17.1%	6649	55.7	8.4	35.7%
<b>Worldwide vehicle sales</b>		<b>91.3</b>				<b>155.9</b>		

Chart 4.2.5: Vehicle sales forecast for developing countries and worldwide

During the fifty years from 1967 to 2017, the automotive worldwide production increased roughly by 3 per cent per year, doubling every 25 years. Our forecast is more conservative for the future with a

global trend of 1.7 per cent per year during the next 30 years, with:

- 0 per cent per year in developed countries
- +2.1 per cent per year in China (down from +11 per cent during last decade)
- + 4.2 per cent per year in developing countries

This relatively conservative forecast for developing countries compared to the last few decades' worth of achievements in China is because of China-specific conditions: its economy and society are centrally planned and these plans are vigorously realised and enforced by the Chinese Government. Such a very strong economic policy in a deliberately stabilised and huge country is difficult to emulate at the same level by many developing countries in the foreseeable future, though India will likely come closest by dint of its size, resources, and its present state of automotive industry evolution.

The automotive industry and naturally the lighting industry will have to prepare for these evolutions, as was done during the last two decades for China's growth (which, during many years, also had relatively deceiving sales stabilised at around 500-600 thousand cars per year).

For the two-wheelers forecast (motorbikes and scooters), important for lighting in some developing countries, we refer to a study done by the European Commission in 2017:

### Production of Powered Two-Wheelers in Key Markets, 2005-2050

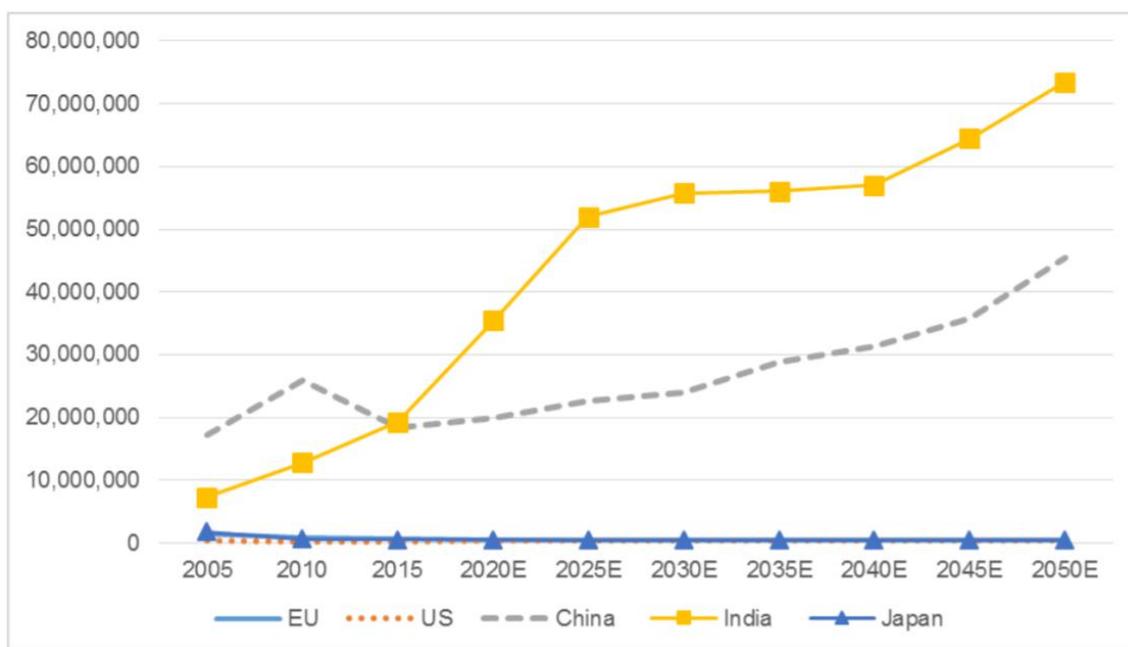


Chart 4.2.6 Two-wheelers production prediction

## 5 - Vehicle Safety in Developing Countries

In a 2018 report, the WHO (World Health Organisation) found that road traffic crashes represent the N° 8 leading cause of death globally. They claim more than 1.35 million lives each year and cause up to 50 million injuries. The WHO report also revealed that low-income and middle-income countries have higher road traffic fatality rates (21.5 and 19.5 per 100K population, respectively) than high-income countries (10.3 per 100K) despite much less traffic in the developing countries. So, over 90 per cent of the world's fatalities on the roads occur in low- and middle-income countries, which have only 48 per cent of the world's registered vehicles. And road traffic injury is the leading cause of death for people aged between 5 and 29 years. Worse, between 2013 and 2016 no reductions in the number of road traffic deaths were observed in any low-income country, while reductions were observed in 48 middle- and high-income countries.

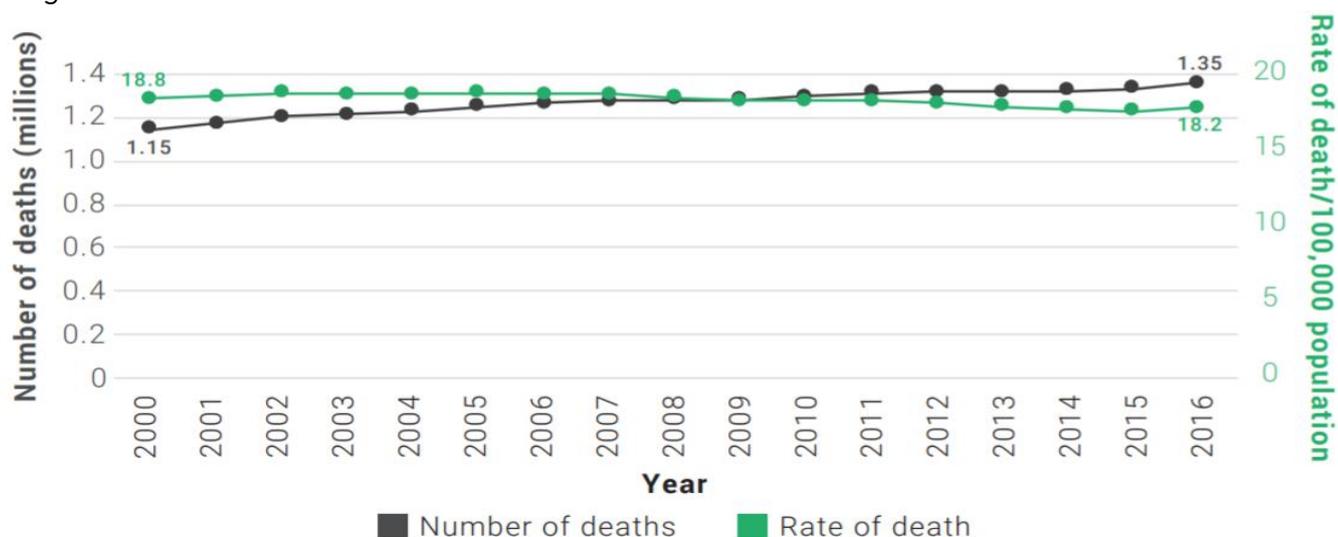


Chart 5.1: Worldwide road traffic deaths, 2000-2016

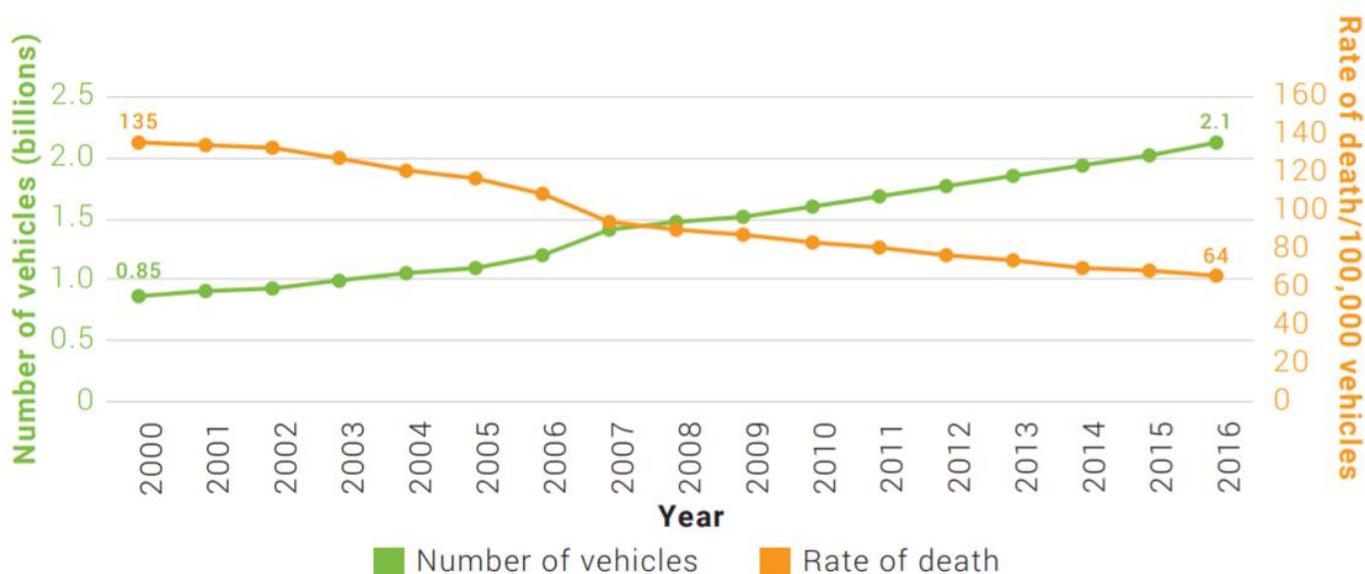
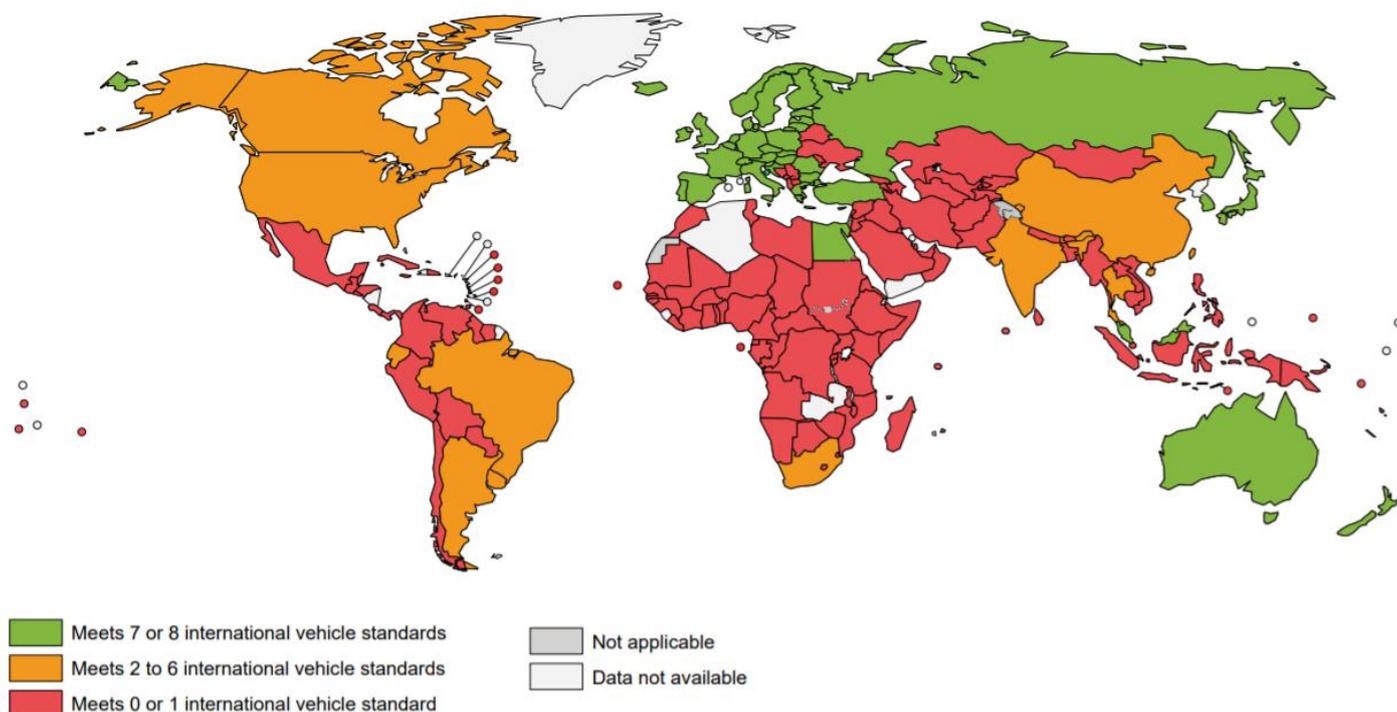


Chart 5.2: Road deaths per billion vehicles, 2000-2016

This improvement per vehicle is mainly due to more stringent laws for speed, drinking, and seat belts,

and to better cars and better road infrastructure. These improvements were also observed in developing countries but starting from a lower basis.

For better cars, the UN has defined eight main criteria including impact protection, electronic stability control, pedestrian front protection, seat belts, child restraints, and motorcycle ABS. Unfortunately, lighting was not considered in this list and the lighting community should work to add to the list a lighting requirement. Very little scientific knowledge is available about the correct level of lighting equipment and performance in the different countries. We can, however, consider that there is some correlation between the correct level of the eight UN vehicle safety priorities and a correct level of lighting, and consider the following chart as likely also significant for a good lighting equipment level:



*Chart 5.3: Priority UN vehicle safety standards, implementation per country*

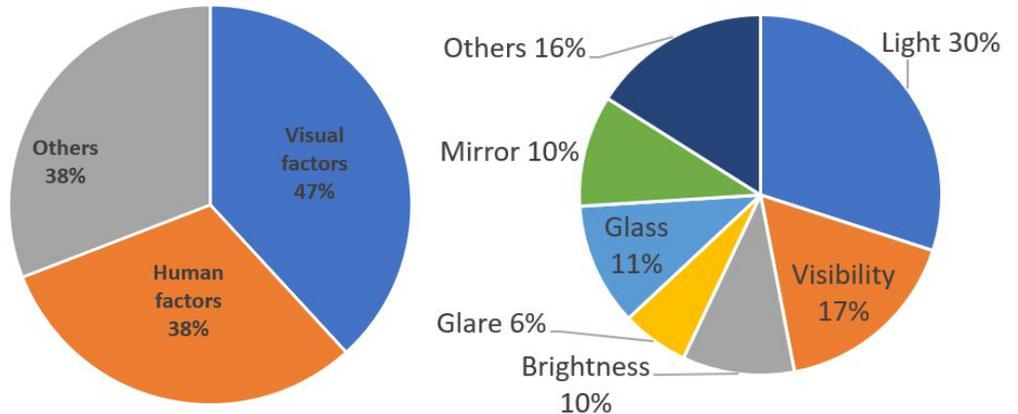
This chart shows that developing countries have on average not the right level of equipment to ensure the best safety.

See Annex 9.6 for some examples of developing countries (Brazil, India, Indonesia, and Germany as a comparative reference) with the split of deaths by road user categories and the trends from 2006 for deaths per 100K population. These statistics show that in developing countries currently, road deaths are much greater for riders of motorised 2- and 3-wheelers than for occupants of 4-wheelers.

For the origin of accidents in developing countries, we refer to a study done in India in 2014: "Analysis of Prime Reasons For Night-time Accidents" by PSR engineering college and RAMCO Institute of Technology. They reported that 60 per cent of accidents in India occurred after dark; 47 per cent of these accidents are due to visual factors, and for visual factors, more than half in relation to lighting.

This study demonstrates that a good lighting system is essential to improve safety, perhaps more in developing countries where road infrastructure and streetlights are often primitive.

Chart 5.4: Night crash causes in India (+ detail of Visual factors)



## 6 Automotive and Lighting Industry

### 6.1. India

#### 6.1.1 India: Environment

##### Automotive Market in India

Overall, domestic automobiles sales increased at 1.29 per cent CAGR from FY16 to FY20, with 21.55 million vehicles sold in FY20.

For four-wheelers, India became the N° 4 auto market in 2019 (displacing Germany) with about 3.99 million passenger and commercial units sold. India is expected to take the N° 3 position from Japan by 2021.

The two-wheeler segment dominates the market in terms of volume, on account of a growing middle class and a young population. India has strong export growth expectations for the near future.

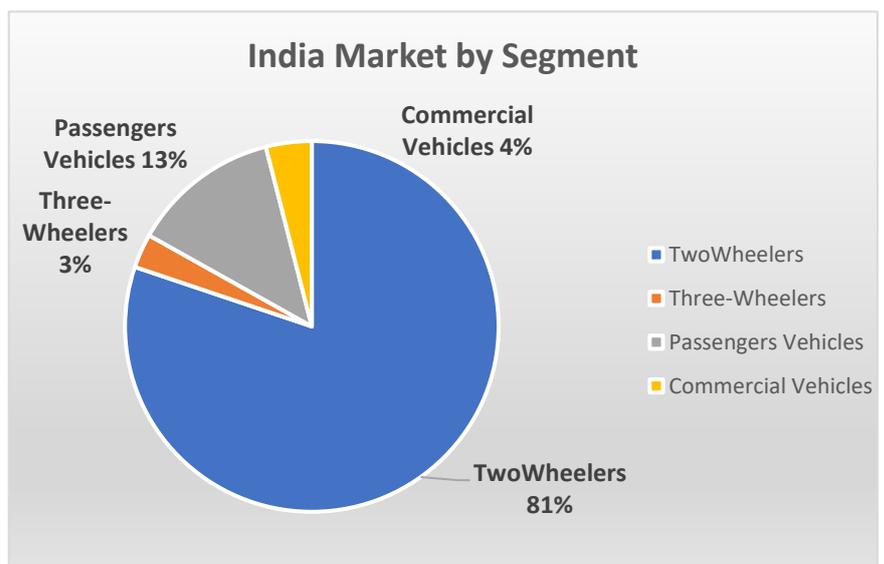


Chart 6.1.1.1: Indian vehicle market segments

## Automotive Production in India

For all segments, domestic automobile production increased at 2.36 per cent CAGR from FY16 to FY20, with 26.36 million vehicles manufactured in FY20. Overall, automobile export reached 4.77 million vehicles in FY20, growing at a CAGR of 6.94 per cent during FY16-FY20. Two-wheelers made up 73.9 per cent of the vehicles exported, followed by passenger vehicles at 14.2 per cent, three-wheelers at 10.5 per cent and commercial vehicles at 1.3 per cent. For passenger cars, Maruti Suzuki are the historic leader and remain a strong one currently with more than half of the market. For commercial vehicles, the leader is Tata Motors.

2019 passenger car sales data<sup>[156]</sup>

Rank	OEM	2019 sales	Share	2018 sales	Share
1	Maruti Suzuki	▼ 1,485,943	▼ 50.6%	1,731,179	51.7%
2	Hyundai	▼ 510,260	▲ 17.4%	550,002	16.4%
3	Mahindra	▼ 219,663	▲ 7.5%	232,181	6.9%
4	Tata Motors	▼ 152,944	▼ 5.2%	213,625	6.4%
5	Honda	▼ 134,741	▼ 4.6%	174,880	5.2%
6	Toyota	▼ 126,701	▼ 4.3%	151,480	4.5%
7	Renault	▲ 88,869	▲ 3.0%	82,368	2.5%
8	Ford	▼ 73,636	▼ 2.5%	97,804	2.9%
9	Kia	▲ 45,494	▲ 1.5%	0	0.0%
10	Volkswagen	▼ 32,324	▼ 1.1%	37,029	1.1%
11	Nissan-Datsun	▼ 23,580	▼ 0.8%	41,583	1.2%
12	MG Motor	▲ 15,930	▲ 0.5%	0	0.0%
13	Škoda	▼ 15,284	— 0.5%	16,692	0.5%
14	Fiat Chrysler	▼ 11,238	▼ 0.4%	19,030	0.6%

Chart 6.1.1.2: India passenger car sales in 2019

The Indian government is pushing for the development of automotive production and R&D centres in India, particularly now for electric vehicles. The Indian vehicle and component industry is expected to reach the equivalent of USD \$251.4bn to \$282.8bn by 2026.

Import duties for cars are extremely high in India, ranging from 60 per cent for small cars to 100 per cent for more expensive cars. So most cars are produced locally, dominated by small and midsize vehicles. Nevertheless, an important new class of buyers is emerging; they're able to buy more expensive cars. JLR for instance decided this year to locally produce their Range Rover Velar model. The Indian market is extremely attractive for all carmakers, as its potential can be compared to the Chinese one; consequently, most of the world's major makers have a presence of one kind or another in India. But it is still a specific and difficult market, very demanding particularly for prices as illustrated by the exit of GM in 2020, trying to sell their plant to Great Wall.

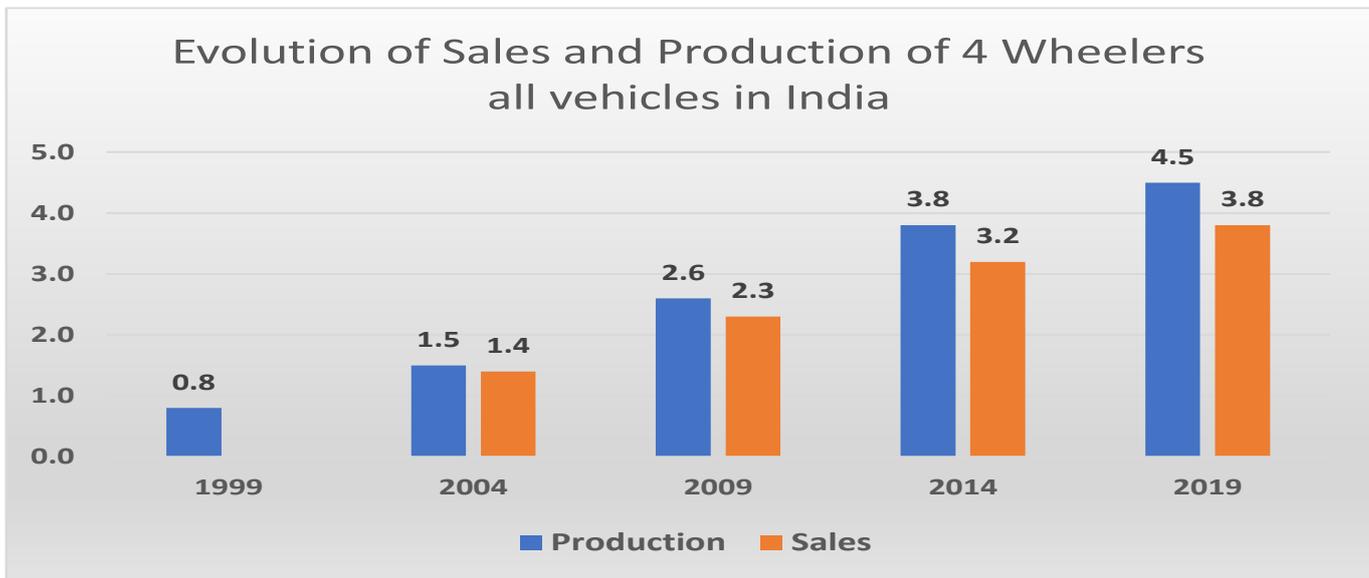


Chart 6.1.1.3: 4-wheeled vehicle production and sales in India, 1999-2019

## 6.1.2 India's Carmakers

### Maruti Suzuki



Maruti Suzuki were founded in 1981. At the beginning, the main shareholders were the Indian state with 54 per cent and Suzuki with 25 per cent, but now Suzuki hold 56.3 per cent of shares, with the rest belonging to Indian financial institutions. There are around 16,000 Maruti Suzuki employees in India.

They first launched in 1983 the iconic Maruti 800. The company strongly leads the Indian market, commanding 52 per cent of the market in 2018. Their Alto is India's N° 1 selling car for 16 consecutive years, with over four million of them sold. The Alto with an 800cc engine ranges from the equivalent of €3,300 to €5,000.

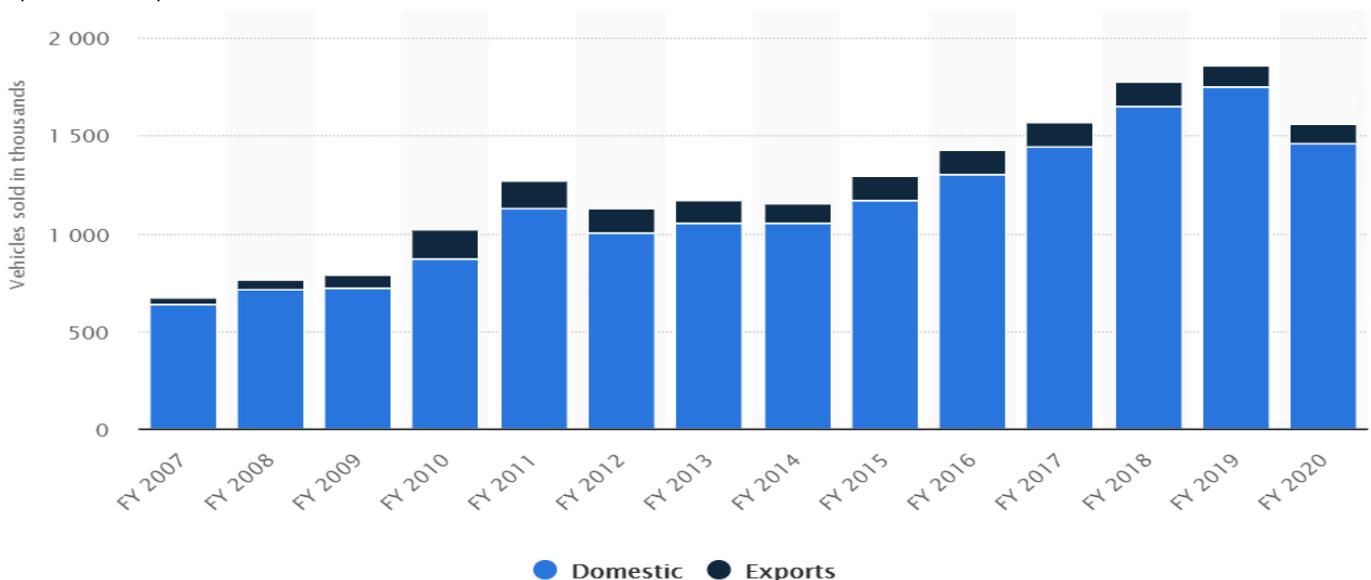


Chart 6.1.2.1: India's vehicle domestic and export sales, FY07 to FY20 (Statista)

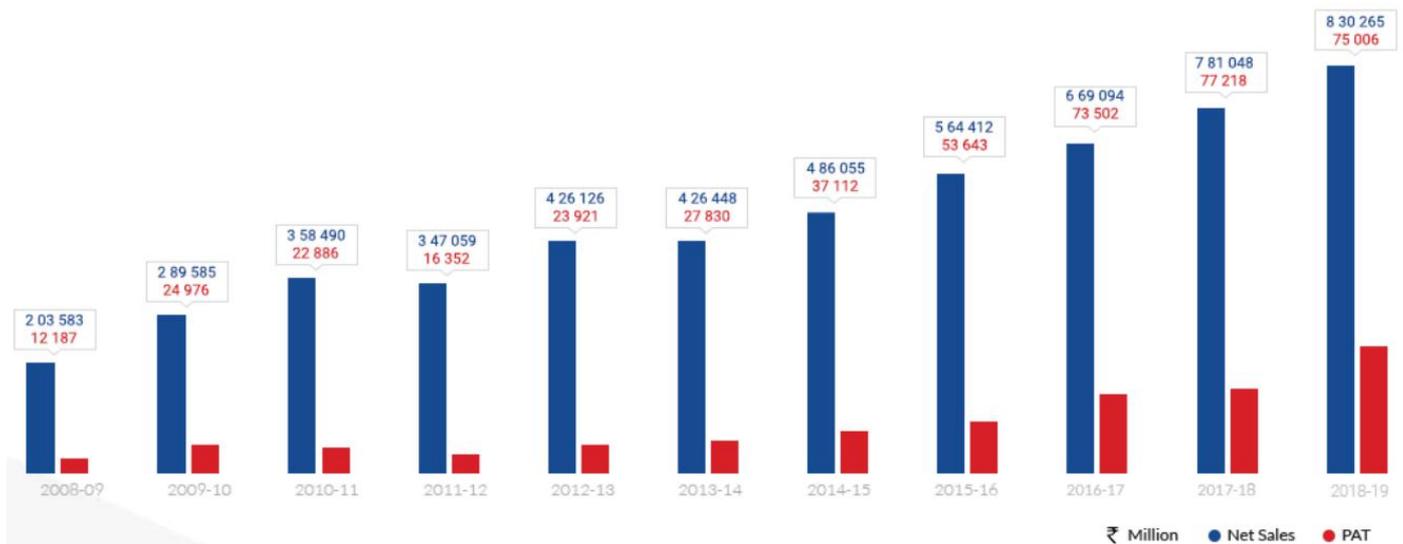


Chart 6.1.2.2: Maruti Suzuki Sales (millions of rupees; ₹1m ≅ €11k)

Global sales in FY18-19 were ₹830bn (approximately €9.13bn), giving an average per car around €5,000. The company's exports mostly go to developing countries, most of them to Indonesia with 10,000 cars; South Africa with 17,000 cars; Chile with 14,200 cars; Uruguay with 4,500 cars, and Bolivia with 4,700 cars.

In FY19, EBIT was 9.6 per cent of sales and cashflow was 8 per cent of sales. Sales in FY20 (ending March 2020) have been severely impacted by Covid, with a 14 per cent decrease in sales to ₹716bn; naturally this has impacted profits.

## Mahindra



Mahindra automotive is part of the Mahindra group created in 1945, totalling 150 companies and 250,000 employees with revenues of \$19.4bn and operations in more than 100 countries in 22 industries—they are also involved in IT, Insurance, logistics, power backup real estate, retail, rural housing finance, steel, trucks, buses, 2-wheelers, and vehicle equipment finance.

The growth of the group is relatively strong with a CAGR of 4.4 per cent during the last decade and with now more than 50 per cent of revenues outside India. The automotive sector is the most important, providing 36 per cent of revenues.



Chart 6.1.2.3: Mahindra sales and revenue

In the automotive sector, Mahindra produce SUVs, pickup trucks, small commercial vehicles, electric trucks (including many 3-wheelers), and buses. They acquired Pininfarina (Italy) in 2015 and SsangYong (Korea) in 2011. In India, Mahindra are № 3 in the market (after Maruti Suzuki and Hyundai), holding a 7.5 per cent market share with sales of passenger cars totalling 220,000 units in 2019.

## Tata



Tata group are enormous. They were founded in India in 1868, and now have more than 722,000 employees and revenues of \$113bn.

Tata motors is the automotive branch, with revenues of \$45bn producing for the local market. Passenger car sales in India were at 220,000 in 2018, but Tata are the market leader for commercial vehicles. Tata acquired Jaguar Land Rover in 2008, and South Korea's Daewoo in 2004. They now have operations in India, the UK, South Korea, Thailand, South Africa, and Indonesia through 109 subsidiary and associate companies.

After introducing their Nano in 2008 with a very low price (the Nano is no longer in production) Tata are now targeting higher-range vehicles. This year they released the Nexon EV, an electric vehicle with specifications like a European or Japanese car, with a full-LED lighting system.



6.12.5: Tata Nexon EV

## 6.1.3 India's Lighting Suppliers

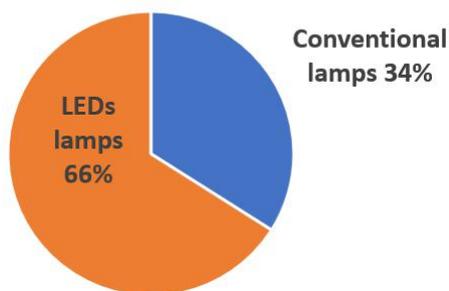
### Lumax



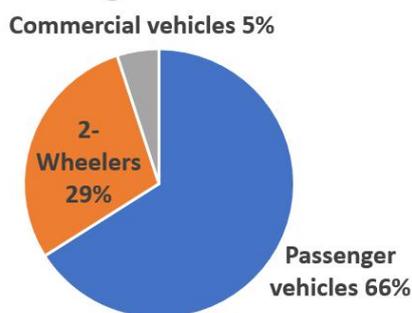
Lumax D.K. Jain Group are a pioneer for India's automotive industry, founded in 1945. They began making lighting equipment in 1956, and are now the leading lighting supplier in India with a share of 50 per cent. They have 9,100 people in 31 manufacturing facilities, four R&D centres in India, and one design centre in Taiwan. Partnerships are established with several other set makers including Stanley in Japan and SL in Korea. Sales amount to around €400m.

In fiscal year 2019-2020, Lumax had the following figures:

Revenue Share by Technology



Segment Mix



Product Mix

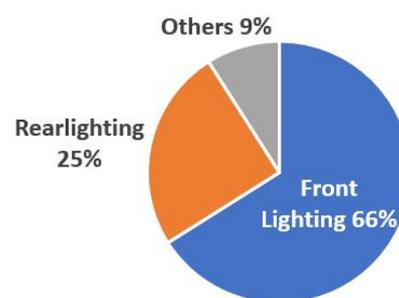


Chart 6.1.3.1: Main figures of Lumax

Lumax management:



Chart 6.1.3.2: Main Lumax managers

# Uno Minda



Uno Minda started operations in 1958, and turnover is now over \$1bn. They have 62 manufacturing plants in India, Indonesia, Vietnam, Spain, Morocco, Mexico, Colombia, and Germany; 10 R&D and design centres in India (Manesar, Pune, & Sonapat), Taiwan, Japan, and Spain, and sales offices in North America, Europe, and ASEAN Countries. Group headquarters is in Manesar, Haryana, India, and the workforce totals over 22,000. They make a wide range of products: Alternative fuel systems, air filtration systems, canisters, brake and fuel hoses, combined braking systems (CBS), noise suppressor caps, PDC parts, alloy wheels, seatbelts, cameras, EA pads, steering wheels and airbags, air brakes, fuel caps, **lighting**, air ducts, washer bottles, spoilers, body seals, 2-wheeler switches and handlebars, 4-wheeler switches and HVAC components, cigarette lighters, wheel covers, shifters, infotainment systems, speakers, RPAS & ADAS, sensors, actuators, controllers, relays, end-to-end telematics and connected car solutions, horns, and seating systems.

## Uno Minda Lighting Division



*6.1.3.4: Uno Minda main location in Manesar*

Founded in 1980, Minda Industries Limited - Lighting Division is one of the leading automotive lamp manufacturers in India, developing lighting products for two-, three-, and four-wheelers and off-road vehicles. Growth has been steadily around 25 per cent CAGR. With around 1,500 employees, the lighting division operates out of different locations across the country: Pantnagar, Haridwar, Sonapat, Manesar and two locations in Pune.

Main automaker customers in India include Yamaha, Suzuki, Hero, Honda, Swaraj Mazda, New Holland, Eicher, Maruti Suzuki, Renault Nissan, Mahindra, Tafe, Royal Enfield, General Motors, Fiat, Volkswagen, Toyota, Tata, and Ford, amongst others; their international customer base includes Daihatsu, MBK, Suzuki, Piaggio, Kawasaki, Torica, and Volkswagen.

There's a design centre and customer support offices in Taiwan and Japan, and a strategic sourcing unit in China. The Design Centre in Taiwan has given expertise in optical and mechanical design of automotive lamps, in addition to capitalising on the strategic advantage of Taiwan as a source of affordable, high-quality tooling. Minda entered a technical licence agreement in December 2012 with AMS, a Korean actor for lighting systems, headquartered in Gyeongbuk. The licence covers design,

manufacture, and sale of highly-engineered automotive Lamps. With this agreement, AMS would provide technical support for design and development of headlamps, taillights, fog lamps, and others with conventional and LED light sources, for automakers in India and Indonesia.

In 2016, Minda Lighting bought Spain-based Rinder Group for an enterprise value of €20m. The acquisition included 100 per cent equity holding in Rinder India and their lighting systems technical centre.

**Products:**

4-wheeler headlamps and rear and interior lamps:



2-wheeler lights:

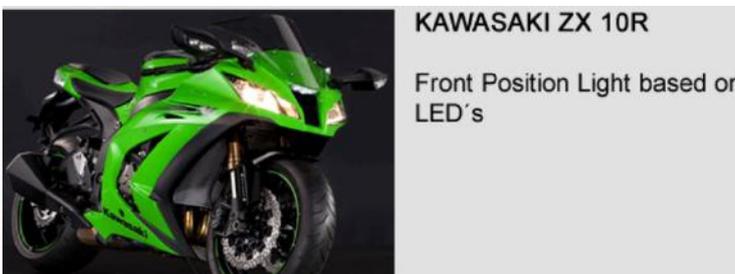


*6.1.3.5: Uno Minda product selection*

Rinder was based in Spain prior to their acquisition in 2016 by India's Minda. Rinder's activities in India go back to 1997, however, and they are now established as one of the leading vehicle lighting manufacturers for two-wheelers and commercial vehicles. Manufacturing facilities are in Pune and Bahadurgarh, 30 km from Delhi.



6.1.3.8: Rinder India HQ



6.1.3.9: Examples of products from Rinder

# Fiem Industries

Fiem, founded by Chairman and Managing Director J.K. Jain, are one of India's leading vehicle lighting suppliers. They also manufacture plastic parts, rearview mirrors, LED luminaries, and LED displays. Turnover is around €150m including more than €100m for lighting; 96 per cent of Fiem's auto segment involves component supply for 2-wheelers.



Mr. J.K. Jain

Chairman & Managing Director



6.1.3.6: Fiem Managing Director and main location



Fiscal year 2020 Breakup

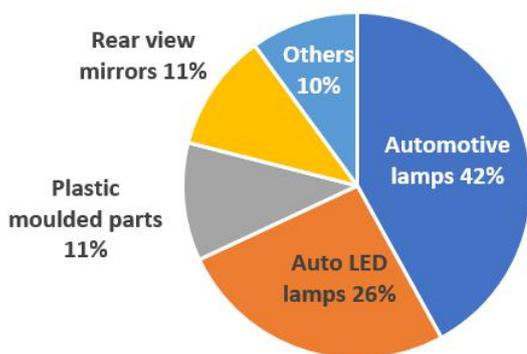


Chart 6.1.3.7: Fiem's main figures

Sales of FIEM are mainly for 2-wheeler market at 96%  
 Sales for 4-wheeler market are accounting only for 4% of FIEM sales

## Other Lighting suppliers in India (subsidiary or in connection with an international major lighting supplier)

**NeoliteZKW - Neokraft:** Neolite was founded in 1952.

The JV NeoliteZKW was established in 2007-2008 and largely oriented to exports, while the specific company Neocraft was created for local home market.

Currently, Neolite ZKW is employing 2000p in 4 plants and presented as the most important company for lighting exports. They have a very large catalogue of universal lamps and auxiliary lamps.



Chart 6.1.3.8 NeoliteZKW new plant



New LED rearlamp and new LED headlamp

## Valeo Lighting

Valeo is established in India near Chennai. Started to supply Renault and Nissan, the company has now diversified its customer base in India. They manufacture front lighting, rear lighting, fog lamps and special products in their plant, where is also implemented a RD center with nearly 200 engineers.

## Koito

End 2019, Koito took the control at 100% of IJL, a joint venture entity between Lucas TVS and Koito Manufacturing Co Ltd started in 1997.

IJL has operations in Chennai and Bawal in Haryana. It is setting up a third plant in Gujarat. In 2018-19, it reached a turnover of Rs 800 crore (€88 M) for both two-wheelers and four-wheelers.

It has a wide customer base, which includes Maruti-Suzuki India Limited, Tata Motors, Toyota-Kirloskar Motors, Honda Motor Company, Yamaha, Isuzu, Daimler, Ashok Leyland, Nissan and Renault-Nissan.



IJL Chennai Plant



IJL Bawal Plant

**Marelli- AL :** A JV for the India market was established in 2008 between Magneti Marelli and Motherson Sumi Systems for Lighting products



The International Centre for Automotive Technology (ICAT), located in Manesar in the northern automotive hub of India, is a leading world class automotive testing, certification and R&D service provider under the aegis of the Indian Government's NATRiP (National Automotive Testing and R&D Infrastructure Project).

## ICAT services:

- ❖ Certification
- ❖ Design and Development
- ❖ Testing and Validation
- ❖ Consultancy

## ICAT capabilities:

- ❖ Automotive Lighting/ Luminaries test facility as per latest AIS standards & ECE regulations.
- ❖ Light source / LED testing as per AIS standards & ECE regulations
- ❖ Measurement of retro reflective devices (retro-reflectors, tapes, markings etc.)
- ❖ General lighting measurements as per IS /IEC standards & CIE guidelines
- ❖ Measurement of light intensity, illuminance, luminance, luminous flux, UV, gloss, surface color, color etc.
- ❖ Research & development in the field of lighting technology, glare , visibility etc.



6.1.3.10: Examples of lighting equipment at ICAT

## Interview of Dr. Madhusudan Joshi *ICAT DGM – Electrical & Electronics*

**DVN:** ICAT is a part of Natrip (National Automotive Testing and R&D Infrastructure Project): can you explain what are the main goals and means of these organizations?

**ICAT:** ICAT is the National Certification Agency for Automotive in India and is one of the primary organization responsible for rule making related to Automotive in India. ICAT automotive lighting measurement laboratory started in June'2005 and had been going strong since then. ICAT Photometry Laboratory has major share of Indian homologation/certification work globally with all major automotive

lighting manufacturers as customers. Automotive Lighting, Hella, ZKW, Varroc, Valeo, Koito, Stanley, Magna, Lumax, Fiem, Neolite to name a few. Since July 2019 ICAT Photometry Lab has started offering services of General Lighting Photometry.

**DVN: Which activities have you particularly for Lighting and ADAS in ICAT?**

**ICAT:** In my opinion, intelligent automotive lighting has a big role to play as far as ADAS is concerned. Though the ADAS is a wide subject and its scope is changing rapidly, but I am sure that intelligent-lighting and signaling will have a vital role to play for all generations of ADAS.

**DVN: How many people are involved in these activities? Which equipment have you?**

**ICAT:** Photometry team at ICAT consist of 10 members who are involved in testing/ validation automotive lighting components. Some of the senior members also participate in regulatory committees both in India and abroad. We have wide variety of test equipment for measurement of light intensity, luminance, gloss, diffusion, haze, reflectivity, retro-reflection coefficient, lumen, luminance factor, color etc. In addition, it is also possible to carry out spectro-radiometry & dimensional analysis.

**DVN: How many tests and certifications are you doing every year for automotive lighting? Which market share have you in India for certifications in the domain of automotive lighting?**

**ICAT:** On an average we carry out 1000+ certification/tests in a year. It's difficult to estimate the market share for the Indian certifications done by ICAT, however we are sure that we have the largest share amongst all.

**DVN: In this domain, which relations have you with other organisms worldwide?**

**ICAT:** ICAT have very strong professional relationship with all the certification / test labs/ technical service providers all around the globe in the field of automotive lighting. All the major automotive lighting manufacturers and our customers directly or indirectly.

**DVN: Are you also realizing the homologation for exports models?**

**ICAT:** ICAT collaborates with all the major E-homologation service providers including TUV, TÜV, TÜV, BV, IDIADA, and VCA.

**DVN: In your internet site, you are informing working for antiglare headlighting system and dynamic headlighting system to improve visibility and reduce glare. Can you detail your research activities in these domains and your main achievements?**

**ICAT:** Topic of visibility and glare has been of interest for ICAT for more than a decade. We have done some work to study the problem of glare and visibility in Indian context. As you may be aware that India has very different road, driving and weather conditions. In our research we have tried to propose some solutions which helps to minimize the glare during night driving and improve visibility. This includes creating an awareness amongst the transport authorities of correct headlight aiming, purpose of main & passing beam, importance of clean headlights, and use of LED based signaling for better reflex. In addition, we have been educating the stake holders regarding the importance of - fog lamps, conspicuity markings, reflex-reflectors, retro-reflective road signage, road-safety devices to enhance active safety. As a result of these efforts, many regulations have been made mandatory since last 05 years for which we feel quite happy.

**DVN: For research, which kind of cooperation have you with car makers or set makers?**

**ICAT:** We are working closely with car makers and set makers to resolve the challenges they are facing in relation to field issues, design validation, product validation etc.

## 6.2 Brazil

### 6.2.1 Brazil's Automotive and Lighting Environment

Vehicles sales in Brazil:

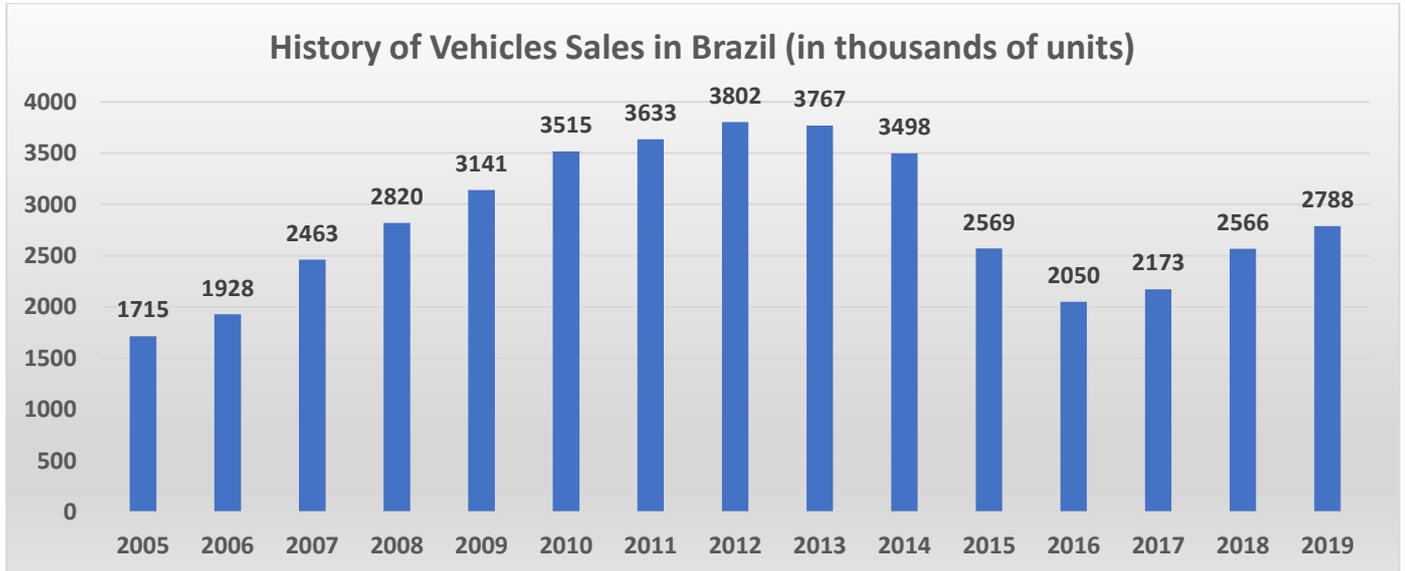


chart 6.2.1.1: Vehicle sales in Brazil, 2005-2019

Production in 2019 was 2.9m vehicles; 95 per cent of the production is for the Brazilian market.

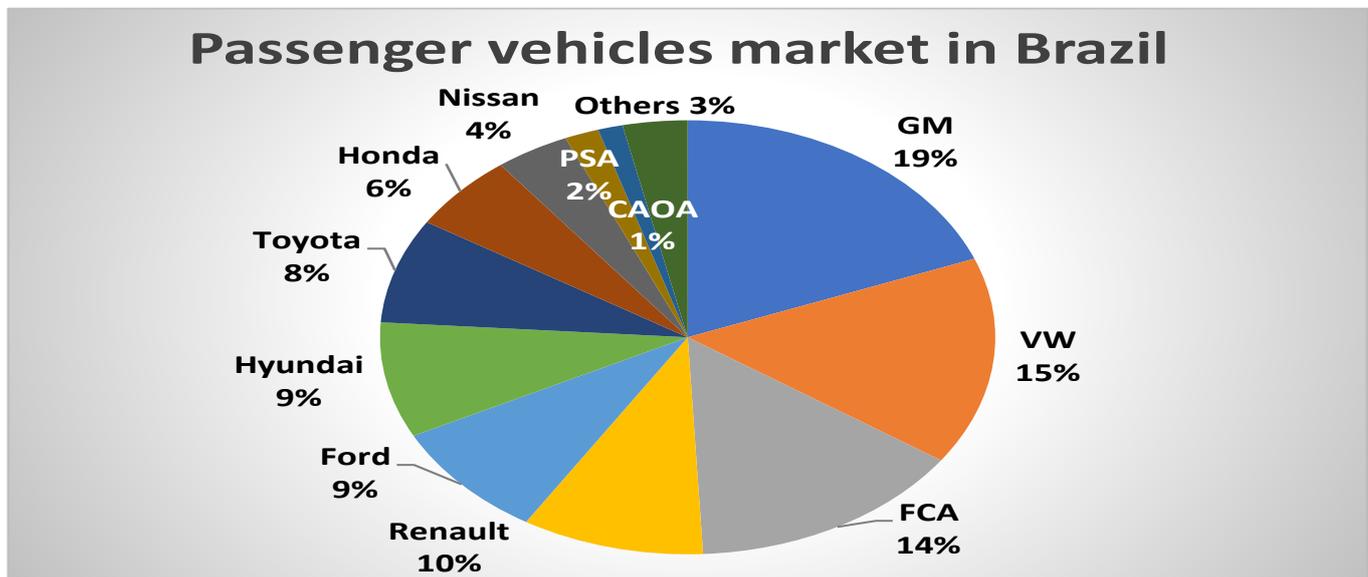


Chart 6.2.1.2: Passenger vehicle market in Brazil

Vehicle production in Brazil in 2019:

- Passenger cars: 2.45m units
- Light Commercial vehicles: 355,000 units
- Trucks: 118,000 units

Most cars sold in Brazil are locally produced, as the Brazil has a 35 per cent tariff on imported vehicles. Auto production in Brazil started in 1956 at São Paulo, the first companies being Chevrolet, Ford, Volkswagen, and Fiat. Since then, the automotive industry has grown extensively in many locations and with other car makers particularly from Japan and Europe.



Chevrolet Onyx: Market share 7.5 per cent



Ford Ka: Market share 5 per cent



Hyundai HB20: Market share 5 per cent

*6.2.1.4 Best-selling cars in Brazil, 2020*



Fiat Strada: Market share 5 per cent

## 6.2.2 Example Car Maker in Brazil: FCA



FCA's development in Latin America is driven by the Giovanni Agnelli Research and Development Centre, located in Betim (Minas Gerais, Brazil). The centre handles vehicle and powertrain design and engineering, and designs models that meet the specific needs and desires of Latin American consumers. These include the Fiat Toro (recipient of the iF Design Award and Red Dot Award for Design),

the Fiat Argo, and the Fiat Cronos.

The largest FCA production site in the world is in Betim (Belo Horizonte area), spanning 610,000 m<sup>2</sup> square meters with the capacity to produce up to 800,000 vehicles per year.



Fiat Chronos



Fiat Mobi



Fiat Argo

*6.2.3: Examples of cars from FCA for Brazil*



Jeep Renegade

## FCA interview with Mr. Dutra: “Adoption of LED headlights is the future”

DVN: Can you describe some of the problems about vehicle lighting in Brazil?

FCA M.Dutra:

- Headlight adjustment: it is neglected, especially in older cars. Even dealerships, despite having the regloscope, do not know how to make the adjustment correctly.
- Burned out bulbs: It happens a lot, especially in older cars / trucks.
- Misuse of headlights: Perhaps the most common of all. Almost all drivers turn on the fog lights unnecessarily. Some drivers use constant high beam on highways.
- Aftermarket with lots of bad products, blue lights, low quality headlights

- More recently, the use of LED chinese auxiliary lights along with the low beam by many drivers, just "to look beautiful"

**DVN: How do you see the transition to LEDs for car lighting in Brazil? Is it happening? How quickly or slowly?**

**FCA M.Dutra:** Considering the country's economic conditions, in a way it is quite present today. Several cars already have LED DRL, some have LED taillights, and more recently top-of-the-line cars are being offered with LED headlights, but still with few running on the streets.

**DVN: Do you think the car lights in Brazil adequately meet Brazilian conditions and needs? If not, what would fix them?**

**FCA M.Dutra:** Yes, they serve satisfactorily. Perhaps greater horizontal spread in the low beam, if possible. Many cars still use simple reflectors and H4 lamps, perhaps using separate reflectors / lamps for low and high light could help. Rear and side lights look ok to me. Note: In Brazil, as of 2009, all cars must have the third brake light, and as of 2016, it became mandatory to use the low beam on highways during the day. Before, use was optional.

**DVN: Some vehicles in Brazil have US-spec lighting systems because of the Mexico trade pact. Do you think these vehicles are more safe, less safe, or about the same as vehicles with the European-spec systems?**

**FCA M.Dutra:** Buyers care more about the look, little or nothing about the performance of the headlights.

**DVN: Are there aspects of drivers, roads, traffic, and culture in Brazil that are not well served because most of the world's lighting technical standards, regulations, and design/engineering seems to happen in developed countries?**

**FCA M.Dutra:** : I do not think so. Our biggest safety problem in Brazil is in the conservation of the roads, many of which are in poor repair, and consequently with a failure in the painting of the lines and a lack of signage.

**DVN: How do you see the future of car lighting in Brazil?**

**FCA M.Dutra:** Adoption of LED headlights by car manufacturers (as it is something that pleases consumers) even if it makes the value of the car higher. The rest must follow the American and European specifications, since historically this is what is done here in Brazil.

## 6.2.3 Lighting Suppliers in Brazil

The two first lighting set makers installed in Brazil were Cibié do Brasil and Ardeb. Cibié do Brasil, originally a Cibié licensee, are now part of Valeo Lighting and are located in Interlagos near São Paulo.



*Valeo Lighting plant Interlagos*



Other set makers came to Brazil following their customers. For instance, Hella started in 2011 with a plant at Itu and then another in Indaiatuba;

*Brazil Hella plant*

*Brazil Varroc plant*

Varroc started in 2017 at Sorrocaba with a plant with Mekra; Marelli AL have a location at Contagem, and Koito started in 2017 (NAL do Brasil) at Sorocaba



*Koito Sorocaba plant*

Arteb was founded in 1934 by Artur Eberhardt in São Paulo. They produced their first OEM lighting equipment in 1959 for VW, the “Beetle” headlamp, combining the most modern elements at that time, included asymmetric bulbs, round parabolics, glass lenses with optics and metal reflector. In 1967 the São Bernardo do Campo plant was built (photo, red buildings) with a good strategic location near the port of Santos, one of the biggest in America, and a good flexibility to allow production expansion.



*Arteb São Bernardo do Campo plant*



*Arteb Sian plant*



In 2002 Sian was installed in Camaçari (Bahia States), near to Ford Motor Company. In 2013 Artebtech started its activities also in São Bernardo do Campo, near to Arteb plant.

The main achievements of Arteb in the past in their national and South America markets were the first CHMSL released (1986), the implementation of headlamp reflectors with BMC (1990), the first tail lamps in multicolor plastic lenses (1995), the polycarbonate lenses for headlamps (1999).

In 1990 the company started its exportations. Historically Arteb counted with a licensing technology with the German-based Hella, but during the last decades the company developed its own technological body.

In 2000 to improve vehicle safety and to be more autonomous for developments, Arteb received the INMETRO (Brazilian institute for Quality) accreditation for automotive lighting systems, an LCOE (Spanish organization for UNECE homologation) agreement for lighting and signaling systems (2005) and a quality management system certification by UCA (Spain 2014).

In 2003 Arteb was the first South America company of its segment to participate in NAFTA.

To better prepare the new technologies, Arteb installed in 2005 its new Technological Center with a complete R&D structure including a night drive laboratory, and in 2013 started Artebtech (2013) to develop and produce the last generation of lighting systems with Electronics.

Arteb has now all the staff to do all development phases and has received several certifications including ISO 9001 (1997), QS 9000 (1998), INMETRO (2000), ISO 14001 (2004) and IATF 16949 (2016) for all plants. They have also received rewards from customers as VW VDA, VW Supply Awards (2006), FORD Q1 (2007 to Sian and 2017 to Arteb), TOYOTA Employees Certification (2013) and GM BIQS (2017).

ARTEB main figures:

- 1200 people
- On more than 42,000 sq m<sup>2</sup>
- 12 million products per year – 40% market share in Brazil

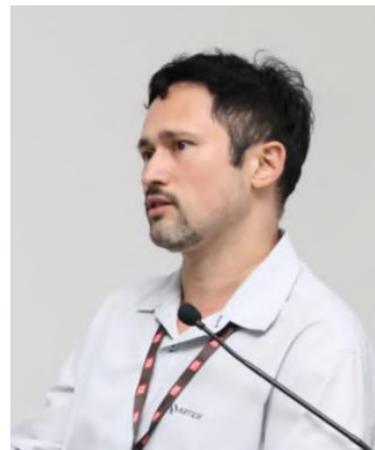
## Interview from Arteb Management: “ We are leader in Brazil and concentrated on autonomous development”



Jarbas Enzenberg  
Engineering and Quality Director



Egidio Vertamatti  
Executive Manager



Carlos Moura  
R&D Coordinator

**DVN: Could you introduce Arteb, the main shareholders, sales in Brazil, facilities, and people?**

**Arteb:** Arteb is a traditional and iconic brand of lighting and signaling auto parts on Brazilian market, presented in most part of national fleet. The company name comes from initial letters of Mr. Artur Eberhardt, its founder and owner. His son, Mr. Pedro Eberhardt, is the current president of the company. Along its 86 years, the company has remained as a pioneer supplier of high-quality products, always introducing new technologies and increasing the vehicle safety level.

Today the Arteb Group is composed of three brands: Arteb, Artebtech and Sian. Located near to each other, Arteb and Artebtech are in São Paulo States. Sian is in Bahia States. Among these brands, Arteb is the biggest, having 36000 m<sup>2</sup> in its development and production structure, which includes a manufacturing area for small components and a Technological Center (CTA). Conceived to be the strategic place for research and developments, CTA has an engineering and laboratory team highly equipped with some of the best global market tools. To improve lighting developments, CTA has a night drive laboratory, a tunnel with a dark urban scenario where prototypes can be evaluated anytime, without worries about weather, daylight or season conditions, since it's closed. This feature is unique in Brazil but is not the only exclusive CTA advantage, its laboratory for product validations – including tests as photometry, colorimetry, vibration and so on – is the only one in automotive market that has maintained, for two decades, an accreditation with INMETRO (National Institute of Metrology, Quality and Technology). The structure includes a long agreement with LCOE, from Spain, to homologate devices according to UNECE regulations (e-mark code).

Artebtech activities, in a 1000 m<sup>2</sup> area, started in 2013 focused on electronic devices, especially conceived to promote lighting in the new era of embedded electronics. The goal is to produce sustainable solutions, with higher energy efficiency, excellence in automotive standards and best practices.

Sian started in 2002, with 6000 m<sup>2</sup> and focused to supply Ford Motor Company, something already done to other customers in the past, and possible to do in the future, that is to say: be closer as necessary and convenient from both parts in favour of successful business.

The Arteb Group has a long tradition in patents for more safer and robust products, among them its

antifog coating and its sealing materials. Both solutions combined, due to its technical properties with mutual protection, are responsible for long life headlamps.

Encouraged with vehicle safety, Arteb has a strong presence on national debates around technical standards, laws, automotive forums, and specialized media. Its structure has gained a lot of awards due to its updated quality management (including the IATF 16949 certificate), environment policy and best practices by automotive rules and criteria.

Today Arteb Group has 1200 employees and continues to be the leader of national market, its brands can produce together 12 million samples per year. The company has been the market-leading for decades and its market share today covers 40% of all lighting systems produced.

**DVN: Vehicles sales in Brazil have important ups and downs, with 1,7M in 2005, 3,8M in 2012 decreasing to 2M in 2016, going up again at 2,8M in 2019 improving by 8,6% compared to 2018. First months of 2020 are also showing a similar level of rise compared to 2019 despite the severe Covid crisis that in the world will strongly reduce sales. What are you thinking about these evolutions and about the future?**

**Arteb:** In fact, numbers change year by year, but we are optimistic in terms of future. The reason is that, even with global crisis, we did not stop producing and to work with new projects, most of them with deeper design complexity, from both materials and electronics aspects. We are seeing carmakers and government in a same engagement for a safer vehicle, which includes the Route 2030 program<sup>1</sup>. And since there is no vehicle safety without high-quality headlamps and tail lamps, we see a lot of opportunities for the next years, mainly for lighting with more electronics, and we are prepared to offer what market needs.

**DVN: What is your activity for exportation? What do you intend to do in international markets?**

**Arteb:** Historically, we have a long presence in the international market, not only to Latin American but also to EUA, Mexico, South Africa and India. The company is opened to international market and some of its strategies include a Chinese Office and a New Business department. All these actions not only improved our products, to combine more and more competitive costs and high technologies, but also let us closer to more potential customers. Some of our new business during the last years came from such placement. We have some more strategic actions to do for the next years, but we prefer to talk about it in another opportunity, showing cases that today are confidential.

**DVN: Which cooperation have you with other set makers? Have you any target for other kinds of cooperation?**

**Arteb:** We had some cooperation in the past, but now we are more concentrated on autonomous growing, incorporating to our structure what is necessary. We are not against cooperation and partnerships, but we try to guarantee our autonomy every time that is possible, especially when new technologies, know-how and intellectual properties are involved. Such vision was on the base of Artebtech creation and it was decisive for our current moment, more prepared than ever for new lighting technologies.

**DVN: Can you present some significant product realizations?**

**Arteb:** Considering that LED usage, especially high-power models for headlamps with complex electronic drivers, only now is expanding in Brazil, unfortunately some of our best examples cannot be shown yet, since they are under development. However, you can see hereafter some current products.

**DVN: What is the level of penetration of LEDs currently in Brazil for signal and for main beams? What is your prediction for the future?**

**Arteb:** Traditionally Brazilian market use to concentrate its LED usage on signaling devices, especially

DRLs, front and rear position lamps. So, the LED penetration is not deep as we expected when Artebtech started its activities (2013), anyway this penetration is growing faster for the last 2 years, based on our current developments.

Along the last years our expectation was even more optimistic, especially due to the mandatory DRL use for vehicles produced from 2023. But this year, due to the COVID-19 impact, such implementation was reviewed and gained one year more to be implemented (2024). Anyway, some customers remained considering DRL on its future releases, so the impact in fact exists but can vary according to each case, since there are suppliers more concentrated in signaling devices than others. By our side, the impact was not too heavy but remains as a negative phase considering the market as a whole.

Our prediction for the future remains optimistic, because national law will turn mandatory<sup>2</sup> not only DRL but also lateral turn signal lamp (ECE category 5 or 6) and emergency braking signalling devices, all of them works better with LEDs and can cover a huge number of cars.

**DVN: How are you developing the electronics needed for new generation of lighting products?**

**Arteb:** Almost 10 years ago we built Artebtech, this was our first step in such direction. We spent last years enriching Artebtech development structure, including high-level tools such as software, last-generation machines for assembly components and prototype building, training for the engineering team and so on.

Part of our strategies, in order to keep the engineering team updated, includes participation in automotive fairs and congresses, deep analysis covering recent embedded systems publications (standards, laws and papers), benchmarking, prototypes building and tests. Beside such involvement in technological aspects, we always try to balance it with the commercial factors by developing and validating strategic components suppliers. Our goal on it is to increase our competitive force, blending new technologies with attractive costs.

**DVN: What do you think about the most advanced lighting technologies as ADB? What could be its future in Brazil and how are you preparing these advanced technologies?**

**Arteb:** Light control techniques for the automotive market is growing fast, a progress that will turn traffic safer and driver work easier. We think that ADB is the future of lighting almost like Autonomous Vehicles is the future of current cars, both technologies can reduce accidents due to human factors. Distraction by manual adjustments in headlamps is a serious problem, as indicated by NHTSA in its report "Distracted Driving (2018)"<sup>3</sup>, so ADB is a big step to safer driving.

We think that such technology can gain a diffusion during the next years, especially because since 2017 AFS is considered in Brazil by CONTRAN<sup>4</sup> (National Traffic Council). The concept, as it was published in Portuguese, followed UNECE Regulation 123. So, in our comments we'll consider both AFS and ADB as synonyms due its similarity in autonomous operations.

Arteb spent the last years, since Artebtech started, preparing such technology by the combination of different efforts like deep researches, benchmarking and prototypes. Anyway, we can't ignore that Brazilian market is still growing in a step back: the transition between halogen system to LED, both in a common lighting conception, based on the UNECE Regulation 112.

Considering this, we think that the easier way to promote AFS faster is to go on with short steps. Technological innovations are allowed by CONTRAN, so by this way we can develop and validate a headlamp only with some AFS features, such as automatic changes between low and high beam instead of all AFS classes. Such a proportion of technology implementation can be done not as AFS or ADB, but as it really is in our legal mechanisms: a technological innovation. Something like that can bring

innovations gradually, preparing the market for a future AFS diffusion in its complete set and costs. So, returning to the main point, Arteb is preparing the future of lighting in more than one way, doing its best to a full technology application and also researching law mechanisms to help customers to see opportunities.

**DVN: Road safety in Brazil seems difficult with roughly 20 deaths people for 100000 habitants, compared for instance to 4 deaths in Germany, despite more vehicles on the roads. Do you think that lighting systems could help to improve safety? Which specifications could be the most useful for safety improvement?**

**Arteb:** Considering how lethal traffic accidents can be at night, lighting systems can make a huge difference in vehicle safety. As a lighting system supplier, we always work to offer the safest product, but we know that our job is not completed without good practices driving, such as appropriate use of each lighting function, respect to speed limits, attention to traffic laws and weather conditions. Also, people responsible for vehicle inspection must do their best in order to avoid traffic with aged lighting systems, we mean especially headlamps with yellowish PC lenses by long exposure to UV rays. Brazilian government can improve some actions on such direction, probably through the popularization of lighting as essential for traffic safety, maybe including heavy fines for aged headlamps and tail lamps, this can bring another level in Brazilian fight against unsafe traffic.

Besides advanced technologies, like AFS, and a stronger work to banish unsafe condition during traffic inspection, we think that safety improvements depend on human conscience too, so education for traffic plays an important role on it. Brazilian government uses to work with educative campaigns<sup>5</sup>, clarifying about traffic risks, but we think that such efforts must be extended to all public and private schools, for children and young people, in order to achieve better and stronger results.

**DVN: How do you see the future of lighting in Brazil and the future of Arteb?**

**Arteb:** We see a great future of lighting in Brazil, our national laws and standards are designing a safer market each year. Government programs, such as Route 2030, clearly indicate the country's compromise with sustainable and safer progress.

Besides this promising horizon, Arteb easily sees itself as an active player for the next years, strong enough to be a smart option for all carmakers. Some of our efforts to say that and to face challenges in an optimistic view include, beyond all we mentioned above, our newer strategies in commercial and marketing, with an updated website<sup>6</sup> and a stronger presence on social media channels and automotive events. Such movements allowed a better relationship with OEM and aftermarket customers, also these improvements are continuing to help with a newer brand perception, something essential for a long-living presence in such a demanding market.

The future of lighting in Brazil is rich in possibilities and Arteb certainly will be part of it, especially because we were working and building this same market for the last 85 years. Above all, since tradition and innovation are in our DNA, we are equally prepared to face challenges, promote solutions and seize opportunities.

<sup>1</sup> REFERENCE (portuguese): [http://www.planalto.gov.br/ccivil\\_03/\\_Ato2015-2018/2018/Lei/L13755.htm](http://www.planalto.gov.br/ccivil_03/_Ato2015-2018/2018/Lei/L13755.htm)

<sup>2</sup> REFERENCE (portuguese): <https://www.gov.br/infraestrutura/pt-br/assuntos/transito/conteudo-contran/resolucoes/resolucao7992020-1.pdf>

<sup>3</sup> REFERENCE: <https://crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/812926> <sup>1</sup> REFERENCES (portuguese)

<sup>4</sup> REFERENCES (portuguese): [https://www.gov.br/infraestrutura/pt-br/assuntos/transito/conteudo-contran/resolucoes/anexos\\_resolucao\\_667\\_17\\_atualizado.rar](https://www.gov.br/infraestrutura/pt-br/assuntos/transito/conteudo-contran/resolucoes/anexos_resolucao_667_17_atualizado.rar)

<https://www.gov.br/infraestrutura/pt-br/assuntos/transito/conteudo-contran/resolucoes/resolucao6672017.pdf>

<sup>5</sup> REFERENCE (portuguese): <https://www.gov.br/infraestrutura/pt-br/assuntos/transito/conteudo-denatran/semana-nacional-de-transito-2020>

<sup>6</sup> REFERENCE (portuguese): <https://www.arteb.com.br/>

**Arteb LED products:** Beyond DRL and Front Position with LED (the trend of last years in Brazil), Arteb has developed the LED technology in some more functions, including main beams

**1 Bicoloured lens    2 Electronic driver**

**3 LED projector module with passive cooling    4 DRL and position lamp with LED**



**1 – Antifog coating on lens    2 – Partial metallization    3 – LED module for its second version with DRL/Position**



**LED Rearlamps from Arteb:** Arteb always worked for LED diffusion, and when it was difficult due to cost impact, some combined features was done to improve the results according to customer desire. In this case, a hybrid light source tail lamp, a optic strategy was done to improve the lit aspect performance (bright dots like LED application).



*1- Tail lamp with replaceable LED module (with variable numbers of LEDs lits between 2- Bulb optics with "LED lit aspect" (bright dots) 3- Version with rear fog lamp*



*1 - Full LED tail lamp*



*2 - Lateral turn signal lamp in plastic light guide*



*3 - Lateral turn signal lamp*



*4 - Some CHMSL models*

**More style with LEDs:** Some signaling devices with optimized illuminating surface for high homogeneity. Such applications include different optic strategies, more components with specific materials and variable finishing



*Arteb rearlamp on VW T-Cross*



*Redesign of products with LED application*



## 6.3 Mexico

The automotive sector is one of Mexico's most significant industries, employing over a million people throughout the country. The sector is divided between the passenger vehicle sector and heavy vehicles for cargo, construction, and agriculture. Mexico is the N° 6 passenger vehicle manufacturing country in the world, producing 3.7 million cars annually. It is the N° 5 producer of auto parts worldwide with USD \$99bn in annual revenues, and is the largest export market for U.S. auto parts. Mexico is the N° 6 manufacturer of heavy-duty vehicles for cargo, and it is the largest tractor truck exporter worldwide, accounting for the most heavy-duty vehicle exports to the United States. It is also the fourth-largest exporter of heavy-duty vehicles for cargo and the second-largest export market for U.S. heavy-duty trucks.

The size of Mexico's passenger vehicle market and the shared border provide a robust market for U.S. automakers and suppliers. In addition, investments by established automakers and new automakers have attracted strong tier-1 and -2 supplier bases.

A replacement for NAFTA (the North American Free Trade Agreement), called CUSMA (the Canada-US-Mexico Agreement) took effect in 2020. CUSMA changed the rules of origin for the automotive sector, requiring that 75 per cent of automotive content be produced in North America and that core auto parts originate from the United States, Canada, or Mexico. Following a phase-in period, only goods meeting these content requirements will receive duty-free access.

Many car makers from USA (GM, Ford, Chrysler); from Japan (Toyota, Nissan, Honda, Mazda); and from Europe (VW, Audi, Fiat) have manufacturing plants in Mexico. Following their customers, many lighting suppliers (Valeo, Hella, Marelli AL, Koito) also operate important facilities in Mexico with a high level of quality.

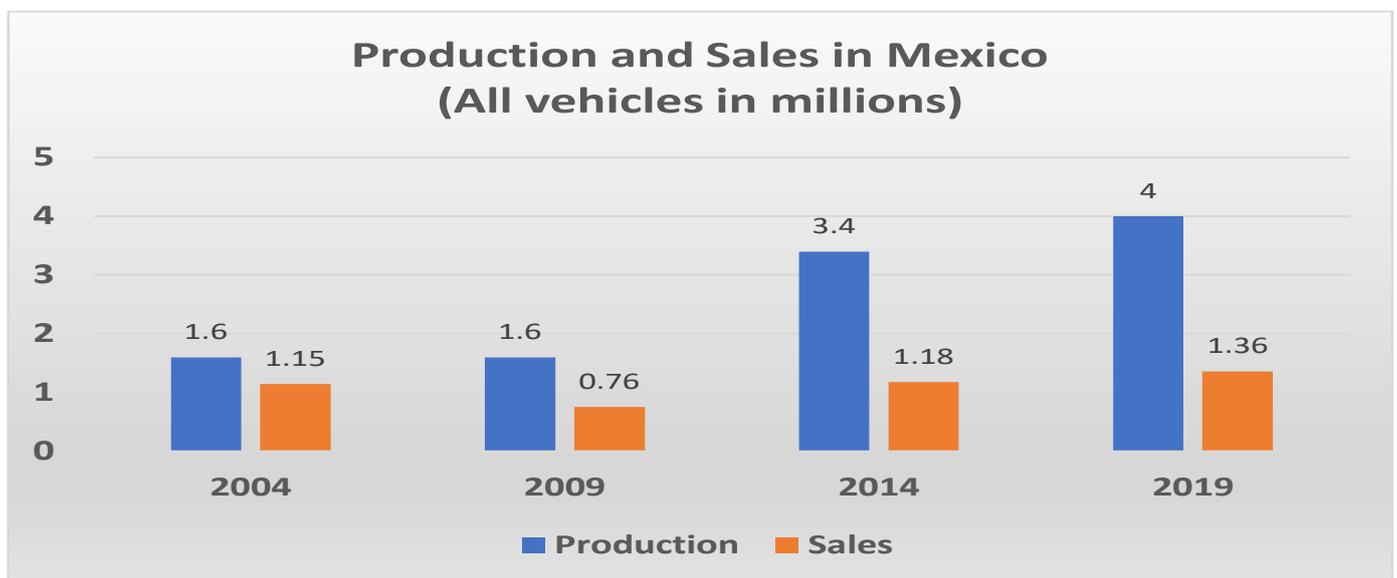


Chart 6.3.2: History of vehicle production and sales in Mexico

## Lighting suppliers in Mexico

Valeo, Hella, ZKW, Koito, Stanley, and Marelli have production plants in Mexico, with quality and technology comparable to US and Canadian plants. Generally these Mexican plants, with young and well-educated employees and modern facilities, are among these setmakers' most productive plants worldwide.

Examples:

- Hella Automotive Mexico: Start of operations in 2014 - 2200 employees, 55000 m<sup>2</sup>
- Valeo Lighting started operations at Queretaro in 1999. A design centre opened in 2017.
- Marelli's Mexican plant is in Juarez
- Koito-NAL Mexico started in 2012, employing around 1,300 at San Luis Potosi



*6.3.5: ZKW plant in Silao, Mexico*



*6.3.4: Mexican Koito NAL plant*

## 6.4 Other South American Countries

The other South America countries involved in the automotive industry are Argentina with a production of 315,000 vehicles, and Colombia with 60,000 vehicles.

Argentina in 2013 produced 791,000 vehicles, a milestone from which the decline began: 617,000 in 2014; 543,467 in 2015; 470,000 annually between 2016 and 2018; and only 314,000 in 2019. There are 12 automotive plants there, some of which have been operating for almost 100 years. In 1925 Ford built their first Model T in Latin America in Buenos Aires. Volkswagen, Peugeot, General Motors, Citroën, and, in recent years, Japanese brands such as Toyota, Honda, and Nissan have opened up shop in Argentina. Fiat, Renault, and Iveco operate in Córdoba.

There are also lighting suppliers in Argentina, prominently including Valeo Lighting (previously Cibié Argentina), located at Cordoba.

## 6.5 Indonesia

The automotive industry in Indonesia plays an important role, contributing 10.16 per cent of the country's GDP. Indonesia's automotive product exports are currently higher in value than their imports. Indonesia is the N° 17 vehicle-producing country in the world, and the N° 5 passenger vehicle producer in Asia, building around 1.3 million vehicles annually lately.

In 2019, 96.3 per cent of cars and trucks sold in Indonesia were from Japanese brands, Toyota being the strong leader in the market along with their Daihatsu subsidiary. That same year, 26 per cent of vehicle production was exported, and imported cars amounted to 7 per cent of sales.

Due to the high taxes (50 to 75 per cent) on sedan-type cars, most vehicles are MPVs with three rows of seats, minicars, and pickup trucks.

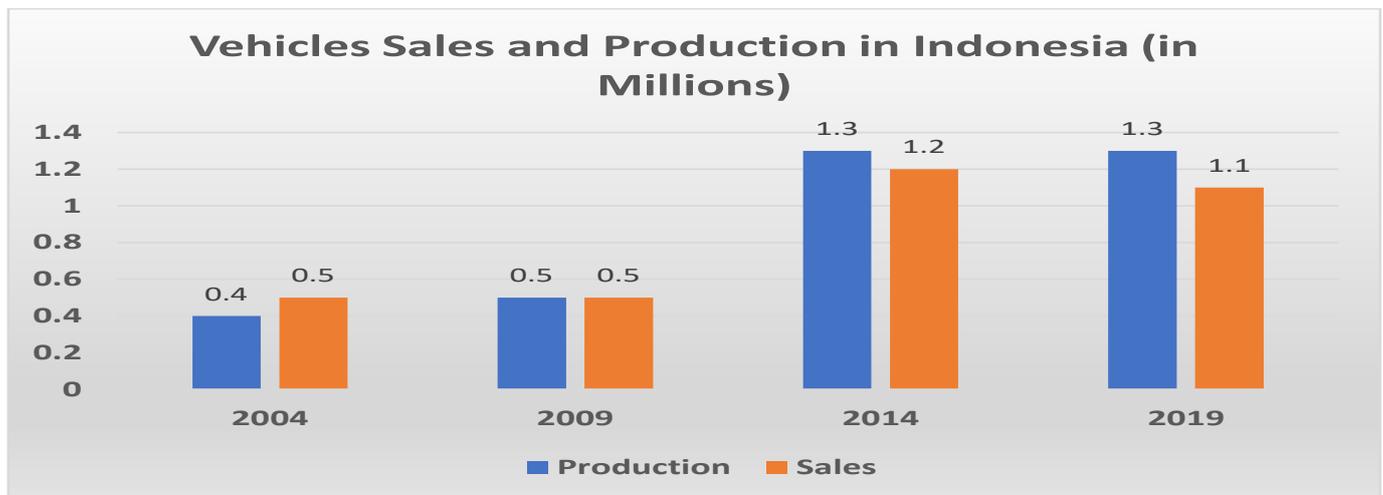


Chart 6.5.1: vehicle sales and production in Indonesia



*Toyota Avanza, Indonesia's best-selling car since 2016.*

*Toyota Astra plant, one of the main plants in Indonesia*



*Astra Daihatsu headquarters in Sunter, North Jakarta. In 2019, 41 per cent of the total Indonesian production came from ADM (Astra Daihatsu Motors).*

Chart 6.5.2: Vehicle production in Indonesia by maker

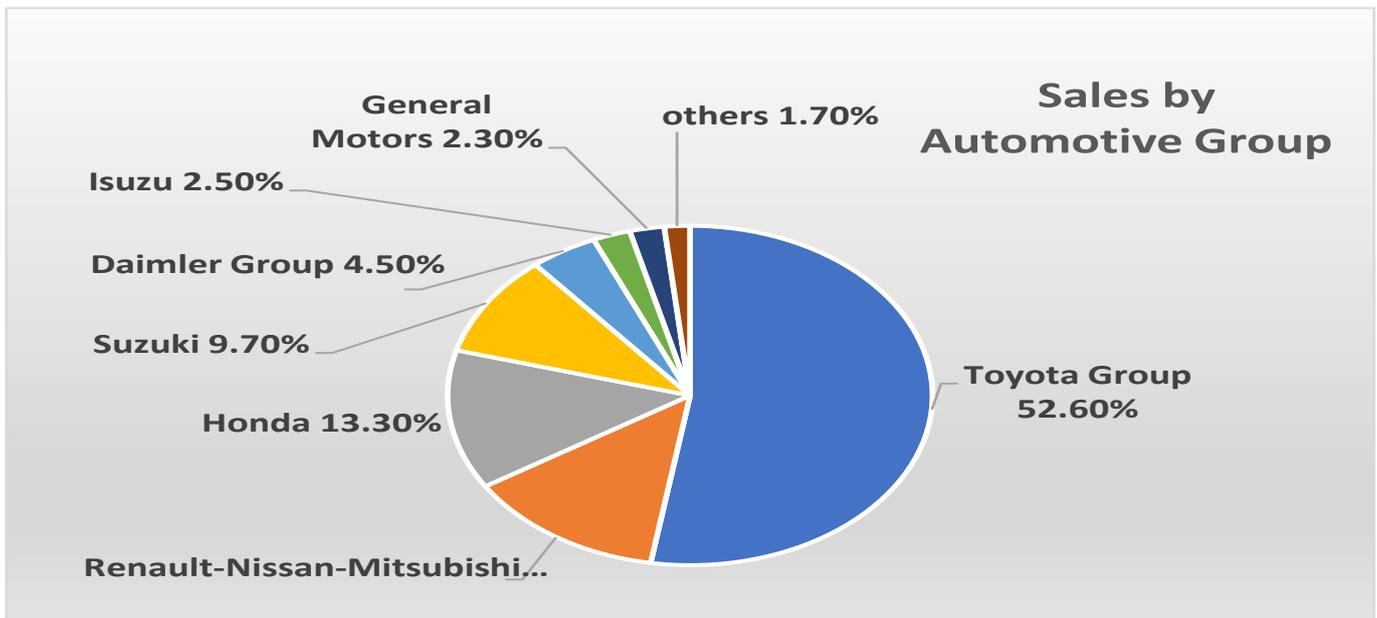


Chart 6.5.3: Vehicle sales in Indonesia by maker

Lighting suppliers in Indonesia are mainly subsidiaries of Japanese set makers:

- Indonesia Koito: \$60m, 700 employees in Java
- Ichikoh Indonesia in West Java
- Stanley Indonesia

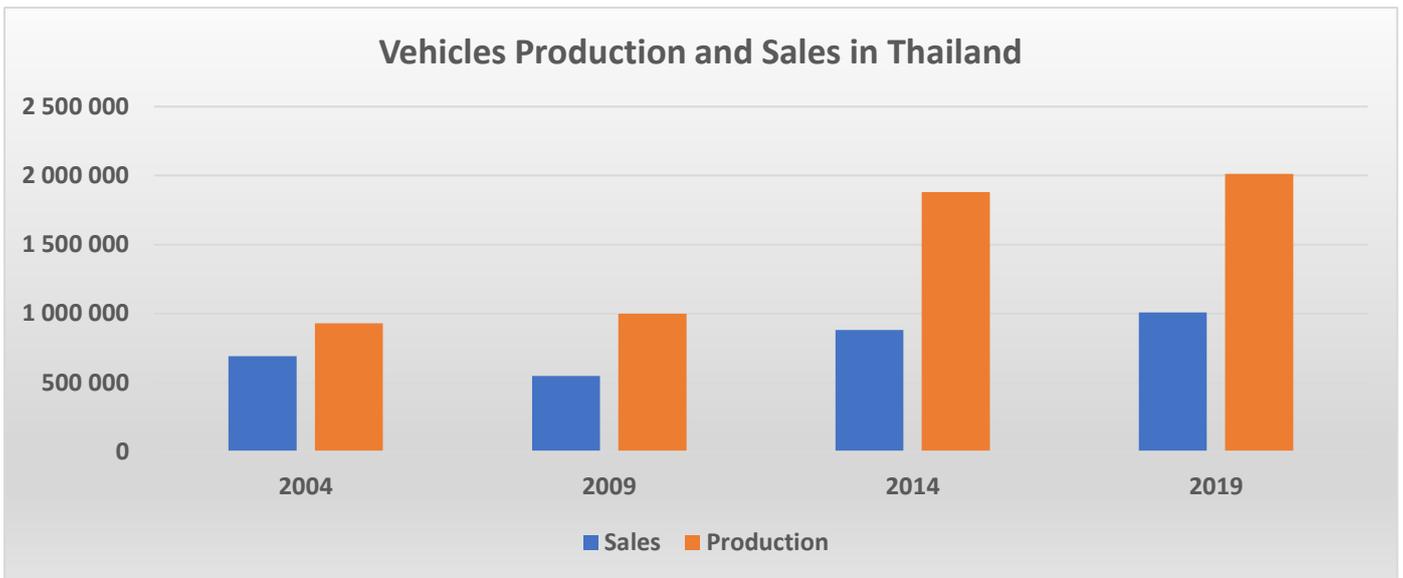


## 6.6 Thailand

The automotive industry in Thailand is the largest in Southeast Asia and the 12<sup>th</sup>-largest in the world. It is the country's top economic sector with around 12 per cent of the GDP. The Thai industry has an annual output of nearly two million vehicles—mostly passenger cars and pickup trucks—which is similar to France and more than countries such as the United Kingdom, Italy, Czechia, and Turkey.

Most of the vehicles built in Thailand are developed and licensed by foreign producers, mainly Japanese, American, and Chinese, but with several other brands as well for KDX (knocked-down export) assembly, notably BMW and Mercedes. The Thai car industry takes advantage of the ASEAN Free Trade Area (AFTA). Thailand is one of the world's biggest markets for pickup trucks with over 50 per cent market share for one-ton trucks.

With production of 2 million cars per year and sales of a million cars, Thailand is exporting more than a million cars per year. Exports represented 12 per cent of the country's total exports in 2017 at \$28bn.



*Chart 6.6.1: Vehicle Production and sales in Thailand*

Japanese car makers practically own the Thai market:

Toyota HiLux	Isuzu D-Max	Ford Ranger	Mazda2 <sup>E</sup>	Toyota Yaris <sup>E</sup>	Mitsubishi Triton	Honda City	Honda Civic	Toyota Yaris ATIV <sup>E</sup>	Toyota Fortuner <sup>P</sup>
1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th

*6.6.2: Best-selling cars in Thailand, 2019*



*6.6.3: Toyota Hilux Revo, Thailand's N° 1-selling model*

Lighting set makers in Thailand are mainly Japanese as they have followed Japanese car makers:

- Thai Koito established in 1986 and employing 2,400
- Ichikoh Industries Thailand
- Thai Stanley Electric



## 6.7 Turkey

Turkey is an important market with more than 80 million people, but the development of the automotive industry was mainly due to low local wages and the geographic position close to the European market, particularly when Turkey was seeking to join the EU—a bid now considered dead for the foreseeable future. Nevertheless, Turkey is still taking profit of advantageous tariff agreements for their strong exports to Europe and elsewhere. Over half a million people are employed in the Turkish automotive industry.

The current decrease in the Turkish market reflects the economic turmoil that also torpedoed the country's EU membership bid. After a peak of one million vehicles built in 2017, this decreased by 35 per cent in 2018 and another 23 per cent in 2019 to reach 491,000 units.

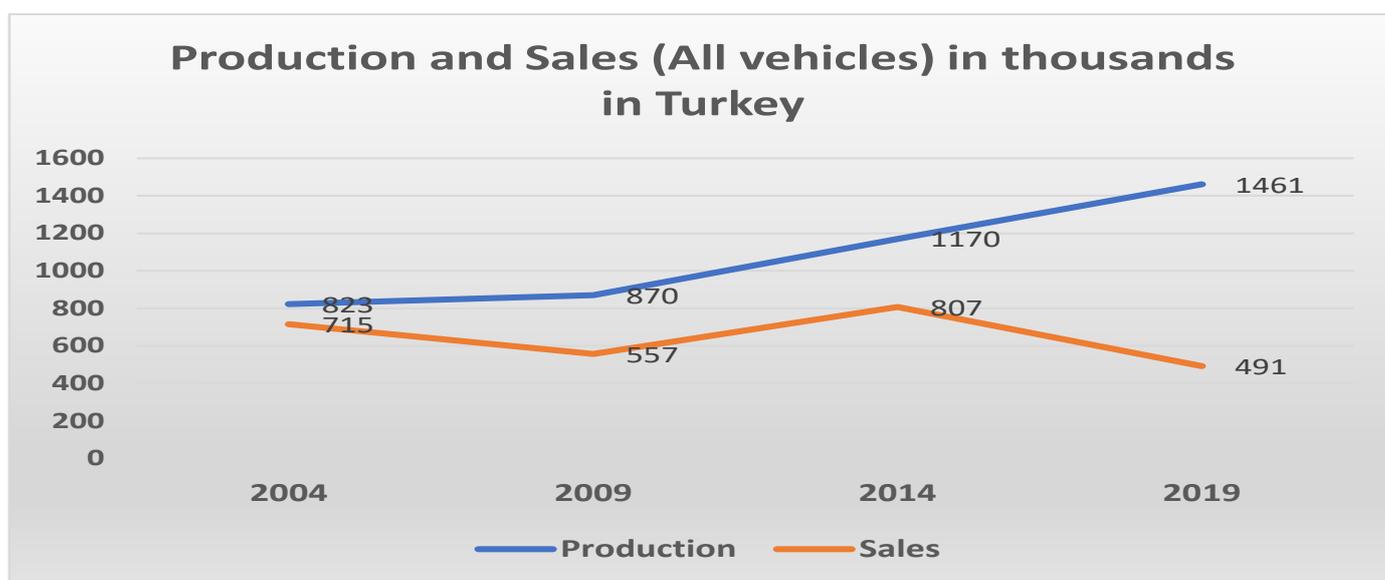


Chart 6.7.1: Production and sales of vehicles in Turkey

### Automakers in Turkey

Turkey's main car makers are mostly subsidiaries of international companies, such as:

**Ford** - first factory in 1959. Production capacity of 415,000 cars per year. The Turkish affiliate is considered Ford's European commercial vehicle manufacturing hub, and exports also North America (Transit Connect vans). The company also owns Turkey's largest R&D centre located on a single campus, in Istanbul. Its exports are worth USD \$4.8bn in 2017 to 83 countries. It is also one of the three largest R&D centres of Ford Global.

**Renault** - Annual production capacity of 375,000 cars and 750,000 engines with over 6,300 employees.

**Fiat** - Established in 1968. Capacity of 450,000 vehicles per year with more than 9,000 workers. The R&D centre in Bursa is the only such Fiat facility outside Italy serving the European market.

**Hyundai** started to manufacture in 1997 in their Izmit factory. Total production capacity of 245,000 vehicles annually, and over 3,000 workers.

**Toyota** have invested almost \$2bn since entering Turkey. They currently have over 3,500 employees, and a 280,000-car annual production capacity.

**Mercedes** production started in 1968, and now there are two Turkish Mercedes plants: a bus factory in Istanbul and a truck factory in Aksaray. The total investment of the company in Turkey amounts to €1bn, and the staff numbers over 6,000.

**Honda** - Production of the Honda Civic started in 1997. Honda's Izmit factory has an annual production capacity of 50,000 cars with over 1,500 employees

**MAN** opened their first factory outside Germany in Turkey in 1966. It is the largest integrated bus company of MAN Global with 2,000 units annual bus production capacity and over 2,000 employees.

Local vehicles makers are more orientated to production of buses, trucks, or special cars:

**BMC:** Commercial buses and trucks

**Etox:** Sports cars

**Onuk:** Super car

**Otokar:** Buses

**TEMSA :** Buses and light trucks

**TOGG:** Togg are the first Turkish national car company, launched in 2019. Togg comprises five Turkish companies under the support of the government to produce electric vehicles. The first model, a C-segment SUV designed with Pininfarina, is targeted to be in production in 2022 near Bursa.



*6.7.2: First TOGG vehicle, with a modern all-LED lighting system*

## Lighting Set Makers in Turkey

### Farba-Odelo:



Farba was established in 1979 in Bursa under the umbrella of Bayraktarlar Holding, created in 1935. They initially manufactured lamps under licence from Cibié (now Valeo). A Koito licence in 1992 and a new Valeo licence in 2000 positioned Farba as one of the main OE lighting suppliers in Turkey. Farba took an important step towards becoming global by purchasing German company Odelo in 2011, a company involved in lighting since 1935.

Before the Odelo purchase, Farba were supplying Renault, Fiat, Toyota, Ford, Daimler, and local carmakers. With Odelo on board they are now also providing lights—especially tail and signal lights—to the VW Group and other car makers. Farba also established a plant in China in 2013. They operate plants in Slovenia, Bulgaria, and Mexico, and they export to South Arica under Koito licence.

In January 2019, the company decided to use the name Odelo for all automotive activities.

In 2014, Odelo-Farba Group had a turnover of €316m and around 3,000 employees.

R&D represented 4.5 per cent of total sales.



6.7.3: Odello Plants: Gebze, Turkey (Left); China (Middle); Bursa, Turkey (Right)

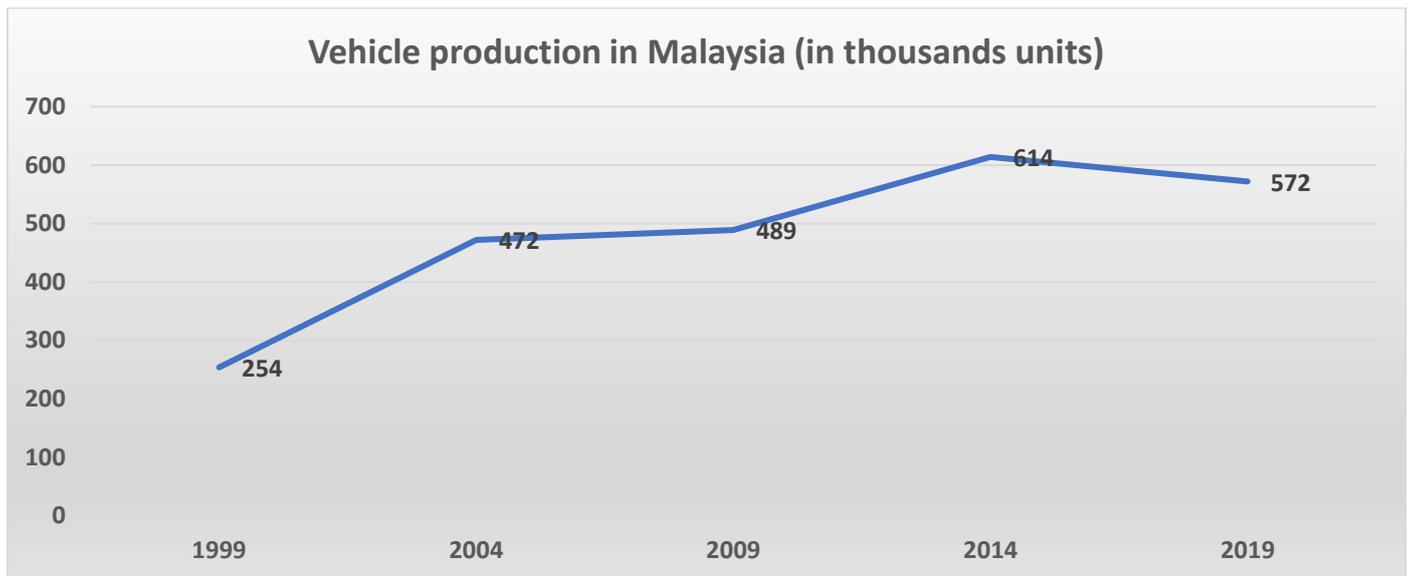


6.7.4: Examples of Odello products

**Varroc** in 2018 bought Sa-ba Automotive, a privately-owned Turkish company specialising in small lights for vehicle interior and exterior applications. The buy included Sa-ba's 10,000m<sup>2</sup> manufacturing and technology centre near Istanbul, and a new 20,000-m<sup>2</sup> plant in Dimitrovgrad, Bulgaria.

**Marelli** acquired Bursa-based Mako in 2005. Mako was established in 1970, and by 2001 they were exporting vehicle lighting components to Europe. By the time Marelli bought them, Mako's OEM customer list for headlamps, rear lamps, and small lamps included BMW, Chrysler, Ford, Hema, Honda, Hyundai, AOS Isuzu, Uzel Massey Ferguson, Otokar Deutz Magirus, Otoyol Iveco, Karsan Peugeot, Mercedes, Oyak Renault, Tofaş Fiat, Toyota, and Volvo. This list expanded further as the Bursa plant grew more modern and capable.

## 6.8 Malaysia



*Chart 6.8.1: Vehicle production in Malaysia*

Sales in Malaysia are slightly higher than the production with 604,000 vehicles in 2019, relatively stable since 10 years after a 100 per cent (plus) increase from 170,000 in 1990 to 350,000 in 2000.

### Main manufacturers in Malaysia:



**Perodua** are the leading manufacturer and seller in Malaysia, selling 240,000 cars in 2019.



Proton are the other local manufacturer with 12,000 people making 100,000 cars in 2019, a major uptick after several years at around 70,000.



## 6.9 Iran

The automotive industry in Iran is second only to that country's energy sector, accounting for some 10 per cent of the gross domestic product and 4 per cent of employment. More than 100,000 people are employed by the two largest local manufacturers, Iran Khodro (IKCO) and Saipa, while another 700,000 Iranians work in industries related to car manufacturing.

These local manufacturers had strong relations with European partners particularly Peugeot group and Renault, but those cooperative arrangements were torpedoed by the American sanctions in 2018. Now, the automobiles industry in Iran is trying to be independent from external sources—a difficult task given the difficulty of procuring some necessary materials.

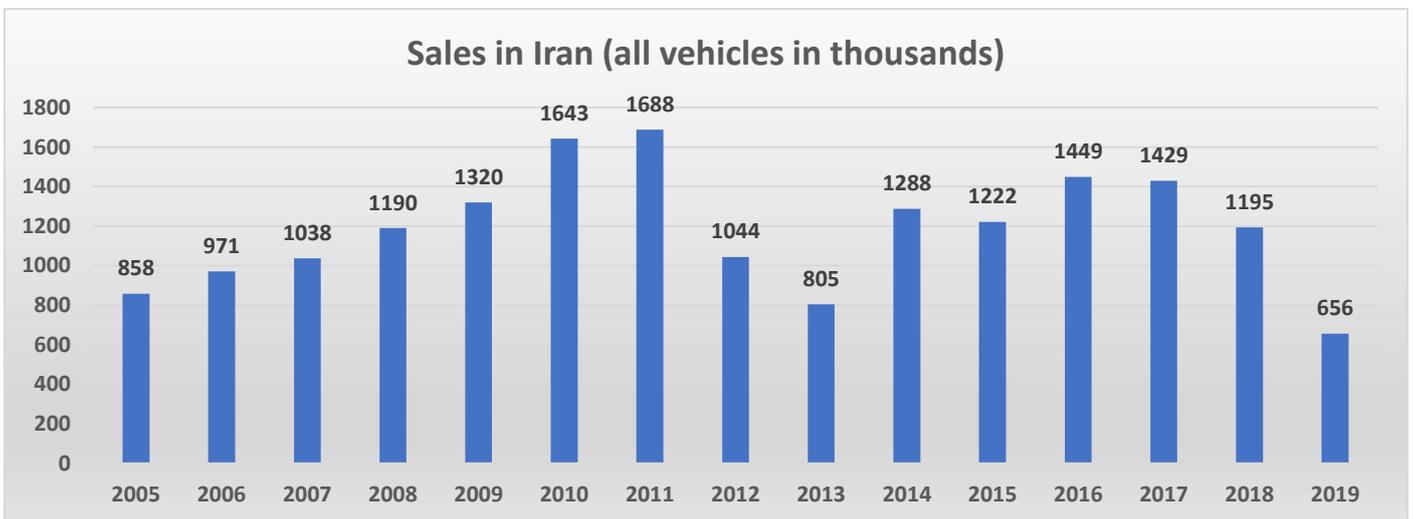
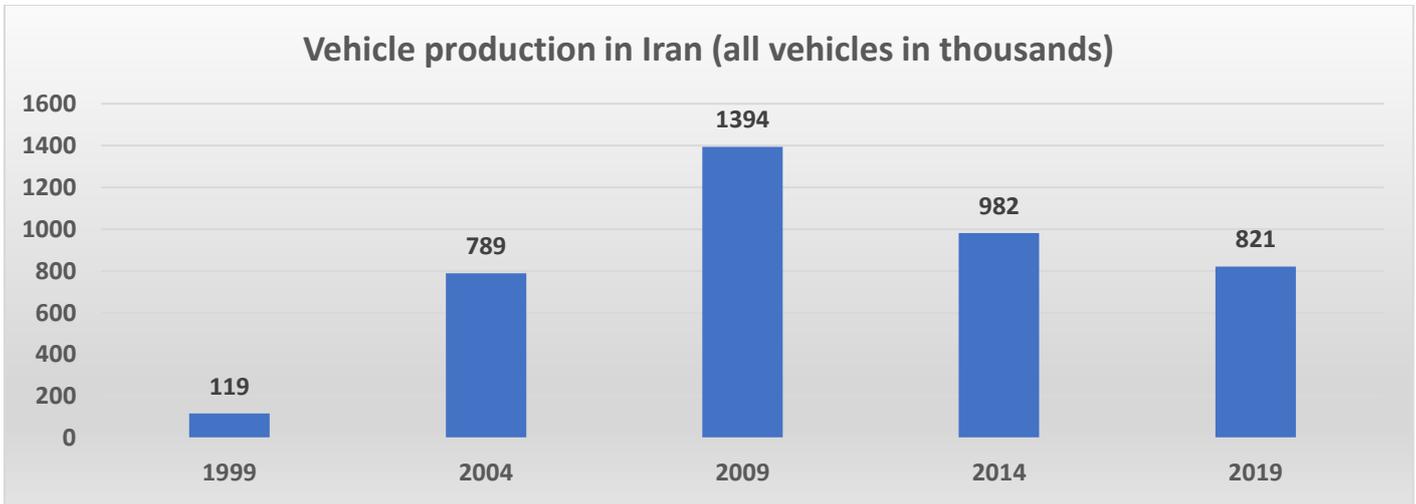


Chart 6.9.1: History of vehicle sales in Iran



*Chart 6.9.2 History of vehicle production in Iran*

Most of the cars sold in Iran are made there, with some limited exports and imports. The American sanctions drive chaotic ups and downs in the economy as a whole, including the automotive sector.

## Iran's Car Makers

### Iran Khodro (IKCO)



*6.9.3: Iran Khodro*



*6.9.3: IKCO Dena (left) and Soren (right)*



6.9.4: IKCO-built Renault Tondar (left) and Peugeot 207 (right)

Khodro had licences from international car makers, particularly from Peugeot group (206, 207, 308) and from Renault (Logan), as well as with Suzuki. Production of cars under these licences was mainly realised by CKD assembly in the past, but since the American sanctions made that impossible, today's efforts are made with mainly local parts. IKCO also have plants in Azerbaijan, Belarus, Senegal, and Venezuela.

## SAIPA (Société Anonyme Iranienne de Production Automobiles)



Formerly a subsidiary of Citroën, now belonging to the Iranian Government, SAIPA are the second-largest auto manufacturer in Iran. They built KDX cars from Renault, Hyundai, and Nissan, and had a new joint-venture contract with Citroën in 2016.



6.9.5: SAIPA vehicles

## Lighting Manufacturers in Iran

Lighting parts are now produced locally.

**Modern Industry Research Group** was established in late 1991 to manufacture headlamps for heavy and light vehicles and motorcycles. MIRG are now the main supplier to IKCO and SAIPA with a capacity of more than 6,000,000 automobile main lights and wing mirrors per year. There are two manufacturing factories; one 32 km southwest of Tehran in Shahriar city, and the other at Ashtian city, Markazi province.





6.9.6: Production of headlamps and rear lamps at MIRG

6.9.7: Examples of MIRG products



## 6.10 South Africa

The RSA (Republic of South Africa) is the only country on the African continent that hosts seven major auto manufacturers— BMW, Ford, Isuzu, Daimler, Nissan, Toyota, and Volkswagen. The automotive industry contributes 6.9 per cent to GDP (4.4 per cent manufacturing and 2.5 per cent retail) and is the largest manufacturing sector in the country's economy. Total automotive revenue in South Africa amounted to €27bn in 2018, when the export of vehicles and automotive components reached a record amount of €11.4bn, equating to 15.5 per cent of South Africa's total exports.

The auto industry is export-orientated; fully 64.1 per cent of RSA light vehicle production in 2019 was exported. 387,125 vehicles were exported that year, including 285,599 units or 73.8 per cent to the

European Union. Vehicles and components are exported to 151 international markets. The manufacturing segment of the industry presently employs more than 112,250 people across its various sectors—component manufacturing, vehicle assembly, etc. Combined with the industry's strong multiplier effect, the industry is responsible for approximately 457,000 jobs across the formal sectors of South African economy.

The best-selling passenger car in RSA is the VW Polo (50,000 per year), and the top commercial vehicle is Toyota's Hilux (40,000 per year).

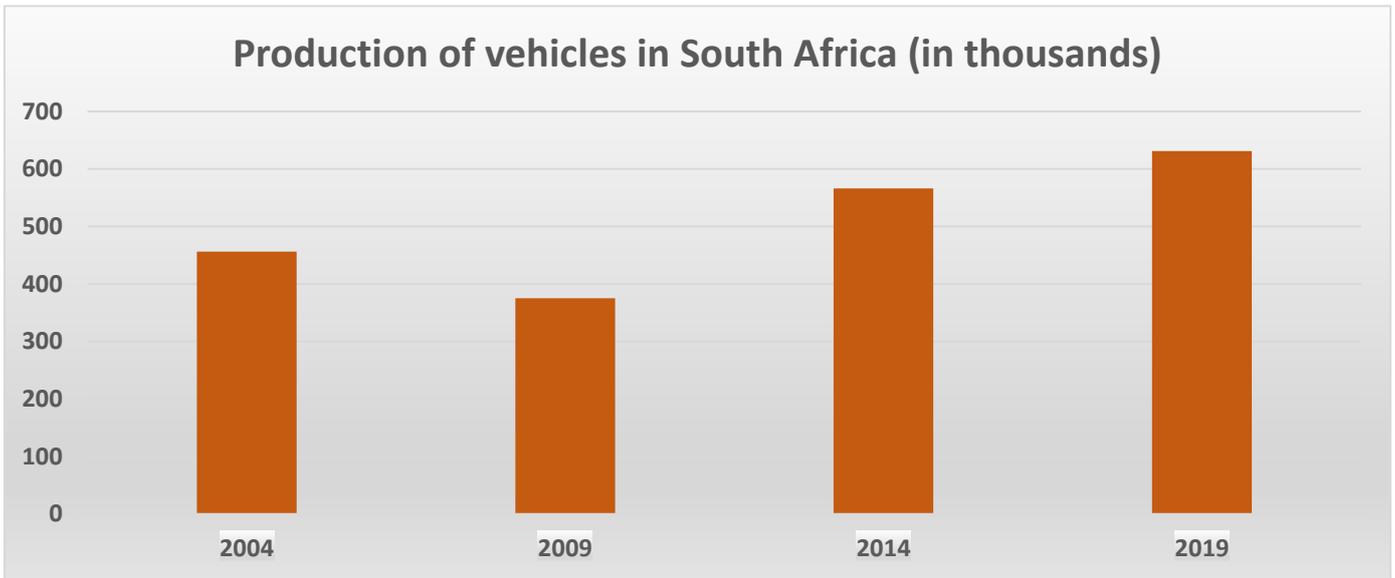


Chart 6.11.1: Production of vehicles in RSA

## 6.11 Morocco

### Car Makers in Morocco:

Morocco is a recent country for the car industry with the installation of Renault and Dacia, Nissan, Peugeot Group, and VW. The global investment for the current 25 automotive projects in the country is higher than \$1.5bn. Renault were first, and presently boast the highest capacity in the area of Tangiers, this investment cluster having special economic conditions. Renault production of 233,000 in 2014 grew to 395,000 in 2019.

The Moroccan market is led currently by Dacia, which early in 2019 held 30 per cent of the market. VW is N° 2. Many cars are produced now locally, but there are also imports; for instance, in 2018 3,100 Mercedes and 1,140 hybrid cars were brought in.

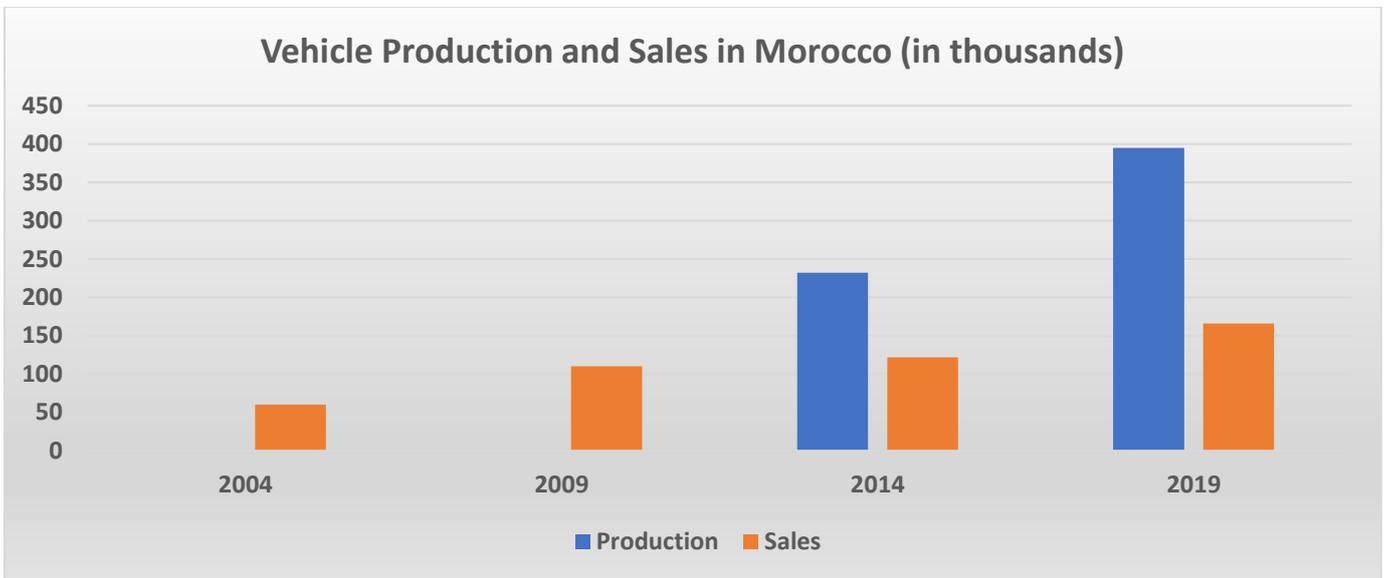


Chart 6.12.1: History of vehicle production and sales in Morocco

### Lighting suppliers in Morocco:

Valeo Lighting (top, since 2017) and Varroc Lighting (bottom, since 2018) are established in Morocco at Tangiers.



## 6.12 Other African Countries

Other producers in Africa are Algeria at 60,000 vehicles per year and Egypt at 18,500.

### Nigeria

The most populous country in Africa had in the past significant production, but the situation is complex there now. In 2019, passenger cars constituted the largest export item from the United States to Nigeria—\$667m worth, according to the U.S. Census Bureau. Auto imports grew rapidly between 2004 and 2014, but shrank significantly between 2015 and 2017 due to high (70 per cent) import duties on vehicles linked to the country's new automotive policy as well as an economic recession that hit during

that period. For example, in 2017 fewer than 7,000 brand-new vehicles were imported into Nigeria. The launch of the NAIDP (Nigerian Automotive Industry Development Plan) in 2014 attracted the interest of leading international carmakers and led to the resumption of small-scale vehicle assembly in the country. According to the NADDC (National Automotive Design and Development Council), there are 31 licensed producers of cars, trucks, and buses currently operating in Nigeria with a combined installed capacity of 205,000 vehicles a year, though far fewer numbers are produced due to huge funding, infrastructure, and capacity gaps. Industry analysts estimate that not more than 10,000 units have been produced each year since the launch of the NAIDP.

## Egypt

Automotive production is now very modest in Egypt, at around 18,500 vehicles in 2019. However, this country has a good education system and has good reputation for software engineers. So, some automotive companies have footprint in Egypt for software development. It is the case for instance for Valeo, who installed starting in 2005 their most important software R&D centre in Cairo, developing now 50 per cent of the group's software—including software for ADAS and lighting systems with more than 2,200 employees.



6.13.1: Valeo R&D centre at Cairo

## Ethiopia

Ethiopia currently has no significant automotive production. This is a country growing rapidly, at a pace of +10.9 per cent/year during the last decade. It is aspiring to become Africa's largest car manufacturer through tariff protection and by increasing the number of local assemblers with extensive support from Chinese companies. Vehicle production has increased recently, due to local assembly investments such as Hyundai's first assembly plant launched in Addis Ababa at the beginning of 2019. Ethiopia recently became the third country in Sub-Saharan Africa to sign a memorandum of understanding with Volkswagen which seeks to seize opportunities in vehicle assembly facilities and localising automotive components in Ethiopia. But today sales are still low at 18,000 vehicles for whole-year 2019, mainly second-hand vehicles.

### Used vehicles in Africa:

Around 2 million used vehicles are imported every year in Africa, nearly double the level of sales of new cars (1.2 million). These imported used vehicles are mostly used-up junk that can no longer pass roadworthiness and emissions tests in developed countries. As such, they are unsafe and polluting. The UN and the EU would like to better control these exports in the future. This could help local automotive industries to develop their activities, as imports of used cars are currently an obstacle.

## 7. Lighting Technologies in Developing Countries

Many leading car makers have developed subsidiaries in developing countries. Similarly, leading set makers have followed their customers in these countries, bringing with them their technologies. Lumax in India, for example, are developing products with licences from major set makers like Stanley and SL. And the Indian company Varroc bought the lighting activities of Visteon, as Turkish Farba did with German Odelo.

So all these strong relations between developing countries and developed countries have led to the use of similar technologies. This is particularly the case for exports from these countries to developed countries, for instance from Turkey or Morocco to Europe, or Mexico to the USA. In that case, the lighting technology is the same as found in the destination markets.

For use in local markets, even if we cannot say that there is a specific technology used in developing countries, the technologies used have important common characteristics. Foremost is affordability, so the least-costly technologies are used. There is a gap of at least five years between adoption of new technologies in developed countries and their showing up on cars in developing countries. For instance, LEDs are now roughly used at 100 per cent for every new car in Europe and Japan both for main and signal lighting. LEDs are used now in developing countries even in some cases with full LEDs, but with a slower adoption. Halogen headlamps and incandescent rear lights are still predominant. And the more advanced technologies like ADB, laser, and OLEDs are not seen in the developing world (nor in the USA, which is certainly food for thought).

Beyond that, lighting in developing countries uses the same materials like polycarbonate for lenses, polypropylene for headlamp housings, and PMMA and ABS or ABS/PC for rearlamps, and also similar processes as in developed countries, directly transferred when they are subsidiaries or brought in by dint of licences.

The second common point is at least in Asia the strong importance of two- and three-wheelers and trucks and buses. These countries are for these categories of products leaders with specialised suppliers like Rinder or FIEM in India.



*7.1 1: Lumax two-wheeler lighting*



*7.1.2:Arteb Headlamp*

Another point to consider is quality. As the car makers are often the same as in developed countries, specifications are similar, sometimes even more severe for dust, humidity, or vibration resistance due to difficult local conditions. Conversely, some specifications for instance in relation to fit and finish required for premium cars in developed countries are not so severe in developing countries. The lighting requirements are often driven by the regulations in effect—usually one or another version, often an older one, of the U.N. Regulations. Lighting performance, particularly with the overwhelmingly prevalent old H4 bulb or the even older R2 tungsten headlight bulb, are legally but not practically adequate in countries where street lighting is weak and sparse (if it is present at all), and vulnerable road users are numerous.

Currently however, there is a trend to create more modern cars in these developing countries, particularly with the arrival of EVs. These new cars are progressively closing the technology gap and this trend will certainly continue in the future.

## 8 – Conclusion

After this analysis of developing countries, we can synthesise some main points:

- Developing countries have a strong dynamism for their population growth, that will increase even more their current domination in that domain in the future;
- Their individual wealth currently lags considerably on average compared to developed countries, but will certainly improve a lot in the future, allowing many people to have the minimum resources to buy new cars. There are currently huge differences among developing countries, some having already a relatively good infrastructure, a good education level even if not generalised as in India and Brazil; other are still in difficult situations aggravated by wars, poverty, corruption, or sanctions.
- The automotive market in these countries will certainly be most dynamic in the future, while developed countries stagnate or recede. In 2050, developing countries globally will be the first worldwide market pulled by the giant India and naturally all the actors of the sector will have to prepare for that change (as with China during the last two decades).
- The international lead automotive and lighting makers are currently generally also the main suppliers in these countries. However, there are some exceptions as some countries have a healthy local automotive and/or lighting ecosystem. Some developing countries also have the political will and government willingness to build a national automotive industry. It is the case in Iran with no choice for them due to American sanctions, and also in Turkey with a new national company emerging to build electric cars.
- Electric cars could simplify the evolution towards some independence—because they are simpler, and because these generally equatorial and tropical countries are flooded by sun helping the transition to photovoltaic solar electric supply.
- The lighting equipment in developing countries is generally still basic currently with a majority of halogen front lighting, and primitive H4 lights at that. However the technology is not so different from developed countries, just with significant lag to implementation (projector headlamps are still talked-up as a novel advance in India, for example, even if they have halogen bulbs). LEDs are more and more used and will eventually push glowing filaments into the history books.
- For the other advanced lighting technologies—ADB and  $\mu$ LEDs, AEB and other ADAS—they will certainly appear, but not for a long time; at least ten years and possibly closer to twenty in many of these countries. However, road safety in these countries badly lags that of developed countries, with death rates around four times higher than the best developed countries. Lighting and ADAS functions could strongly help for improvement, even if speed, impaired (drunk, etc) driving, and road infrastructure are the current priorities.
- Even if sales and production in recent past years have been chaotic rather than stable for many developing countries, the centre of gravity of humankind will progressively move towards them, bringing better balance in the world that could certainly be profitable for everybody.

## 9 Annexes

Africa		Asia	Latin America and the Caribbean
North Africa	Southern Africa	East Asia <sup>b</sup>	Caribbean
Algeria	Angola	Brunei Darussalam	Bahamas
Egypt	Botswana	Cambodia	Barbados
Libya	Eswatini	China	Belize
Mauritania	Lesotho	Democratic People's Republic of Korea <sup>c</sup>	Guyana
Morocco	Malawi	Fiji	Jamaica
Sudan	Mauritius	Hong Kong SAR <sup>d</sup>	Suriname
Tunisia	Mozambique	Indonesia	Trinidad and Tobago
Central Africa	Namibia	Kiribati	Mexico and Central America
Cameroon	South Africa	Lao People's Democratic Republic	Costa Rica
Central African Republic	Zambia	Malaysia	Cuba
Chad	Zimbabwe	Mongolia	Dominican Republic
Congo	West Africa	Myanmar	El Salvador
Equatorial Guinea	Benin	Papua New Guinea	Guatemala
Gabon	Burkina Faso	Philippines	Haiti
Sao Tome and Principe	Cabo Verde	Republic of Korea	Honduras
East Africa	Côte d'Ivoire	Samoa	Mexico
Burundi	Gambia (Islamic Republic of the)	Singapore	Nicaragua
Comoros	Ghana	Solomon Islands	Panama
Democratic Republic of the Congo	Guinea	Taiwan Province of China	South America
Djibouti	Guinea-Bissau	Thailand	Argentina
Eritrea	Liberia	Timor-Leste	Bolivia (Plurinational State of)
Ethiopia	Mali	Vanuatu	Brazil
Kenya	Niger	Viet Nam	Chile
Madagascar	Nigeria	South Asia	Colombia
Rwanda	Senegal	Afghanistan	Ecuador
Somalia	Sierra Leone	Bangladesh	Paraguay
South Sudan <sup>e</sup>	Togo	Bhutan	Peru
Uganda		India	Uruguay
United Republic of Tanzania		Iran (Islamic Republic of)	Venezuela (Bolivarian Republic of)
		Maldives	
		Nepal	
		Pakistan	
		Sri Lanka	
		Western Asia	
		Bahrain	
		Iraq	
		Israel	
		Jordan	
		Kuwait	
		Lebanon	
		Oman	
		Qatar	
		Saudi Arabia	
		State of Palestine <sup>e</sup>	
		Syrian Arab Republic	
		Turkey	
		United Arab Emirates	
		Yemen	

### Annex 9.1: List of developing economies as defined by 2019 UN report

Despite the UN's categorisation, we do not count China or Israel as developing countries for the purpose of this present DVN Report.

## Annex 9.2 Evolution of worldwide population 2020 and 2050 (in thousands data from UN)

### Top 50 countries by population in 2020

	Country (or dependent territory)	2020
	China	1397,0
	India	1326,1
	United States	334,5
	Indonesia	279,1
	Brazil	216,0
	Pakistan	213,7
	Nigeria	205,0
	Bangladesh	169,8
	Russia	145,7
	Mexico	128,7
	Japan	126,1
	Ethiopia	114,6
	Philippines	109,2
	Egypt	99,7
	Vietnam	98,7
	Democratic Republic of the Congo	89,3
	Iran	86,5
	Germany	83,0
	Turkey	82,0
	Thailand	69,0
	France	67,8
	United Kingdom	65,8
	Italy	62,4
	Myanmar	59,1
	Tanzania	58,6
	South Africa	56,5
	Spain	50,0
	Kenya	49,9
	South Korea	49,4
	Colombia	49,1
	Argentina	45,4
	Ukraine	43,9
	Uganda	43,5
	Algeria	43,0
	Iraq	42,2
	Sudan	41,1
	Poland	38,3
	Morocco	38,0
	Afghanistan	36,6
	Canada	36,4
	Nepal	34,2
	Malaysia	32,7
	Peru	31,9
	Venezuela	31,3
	Uzbekistan	30,6
	Yemen	29,9
	Saudi Arabia	29,8

### Top 50 countries by population in 2050

	Country (or dependent territory)	2020	2050	Evolution 2050/2020
	India	1326,1	1656,6	24,9
	China	1397,0	1438,0	2,9
	Nigeria	205,0	402,2	96,3
	United States	334,5	398,3	19,1
	Indonesia	279,1	327,3	17,3
	Pakistan	213,7	290,8	36,1
	Brazil	216,0	238,4	10,4
	Ethiopia	114,6	228,1	98,9
	Bangladesh	169,8	201,2	18,5
	Philippines	109,2	155,4	42,3
	Mexico	128,7	150,6	17,0
	Democratic Republic of the Congo	89,3	144,8	62,2
	Egypt	99,7	137,9	38,3
	Russia	145,7	129,9	-10,9
	Tanzania	58,6	118,6	102,5
	Vietnam	98,7	111,2	12,6
	Japan	126,1	107,2	-15,0
	Iran	86,5	107,2	23,8
	Uganda	43,5	93,5	114,8
	Turkey	82,0	89,3	8,9
	Germany	83,0	71,5	-13,8
	United Kingdom	65,8	71,2	8,2
	Kenya	49,9	70,8	41,9
	Myanmar	59,1	70,7	19,5
	France	67,8	69,5	2,4
	South Africa	56,5	68,5	21,4
	Thailand	69,0	66,1	-4,2
	Afghanistan	36,6	63,8	74,1
	Italy	62,4	61,4	-1,6
	Sudan	41,1	59,1	43,8
	Mozambique	28,6	59,0	106,3
	Colombia	49,1	56,2	14,6
	Algeria	43,0	55,4	29,0
	Argentina	45,4	53,5	17,9
	Spain	50,0	52,5	4,9
	Ghana	29,3	52,4	78,6
	Cameroon	27,0	51,9	92,5
	Malawi	21,2	51,8	144,3
	Burkina Faso	22,0	47,4	115,8
	Yemen	29,9	46,1	54,2
	Morocco	38,0	46,0	21,3
	Nepal	34,2	46,0	34,4
	Angola	22,5	45,9	104,1
	Madagascar	27,0	45,8	69,9
	Niger	21,2	44,2	109,1
	South Korea	49,4	43,4	-12,1
	Malaysia	32,7	42,9	31,5

## Annex 9.3 Evolution of Gross National Income per capita in developing countries

In the following charts are indicated the GNI (Gross National Income) per capita of some significant developing countries, the average of growth during the period 2010-2019, and a projection in 2050 of the GNI in the hypothesis that the growth per year in the next thirty years will be the same than during the period 2010-2019.

USA and China are also presented as references.

It appears in these conditions:

- That China would be close to USA per capita in 2050 and much higher than USA today.
- That many developing countries would have in 2050 a GNI per capita similar or even higher than China currently, particularly India, Indonesia, Philippines, Mexico.
- As these developing countries will have a large population in 2050, they could have with this projection of GNI the required conditions to have at that time a strong automotive market, like the current one in China per capita.
- Conversely, several countries like Nigeria and many others in Africa currently among the least developed countries, could still in 2050 have a modest GNI per capita limiting the ambition to have a strong automotive market. In fact, for many of these countries, their growth could be much higher with political stability and good economic policy—as Ethiopia demonstrated during the period 2010-2019 with an average growth of roughly 10 per cent per year.

GNI per capita in 2019 in USD \$ for some significant developing countries and projection in 2050 with extrapolation. In parallel, forecast of GDP PPP (Per Purchasing Parity) from PWC

USA and China considered as references						
	GNI 2019 in \$	Annual growth of GDP 2010-2019	Evolution of population 2020-2050 in %	Projection of GNI in 2050 with same growth during the period	Forecast of GDP by PWC per capita (PPP)	Population in 2050
USA	65000	2.29	19.1	107961	95400	398
China	10410	7.61	2.9	91513	37500	1438
GNI per capita in 2019 for some significant developing countries and forecast for 2050						
	GNI 2019 in \$	Annual growth of GDP 2010-2019	Evolution of population 2020-2050 in %	Projection of GNI in 2050 with same growth during the period	Forecast of GDP by PWC per capita (PPP)	Population in 2050
Turkey	9610	5.96	8.9	50343	56400	89
Mexico	9430	2.93	17	19239	49000	150
Brazil	9130	1.39	10.4	12526	37000	238
South Africa	6040	1.85	21.4	8643		68
Indonesia	4050	5.42	17.3	16946	19400	327
Philippines	3850	6.32	42.3	17304		155
Morocco	3190	3.85	21.3	8217		46
Egypt	2690	3.82	38.3	6041		138
India	2130	7.34	24.9	14475	22800	1656
Nigeria	2030	3.44	96.3	2875	3867	402
Ethiopia	850	9.75	98.9	7301		228

## Average of Gross National income per capita in 2019 and projection for 2050 for developing countries

Average GNI 2019	Average Annual growth of GDP	Average Annual growth of population	Average GNI 2050	Average GDP 2050 (PPP) forecast by PWC	Total population of these countries
3383	4.6	36.7	13486	23351	3497

Note: The forecast of GNI in 2050 extrapolated with the CAGR of 2010-2019 is naturally a bit adventurous as for many of these countries, the evolution is far from linear. For instance, there is a chance that Brazil would perform better as the past decade was relatively disappointing, and on the other hand, some could have worse results than past decade, for instance Turkey after a very strong beginning of past decade is now facing societal strife, or Ethiopia after the past strong increase could have more difficulties in the future, particularly if war breaks out again as seems to be the case now. Nevertheless, the evolution of the average GNI per capita putting these developing countries in 2050 roughly at the level of China today seems reasonable.

The forecasts from PWC are more conservative for the advanced economies and more optimistic for developing countries, but going in the same direction and showing that while a developed country like the USA will improve their GNP per capita by roughly 50 per cent till 2050, developing countries on average could have their GNP per capita multiplied by 3 or 4, helping them to be a solid base for car purchases.

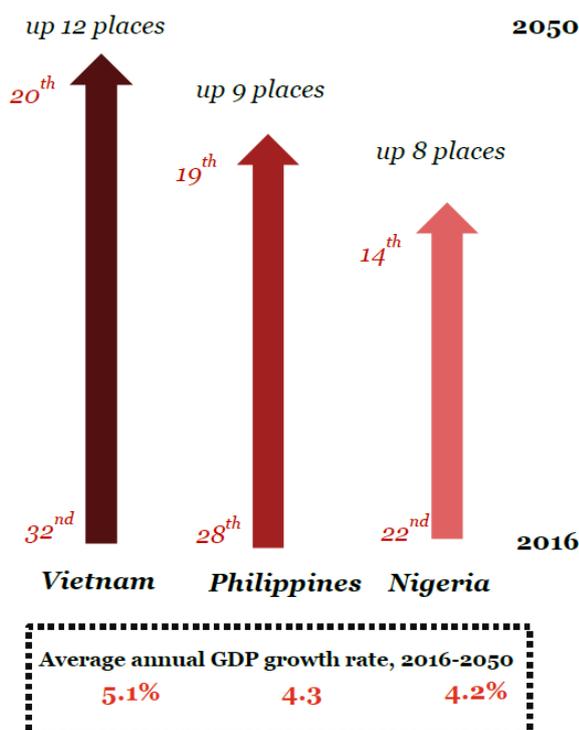
If we are looking at the global GDP PPP per country, the following forecast from PWC with IMF data demonstrates the strong evolution that every company will have to consider, particularly the automotive industry.

### Emerging markets will dominate the world's top 10 economies in 2050 (GDP at PPPs)

### Vietnam, the Philippines and Nigeria could make the greatest moves up the rankings by 2050

	2016	2050	
China	1	1	China
US	2	2	India
India	3	3	US
Japan	4	4	Indonesia
Germany	5	5	Brazil
Russia	6	6	Russia
Brazil	7	7	Mexico
Indonesia	8	8	Japan
UK	9	9	Germany
France	10	10	UK

  E7 economies   G7 economies



## The US and Europe will steadily lose ground to China and India

## Global economic power will shift to the E7 economies

Share of world GDP (PPPs) from 2016 to 2050...



Sources: IMF for 2016 estimates, PwC analysis for projections to 2050

In...

1995

E7

were **half** the size of

G7

By...

2015

E7

were around the **same** size as

G7

And in just 25 years...

2040

E7

could be **double** the size of

G7

G7: US, UK, France, Germany, Japan, Canada and Italy  
E7: China, India, Indonesia, Brazil, Russia, Mexico and Turkey

## Annex 9.4 Vehicles Sales in developing countries and comparison with developed countries and China during last fifteen years

In the following charts and graphs from 2005 to 2019, it appears that:

- Sales in developed countries were relatively stable during this period, except after the 2008 financial crisis (with similar decrease expected due to the Covid pandemic). Their share in total sales, however, are strongly decreasing from 75.2 per cent in 2005 to 54.7 per cent in 2019.
- China is the big winner, evolving from a market share of 8.8 per cent in 2005 to 28.3 per cent in 2019; multiplying the sales by 4.4 (and certainly more in value taking into account the increase of mean price of cars, now often from higher categories).
- Developing countries have globally a significant increase of +47 per cent, but their worldwide share is relatively stable evolving only from 16 per cent to 17 per cent from 2005 to 2019. India is the one with the best evolution, with a multiplication by 2.7 of its sales from 2005 to 2019—less than China, but still quite strong.

Developing countries on other continents are really disappointing:

- o less than 10 per cent evolution in Africa with a much bigger population evolution, meaning that the number of vehicles sold per capita has decreased during these last fifteen years. Political instability and wars in some countries in conjunction with not enough effort to improve the bad infrastructure explain some of this weak evolution.

- +24 per cent in other developing countries in Asia and even +38 per cent in Central and South America are positive evolutions, but not enough considering their potential.

Sales all vehicles	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
<b>Developed Countries</b>	<b>49.5</b>	<b>49.9</b>	<b>50.4</b>	<b>46.0</b>	<b>39.1</b>	<b>41.1</b>	<b>42.9</b>	<b>45.0</b>	<b>46.0</b>	<b>47.5</b>	<b>48.5</b>	<b>49.5</b>	<b>50.3</b>	<b>50.5</b>	<b>49.9</b>
Europe + Russia (Excluding Turkey)	20.3	21.2	22.4	21.4	18.1	18.0	18.9	17.8	17.5	17.8	18.0	19.1	19.8	20.2	20.4
NA: USA + Canada	19.1	18.7	18.2	15.2	12.1	13.4	14.7	16.5	17.7	18.7	19.8	19.8	19.6	19.7	19.5
Oc + S.AM: Australia + New Zeland + Argt.	1.5	1.5	1.7	1.7	1.5	1.8	2.0	2.0	2.2	1.9	1.9	2.0	2.2	2.1	1.6
East Asia: Japan, Korea, Taiwan	7.4	7.2	6.9	6.5	6.3	6.7	6.1	7.2	7.2	7.5	7.1	7.1	7.5	7.3	7.2
West Asia: Israel + Petrol producers	1.2	1.2	1.2	1.3	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.4	1.2	1.2	1.3
<b>China</b>	<b>5.8</b>	<b>7.3</b>	<b>8.8</b>	<b>9.4</b>	<b>13.7</b>	<b>18.1</b>	<b>18.6</b>	<b>19.4</b>	<b>22.0</b>	<b>23.6</b>	<b>24.7</b>	<b>28.1</b>	<b>28.9</b>	<b>28.1</b>	<b>25.8</b>
	<b>2005</b>	<b>2006</b>	<b>2007</b>	<b>2008</b>	<b>2009</b>	<b>2010</b>	<b>2011</b>	<b>2012</b>	<b>2013</b>	<b>2014</b>	<b>2015</b>	<b>2016</b>	<b>2017</b>	<b>2018</b>	<b>2019</b>
<b>Developing Countries</b>	<b>10.6</b>	<b>11.2</b>	<b>12.3</b>	<b>12.8</b>	<b>12.7</b>	<b>15.7</b>	<b>16.7</b>	<b>17.7</b>	<b>17.5</b>	<b>17.2</b>	<b>16.4</b>	<b>16.2</b>	<b>16.6</b>	<b>17.0</b>	<b>15.6</b>
Asia with Turkey without India WO China	4.1	3.9	4.1	4.4	4.4	5.7	5.9	6.2	6.2	6.2	6.1	6.3	6.4	5.9	5.1
India	1.4	1.8	2.0	2.0	2.3	3.0	3.3	3.6	3.2	3.2	3.4	3.7	4.1	4.4	3.8
Africa	1.1	1.3	1.3	1.3	1.2	1.3	1.4	1.6	1.7	1.7	1.5	1.3	1.1	1.2	1.2
South and central America	3.9	4.2	4.9	5.1	4.9	5.7	6.0	6.3	6.4	6.1	5.3	5.0	5.0	5.4	5.4
<b>Total World</b>	<b>65.9</b>	<b>68.3</b>	<b>71.5</b>	<b>68.3</b>	<b>65.5</b>	<b>74.9</b>	<b>78.1</b>	<b>82.1</b>	<b>85.5</b>	<b>88.3</b>	<b>89.6</b>	<b>93.8</b>	<b>95.8</b>	<b>95.6</b>	<b>91.3</b>
	<b>2005</b>	<b>2006</b>	<b>2007</b>	<b>2008</b>	<b>2009</b>	<b>2010</b>	<b>2011</b>	<b>2012</b>	<b>2013</b>	<b>2014</b>	<b>2015</b>	<b>2016</b>	<b>2017</b>	<b>2018</b>	<b>2019</b>
<b>Share of sales</b>	<b>2005</b>	<b>2006</b>	<b>2007</b>	<b>2008</b>	<b>2009</b>	<b>2010</b>	<b>2011</b>	<b>2012</b>	<b>2013</b>	<b>2014</b>	<b>2015</b>	<b>2016</b>	<b>2017</b>	<b>2018</b>	<b>2019</b>
Developed countries	75.2	73.1	70.5	67.4	59.7	54.9	54.9	54.8	53.8	53.8	54.2	52.8	52.5	52.8	54.7
China	8.8	10.6	12.4	13.8	20.9	24.2	23.8	23.6	25.8	26.7	27.6	29.9	30.2	29.4	28.3
Developing countries	16.0	16.3	17.2	18.7	19.4	20.9	21.4	21.6	20.5	19.5	18.2	17.3	17.3	17.8	17.0

Share of sales	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Developed countries	75.2	73.1	70.5	67.4	59.7	54.9	54.9	54.8	53.8	53.8	54.2	52.8	52.5	52.8	54.7
China	8.8	10.6	12.4	13.8	20.9	24.2	23.8	23.6	25.8	26.7	27.6	29.9	30.2	29.4	28.3
Developing countries	16.0	16.3	17.2	18.7	19.4	20.9	21.4	21.6	20.5	19.5	18.2	17.3	17.3	17.8	17.0

Chart 9.4.1: Sales evolution from OICA figures including heavy trucks, buses and coaches.

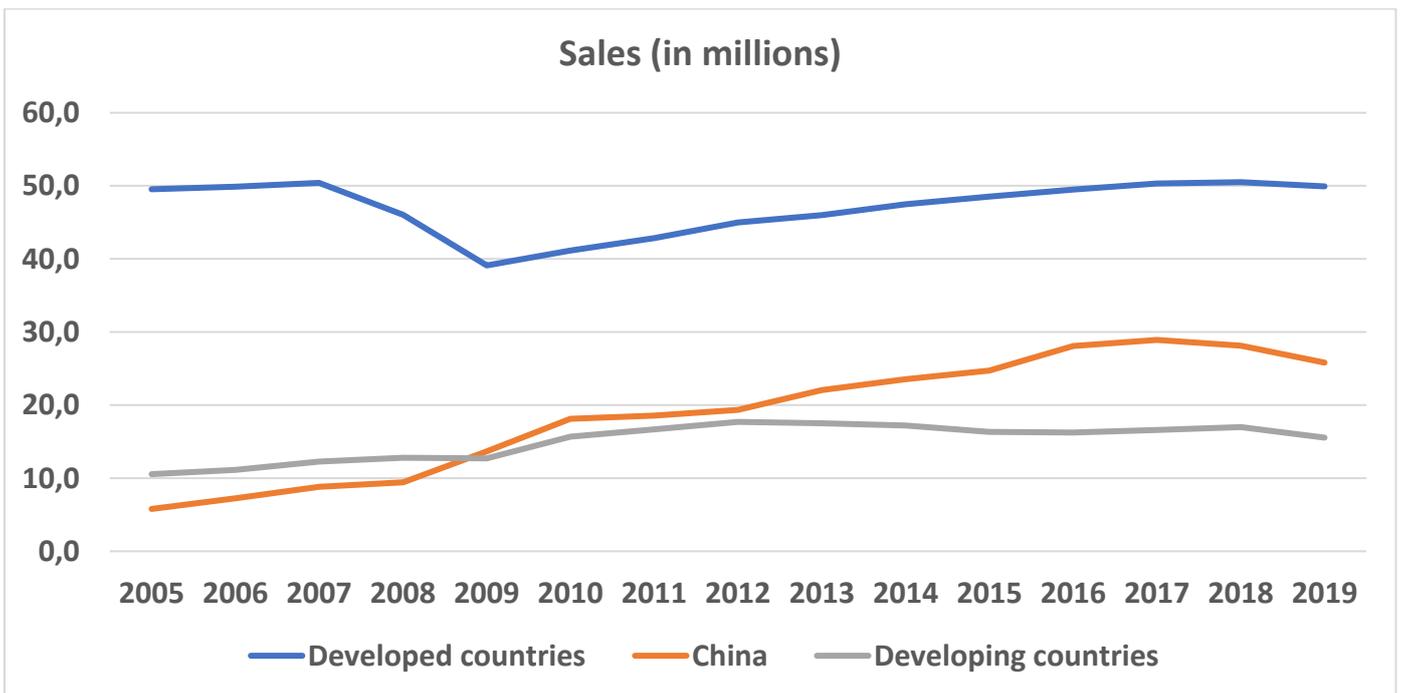


Chart 9.4.2: Respective evolution of sales of cars in developed and developing countries and in China

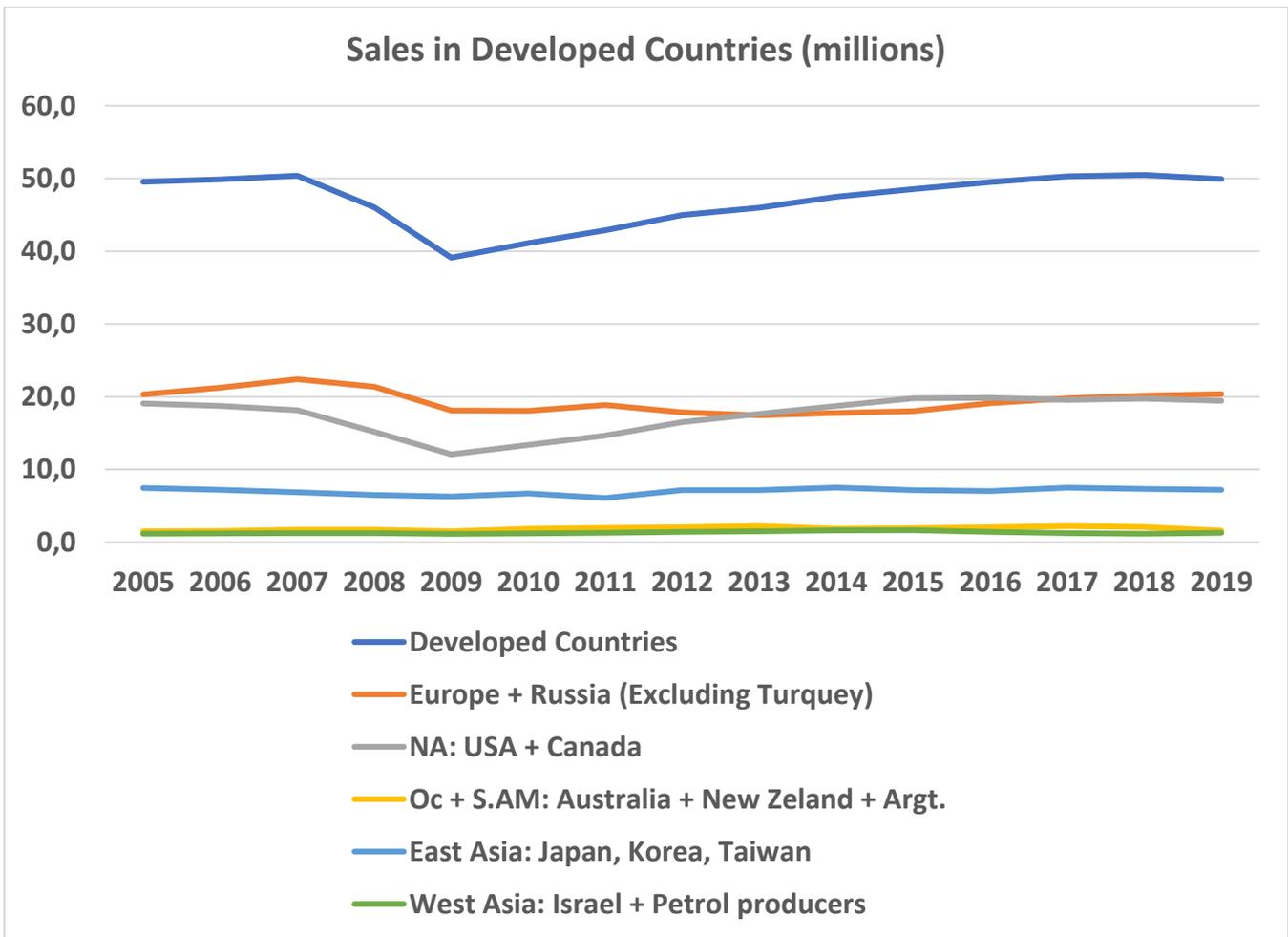


Chart 9.4.3: Detailed evolution of sales of cars in developed countries

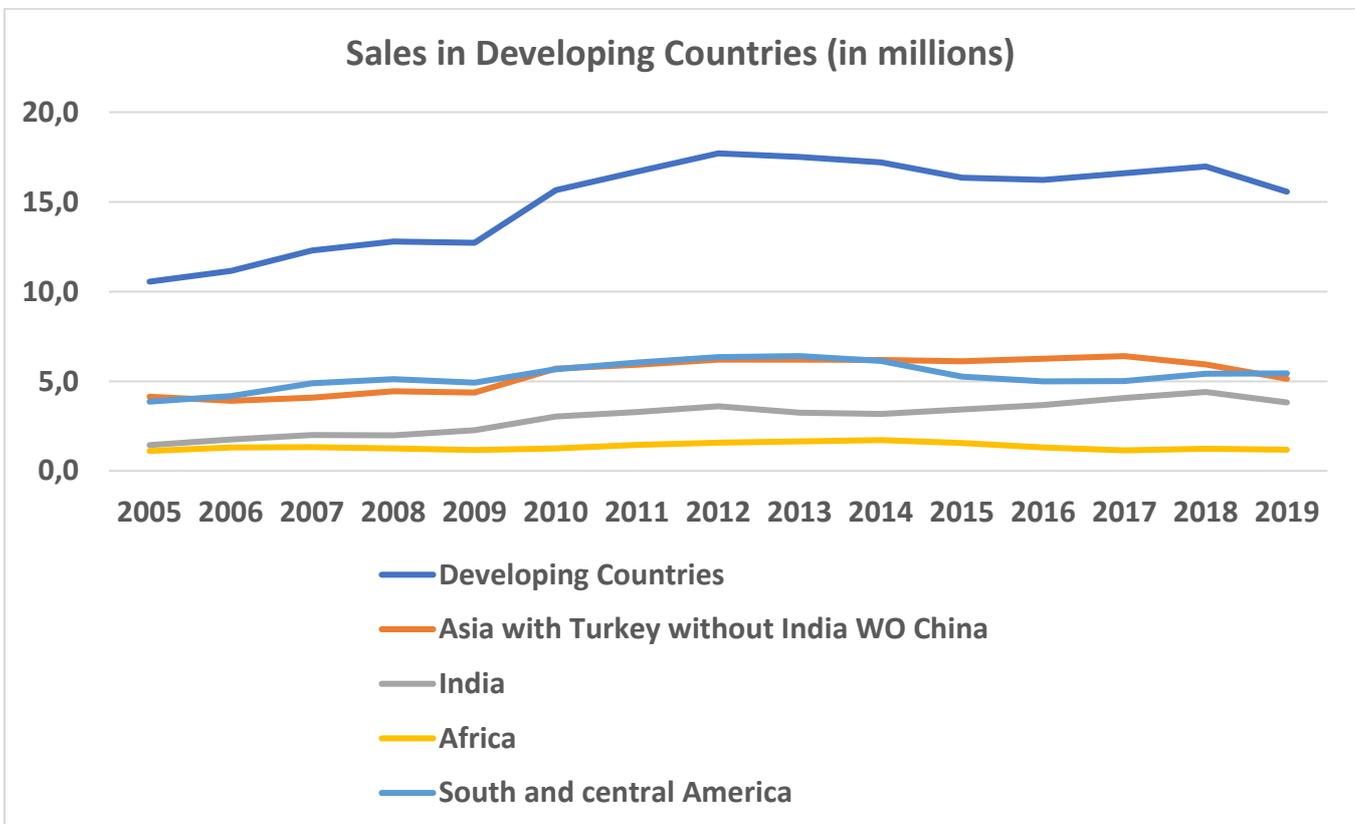


Chart 9.4.4: Detailed evolution of evolution of sales of cars in developing countries

## Annex 9.5: Vehicle sales forecast to 2050

First, we must consider the prediction of evolution of population seen in chapter 3 with an evolution of population in developing countries of +36 per cent and in developed countries of +0.2 per cent (China being classified as a developed country).

If we are considering the evolution of wealth per capita of the population of these developing countries, the average of their GNI per capita in 2050 would be around \$13,500, to be compared to the current \$10,500 in China. Based only on this criterion of wealth per capita, and with the assumption that developing countries would have the same interest for cars that Chinese people exhibit today, the sales in developing countries could be in 2050:  $(\text{GNI per capita in developing countries in 2050} \div \text{GNI per capita in China in 2019}) \times (\text{population of developing countries in 2050} \div \text{population of China in 2019}) \times \text{Sales of vehicle in 2019 in China}$ . So,  $(13500 \div 10500) \times (6649 \div 1397) \times 25.8 = 158$  million vehicles—a very high figure.

Another way to anticipate these sales is the projection of the past sales in these countries.

If we are simply considering the last 14 years known, sales were 10.6m in 2005 and 15.6m vehicles in 2019, so an average rate of +2.8 per cent per year. The extrapolation to 2050 with the same rate from the 2019 level would be 36.7m vehicles, a relatively low level.

However, since 2012, there were decreases due to specific economic difficulties in several developing countries, for instance Argentina, Turkey, and Iran.

For the extrapolation of developing countries except India, we have taken the more normal rate of the years 2005 to 2012 at +3.5 per cent for the years until 2035, and +3 per cent afterward.

For India, we have extrapolated the average growth observed during the years 2005-2019 for the period to 2040 as +6.9 per cent per year, with a slight decrease in this growth to +5.7 per cent from 2040. The forecast of 25m vehicles in 2050 obtained matches the forecast of the European Commission in a study (EU Gear 2030) for India in 2017.

For China, the years 2005-2010 were exceptionally fast-paced with +25 per cent per year, not sustainable for the long term. We have therefore taken the years 2010-2019 as reference with +2.4 per cent per year extrapolated to 2025. After that year, a slightly reduced pace at +1.8 per cent was used, giving 49.5m vehicles sold in China in 2050, similar also to the forecast of the European Commission and the forecast of the US department of Energy (Argonne). This forecast is also defended by the fact that the level of sales per capita in USA is a kind of asymptote. As China would have a level of GNI per capita in 2050 like the current one in USA today, the same level of sales per capita in China would mean 63m vehicles sold in 2050. We are therefore presenting a more reasonable figure of 50m vehicles, meaning an evolution of "only" +2.2 per cent per year.

More obviously, developed countries will certainly have stable sales as seen already since several years at around 50m vehicles.

Here, then, is a prediction of sales according to the above hypothesis:

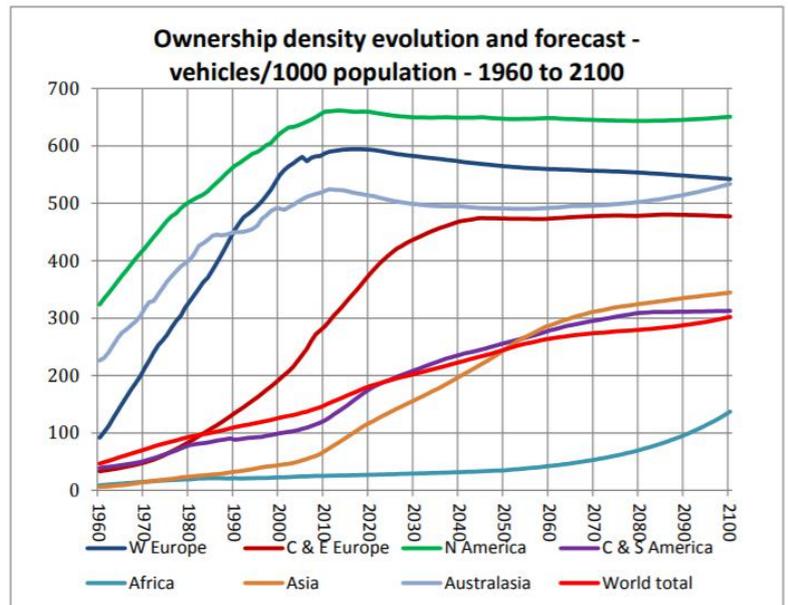
Sales and prediction till 2050	2005	2010	2015	2019	2025	2030	2035	2040	2045	2050	Average Growth 2019-2050
Developed Countries	49.5	41.1	48.5	49.9	50.0	50.2	50.3	50.4	50.6	50.7	0.05%
China	5.8	18.1	24.7	25.8	29.3	33.2	37.7	41.3	45.2	49.5	2.13%
Developing countries	10.6	15.7	16.4	15.6	19.3	24.1	30.1	37.3	45.5	55.7	4.19%
India	1.4	3	3.4	3.8	5.3	7.4	10.3	14.4	19.0	25.1	6.28%
Other development cour	9.2	12.7	13	11.8	14.0	16.7	19.8	22.9	26.5	30.6	3.12%
<b>Total</b>	<b>65.9</b>	<b>74.9</b>	<b>89.6</b>	<b>91.3</b>	<b>98.6</b>	<b>107.5</b>	<b>118.2</b>	<b>129.0</b>	<b>141.3</b>	<b>155.9</b>	<b>1.74%</b>

Chart 9.5.1: sales forecasts to 2050

### Other predictions for vehicle sales, by Pemberton

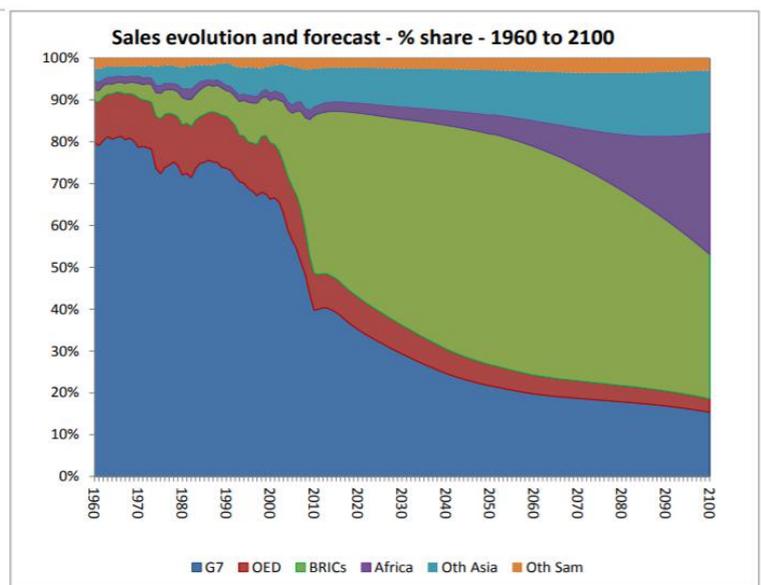
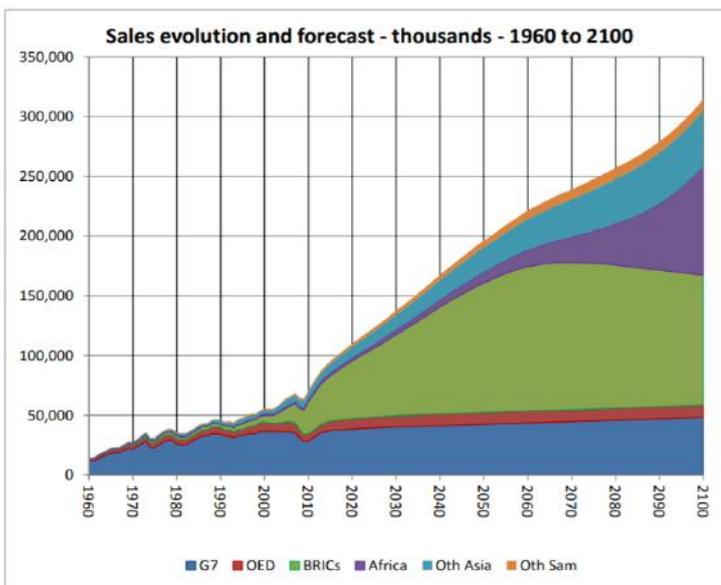
Here we present some other long-term prediction from Pemberton associates, a little bit more optimistic than ours (prediction with a global evolution of +2.55 per cent per year from 2010 to 2050 instead of our +1.7 per cent, and +1 per cent per year from 2050 to 2100).

We can see the same trends with the growing importance of developing countries, Africa really accelerating its development in the second part of the century.



### Prediction of vehicle density (Pemberton)

#### Sales forecast



## Annex 9.6: Examples countries for road safety statistics

### Brazil:

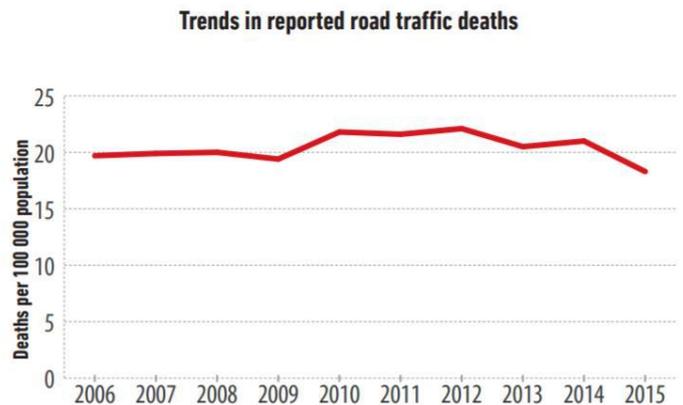
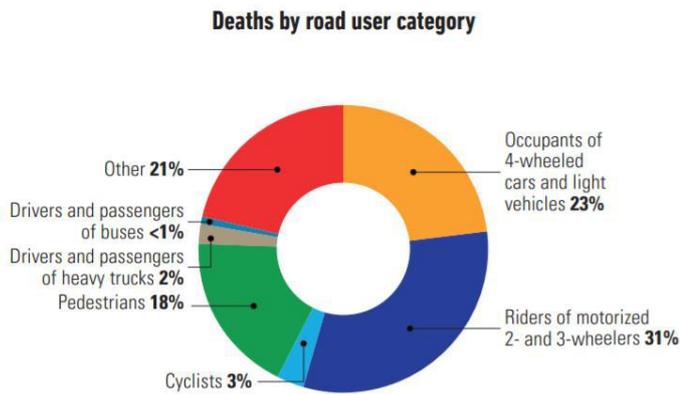
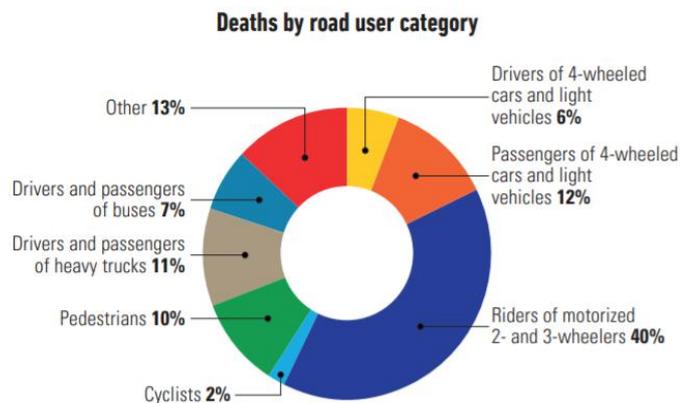


Chart 9.6.1: Road deaths in Brazil

### India:

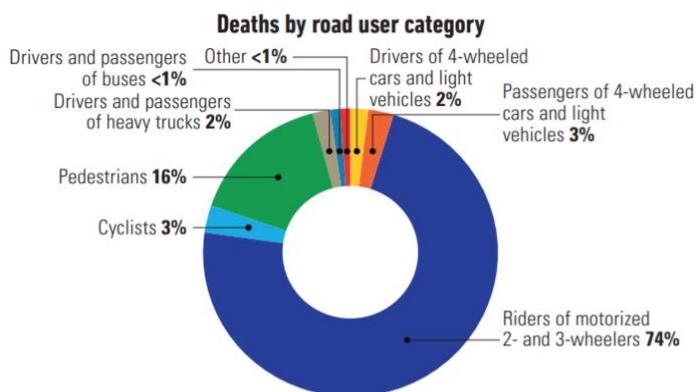


Source: Ministry of Road Transport and Highways, Road Accidents in India 2016

Source: Ministry of Road Transport and Highways, Road Accidents in India 2016

Chart 9.6.2: Road deaths in India

### Indonesia:

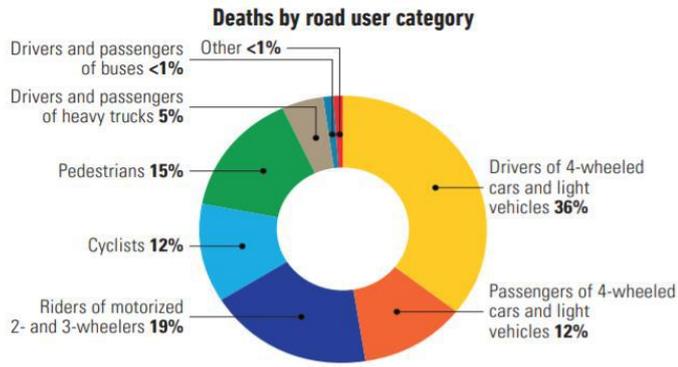


Source: 2016, Indonesia National Police

Source: IRSMS Korlantas Polri

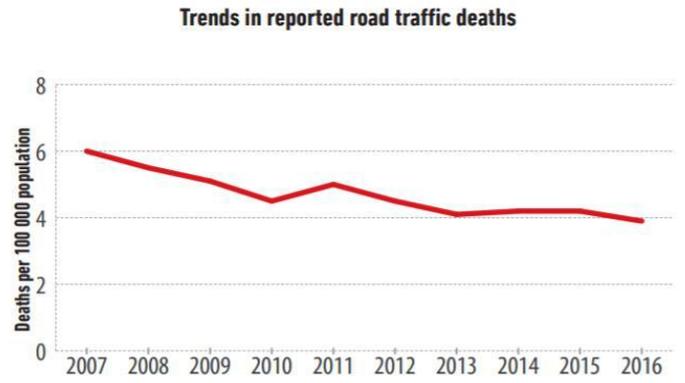
Chart 9.6.3: Road deaths in Indonesia

## Germany (developed-country comparative reference)



Source: 2016, Federal Statistical Office

**Chart 9.6.4: Road deaths in Germany**



Source: Federal Statistical Office

# List of DVN Gold & Platinum Members

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Aston Martin, UK  
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Bentley, UK  
BMW, Germany  
Daimler, Germany  
FCA, USA  
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Geely, Germany  
GM, USA  
Honda, Japan, USA  
Hyundai Motor, Korea  
Jaguar-Land Rover, UK  
Mitsubishi Motors, Japan  
Nio, China  
Nissan, Japan, Europe  
Opel, Germany  
Porsche, Germany  
PSA, France  
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Seat, Spain  
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Preh, Germany  
Recticel, Germany  
Sensata, UK, France  
Texas Instruments, USA  
Valeo, France, Spain,  
China  
ZKW, Austria

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Farba, Turkey  
Flex-N-Gate, USA  
Grakon, USA,  
Grote, USA  
Hascovision, China  
Hella, Germany  
Ichikoh, Japan  
J.W. Speaker, USA  
Koito, Japan, Europe  
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Mobis, Korea  
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Dominant Opto Tech., Malaysia  
Everlight Electronic, Taiwan  
Excellence Opto Inc., Taiwan  
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Nichia, Japan  
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Samsung Electronics, Korea  
Seoul Semiconductor, Korea  
Sora Laser Diode, USA  
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Mr Shunxing Wang, China

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Enmech-Mektec, Germany  
GXC Coatings, Germany  
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Keboda, China  
Less, Switzerland  
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Luminus, USA  
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ON Semiconductor, Europe, Asia  
Optoflux, Germany  
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Red Spot, USA  
Sabic, USA  
Sapphire, USA  
Sea Link International, USA  
SUSS MicroOptics, Switzerland  
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Texas Instruments, USA  
TQ Technology, Taiwan  
Weidplas CH, Switzerland  
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Tier-2 & -3 in Vehicle Lighting  
ZKW company profile  
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Interior Lighting  
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IAA Auto Show 2015  
ISAL 2015  
Peterson Manufacturing  
NAIAS Auto Show  
Delhi Auto Expo 2016

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Geneva Auto Show 2016  
Vision of lighting 2025-2030  
DVN Tokyo workshop  
Automotive lighting Regulations worldwide  
New ADB technologies  
Mondial Paris Auto Show  
VISION Congress Vehicle  
Lighting in USA  
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